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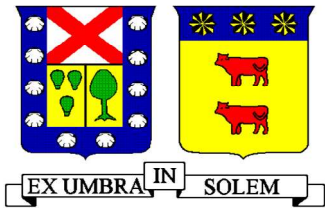
2018

INFLUENCIA DE LAS UNIONES PARCIALMENTE RESTRINGIDAS EN EL DISEÑO DE EDIFICIOS DE ACERO

ZAPATA NEIRA, CECILIA ANDREA

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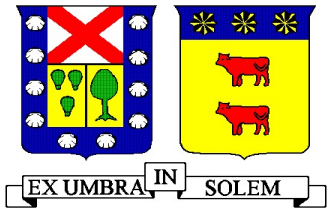
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Memoria de titulación presentado por
Cecilia Andrea Zapata Neira

Como requisito parcial para optar al título de
INGENIERO CIVIL

Profesor Guía
Carlos Aguirre Ahumada

mayo de 2018



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INFLUENCIA DE LAS UNIONES PARCIALMENTE RESTRINGIDAS EN EL DISEÑO DE EDIFICIOS DE ACERO

RESUMEN EJECUTIVO

Se presenta un análisis de la influencia de las uniones parcialmente restringidas en las estructuras metálicas. Se desarrolla en primera instancia, un estudio y categorización de ensayos de uniones, clasificándolas de acuerdo a los patrones de carga y a los diagramas momento-curvatura de cada una.

Se realiza diseño tradicional de edificios de 4, 8 y 12 pisos; para luego realizar el análisis de las mismas estructuras incluyendo el efecto de las uniones. Con estos análisis se hace comparación de esfuerzos, deformaciones y pesos de cada estructura, considerando lo requerido por la normativa chilena.

INFLUENCIA DE LAS UNIONES PARCIALMENTE RESTRINGIDAS EN EL DISEÑO DE EDIFICIOS DE ACERO

AUTOR:

Cecilia Andrea Zapata Neira

Memoria de titulación presentada como requisito para optar al título de INGENIERO CIVIL

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Valparaíso, mayo de 2018.

INFLUENCIA DE LAS UNIONES PARCIALMENTE RESTRINGIDAS EN EL DISEÑO DE EDIFICIOS DE ACERO

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1 INTRODUCCIÓN

El comportamiento sísmico de una estructura depende de muchos factores, entre ellos, el tipo de elemento estructural que la conforman (vigas, muros, columnas), dimensiones de estos elementos, material utilizado, etc. Además de propiedades no inherentes como zona sísmica en la cual se encuentra emplazada y tipo de suelo de fundación.

El objetivo de los códigos actuales ha sido proveer de estándares mínimos para asegurar el buen comportamiento de las estructuras ante eventos sísmicos de distinta magnitud. Para tal efecto el Comité de Sismología de la Asociación de Ingenieros Estructurales de California publica en 1990 'Recommended Lateral Force Requirements and Commentary' [Structural Engineers Asociation CA.] con recomendaciones que 'intentan proveer la mínima resistencia requerida a un movimiento sísmico' especificando que las estructuras debieran:

- 'Resistir un sismo menor sin daño'
- 'Resistir un sismo moderado sin daño estructural, pero posiblemente experimentar cierto grado de daño no estructural'
- 'Resistir un sismo de mayor nivel teniendo una intensidad igual a ya sea el más fuerte experimentado o pronosticado, sin colapsar, pero posiblemente con algún daño estructural así como también no estructural'

Para tal efecto, los códigos de los distintos países han ido evolucionando incluyendo, en la medida de sus posibilidades, los últimos conocimientos con respecto al comportamiento de las estructuras, zonificaciones sísmicas y clasificaciones de suelo, como es posible apreciarlo en las Normas Chilenas NCh 433 Mod.2009 [INN Chile] y NCh 2369 of.2003 [INN Chile], además, de incluir en ellas toda la experiencia obtenida a lo largo de las propias historias sísmicas.

A pesar de todos estos esfuerzos para lograr diseños cada vez más seguros y eficientes, se ha podido apreciar en los últimos años, que el nivel de daño sufrido por muchas estructuras, sin llegar al colapso, se ha convertido en un problema económico de grandes proporciones. Es así como en el terremoto de Northridge del 17 de enero de 1994, los costos de los daños se estimaron entre US$20 a US$40 billones. La explicación de tal situación ha sido motivo de numerosos estudios, entre ellos, una serie de ensayos e investigaciones relacionados con el estudio del comportamiento de las uniones utilizadas en estructuras de acero.

Las uniones en acero han sido generalmente consideradas un elemento ajeno a la modelación de las estructuras, no considerando la gran influencia que éstas tienen en el comportamiento sísmico donde se encuentran. Un supuesto básico del análisis de estructuras, específicamente en sus modelaciones, es que las conexiones presentan la completa o nula transferencia de momento en la conexión, aun cuando toda conexión es

capaz de tomar momento o de permitir un giro. Desde el punto de vista sísmico, el comportamiento de éstas puede verse seriamente alterado según el tipo de unión que se escoja, ya que la rigidez real implica que la estructura tiene un periodo natural diferente al que se obtiene con las hipótesis antes mencionadas, cambiando la zona del espectro en la que trabaja y por ende las fuerzas con las cuales debe diseñarse tal estructura y las deformaciones que esta presenta.

Con la evolución de los programas de cálculo estructural, en este momento es posible realizar aproximaciones cada vez más precisas de las uniones de elementos estructurales, sin embargo es válido preguntarse si es necesario incluir de manera más detallada el comportamiento de la unión, es decir si el gasto de tiempo computacional es poco significante en comparación con la exactitud de resultados que pueda conseguirse al aplicar un modelo más detallado. Para este punto, más que tener un problema de modelación computacional, lo importante es conocer las relaciones constitutivas de la unión.

Por tal motivo, el presente trabajo analizará de manera cualitativa y cuantitativa la influencia de las uniones viga columna en distintas estructuras, comparando los resultados de las modelaciones al incluir el comportamiento de la unión en el modelo y sin la inclusión de ésta.

Esta modelación se realizará utilizando una curva momento-curvatura simplificada de cada unión. Esta curva simplificada se obtiene de las propiedades geométricas y mecánicas de las vigas a conectar, y de acuerdo a parámetros para la caracterización de cada tipo de unión (momento, corte o intermedia).

Para poder desarrollar las curvas de las uniones, se ha considerado los resultados provenientes del ‘Data Base of Steel Beam-to-Column Connections’ [SAC Steel Org.] el cual consta con un total de 396 ensayos de uniones desde el año 1936 (J.C.Rathbun) hasta 1996 (L.F.L.Ribeiro &R.M. Gonçalves).

1.1 Objetivos Generales

- Realizar la clasificación de uniones viga-columna según su comportamiento.
- Realizar una recopilación de resultados de ensayos de uniones.
- Analizar la influencia de las características de las uniones en el diseño de una estructura.

1.2 Objetivos Específicos

- Comparar el diseño tradicional de las estructuras con el diseño incluyendo el comportamiento de las uniones.
- Revisar los parámetros de diseño fundamentales de las estructuras una vez se incorpora el efecto de las uniones.
- Determinar las diferencias en las estructuras al ser diseñadas con y sin efecto de las uniones, según lo solicitado por la normativa chilena actual.
- Determinar las diferencias en peso de las estructuras al ser diseñadas con y sin efecto de las uniones.

2 ANTECEDENTES GENERALES DE UNIONES EN ACERO

Una unión es un grupo de elementos destinados a conectar dos o más elementos estructurales con el fin de dar continuidad y resistencia adecuada a una estructura.

Las conexiones pueden clasificarse según la forma de transmisión de las solicitaciones. De esta forma se tienen uniones a cizalle, a tracción o una combinación de ambas. A su vez éstas pueden ser centradas o excéntricas según la posición de la resultante de fuerzas actuando en ellas con respecto a la posición de los conectores o soldadura.

Sin embargo, dentro de las clasificaciones más conocidas están las referentes al tipo de solicitación para las cuales están ideadas, es decir uniones de tensión, compresión, corte o momento. Se debe tener en cuenta que al hablar de unión a corte o momento, se hace difícil encontrar en la vida real uniones que resistan exclusivamente sólo una de estas solicitaciones, sino que siempre se encuentran presentes la dos, ya sea en mayor o menor medida.

La clasificación más afín con el presente trabajo es la establecida por el AISC [Manual of Steel Construction 14th] según el comportamiento momento-curvatura de las conexiones, en la cual se distinguen tres grupos: uniones totalmente restringidas (FR tipo1) y las uniones parcialmente restringidas (PR tipo 2 y 3).

La clasificación de uniones según patrón de carga se refiere a la diferenciación dependiendo del tipo de solicitaciones a las que se supone estará sometida la unión, o en otras palabras, del modo en el que se espera se comporte ésta.

Dentro de esta clasificación es posible encontrar: Tensión / Compresión, Corte y Momento, siendo estas dos últimas las más relevantes para el estudio que acá se presenta, por lo cual se dará relevancia a la explicación de éstas.

2.1 Uniones en Tensión / Compresión

Dentro de esta clasificación se encuentran uniones diseñadas para resistir cargas axiales, como las uniones del tipo 'cargadas directamente', Hanger (tipo percha), Bracing y placas base, como se muestra en la figura 2.1, donde se se ven dos vigas conectadas por pernos, donde una de ellas se encuentra 'colgada' de la otra.

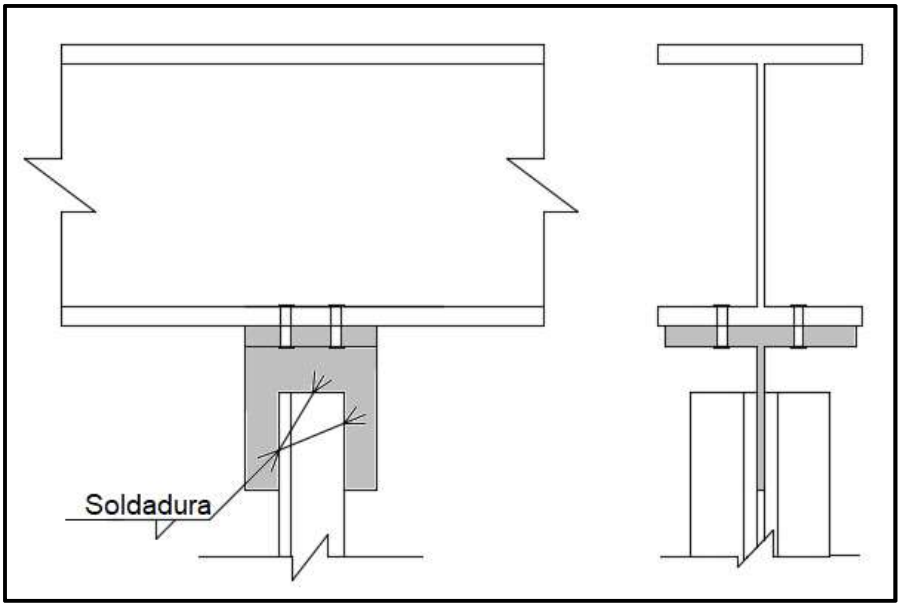


Figura 2.1 Esquema unión Hanger (tipo percha)

2.2 Uniones a Corte

Al hablar de uniones a corte y de uniones a momento, se asume el diseño de cada una de ellas de forma idealizada. De esta forma, la unión resistente a corte se diseña considerando que su misión es resistir las cargas gravitacionales de la estructura y por lo tanto su capacidad de momento es despreciable y su capacidad de rotación es ilimitada. Estas características son representadas a través de rotulas.

Es común que las uniones de corte sean uniones principalmente apernadas o con poco uso de soldadura, dada la alta capacidad de rotación que ofrece este tipo de conexión, considerando en general un número pequeño de conectores.

La unión a corte básica es posible representarla a través de un solo conector, el cual podrá transmitir idealmente sólo cargas gravitacionales y presentar una capacidad de rotación ilimitada. Sin embargo, por consideraciones estructurales de resistencia y seguridad, las uniones básicas a corte se han restringido a un mínimo de dos conectores por unión.

Esta regla básica del diseño práctico de uniones en acero, ya implica una cierta rigidez de la unión, la cual eventualmente aumentará con el número de conectores que compongan la unión y de la disposición que estos tengan.

Sin embargo, de forma global, se acepta como uniones a corte a las siguientes configuraciones:

2.2.1 Angulo Simple

Consta de un ángulo que puede estar soldado o apernado a los elementos a unir. Esta unión posee pocas partes y facilita la construcción, sin embargo, se requieren ángulos de mayor tamaño y pernos de mayor diámetro o mayor cantidad de soldadura. En la figura 2.2 se muestra una unión viga-columna compuesta de un ángulo apernado a la viga y soldado a la columna, y en la figura 2.3 se muestra una unión viga columna apernada a ambos elementos.

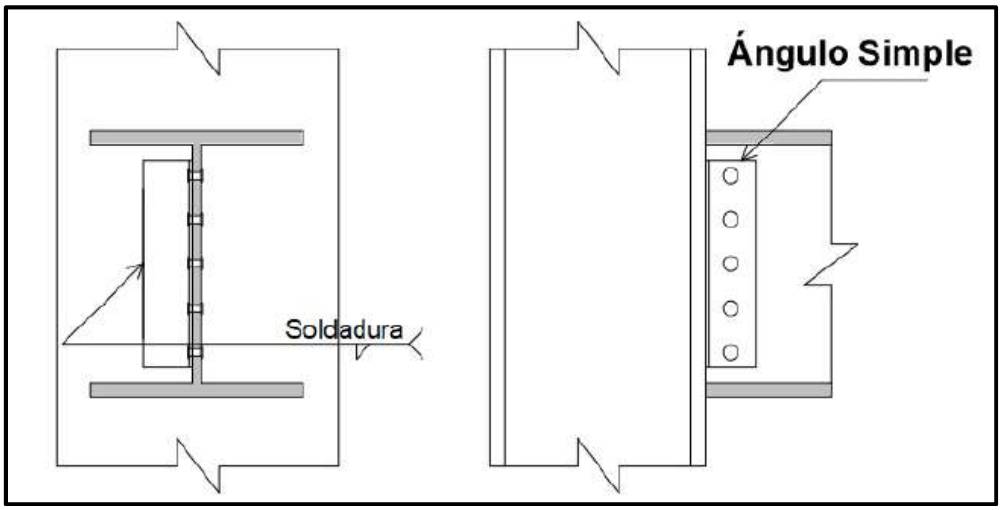


Figura 2.2 Esquema unión de corte apernada al alma de la viga soldada a la columna

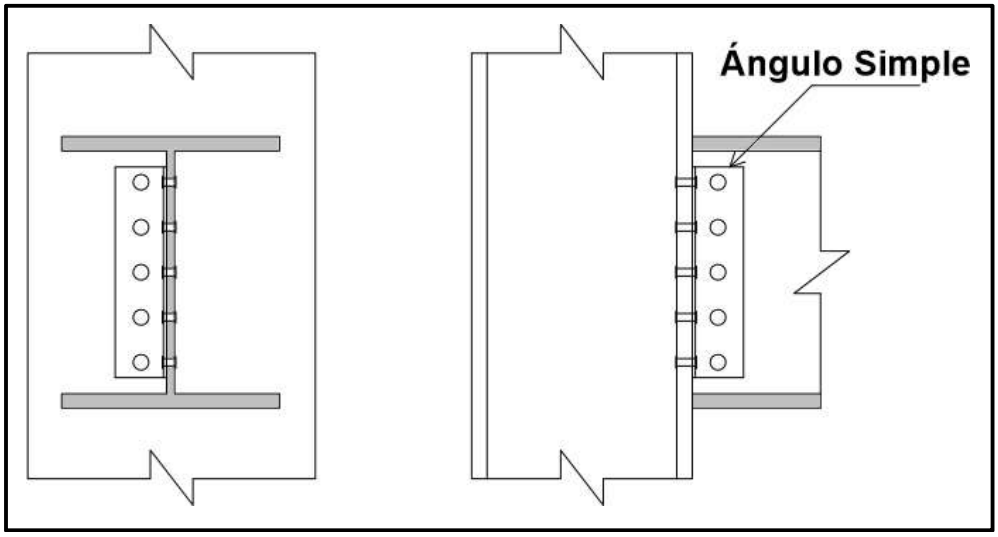


Figura 2.3 Esquema unión de corte apernada al alma de la viga y a la columna

2.2.2 Doble Ángulo

Consta de dos ángulos que pueden soldarse o apernarse al alma o ala de los elementos a unir (viga-columna). Esta unión presenta las ventajas de que puede ser de tipo apernada o soldada y que las dimensiones de las vigas pueden ser variables. Sin embargo, cuando se tienen conexiones a ambos lados del alma de una columna se pueden producir problemas en la construcción. La figura 2.4 muestra una conexión viga columna donde los ángulos se encuentran apernados al alma de la viga y soldados a la columna. La figura 2.5 muestra una unión viga columna donde los ángulos se encuentran apernados a ambos elementos.

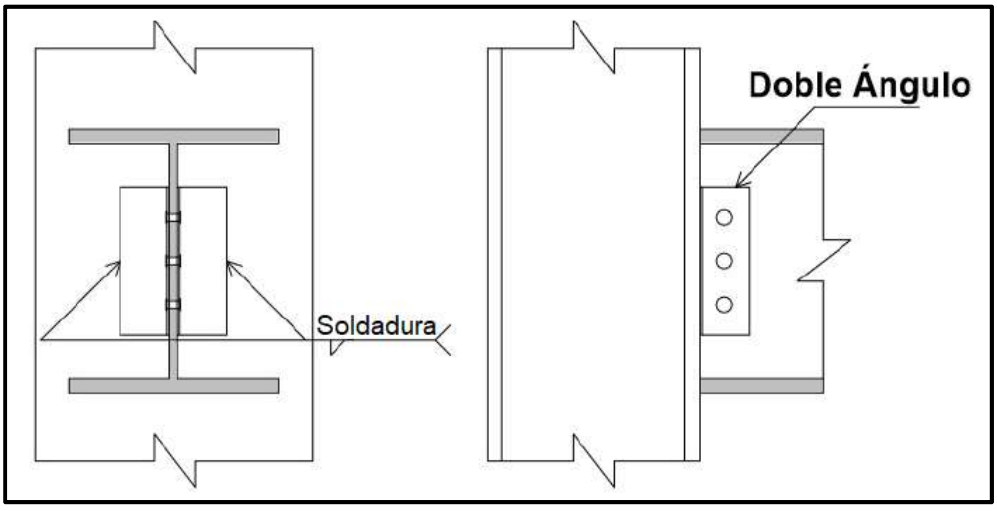


Figura 2.4 Esquema unión doble ángulo apernado al alma de la viga, soldada a la columna

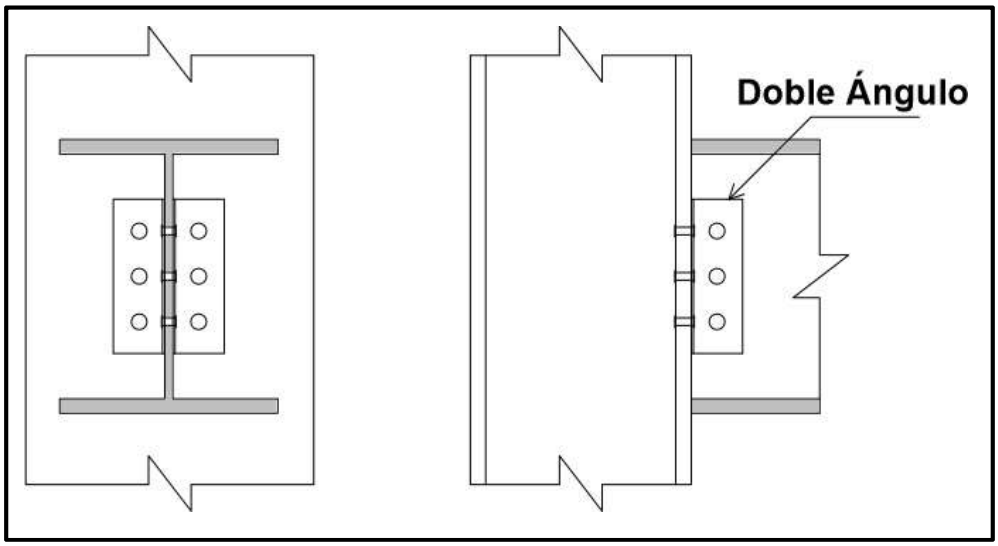


Figura 2.5 Esquema unión doble ángulo apernado al alma de la viga y a la columna

2.2.3 Placa Final de Corte

Consiste en una placa que es soldada perpendicularmente al alma de la viga y se conecta con pernos al alma o ala de la viga o columna. Es una unión simple, de pocos elementos y evita los agujeros en el alma de la viga, y se muestra en la figura 2.6.

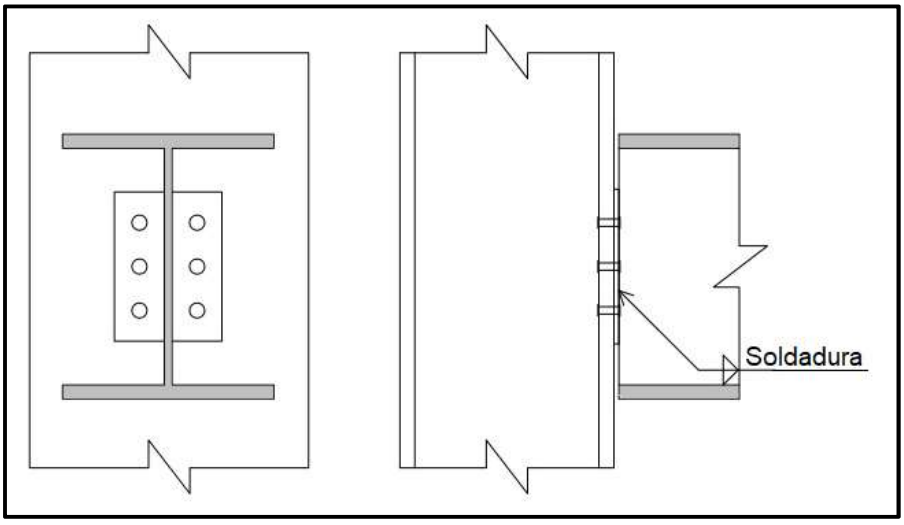


Figura 2.6 Esquema unión placa final de corte

2.2.4 Placa de corte (Shear Tab)

Consiste en una placa apernada al alma de la viga y soldada al otro elemento. Es una unión simple de pocos elementos que no requiere soldadura en la viga, sin embargo se requiere de un diseño cuidadoso. Además se considera una unión más rígida que otras de su tipo. La figura 2.7 muestra una unión placa de corte.

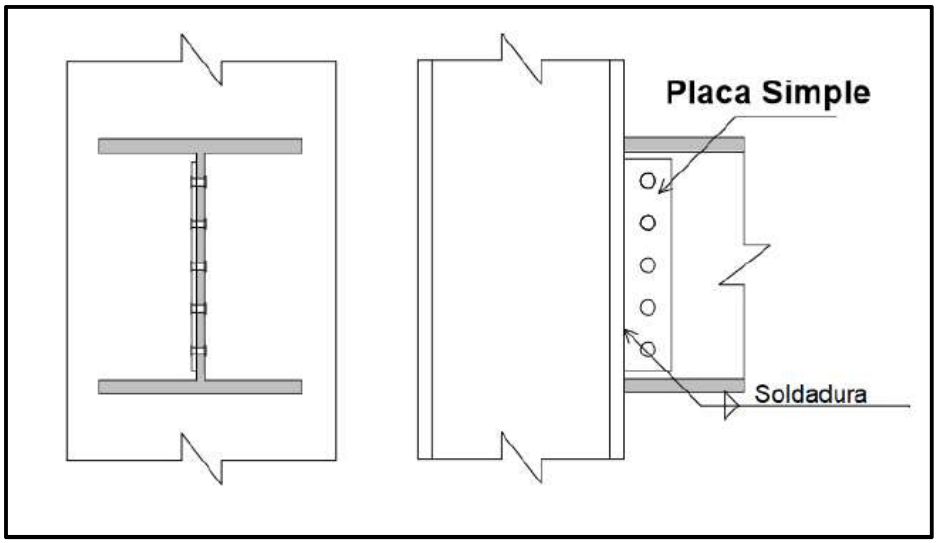


Figura 2.7 Esquema unión placa simple o shear tab

2.2.5 Unión en T

Esta unión consiste en un perfil de acero en forma de T que se emperna al alma de la viga y se suelda a la columna. Esta unión puede ser bastante pesada y en un principio se utilizaba para conectar columnas a muros de hormigón o a construcciones existentes. Para el caso de anclaje a muro de hormigón se requiere de una placa inserta donde soldar la T. En la figura 2.8 se muestra un esquema de una unión en T, donde se aprecia un inserto de acero en un muro de hormigón, y una placa T apernada al alma de la viga y soldada al inserto.

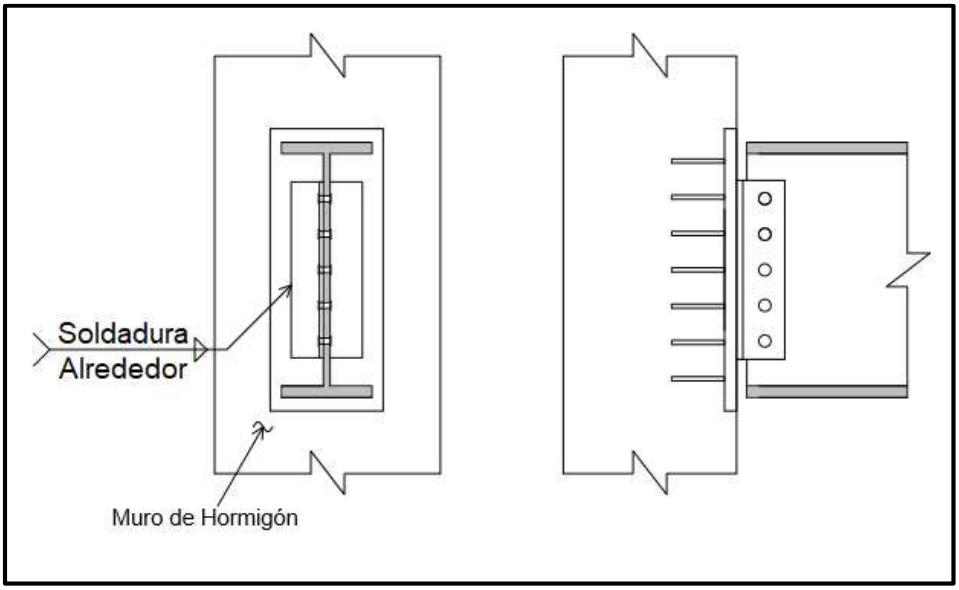


Figura 2.8 Esquema unión en T a muro de hormigón

2.3 Uniones a momento

Las uniones a momento tienen por objetivo darle la resistencia lateral necesaria a una estructura para resistir las cargas que impondrá el sismo de diseño. Estas uniones se idealizan como empotramientos perfectos, con nula capacidad de rotación.

Las uniones de momento son las uniones sísmicas por excelencia. Sin embargo, al utilizarlas se incurre en algunos vicios dada su idealización extrema, lo cual puede llevar a hacer consideraciones de deformaciones globales de la estructura muy optimistas. Si se considera que la limitación de deformaciones en el diseño sísmico es un punto fundamental, el hecho de considerar las uniones como completamente rígidas puede volverse una desventaja.

La representación que se hace de esta unión es claramente ilusoria, ya que aunque se diseñe considerando una rigidez infinita, los materiales y las partes componentes de las uniones siempre presentarán un grado de flexibilidad.

Lo usual es que este tipo de uniones sean soldadas o cuenten con un número elevado de conectores mecánicos, así como también rigidizadores que permitan mantener la geometría de la unión, procurando deformaciones mínimas y transferencias de carga acorde a una unión de momento.

Dentro de las uniones consideradas como ‘de momento’, es posible encontrar las siguientes:

2.3.1 Unión Alas Soldadas / Alma Apernada

En esta unión las alas de la viga se sueldan a la columna, además, al alma de la viga se emperna una placa que va soldada a la columna. La unión requiere cuidado en la ejecución para que las partes concuerden en el montaje. Para esta unión no es recomendable la soldadura de penetración parcial y el filete deberá ser capaz de desarrollar la capacidad a tensión del ala de la viga. La figura 2.9 muestra una unión donde se encuentra apernada un placa al alma de la viga y soldada a la columna, además de las alas de la viga soldadas en terreno a la columna.

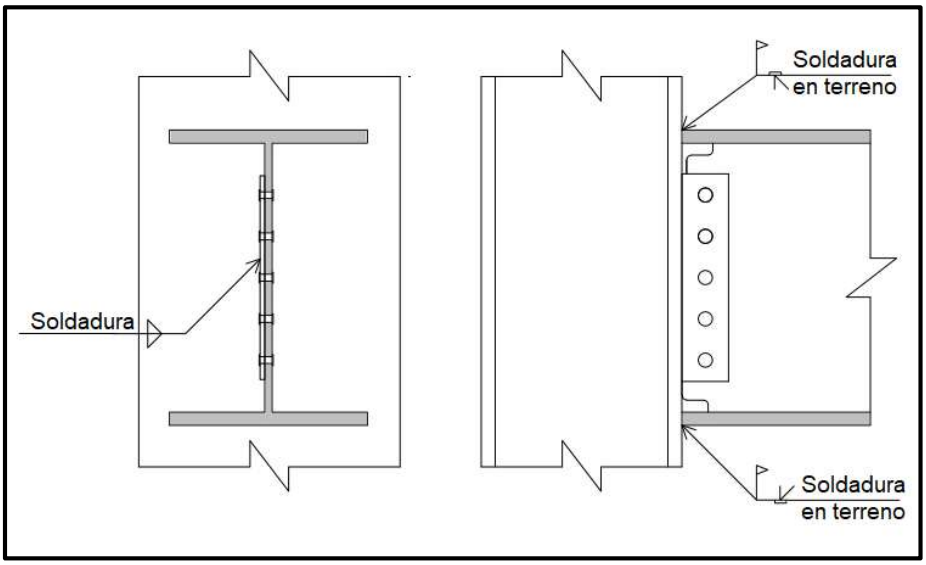


Figura 2.9 Esquema unión alas soldadas alma apernada

2.3.2 Unión Placa Soldada a las Alas / Alma Apernada

Esta unión consiste en dos placas soldadas a las alas de la viga y a la columna, además de una placa apernada al alma de la viga y soldada a la columna. La placa soldada al ala superior debe ser de un ancho menor que ésta, y la placa soldada al alma inferior debe ser de un tamaño mayor, como se muestra en la figura 2.10.

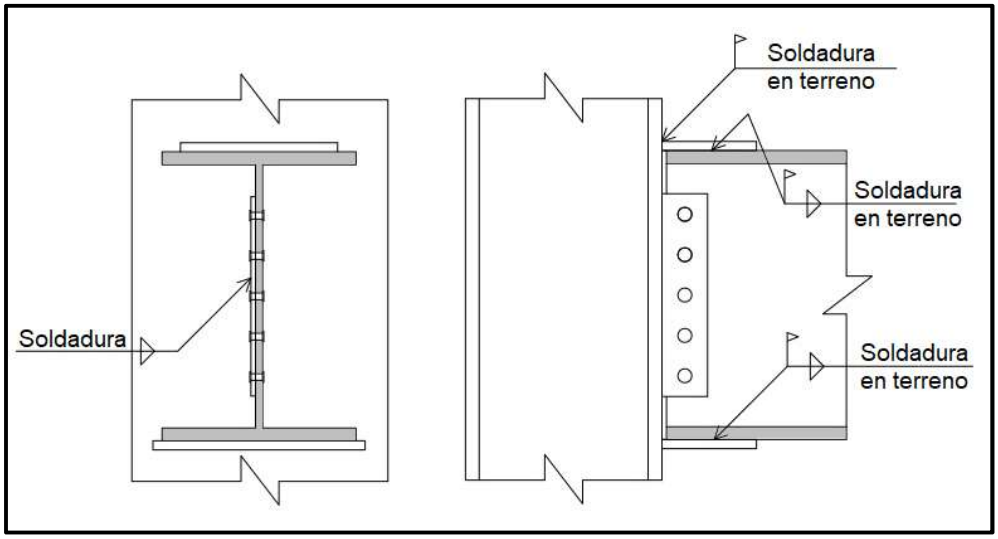


Figura 2.10 Esquema unión placas soldadas a alas y alma apernada

2.3.3 Unión Placa Apernada a las Alas / Alma Apernada

Esta unión consiste en dos placas apernadas a las alas de la viga y a la columna, además de una placa apernada al alma de la viga y soldada a la columna. En este caso las placas no requieren ser de un tamaño menor a las alas de la viga, pero deben detallarse cuidadosamente dado el alto número de conectores que la conforman. La figura 2.11 muestra una unión con los elementos conectores soldados a la columna y apernados a la viga.

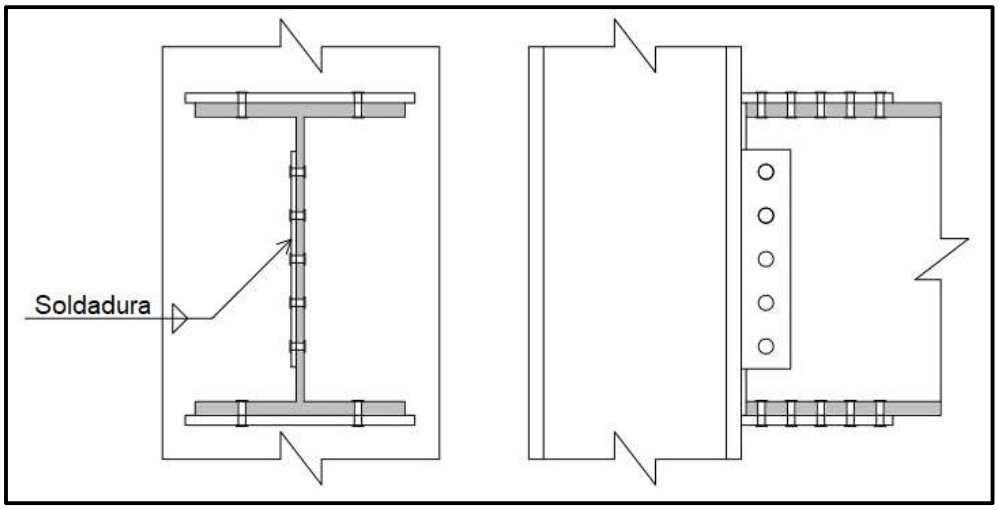


Figura 2.11. Esquema unión placas apernadas a alas y alma

2.3.4 Tee-Stub

Esta unión fue muy utilizada en los años 30 en EE.UU. Es una unión que posee una alta rigidez y un gran número de conectores. Consiste en dos perfiles de sección T que se empernan a las alas de la viga y al ala de columna que se está conectando, y además posee una placa soldada a la columna que se emperna al alma de la viga. La figura 2.12 muestra la unión viga columna citada, y la figura 2.13 muestra la T que se utiliza en este tipo de uniones.

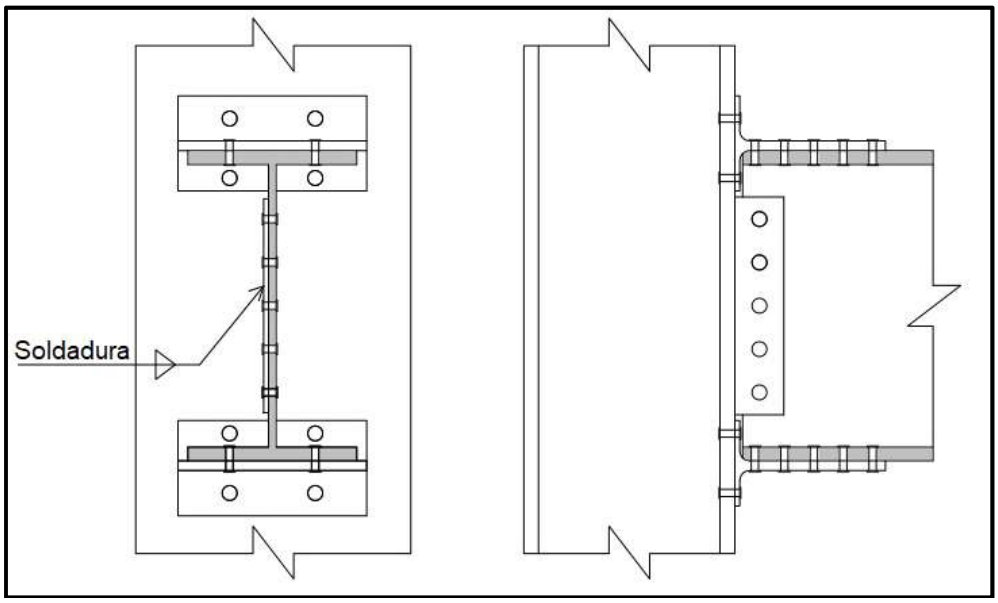


Figura 2.12. Esquema unión Tee Stub

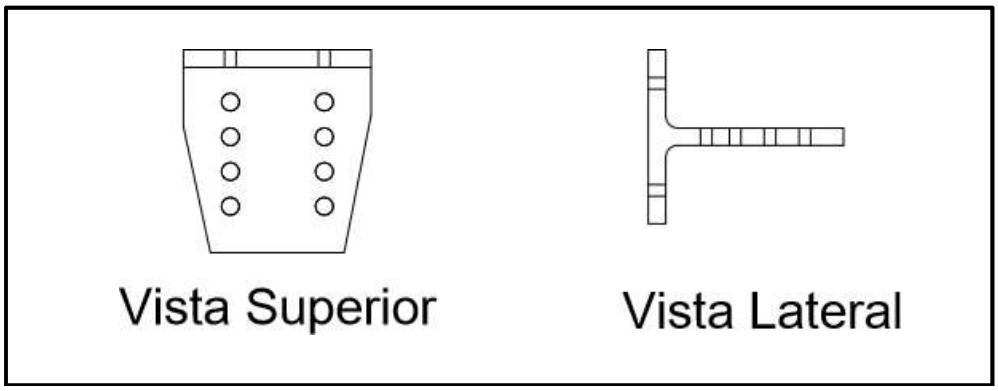


Figura 2.13. Esquema componentes unión Tee Stub

2.3.5 Placa Final de Momento

Esta unión consiste en una placa soldada en forma perpendicular a la viga y apernada a la columna. La placa puede tener dimensiones mayores a las de la viga a conectar, se les llama placa final de momento extendidas, y puede ser atiesada o no. La figura 2.14 muestra una unión placa final de momento sin atiesar, y la figura 2.15 muestra el mismo tipo de unión pero con un atiesador superior.

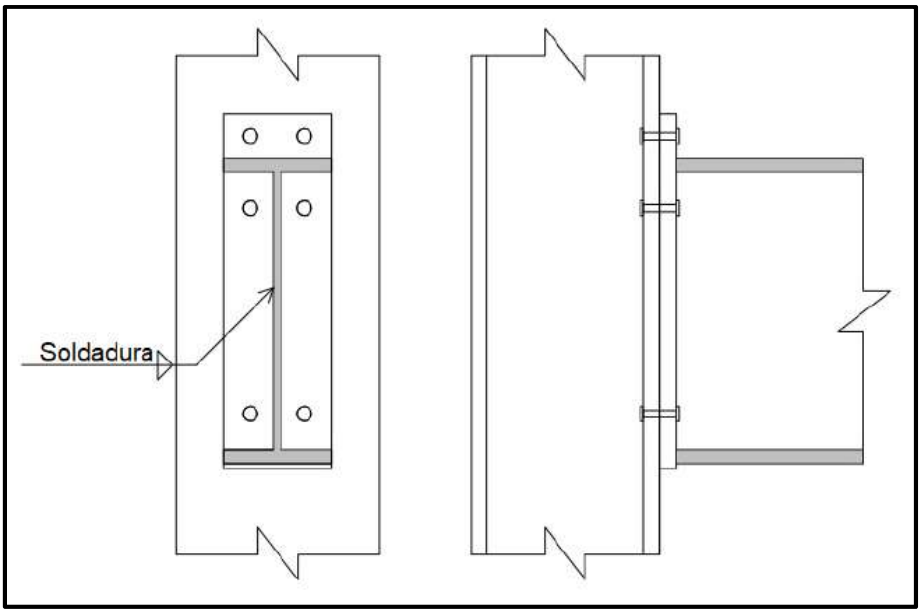


Figura 2.14. Esquema unión Placa Final de Momento

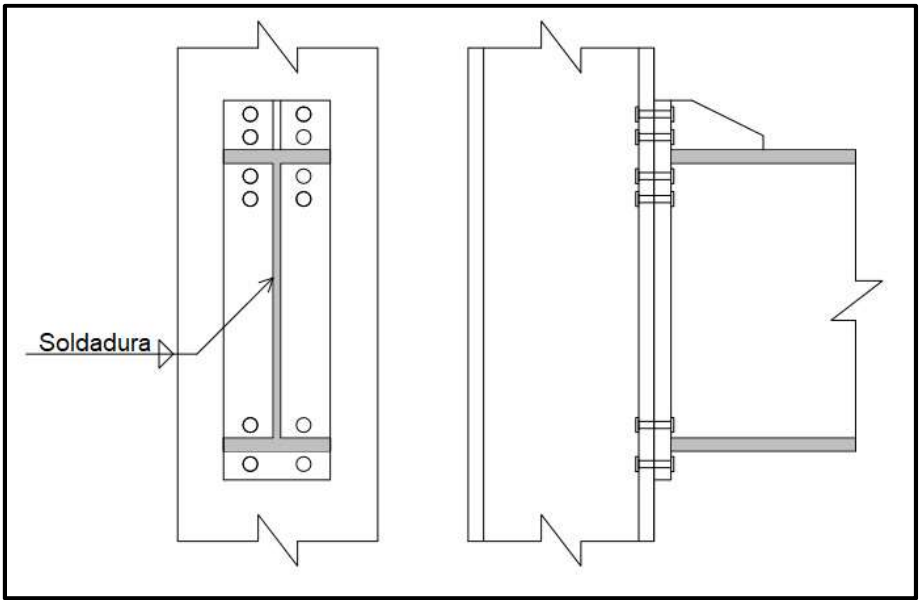


Figura 2.15. Esquema unión Placa Final de Momento Extendida

3 CLASIFICACIÓN DE UNIONES SEGÚN DIAGRAMA MOMENTO-CURVATURA

Una de las clasificaciones de uniones utilizadas pretende asociar el tipo de unión con el comportamiento de ésta, más allá de si la unión es considerada como unión de corte o de momento, es decir, clasificarla según la capacidad de resistir momento y la capacidad de rotación que puede desarrollar. En las nuevas consideraciones de diseño del LRFD Load and Resistance Factor Design [Manual of Steel Construction] (Diseño por Factores de Carga y Resistencia) existen dos categorías principales para las conexiones: las uniones FR (Fully Restrained: totalmente restringidas) que tienen características similares a las del Tipo 1 indicadas en el diseño ASD Allowable Stress Design (Diseño por Tensiones Admisibles), y las uniones PR (Partially Restrained: parcialmente restringidas), las que corresponderían al Tipo 2 y Tipo 3 del ASD.

Numerosos resultados experimentales muestran que en un mismo tipo de unión se pueden encontrar conexiones con la misma capacidad de rotación. Sin embargo las capacidades de resistir momento difieren enormemente.

Es claro pensar entonces que una estructura se comportará de modo distinto dependiendo del tipo unión con que se diseñe. El problema es que el comportamiento de la unión no suele incluirse dentro del modelo estructural, con lo que, a pesar del uso de programas de diseño cada vez más sofisticados, los resultados siguen siendo poco exactos, ya no por un problema de cálculo, si no porque conceptualmente el modelo es incompleto.

La clasificación de las uniones según momento-curvatura asocia principalmente ciertas propiedades geométricas de la viga a conectar. Una de las clasificaciones más utilizadas es la propuesta por Bjorhovde-Colson-Brozzetti [Clasification System Beam to collumn Connection]. Gráficamente esta clasificación consiste en la división en tres regiones de un diagrama momento-curvatura, como se muestra esquemáticamente en la figura 4.1, las uniones FR tipo 1 se encuentran en un rango donde resisten mayores momentos con menores curvaturas, las uniones PR tipo 2 resisten menor momento y con mayor curvatura, y entre ambas se encuentran las uniones PR tipo 3.

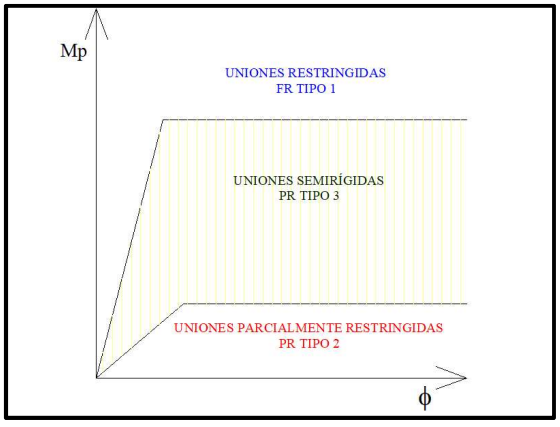


Figura 3.1. Clasificación momento-curvatura

Los puntos singulares de estas curvas dependen de parámetros como el momento plástico de la viga y las propiedades geométricas equivalentes de la unión en comparación con las propiedades de la viga a conectar.

El método utilizado en este trabajo para determinar la capacidad de rotación de una unión se basa en la longitud equivalente de la unión, y se han adoptado los valores propuestos por Kishi y Chen (1986) [Date Base of Steel to Column Connection]. Esta clasificación asocia de forma inversa la rigidez de la unión con la longitud equivalente de ésta, expresada como múltiplo de la profundidad de la viga conectada. En la tabla 3.1 se presenta los valores adoptados, considerado que 'd' corresponde a la profundidad de la viga a conectar.

Tabla 3.1 Longitudes equivalentes para distintas uniones

	Rígida	Semirígida		Flexible	
Descripción	Placa Final Extendida	Placa Final	Ángulo sup e inf. y áng. en el alma	Placa de Cabecera	Doble Ángulo
Longitud equivalente	$d<l_e<2d$	$2d<l_e<5d$	$4d<l_e<7d$	≈10d	≈15d
Momento último	≈0.9Mp	≈0.6Mp	0.45 – 0.6 Mp	≈0.2 Mp	≈0.15 Mp

De esta forma es posible determinar la rotación de la unión según la rigidez inicial

$C_c = \frac{EI}{\alpha d}$ y el momento último Mu resistente teórico.

Donde:

E : Módulo de Young

I : Inercia de la viga

D : Profundidad de la viga

α : es el factor de amplificación determinado para cada tipo de unión, que según el estudio de Kishi y Chen puede considerarse en los siguientes rangos:

$1 < \alpha < 2$ para uniones rígidas

$2 < \alpha < 7$ para uniones semirígidas

$\alpha < 10$ para uniones flexibles

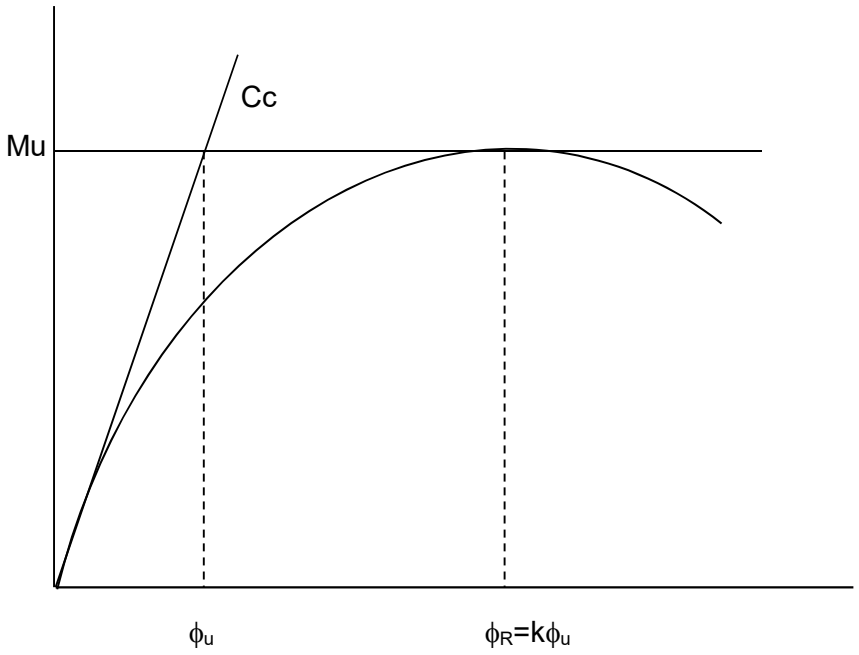


Figura 3.2. Parámetros diagrama momento-curvatura

En este caso ϕ_R representa la capacidad de rotación de la unión y la rotación plástica teórica es:

$$\phi_u = \frac{M_u}{Cc} \qquad \textit{Ecuación 3.1}$$

Reemplazando Cc se obtiene:

$$\phi_u = \frac{M_u \cdot \alpha d}{EI} \qquad \textit{Ecuación 3.2}$$

A continuación se presenta cada tipo de unión y su correspondiente curva.

3.1 Uniones restringidas FR tipo 1

Estas uniones presentan una gran capacidad para resistir momento, sin embargo desarrollan una ductilidad limitada. Estas características son similares a las nombradas en las uniones a momento, sin embargo hay que tener en cuenta que esta clasificación acepta que estas uniones puedan rotar.

De acuerdo a la ecuación 3.2 y a la tabla 3.1 una unión FR tipo 1, presentaría una curva límite, como la siguiente, donde se presentan los puntos característicos:

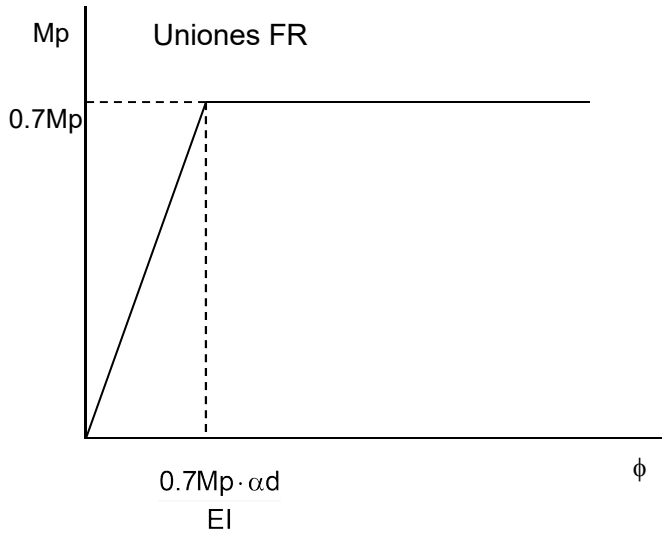


Figura 3.3. Curva Unión Totalmente Restringida

Se considera que la curva límite es la que, valga la redundancia, limita de forma teórica el sector dónde se encontrarían las curvas esperimentales de las uniones, en este caso, para las uniones FR tipo 1, se esperaría que tuvieran curvas experimentales por sobre la línea graficada más arriba.

Como es posible apreciar, cada unión tendrá su propia curva limitante, puesto que el momento plástico y la inercia son propiedades de cada viga a conectar. El parámetro α se considerará igual a 2.

3.2 Uniones parcialmente restringidas PR tipo 2

Estas uniones son fácilmente asociables con las uniones de corte. Su baja capacidad de resistir momento y gran capacidad de rotación hacen que su idealización más cercana corresponda una rótula.

En este caso, la imagen 3.3, muestra la curva que limita en forma superior el área donde se espera encontrar los resultados de ensayos de uniones PR tipo 2.

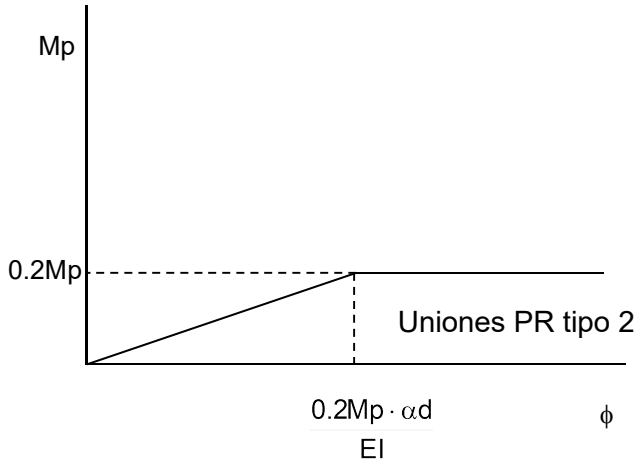


Figura 3.4. Curva Unión Parcialmente Restringida tipo PR2 (Flexible)

Para este caso, el parámetro α se ha considerado igual a 10.

3.3 Uniones parcialmente restringidas PR tipo 3

En esta categoría se encuentra el mayor número de uniones reales. Presentan una capacidad de resistir momento menor a las uniones FR, sin embargo una rotación intermedia entre ésta y la PR tipo 2.

Los límites que restringen esta unión se presentan en la siguiente curva:

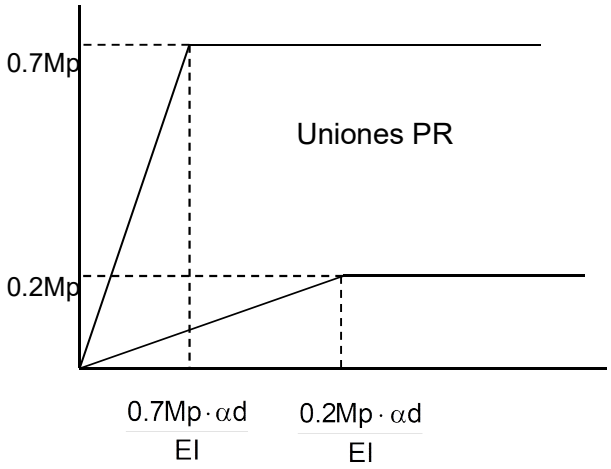


Figura 3.5. Curva Unión Parcialmente Restringida Tipo 3

El parámetro α se ha considerado igual a 2 para el límite asociado al 70% del momento plástico, y 10 para el caso más flexible.

Dado que el rango donde se encuentra este tipo de uniones es intermedio con respecto a lo considerado como unión de momento o de corte, resulta poco claro que éstas puedan idealizarse como uniones rotuladas o totalmente restringidas.

Como se ha mostrado anteriormente, cada unión tiene sus límites claramente establecidos. Sin embargo, es importante reafirmar esta clasificación a través de ejemplos claros que se muestran en el siguiente capítulo, con la información experimental recopilada.

4 RESULTADOS EXPERIMENTALES DE ENSAYOS DE UNIONES

Como se ha mostrado anteriormente, cada unión tiene parámetros límites claramente establecidos que la catalogan en algún tipo de unión, ya sea FR, PR2 o PR3. Sin embargo, es importante reafirmar esta clasificación a través de ejemplos claros.

Para tal efecto se cuenta con un conjunto de 396 ensayos de uniones [SAC Steel Org.], que se han divido en 17 grupos de acuerdo al tipo de unión:

- Unión de ángulo simple viga apernada / columna apernada
- Unión de ángulo simple viga apernada / columna soldada
- Unión con ángulo superior e inferior apernado
- Unión con ángulo superior en inferior remachado
- Unión doble ángulo con asiento superior e inferior todo apernado
- Unión doble ángulo con asiento superior e inferior todo remachado
- Unión doble ángulo viga soldada / columna apernada
- Unión doble ángulo viga apernada / columna apernada
- Unión doble ángulo viga remachada / columna remachada
- Unión doble ángulo viga remachada / columna apernada
- Unión doble ángulo viga soldada / columna apernada
- Unión placa de cabecera apernada con atiesador
- Unión placa de cabecera apernada
- Unión placa extendida apernada
- Unión placa extendida apernada con atiesador
- Unión placa rígida apernada con atiesador
- Unión placa rígida apernada

En este trabajo se analizarán sólo algunas uniones, aquellas que son de uso más común y que poseen más información en la base de datos, y de estas uniones se considerarán las curvas más relevantes para este estudio

La totalidad de la curvas momento-curvatura de cada unión se presenta en forma detallada en el Anexo 1.

Los materiales utilizados en los ensayos corresponden a los siguientes:

Tabla 4.1 Propiedades de calidades de acero utilizados en los ensayos [SAC Steel Org.]

Tipo de Acero	Ff	E
	kg/m^2	kN/m^2
A36	25344000	200076800
G40.21	28160000	200076800
A441	35200000	200076800

4.1 Uniones de ángulo simple viga apernada / columna apernada

Como fueron descritas anteriormente, estas uniones se consideran uniones de corte y con una alta capacidad de rotación.

En este grupo la viga conectada es una W21x62 y los parámetros más importantes se muestran en la siguiente tabla:

Tabla 4.2 Propiedades Viga W21x62 Acero A36 y puntos singulares curvas límites

Viga	d	I	Z	Mp	0.7 Mp	ϕ (0.7 Mp)	0.2 Mp	ϕ (0.2 Mp)
	m	m^4	m^3	KN-m	KN-m	[rad]/1000	KN-m	[rad]/1000
W21X62	0,53	0,000552	0,002356	585,163	409,614	3,957	117,033	5,652

A continuación se presentan los gráficos con las curvas experimentales. Los valores para cada curva pueden encontrarse en forma detallada en el anexo 1.

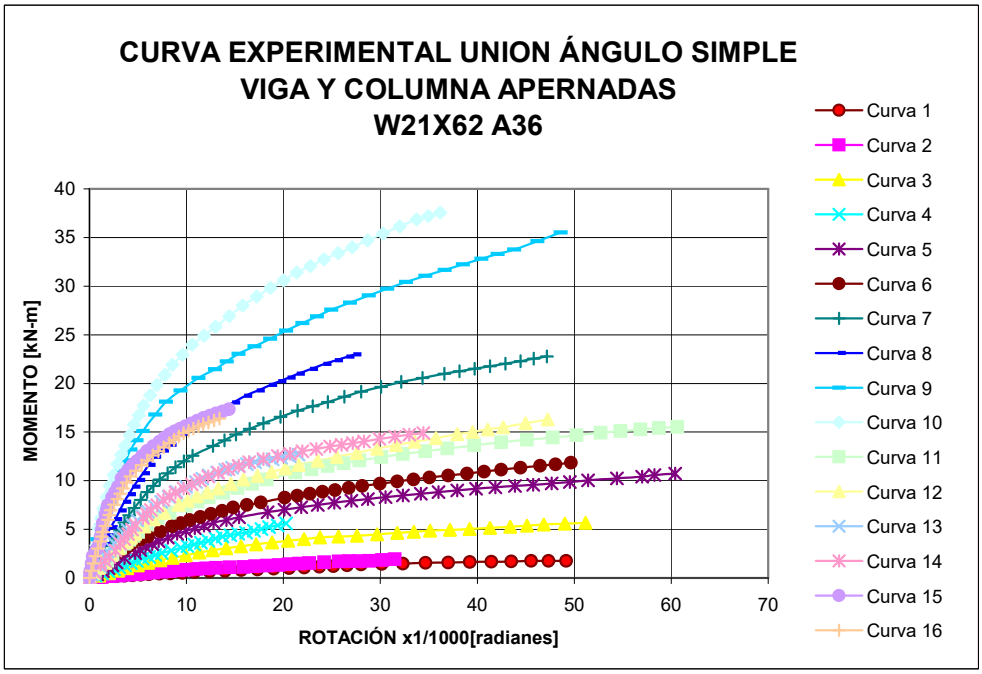


Figura 4.1. Valores experimentales unión ángulo simple

Clasificando estos ensayos según las curvas momento curvatura se obtiene el siguiente gráfico:

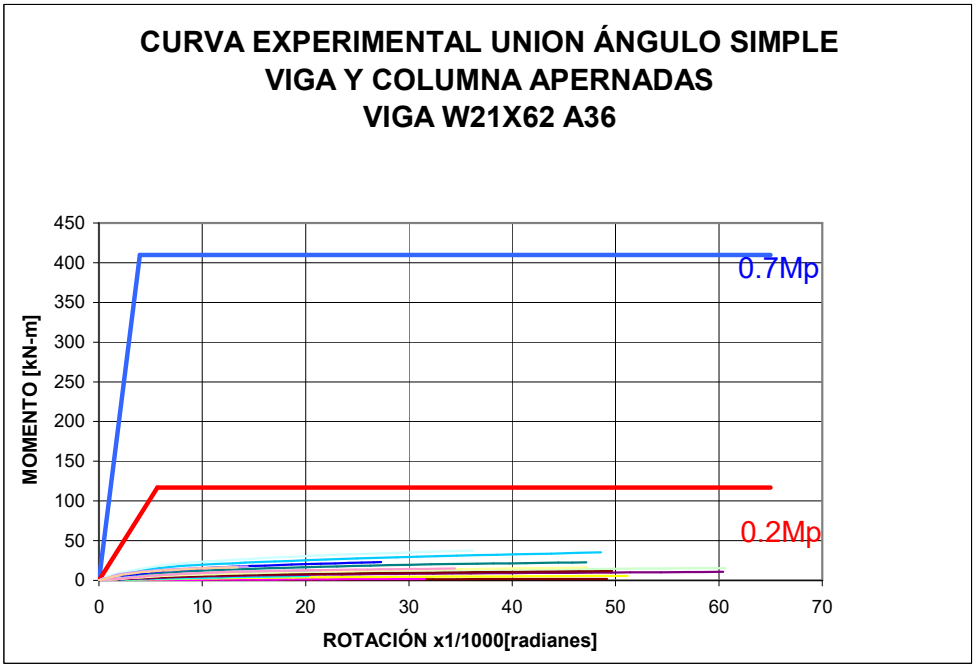


Figura 4.2. Valores experimentales unión ángulo simple

Claramente se aprecia que los ensayos demuestran que este tipo de unión corresponde a una tipo PR2 con muy baja capacidad de resistir momento con respecto a la viga conectada y con una alta capacidad de rotación, por lo cual se puede considerar a ésta como un buen ejemplo de unión de corte.

Más detalladamente se observa:

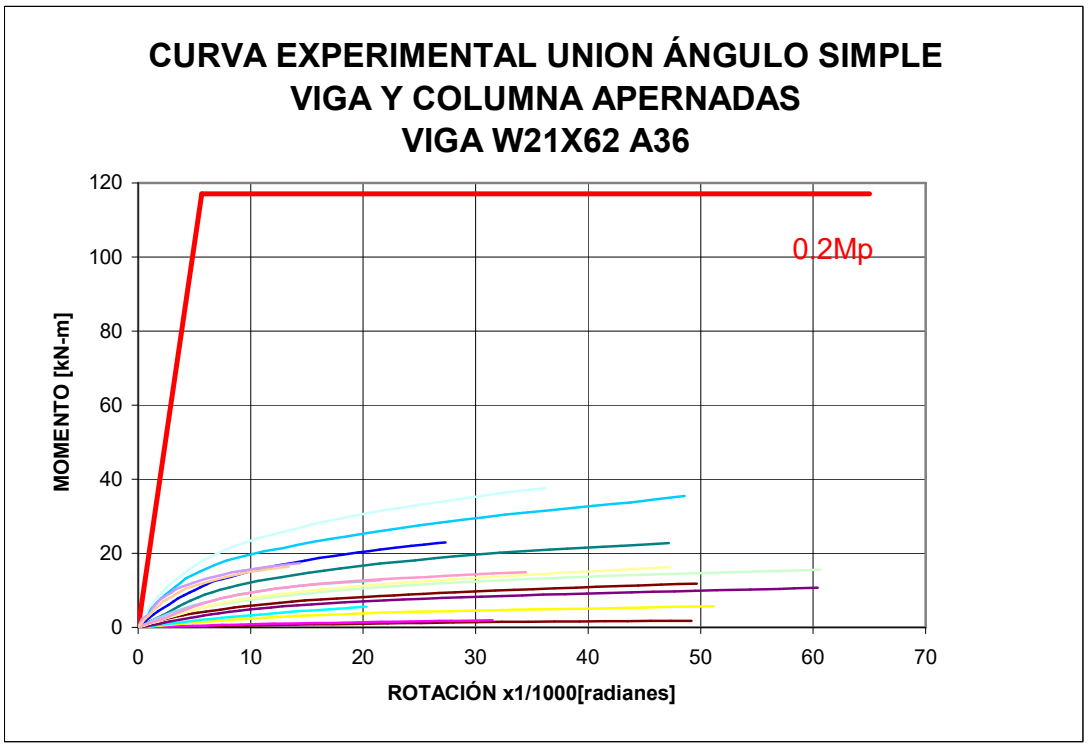


Figura 4.3. Valores experimentales unión ángulo simple

4.2 Uniones de ángulo simple viga apernada / columna soldada

En este caso los ensayos diponibles corresponden al mismo tipo de viga anterior. Sin embargo es importante notar la relevancia del número de conectores presentes en la unión.

En este grupo la viga conectada es una W21x62 y los parámetros más importantes se muestran en la siguiente tabla:

Tabla 4.3 Propiedades Viga W21x62 Acero A36 y puntos singulares curvas límites

Viga	d	I	Z	Mp	0.7 Mp	ϕ (0.7 Mp)	0.2 Mp	ϕ (0.2 Mp)
	m	m^4	m^3	KN-m	KN-m	[rad]/1000	KN-m	[rad]/1000
W21X62	0,53	0,000552	0,002356	585,163	409,614	3,957	117,033	5,652

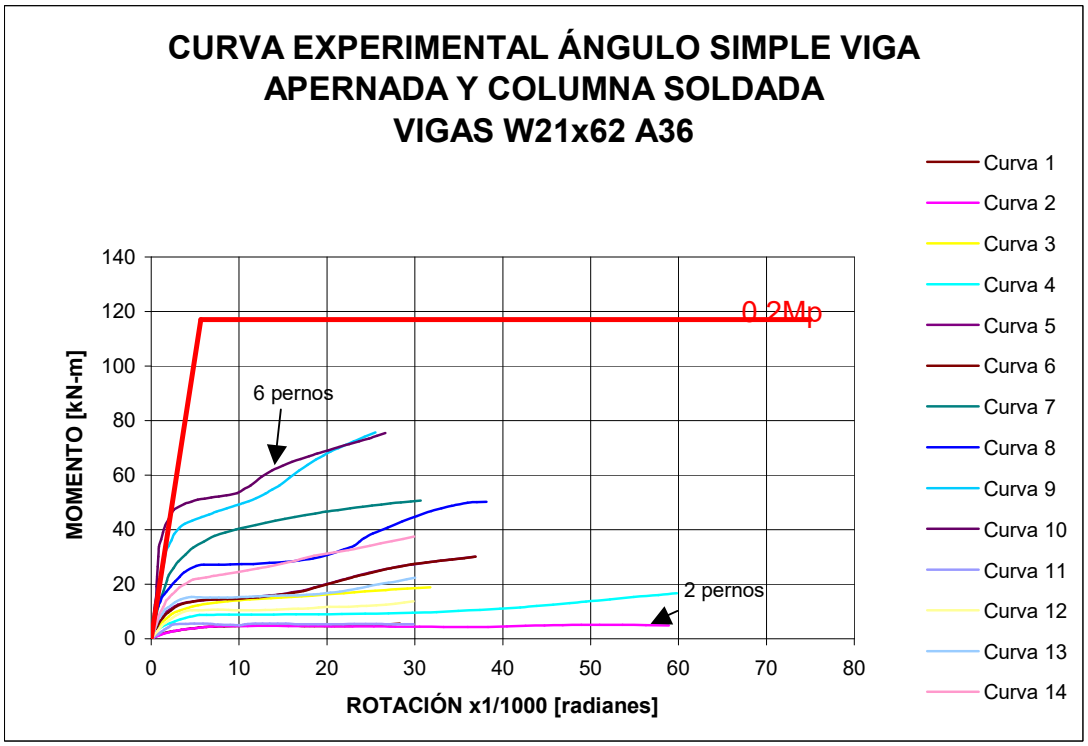


Figura 4.4. Valores experimentales uniones ángulo simple

Cabe señalar que el número de conectores aumenta significativamente la capacidad de resistir momento de la unión, pero también controla la rotación. Esto es debido no sólo a un aumento en la cantidad de pernos, sino también al tamaño del ángulo requerido para unir los elementos con dicha cantidad de pernos.

4.3 Unión con ángulo superior e inferior apernado

Para este caso la viga conectada es una W5x16 y el acero es del tipo G40.21. Se debe tener en cuenta también que los resultados corresponden al mismo tipo de unión pero con dos tipo de ángulos, el primero de dimensiones 4x4x1/2x5 y el segundo de 4x4x1/4x5, es decir uno posee un espesor el doble del otro. Los parámetros más importantes de la viga se muestran en la siguiente tabla:

Tabla 4.4 Propiedades Viga W5x16 Acero G40.21 y puntos singulares curvas límites

Viga	d	I	Z	Mp	0.7 Mp	ϕ (0.7 Mp)	0.2 Mp	ϕ (0.2 Mp)
	m	m^4	m^3	KN-m	KN-m	[rad]/1000	KN-m	[rad]/1000
W5X16	0,127	9.33 E-6	1.66 E-4	45,811	32,067	4,363	9,162	6,233

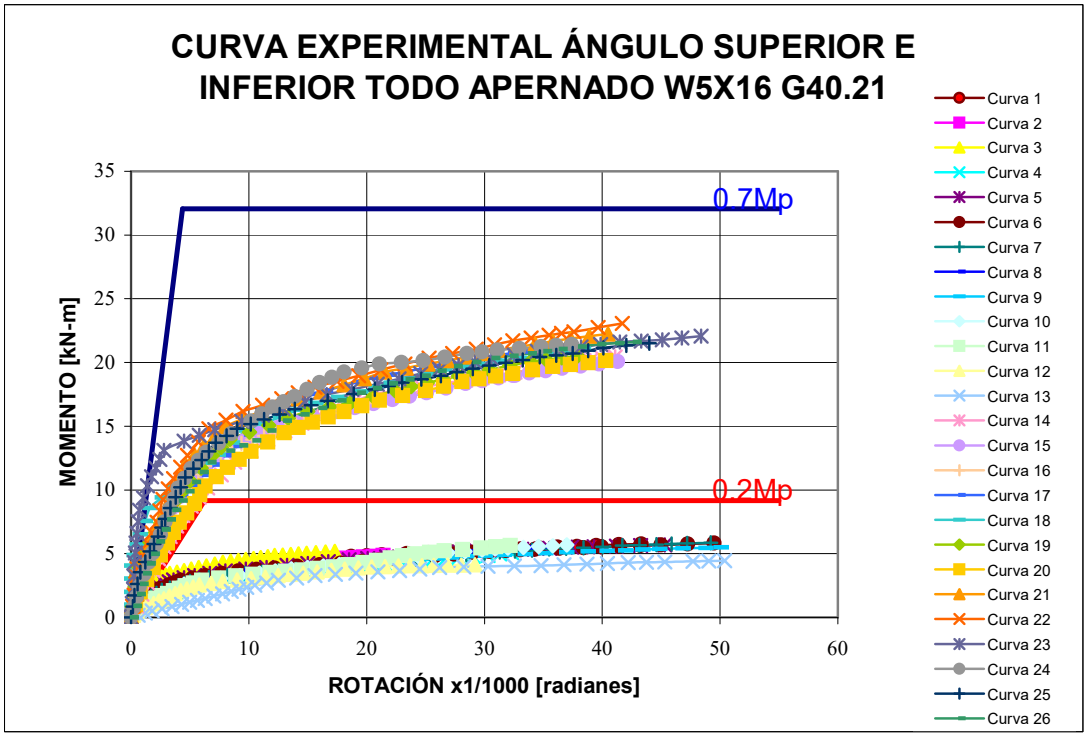


Figura 4.5. Valores experimentales unión con ángulo superior e inferior

A simple vista es posible notar que los ensayos se encuentran divididos en 2 grupos, y además es claro que estos dos grupos se encuentran en distintas categorías del diagrama momento curvatura. Separando los ensayos se obtienen los siguientes gráficos:

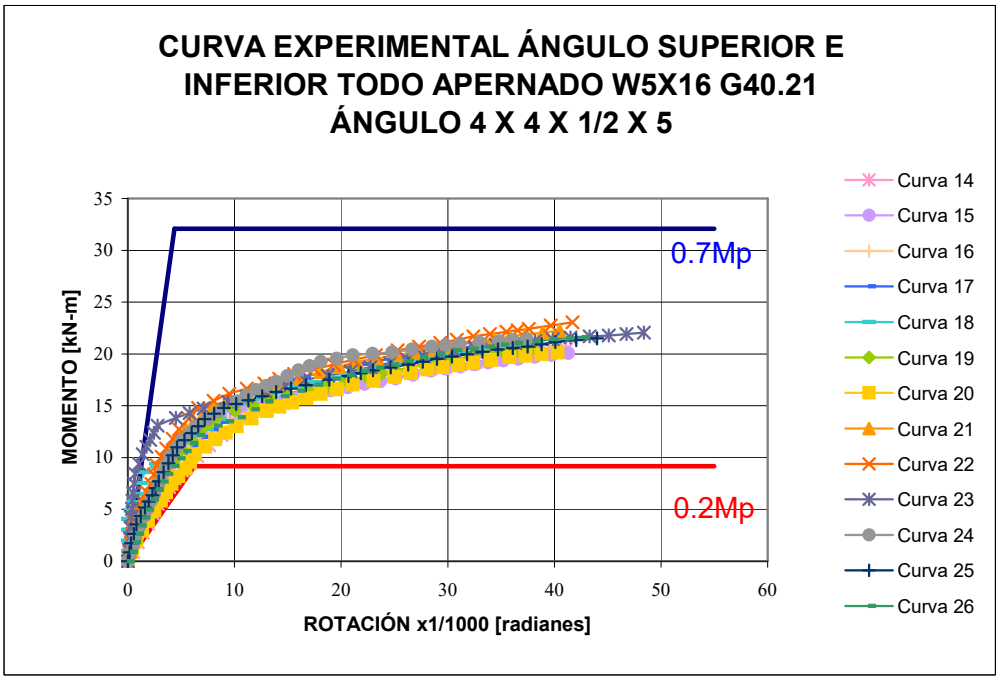


Figura 4.6. Valores experimentales unión con ángulo superior e inferior.

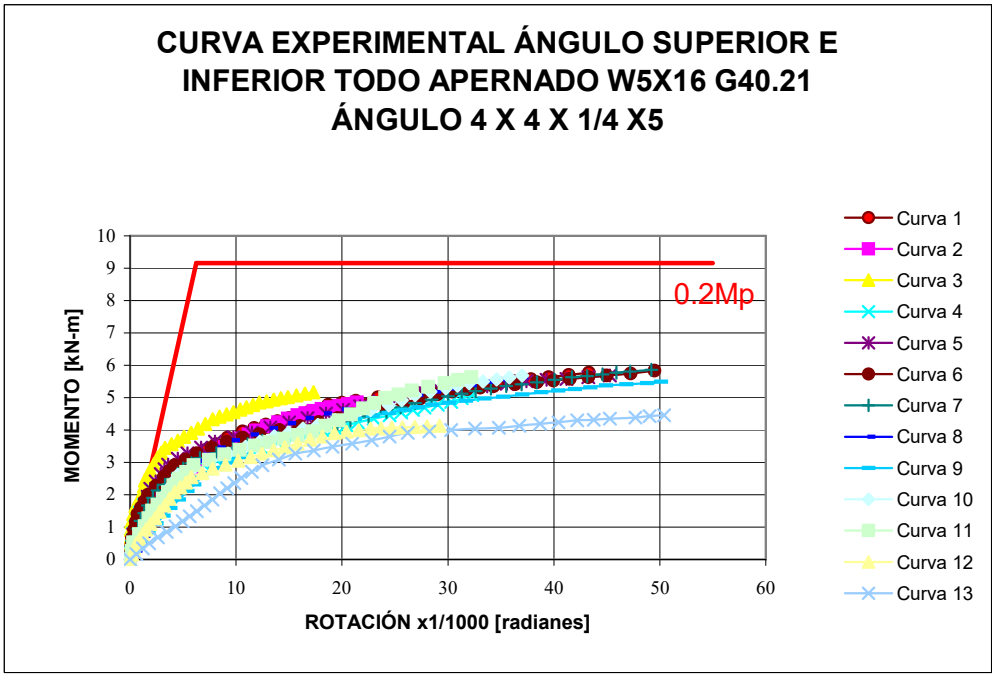


Figura 4.7. Valores experimentales unión con ángulo superior e inferior

Los gráficos anteriores reafirman la idea de que el tamaño de los elementos de la unión determinan drásticamente el comportamiento de ella, y que el hecho de considerar un cierto tipo de conexión como unión de corte o de momento, no es siempre la mejor aproximación que se pueda hacer de ella, ya que los supuestos bajo los que éstas se diseñan no se cumplen de buen modo en todos los casos reales.

4.4 Unión doble ángulo con asiento superior e inferior todo apernado.

En general las uniones doble ángulos suelen catalogarse como uniones a corte y en algunos casos se les suele incluir asientos regidizadores para mantener la geometría de la unión y facilitar el montaje.

En este caso se presentan los ensayos realizados con dos vigas diferentes, pero del mismo material.

Los propiedades de cada viga son las siguientes:

Tabla 4.5 Propiedades Viga W5x16 Acero A36 y puntos singulares curvas límites

Viga	d	I	Z	Mp	0.7 Mp	ϕ (0.7 Mp)	0.2 Mp	ϕ (0.2 Mp)
	m	m^4	m^3	KN-m	KN-m	[rad]/1000	KN-m	[rad]/1000
W8x21	0,21	3.14E-5	3.4E-4	84,446	59,112	3,952	16,889	5,645
W14x38	0,358	1.67E-4	1.045E-3	259,796	181,857	3,897	51,959	5,567

Es posible apreciar que los valores de los momentos son muchísimo mayores para la viga W14x38, lo que es lógico ya que el momento plástico depende de la geometría de la viga, sin embargo, las rotaciones obtenidas son similares para ambos casos.

Para tener una idea general de los valores experimentales, se presentarán, en principio, todos en un solo gráfico, para posteriormente dividirlos de acuerdo a la viga conectada.

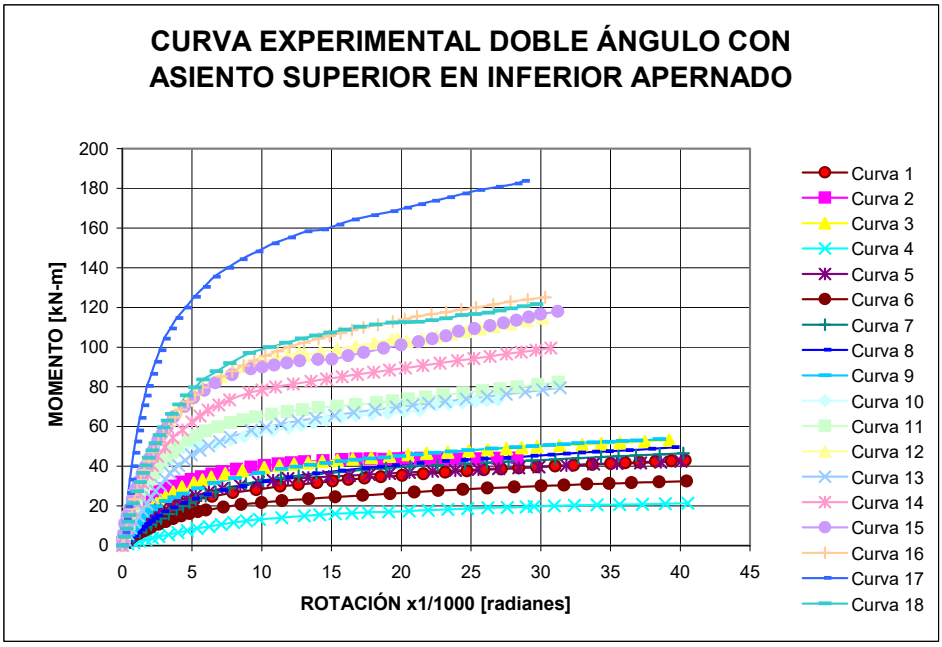


Figura 4.8. Curvas experimentales unión doble ángulo

El gráfico anterior muestra una gran dispersión en las curvas, sin embargo al separarlas es posible ver que sus comportamientos momento-curvatura son similares.

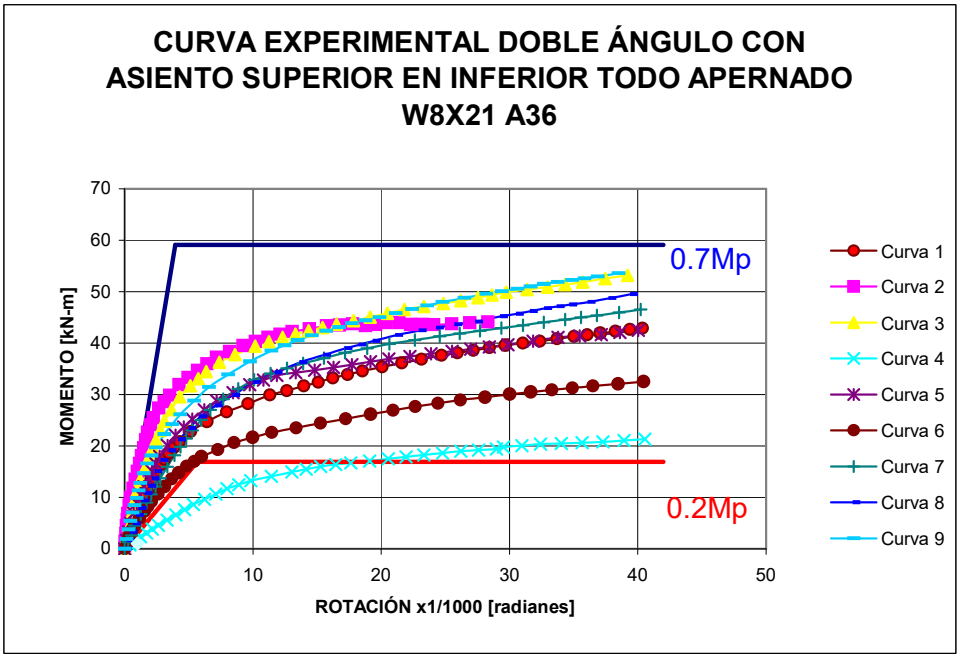


Figura 4.9. Curvas experimentales unión doble ángulo

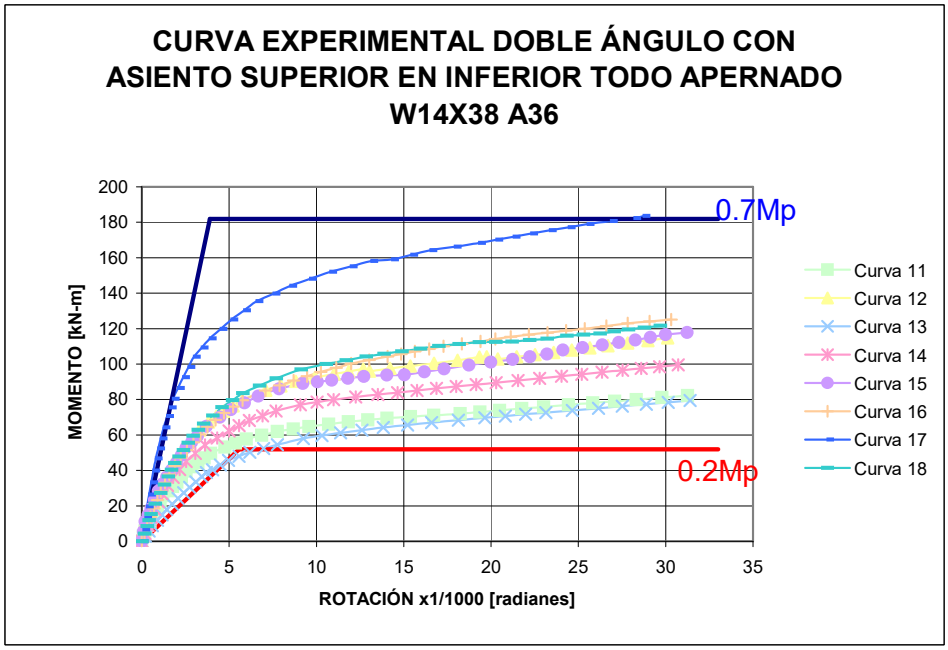


Figura 4.10. Curvas experimentales unión doble ángulo

Según los gráficos anteriores es posible catalogar este tipo de unión como PR tipo 3, independiente del tipo de viga a conectar, esto porque el diagrama momento curvatura variará de acuerdo a cada viga, es decir, el momento resistente podrá ser mucho mayor en un caso que en otro, pero también es mayor la pendiente que presentan las curvas límites, esto porque las rotaciones para ambos casos son muy parecidas.

4.5 Unión doble ángulo viga apernada columna apernada

Esta unión, a diferencia de la anterior, no presenta asientos que le ayuden a mantener la geometrìa de la unión, por lo cual se espera que al menos las rotaciones alcanzadas en este caso sean mayores.

Para este caso se presentan los ensayos de una misma viga, pero con dos tipos de acero. Los parámetros más importantes se muestran en la siguiente tabla:

Tabla 4.6 Propiedades Viga W21x62 Acero A36, Acero A441 y puntos singulares curvas límites

Viga	d	I	Z	Mp	0.7 Mp	ϕ (0.7 Mp)	0.2 Mp	ϕ (0.2 Mp)
	m	m^4	m^3	KN-m	KN-m	[rad]/1000	KN-m	[rad]/1000
W21x62 A36	0,533	5.52E-4	2.36E-3	585.163	409.614	3.954	117.033	5.648
W21x62 A441	0,533	5.52E-4	2.36E-3	812.726	568.908	5.491	162.545	7.845

En principio, es posible apreciar que las rotaciones y los momentos son mayores para las vigas de calidad A441, es decir la calidad del acero sí es determinante en los valores absolutos de los parámetros de la unión, sin embargo, observando los siguientes gráficos, será posible darse cuenta que para ambas calidades la unión podrá catalogarse dentro de un mismo grupo.

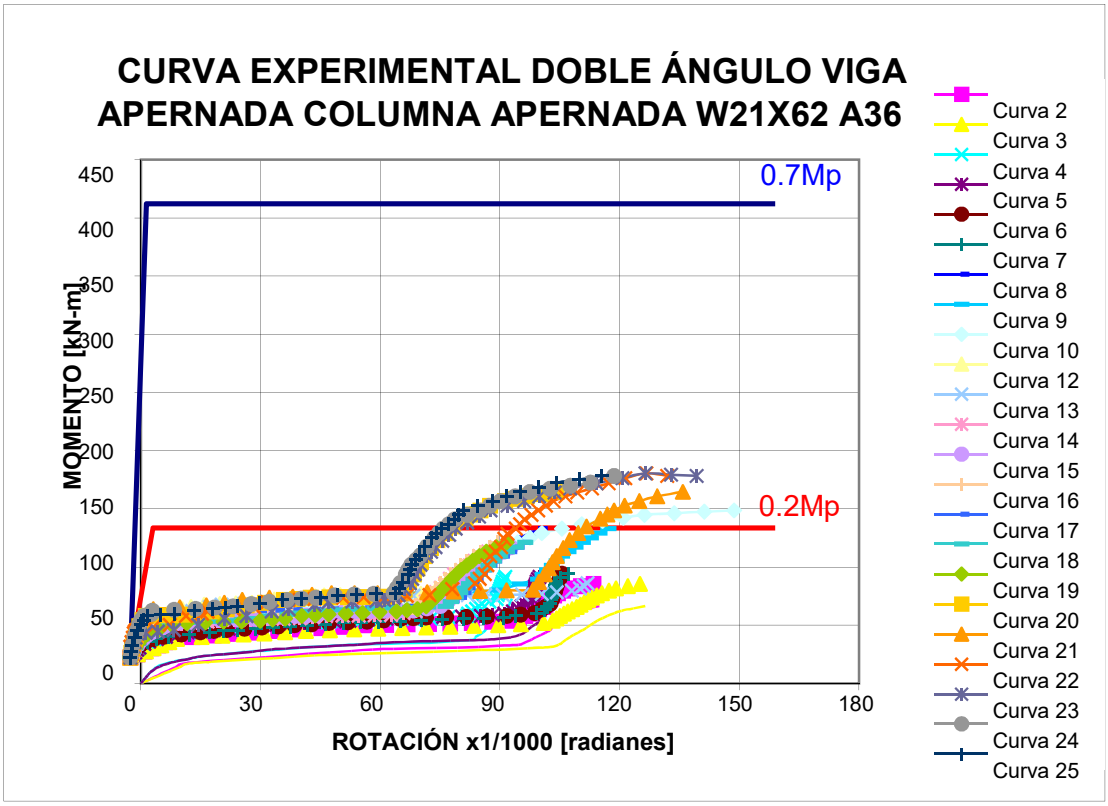


Figura 4.11. Curvas experimentales unión doble ángulo

De este primer gráfico es posible apreciar claramente que la unión corresponde a una tipo PR2, es decir, muy baja capacidad de soportar momento con respecto a la viga conectada y una alta rotación.

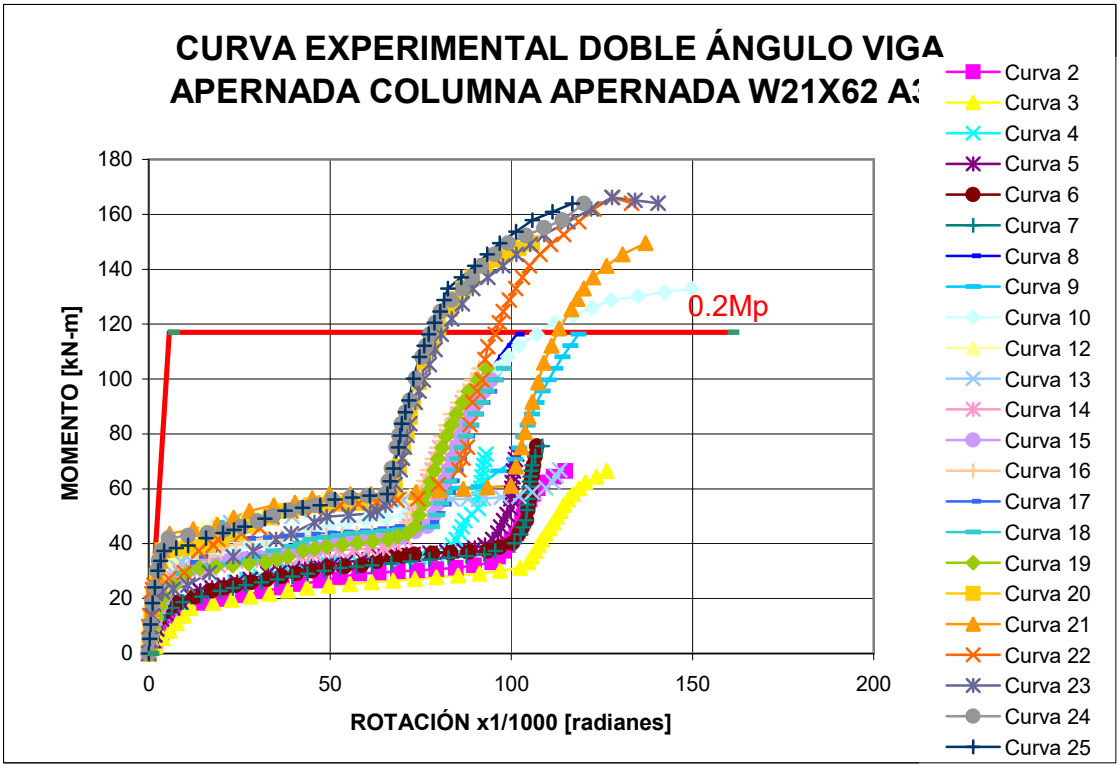


Figura 4.12. Curvas experimentales unión doble ángulo

En forma más detallada es posible apreciar que casi todos los valores se encuentran por debajo el 20% del momento plástico de la viga, sin embargo, una vez alcanzada una cierta rotación, se observa un incremento en la resistencia de la unión, lo que la lleva a alcanzar valores superiores al 0.2 Mp, es claro notar que estos valores se alcanzan para rotaciones elevadas cercanas a 0.1 radianes, lo cual se debe a varios factores. Uno de ellos, es que para tales rotaciones los pernos utilizados en la unión presentan un trabajo más activo, lo cual hace que esta eleve su capacidad resistente.

El segundo grupo de ensayos muestra las siguientes características:

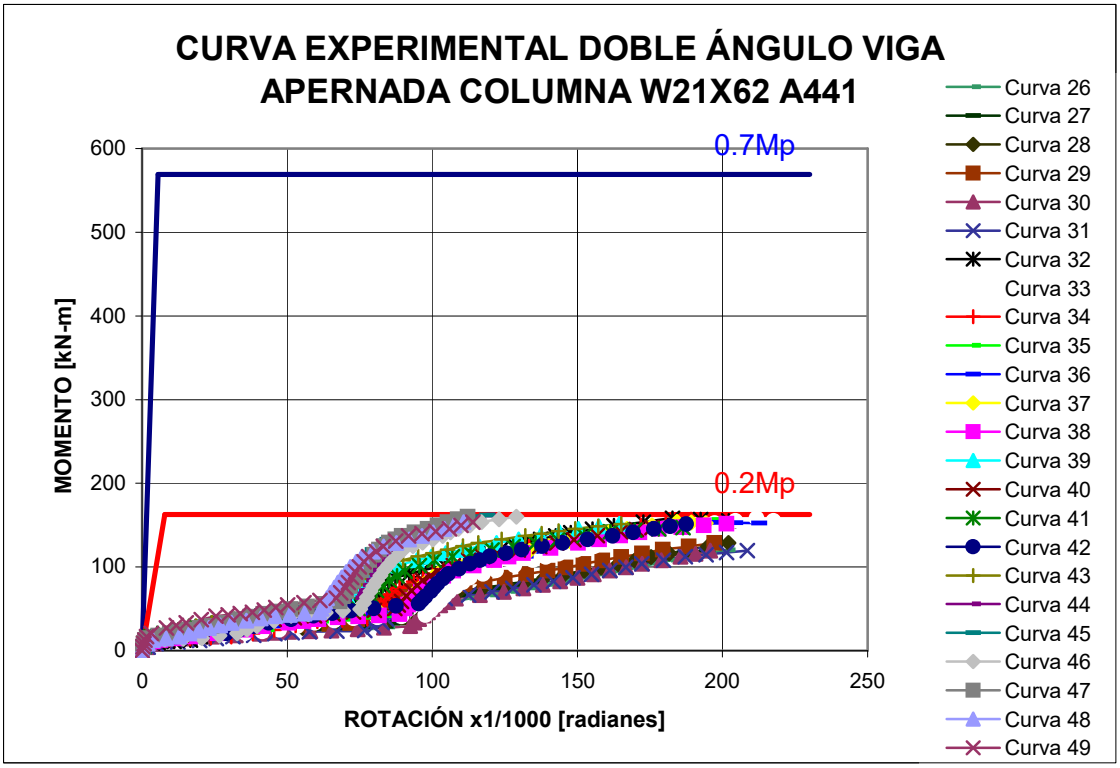


Figura 4.13. Curvas experimentales unión doble ángulo

En este caso también es claro que la unión se encuentra dentro del rago de uniones parcialmente restringidas tipo 2 sin embargo, las rotaciones alcanzadas son considerablemente mayores.

Más detalladamente se ve que las curvas se ajustan casi a la pefección al rango indicado.

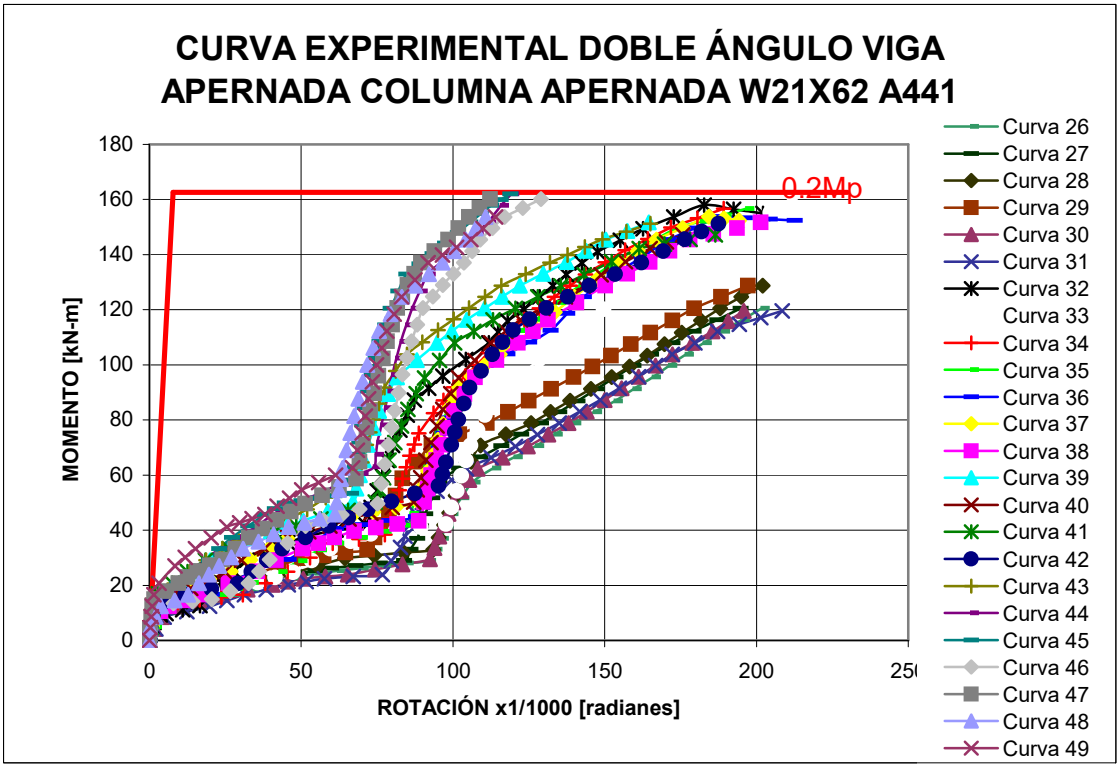


Figura 4.14. Curvas experimentales unión doble ángulo

Comparando ambos gráficos es posible notar que coincidentemente el valor de momento plástico para el cual se produce un cambio en la pendiente de las curvas se encuentra en ambos casos en un rango entre los 40 y 60 KN-m, sin embargo los valores finales son siempre mayores para la calidad de acero A441. Esto reafirma la idea que el tipo de acero de la viga a conectar es un parámetro muy influyente, ya que se alcanzan mayores valores de momento y rotación, pero en términos globales, el tipo de acero no condiciona el comportamiento de unión en cuanto a su diagrama momento-curvatura.

4.6 Unión placa de cabecera apernada

Para este caso se cuenta con resultados de tres tipos de vigas pero todas de la misma calidad de acero, por lo tanto las diferencia entre cada unión serán tan solo geométricas.

Los parámetros más importantes para los tres tipos de vigas se muestran en la siguiente tabla:

Tabla 4.7 Propiedades Viga W12x27, W18x45, W24x76, Acero G40.21y puntos singulares curvas límites

Viga	d	I	Z	Mp	0.7 Mp	ϕ (0.7 Mp)	0.2 Mp	ϕ (0.2 Mp)
	m	m^4	m^3	KN-m	KN-m	[rad]/1000	KN-m	[rad]/1000
W12x27	0.305	8.491E-5	6.227E-4	171.848	120.293	3.048	34.369	6.166
W18x45	0.454	2.938E-4	1.469E-3	405.651	283.955	4.382	81.13	6.259
W24x76	0.608	9.02E-4	3.403E-3	939.119	657.383	4.429	187.824	6.328

El primer conjunto de ensayos es mostrado en el siguiente gráfico:

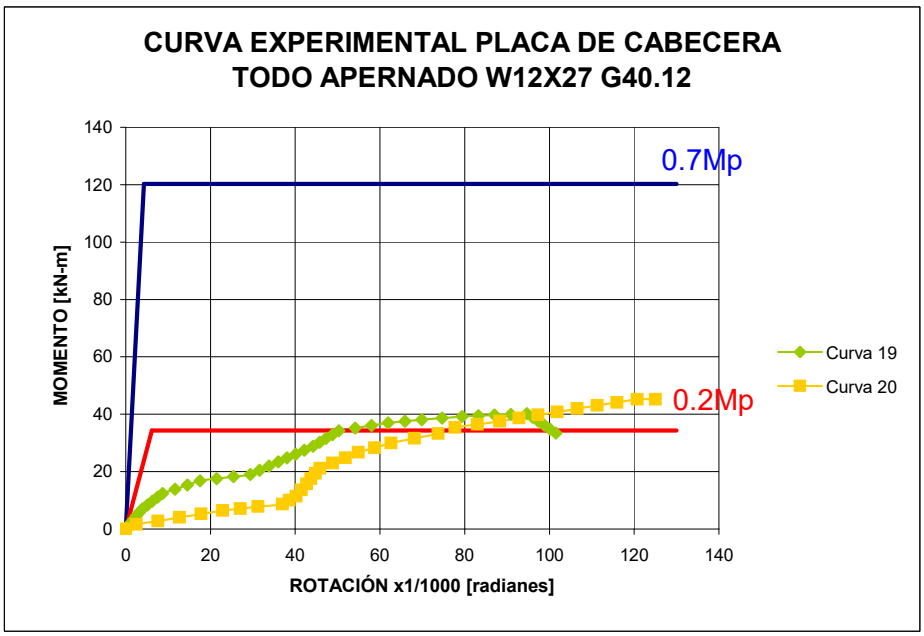


Figura 4.15. Curvas experimentales unión placa de cabecera

Si bien se presentan tan solo dos curvas, es apreciable que estas pertenecen a la categoría PR tipo 2 con incursión en el rango del tipo 3 sobre los 0.05 radianes de rotación como se aprecia en el siguiente gráfico:

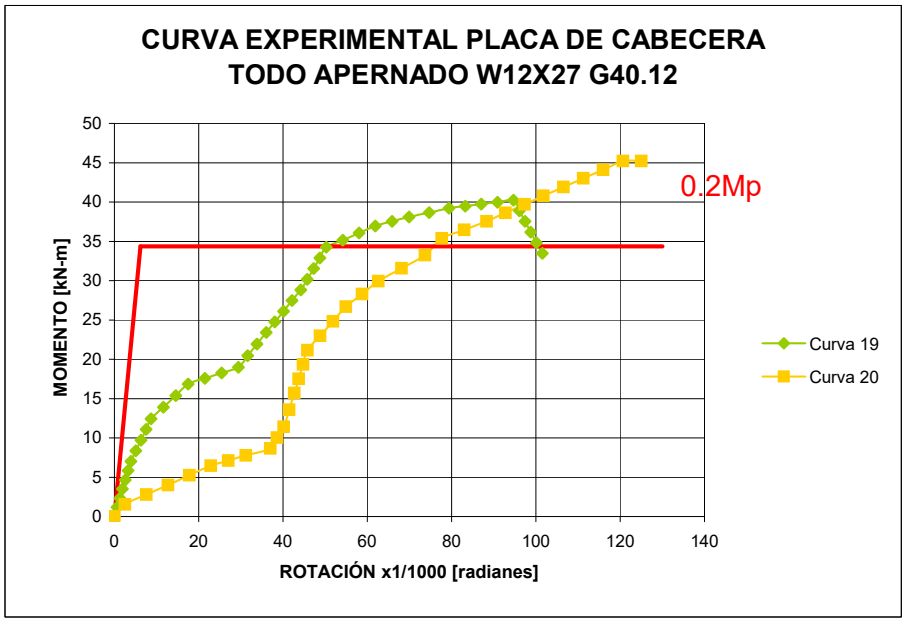


Figura 4.16. Curvas experimentales unión placa de cabecera

El siguiente grupo de uniones muestra características similares

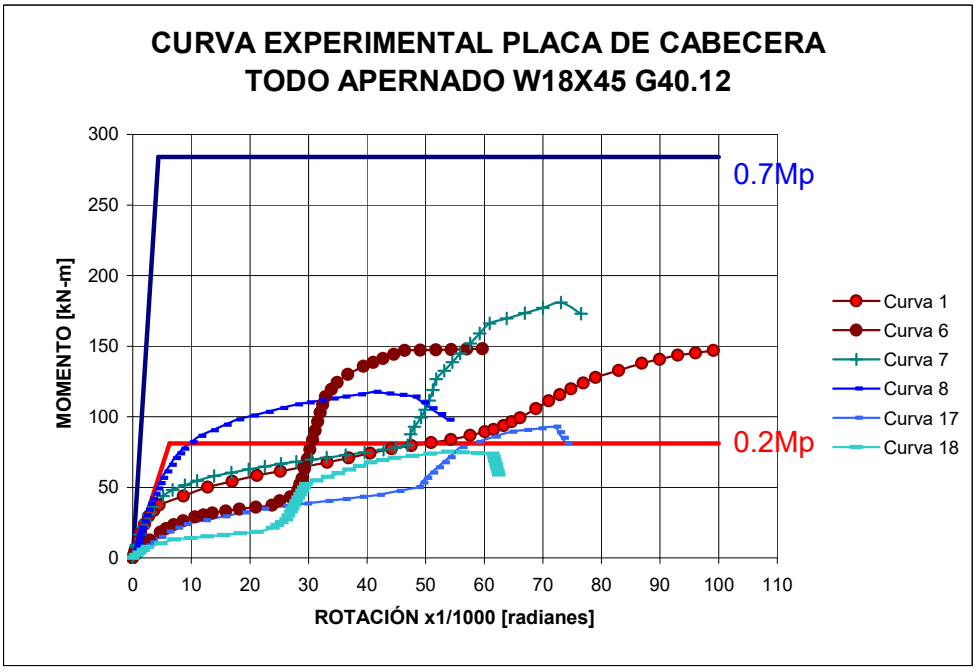


Figura 4.17. Curvas experimentales unión placa de cabecera

Es claro notar que dado que la viga conectada es de mayor tamaño, los momentos alcanzados por esta unión son mayores que los anteriores, sin embargo las rotaciones se mantienen dentro del mismo orden.

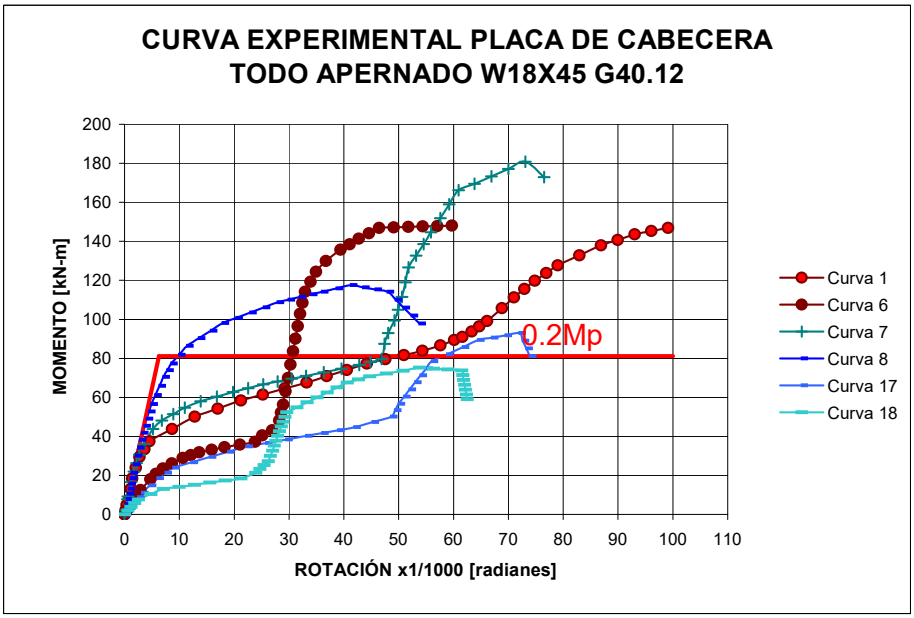


Figura 4.18. Curvas experimentales unión placa de cabecera

El último grupo, corresponde a la viga de mayor altura, por lo que se espera que la unión entregue mayores valores de momento.

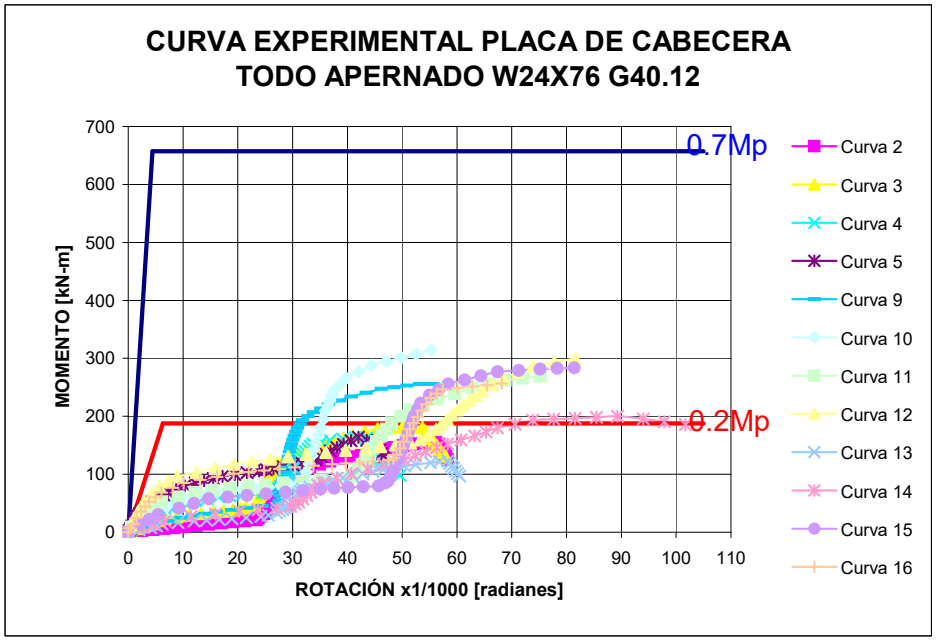


Figura 4.19. Curvas experimentales unión placa de cabecera

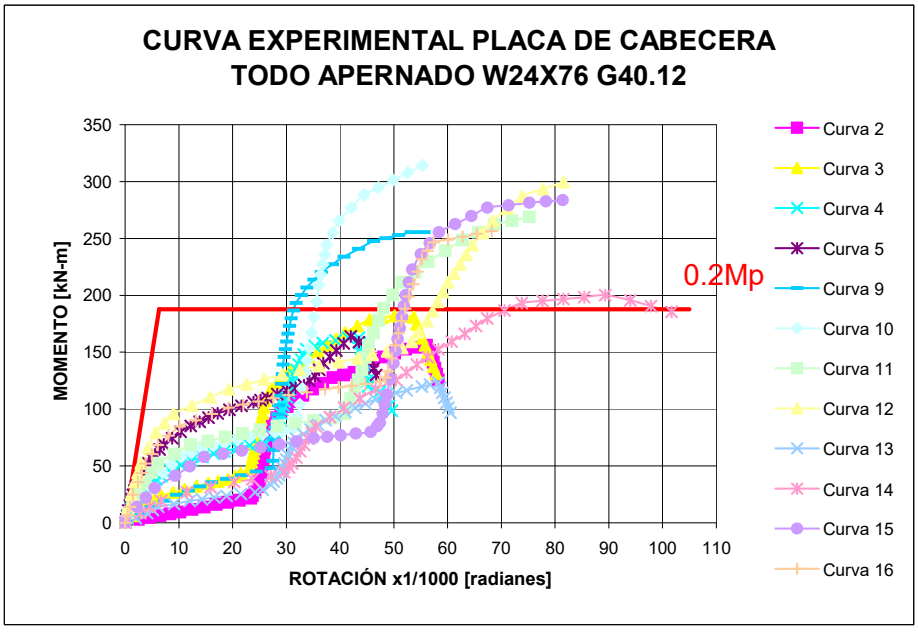


Figura 4.20. Curvas experimentales unión placa de cabecera

Sin embargo, tomando en cuenta las diferencias de altura entre las vigas, el comportamiento momento curvatura se ajusta de buena forma en los tres casos, es decir, todos los grupos se pueden catalogar como unión PR tipo2 pero con incursiones fuera de su rango, es decir, la gran mayoría de las curvas de esta unión presenta un punto donde

se rigidizan y este punto se encuentra entre los 0.03 y 0.06 radianes. Además es interesante notar que las rotaciones máximas se encuentran cercanas a 0.1 radianes para los tres grupos.

4.7 Unión placa extendida apernada con atiesador

Para este tipo de unión se cuenta con ensayos realizados con 7 tipos de vigas distintas, pero todas de la misma calidad de acero. Los parámetros más importantes se muestran en la siguiente tabla:

Tabla 4.8 Propiedades Vigas, Acero A36 y puntos singulares curvas límites

Viga	d	I	Z	Mp	0.7 Mp	ϕ (0.7 Mp)	0.2 Mp	ϕ (0.2 Mp)
	m	m^4	m^3	KN-m	KN-m	[rad]/1000	KN-m	[rad]/1000
W14x22	0.348	8.24E-5	5.424E-4	134.719	94.304	3.986	26.944	5.694
W16x26	0.397	1.249E-4	7.210E-4	179.083	125.358	3.989	35.817	5.699
W18x35	0.45	2.27E-4	1.162E-3	288.607	202.025	4.003	57.721	5.719
W24x55	0.599	5.82E-4	2.273E-3	564.548	395.183	4.066	112.909	5.808
W24x100	0.599	5.82E-4	2.273E-3	1139.621	797.735	3.893	227.924	5.561
W24x162	0.635	2.195E-3	7.816E-3	1941.269	1358.889	3.929	388.254	5.614
W27x114	0.693	1.739E-3	5.722E-3	1421.180	994.826	3.963	284.236	5.661

A continuación se presentan los gráficos correspondientes a cada grupo:

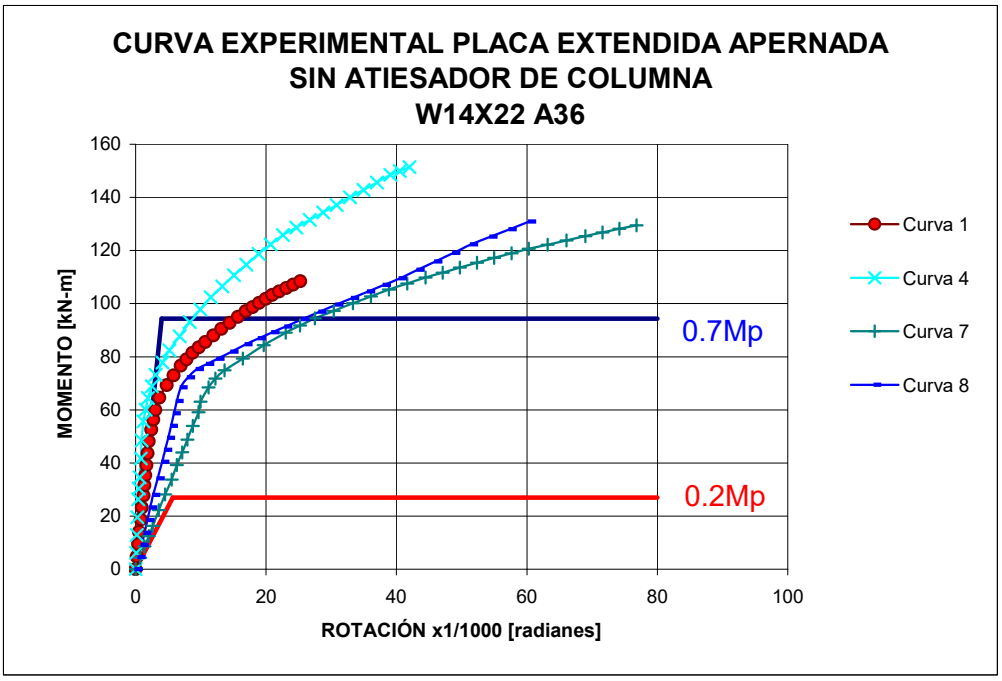


Figura 4.21. Curvas experimentales unión placa extendida

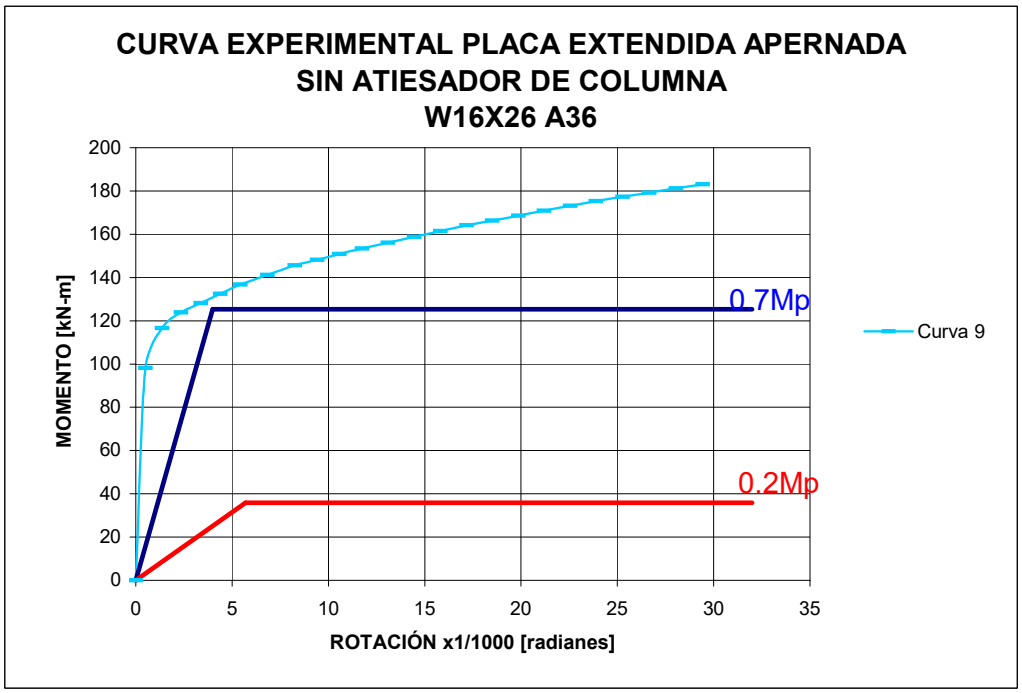


Figura 4.22. Curvas experimentales unión placa extendida

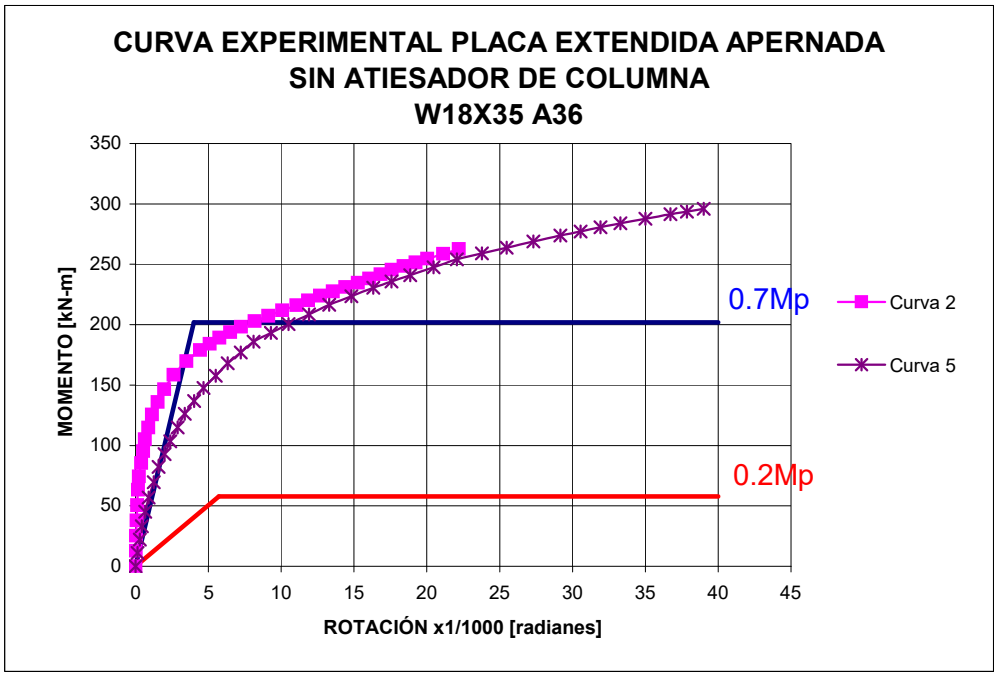


Figura 4.23. Curvas experimentales unión placa extendida

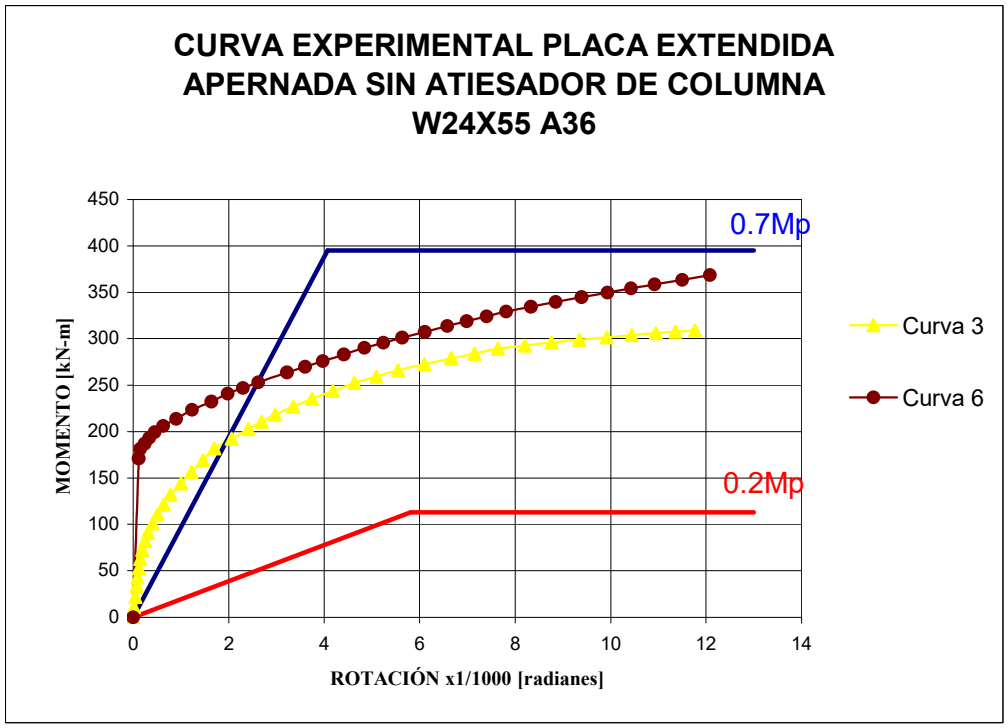


Figura 4.24. Curvas experimentales unión placa extendida

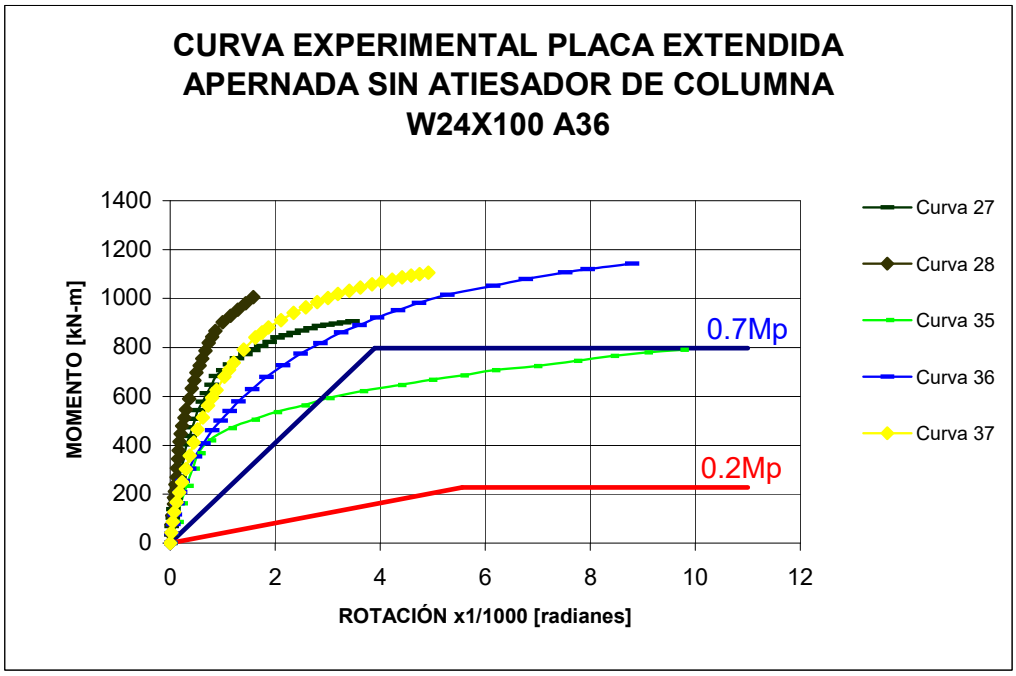


Figura 4.25. Curvas experimentales unión placa extendida

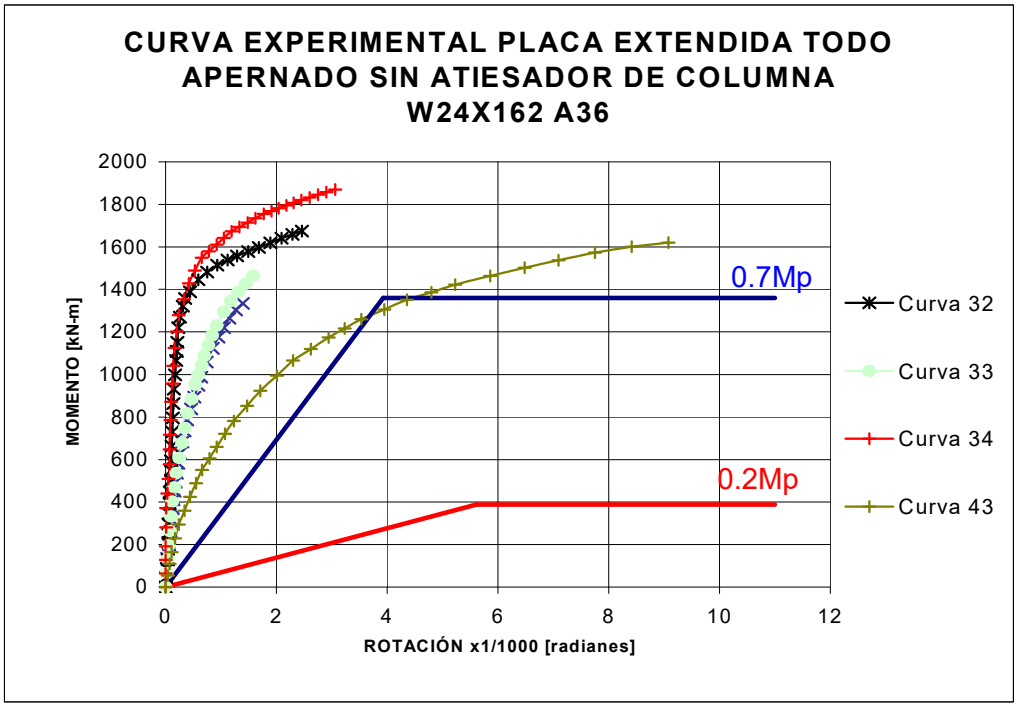


Figura 4.26. Curvas experimentales unión placa extendida

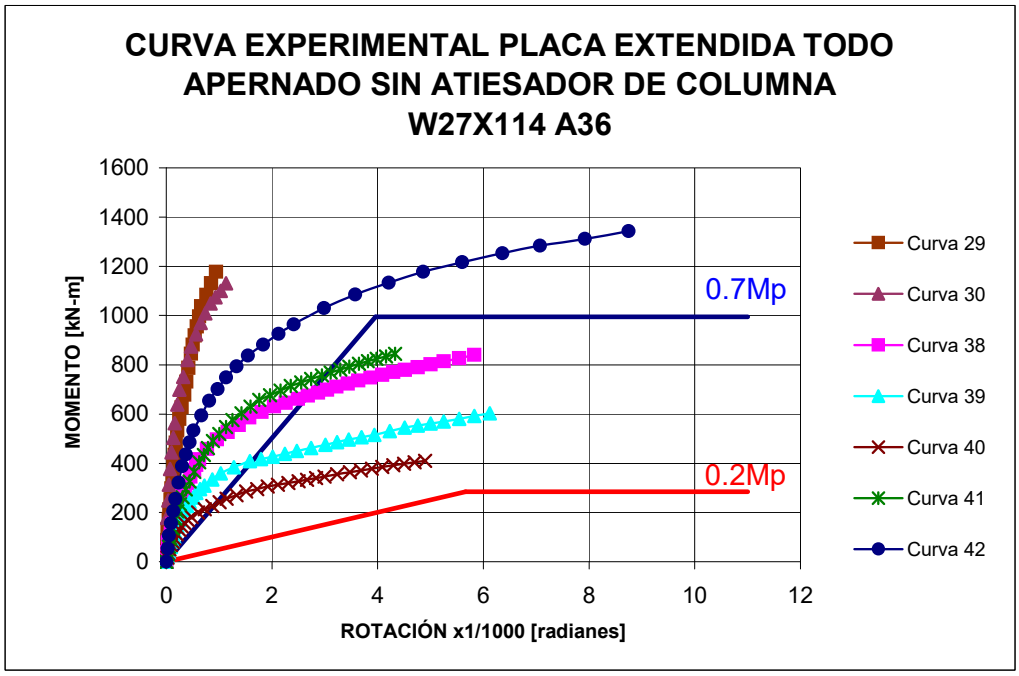


Figura 4.27. Curvas experimentales unión placa extendida

De los gráficos anteriores es posible observar que en general la mayoría de las conexiones presenta una rigidez inicial muy alta, así como también una rotación significativamente menor a lo que se había observado en las uniones anteriores. Los momentos que desarrollan estas uniones también son muy superiores a los vistos anteriormente, y en términos generales es lógico aceptar que estas son uniones totalmente restringidas FR tipo 1 o también pueden clasificarse como uniones a momento. Sin embargo es importante notar que muchas de las uniones ensayadas son mixtas, es decir, si bien en principio su comportamiento es claramente tipo FR luego pasan al rango PR tipo 3, es decir para hablar de una unión totalmente restringida es importante determinar dentro de qué rangos se espera que ésta se comporte de tal forma.

4.8 Unión placa rígida apernada con atiesador

Para este grupo se cuenta con el ensayo para dos tipos de vigas pero ambas de la misma calidad de acero. Los parámetros más importantes se muestran en la siguiente tabla:

Tabla 4.9 Propiedades Vigas, Acero A36 y puntos singulares curvas límites

Viga	d	I	Z	Mp	0.7 Mp	ϕ (0.7 Mp)	0.2 Mp	ϕ (0.2 Mp)
	m	m^4	m^3	KN-m	KN-m	[rad]/1000	KN-m	[rad]/1000
W10x21	0,251	4.45E-5	3.94E-4	98.089	68.662	3.875	19.618	5.536
W12x27	0.304	8.49E-5	6.23E-4	154.663	108.264	3.872	30.933	5.531

Los siguientes gráficos muestran las curvas experimentales obtenidas para este grupo:

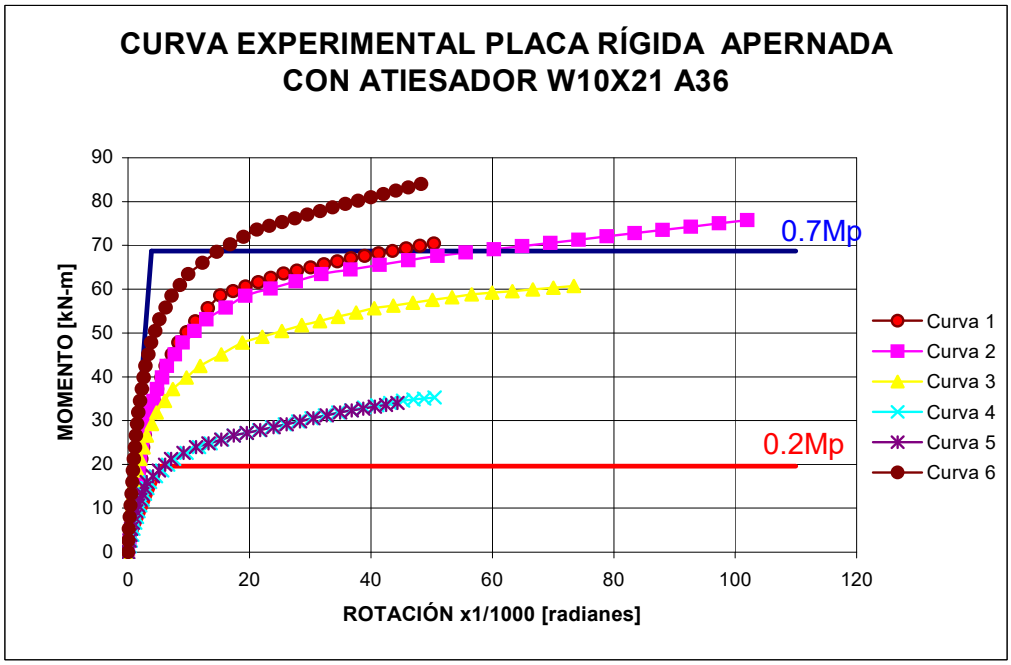


Figura 4.28. Curvas experimentales unión placa rígida

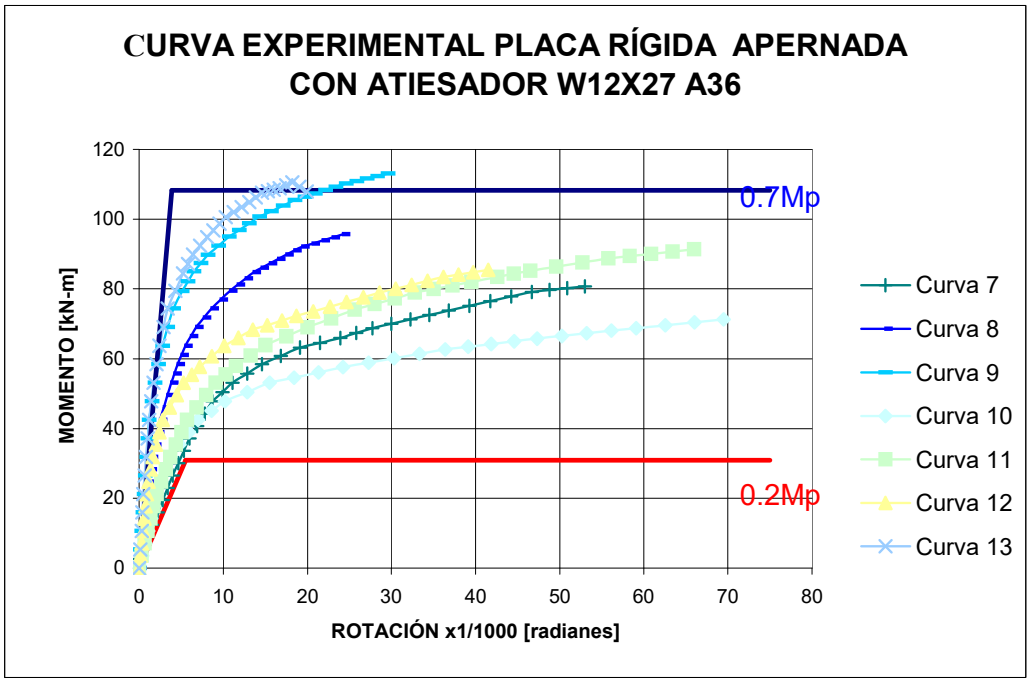


Figura 4.29. Curvas experimentales unión placa rígida

Los gráficos anteriores muestran que este tipo de unión puede ser considerada de tipo PR3, es decir, no se puede idealizar ni como una rótula perfecta ni como un empotramiento perfecto sin entrar en importantes errores conceptuales con respecto al comportamiento de ésta.

4.9 Unión placa rígida apernada

Esta unión es similar a las graficadas anteriormente, pero sin atiesador. Las vigas utilizadas en el ensayo son W10x21 y W12x27, y el acero de calidad A36, por lo cual las curvas son comparables con las del gráfico anterior.

Tabla 4.10 Propiedades Vigas, Acero A36 y puntos singulares curvas límites

Viga	d	I	Z	Mp	0.7 Mp	ϕ (0.7 Mp)	0.2 Mp	ϕ (0.2 Mp)
	m	m^4	m^3	KN-m	KN-m	[rad]/1000	KN-m	[rad]/1000
W10x21	0,251	4.45E-5	3.94E-4	98.089	68.662	3.875	19.618	5.536
W12x27	0.304	8.49E-5	6.23E-4	154.663	108.264	3.872	30.933	5.531

Los siguientes gráficos muestran las curvas experimentales obtenidas para este grupo:

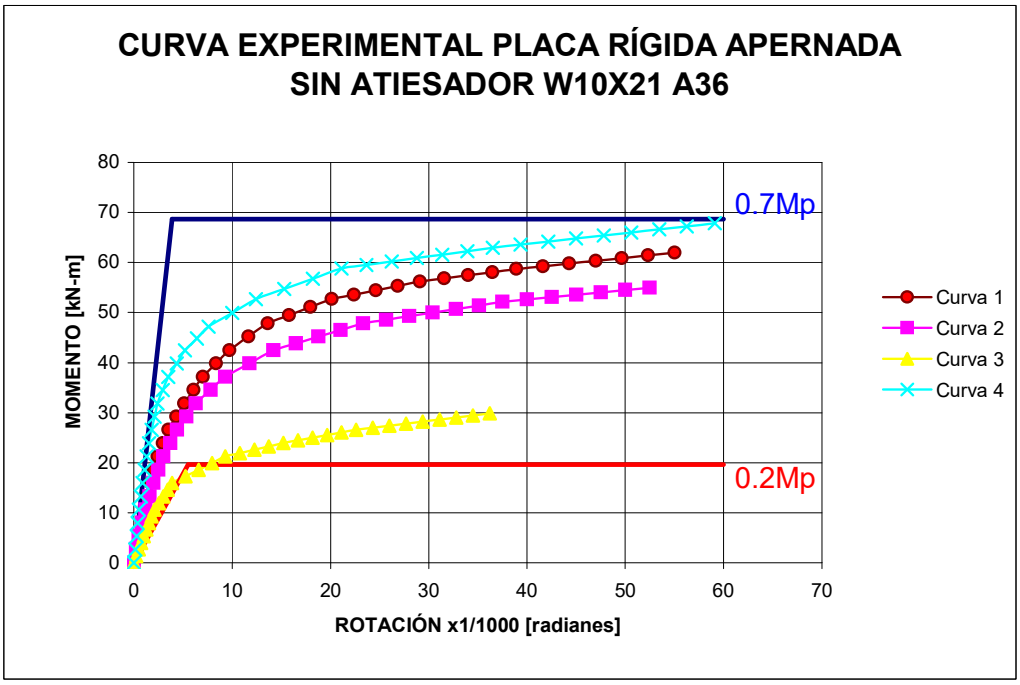


Figura 4.30. Curvas experimentales unión placa rígida apernada sin atiesador

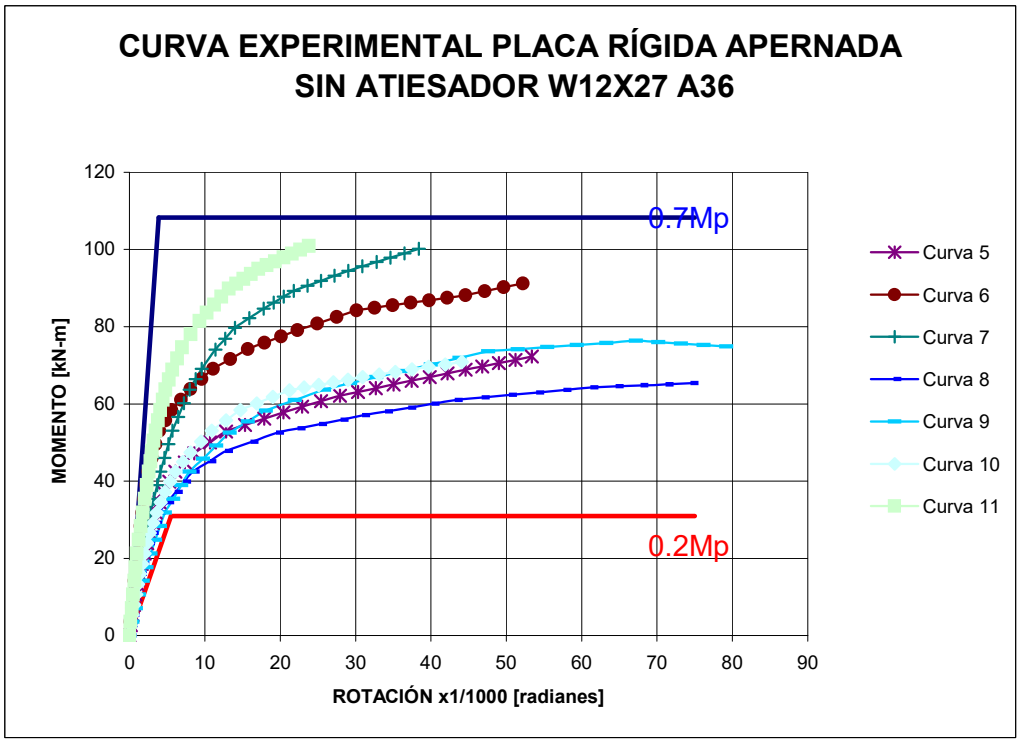


Figura 4.31. Curvas experimentales unión placa rígida apernada sin atiesador

Como es posible apreciar, las curvas se mantienen dentro de los rangos correspondientes a las uniones PR tipo 3 y con capacidades de rotación intermedias entre las uniones totalmente restringidas FR y las uniones parcialmente restringidas PR tipo 2.

De todos los gráficos vistos anteriormente es claro que hay muchas uniones que no pueden ser consideradas ya sea como rótulas o como empotramientos al incluirlas dentro del análisis de una estructura, por eso es importante al diseñar el tener conceptualmente claro cuál es el tipo de unión que se desea y dentro de qué rangos se espera que ésta se comporte, e incluir el efecto que ésta tiene dentro del comportamiento global de la estructura.

Este último punto será analizado en detalle en los siguientes capítulos, enfatizando el efecto de las uniones parcialmente restringidas PR tipo 3 que no son fácilmente asimilables a condiciones de apoyo extremas.

5 DISEÑO DE EDIFICIOS

Se ha considerado 3 edificios de acero, de 4, 8 y 12 pisos, los cuales han sido diseñados mediante el método de tensiones admisibles, considerando el comportamiento lineal elástico del acero, sin incluir en el análisis el efecto de las conexiones. Se ha tomado en cuenta los requerimientos de la normativa chilena actual NCh 433 Of. 96 Mod.2009 [INN Chile].

El análisis se hizo de modo lineal elástico, de forma tradicional, utilizando para esto el programa de cálculo GTStrudl versión 28, verificando a su vez los elementos de acero de acuerdo a ASD9 automáticamente por el programa. La modelación de las estructuras se hizo mediante elementos vigas y columnas, con compatibilidad de deformaciones a través de diafragmas rígidos con tres grados de libertad por piso. Se considera que las masas sísmicas (pesos propios y correspondientes sobrecargas) se concentrarán en el centro de masas de cada piso. Dada la regularidad de las estructuras, esto permitirá el cálculo mediante torsión accidental de manera sencilla, desplazando transversalmente la ubicación de los centros de masas en las direcciones ortogonales de análisis.

Para efectos de diseño se consideró que los edificios se encuentran ubicados en la zona de mayor riesgo sísmico del país, Zona 3 de acuerdo a NCh 433 Of. 96 Mod.2009 [INN Chile] y en terreno tipo III de acuerdo a la misma norma.

Como término general, las deformaciones se encuentran de acuerdo a lo admisible dentro de la normativa actual vigente y los perfiles presentran una resistencia al menos igual o menor a lo solicitado por las cargas espectrales resultantes de la aplicación de NCh 433 Of. 96 Mod.2009 [INN Chile].

En este análisis se ha omitido el efecto de las uniones en el diseño de la estructura y en la determinación de las deformaciones y esfuerzos, es decir se ha realizado un diseño típico considerando las uniones a corte o a momento, sin tener en cuenta las curvas M-ø de las uniones. Este análisis se realizará posteriormente, una vez se tengan los perfiles el diseño de las estructuras del modo tradicional.

5.1 Estructuración de los modelos

Los edificios se han estructurado con vigas y columnas de acero, considerando la resistencia a las acciones laterales mediante marcos resistentes a momento, además de marcos ‘’gravitacionales’’ que ayudarán a la resistencia de pesos propios y sobrecargas. Dado lo anterior, la resistencia ante eventos sísmicos estará determinada por la capacidad a flexión de los elementos, así como también del comportamiento de las uniones. La deformación total de las estructuras se limitará con la geometría de las vigas y columnas.

Los edificios son geométricmanete idénticos en planta, sin embargo en altura tenemos 4, 8 y 12 pisos. En todas las estructuras, el primer piso tiene una altura de 4 metros y en los niveles superiores la altura es de 3 metros entre pisos.

Para los tres casos, los ejes resistentes a momento se presentan conectando las vigas a las alas de las columnas. En la dirección del Eje X de este estudio, los ejes resistentes corresponden al eje A y eje D. En esta dirección los ejes B y C se han considerado en el diseño como marcos estáticos, especificando sus conexiones viga-columna como uniones de corte. El sentido del Eje X del modelo será la base para el diseño de las estructuras en este capítulo y en los siguientes, ya que el análisis y posterior comparación de resultados se realizará modificando las uniones de los ejes resistentes A y D.

En la siguiente imagen se muestra la estructuración en planta de los edificios y en las figuras siguientes, las vistas isométricas de los modelos de 4, 8 y 12 pisos:

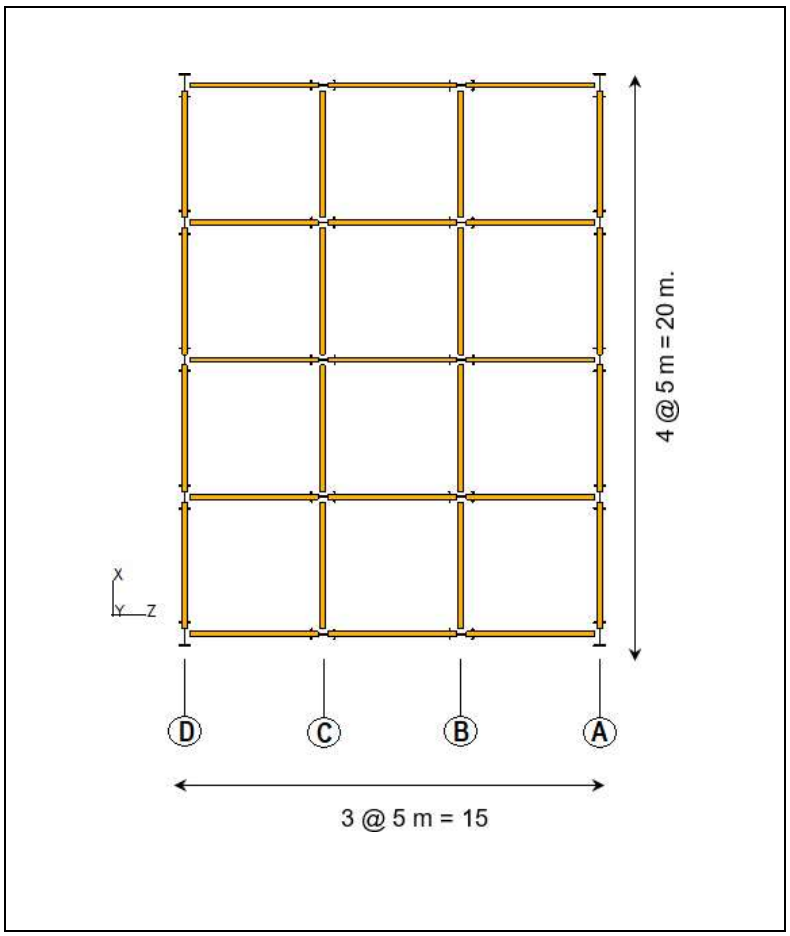


Figura 5.1. Vista de planta de los edificios

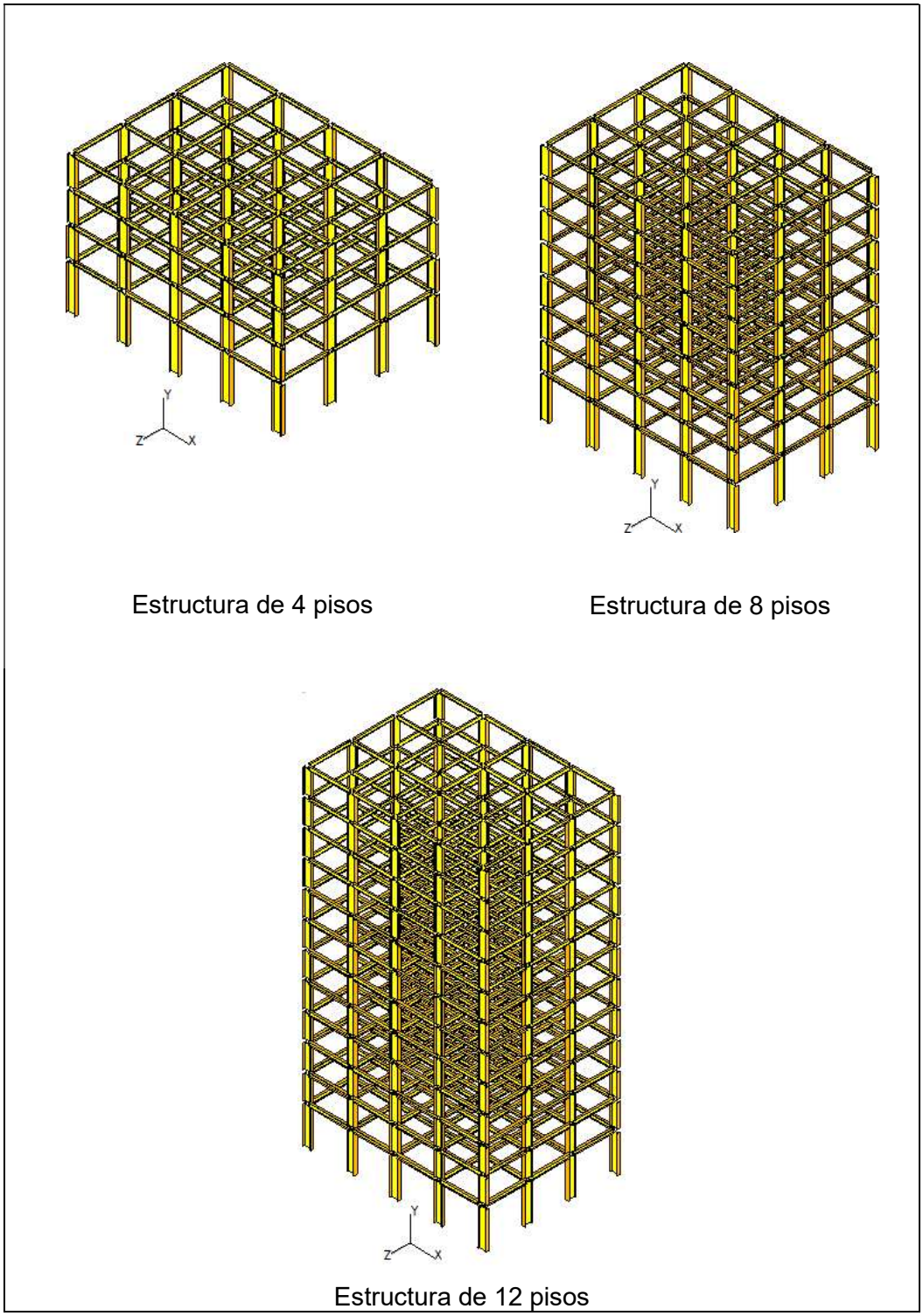


Figura 5.2. Vista Isométrica de las 3 estructuras

5.2 Bases de diseño

Los edificios se han calculado bajo las siguientes hipótesis básicas para diseño elástico.

- Marcos rígidos con conexiones a momento en los ejes resistentes.
- Zona Sísmica 3, de acuerdo a NCh 433 of. 96 Mod.2009 [INN Chile]
- Suelo tipo III, de acuerdo a NCh 433 of.96 Mod.2009 [INN Chile]
- Perfiles de material acero A36 con tensión de fluencia F_y 2530 kg/cm^2
- Cargas
- Peso Propio: perfiles de forma automática por el programa
- Losa de hormigón 15 cm de espesor como carga distribuida de 375 kg/m^2

  Sobrecarga: 250 kg/m^2 para piso

  100 kg/m^2 para techo

  Sismo: de acuerdo a NCh 433 of. 96 Mod.2009 [INN Chile]

  Viento: de acuerdo a NCh 432 of. 71

- Combinaciones de carga de acuerdo a NCh 433 of. 96 Mod.2009 [INN Chile] considerando torsión accidental mediante desplazamiento de centros de masas.

La carga sísmica utilizada para la obtención de las fuerzas sísmicas considera el 100% de los pesos propios y el 25% de la sobrecarga.

Las deformaciones máximas deben estar limitadas a lo que estipula la norma chilena.

'El desplazamiento relativo máximo entre dos pisos consecutivos, medido en el centro de masas en cada una de las direcciones de análisis, no debe ser mayor que la altura de entrepiso multiplicada por 0.002'.

'El desplazamiento relativo máximo entre dos pisos consecutivos, medido en cualquier punto de la planta en cada una de las direcciones de análisis, no debe exceder en más de 0.001h al desplazamiento relativo correspondiente medido en el centro de masa, en que h es la altura de entrepiso'.

5.3 Geometría de diseño

Los edificios fueron diseñados de acuerdo a las hipótesis antes mencionadas con perfiles tipo “doble T” de acero A36 y verificados de acuerdo a método de tensiones admisibles.

5.3.1 Edificio de 4 pisos

Los marcos resistentes de este edificio muestran la siguiente geometría

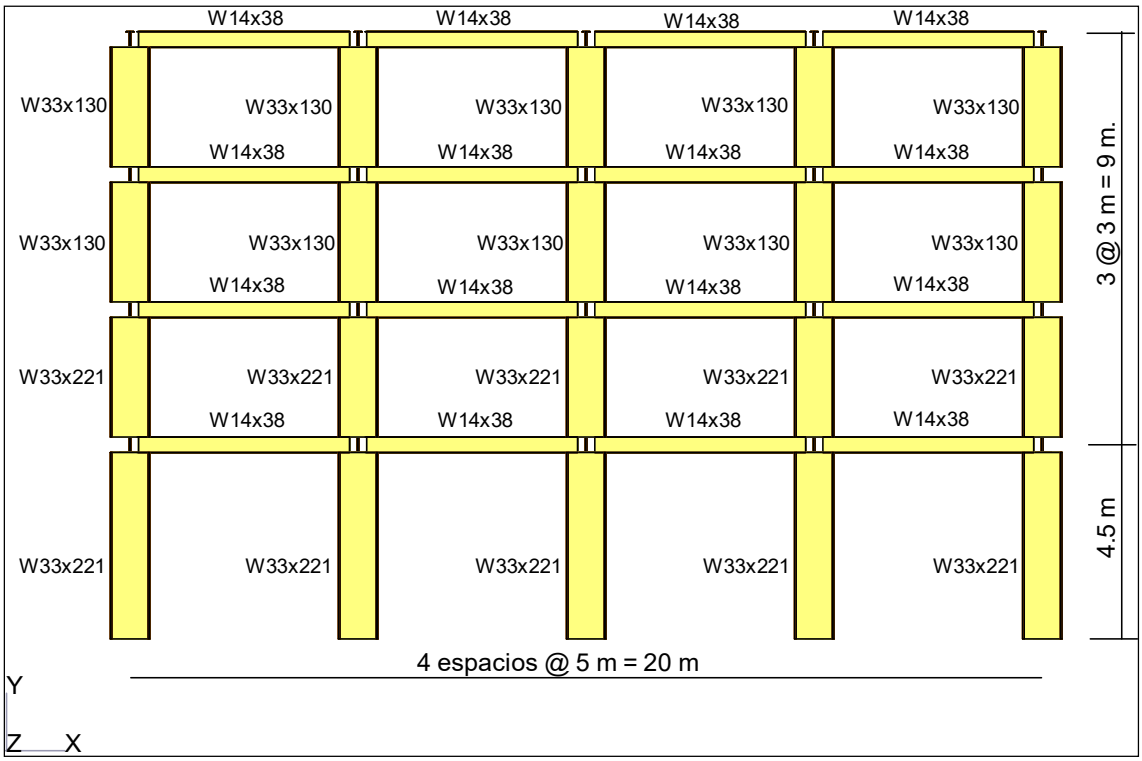


Figura 5.3. Eje Resistente Edificio de 4 pisos.

Las propiedades de los perfiles indicados en la figura 5.3 son las siguientes:

Tabla 5.1 Propiedades perfiles utilizados en diseño

Perfil	H (cm)	B (cm)	e (cm)	t (cm)	b/e	h/t
W33x221	86,2	40,1	3,24	1,97	6,19	40,46
W33x130	84	29,2	2,17	1,47	9,93	54,2
W14x38	35,8	17,2	1,4	0,8	6,14	41,3

H : Altura total del perfil

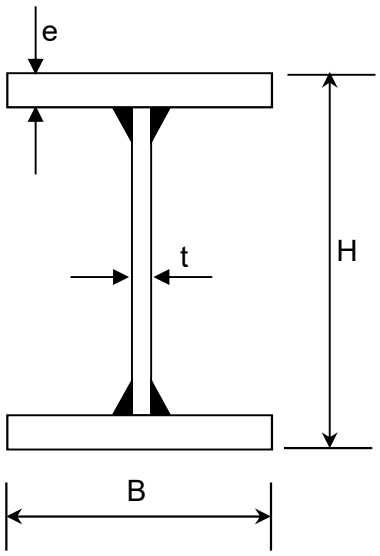
B : Ancho de ala del perfil

e : Espesor del ala del perfil

t : Espesor del alma del perfil

b : B/2

h : H-2e



5.3.2 Edificio de 8 pisos

Los marcos resistentes de este edificio muestran la siguiente geometría:

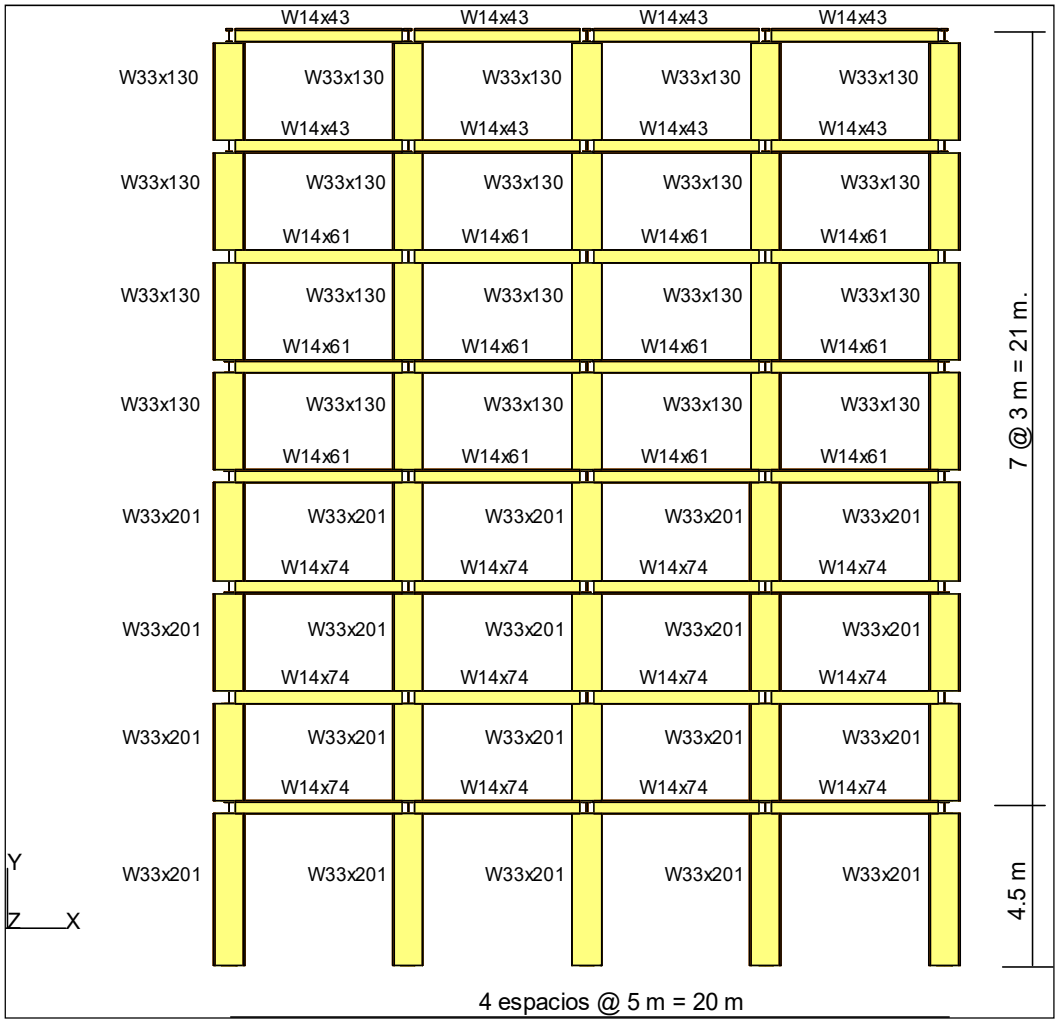


Figura 5.4. Eje Resistente Edificio de 8 pisos.

Las propiedades de los perfiles indicados en la figura 5.4 son las siguientes:

Tabla 5.2 Propiedades perfiles utilizados en diseño

Perfil	H (cm)	B (cm)	e (cm)	t (cm)	b/e	h/t
W33x201	85,5	40	2,92	1,82	6,85	43,8
W33x130	84	29,2	2,17	1,47	9,93	54,2
W14x74	36	25,6	1,99	1,14	6,43	28,1
W14x61	35,3	25,4	1,64	0,95	7,74	33,7
W14x43	34,7	20,3	1,35	0,77	7,52	41,6

5.3.3 Edificio de 12 pisos

Los marcos resistentes de este edificio muestran la siguiente geometría:

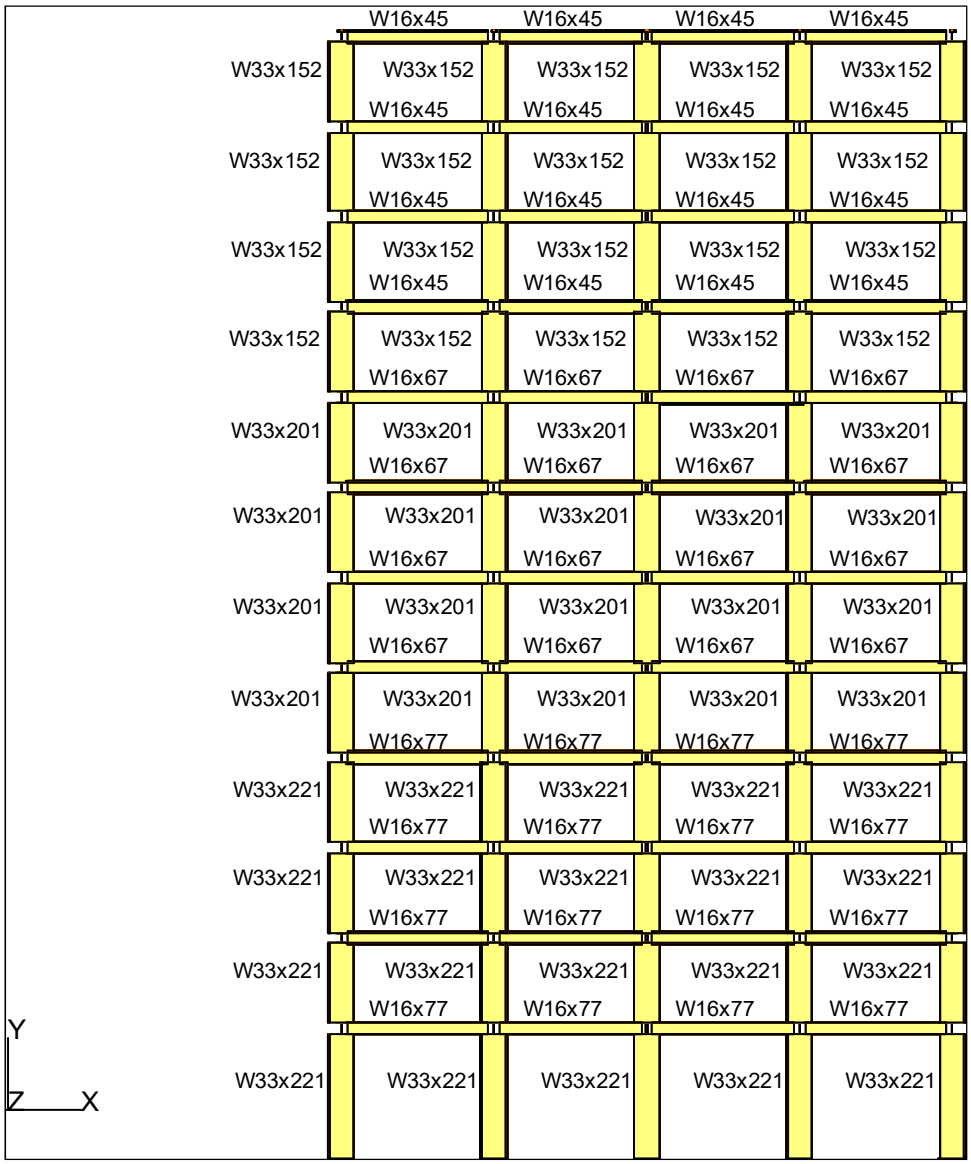


Figura 5.5. Eje Resistente Edificio de 12 pisos.

Las propiedades de los perfiles indicados en la figura 5.5 son las siguientes:

Tabla 5.3 Propiedades perfiles utilizados en diseño

Perfil	H (cm)	B (cm)	e (cm)	t (cm)	b/e	h/t
W33x221	86,2	40,1	3,24	1,97	6,19	40,46
W33x201	85,5	40	2,92	1,82	6,85	43,8
W33x152	85,1	29,4	2,68	1,61	5,49	49,53
W16x45	41	17,9	1,44	0,88	6,22	43,3
W16x67	41,5	26	1,69	1,0	7,69	38,1
W16x77	42	26,1	1,93	1,16	6,76	32,8

5.4 Resumen del diseño de las estructuras

A continuación se presenta el resumen del diseño de los tres edificios. Estos resultados fueron obtenidos al aplicar la norma NCH 433 of 96 Mod 2009 [INN Chile], en cuanto a esfuerzos y deformaciones. Se muestran también los gráficos para identificar claramente la zona del espectro en el cual se encuentra la estructura, indicando además el corte máximo y mínimo, y el gráfico de los desplazamientos admisibles y obtenidos del análisis.

5.4.1 Estructura 4 pisos

Los parámetros para la obtención del espectro de diseño para la estructura de 4 pisos son los siguientes:

$$Sa = \frac{I \cdot A_0 \cdot \alpha}{R^*} \qquad \textit{Ecuación 5.1}$$

Donde:

$I = 1$

$A_0 = 0{,}4g$

$$\alpha = \frac{1+4{,}5\cdot\left(\frac{T_n}{T_0}\right)^p}{1+\left(\frac{T_n}{T_0}\right)^3}$$ *Ecuación 5.2*

$$R^* = 1 + \frac{T^*}{0{,}1T_0 + \frac{T^*}{R_0}} = 5{,}42$$ *Ecuación 5.3*

T_0 = 0,75 (parámetro dependiente del tipo de suelo)

p = 1,0 (parámetro dependiente del tipo de suelo)

S = 1,2 (parámetro dependiente del tipo de suelo)

R_0 = 11

T^* = 0,55 (s)

Los cortes límites son los siguientes:

$$V_{min} = \frac{A_0}{6g}$$ *Ecuación 5.4*

$$V_{max} = \frac{0{,}35\cdot S\cdot A_0}{g}$$ *Ecuación 5.5*

Con lo cual se obtiene el siguiente gráfico:

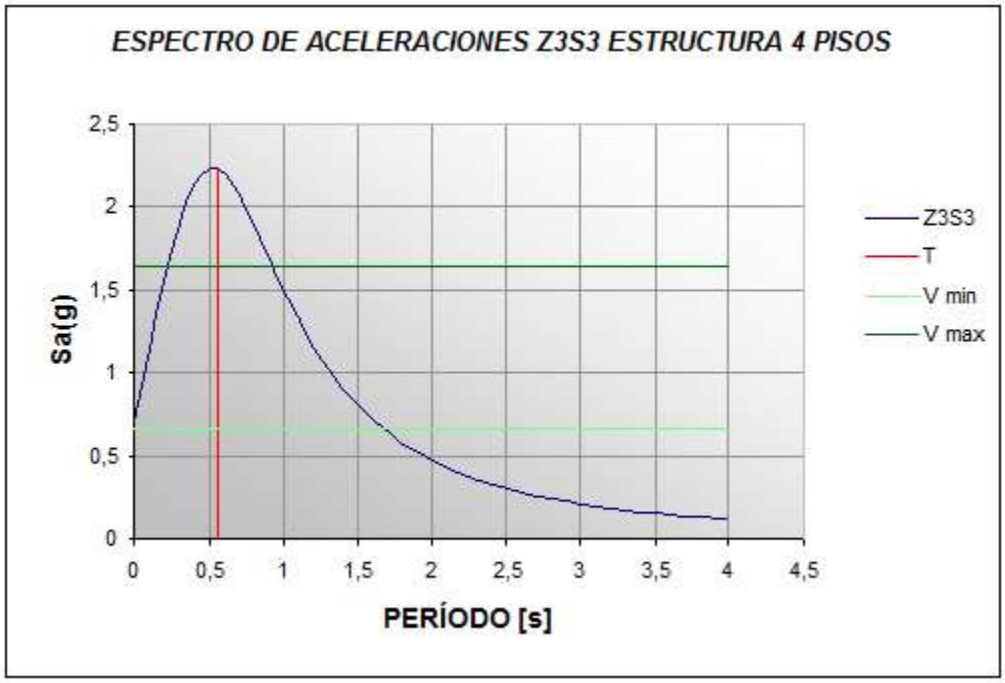


Figura 5.6. Espectro de aceleraciones Estructura 4 pisos.

Como es de esperar para edificios bajos, éstos presentan períodos cortos, por lo cual se ven dominados por el corte máximo. En este caso la reducción de cargas sísmicas debido al corte se ha realizado en las combinaciones de cargas, para el caso de la resistencia de los perfiles. El factor de reducción se encuentra dado por el cociente de los cortes de análisis y máximo, como se indica en la siguiente tabla:

Tabla 5.4 Resultados parámetros diseño edificio 4 pisos

Peso Sísmico	:	615,21 ton
Corte Mínimo	:	41,014 ton
Corte Máximo	:	103,36 ton
Corte de Análisis	:	135,95 ton
Factor de Corrección	:	0,76 (aplicable solo a esfuerzos)

Sin embargo la reducción de deformaciones no es permitida por la norma, por lo tanto, para la obtención de las deformaciones se ha utilizado toda la fuerza sísmica correspondiente. Dado lo anterior se obtienen las siguientes deformaciones, considerando el efecto de torsión accidental en el análisis, mediante desplazamiento de los centros de masa:

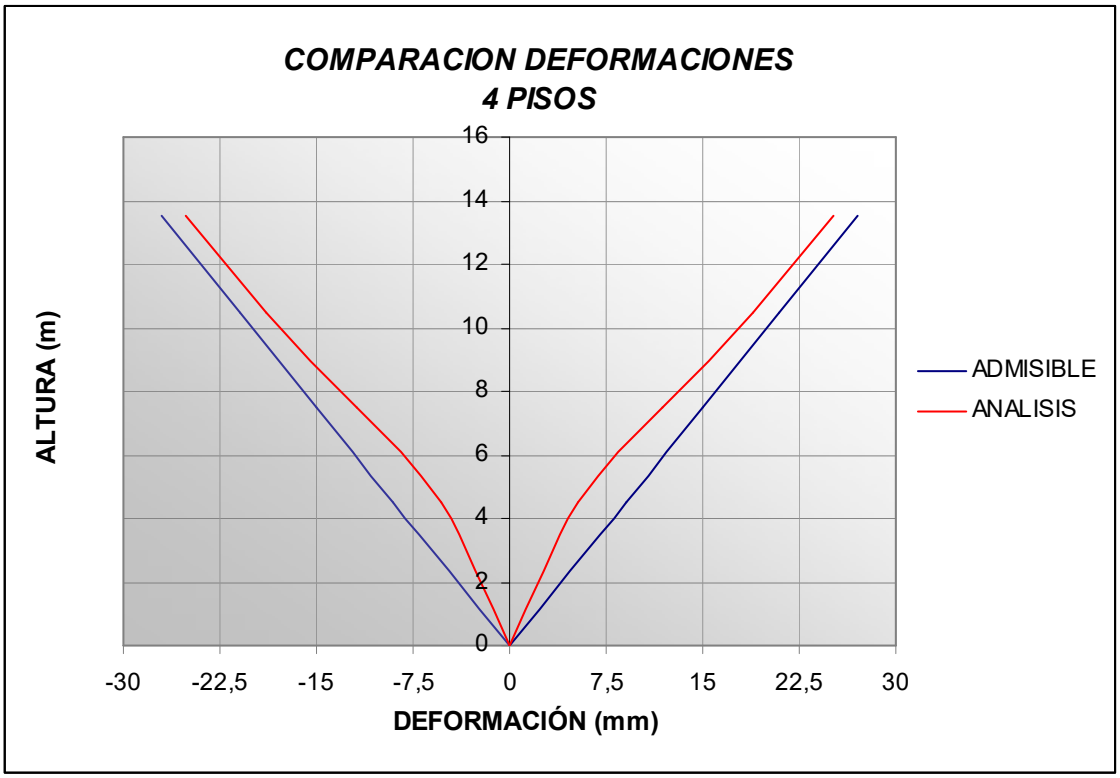


Figura 5.7.Comparación deformación edificio 4 pisos. Deformación de análisis y admisible.

En el gráfico superior se muestra en color rojo la deformación obtenida del análisis, y en azul la deformación máxima permimtida por la normativa. Como es posible apreciar, las deformaciones no sobrepasan las admisibles y además como se muestra en el gráfico a continuación, los esfuerzos tampoco sobrepasan los máximos.

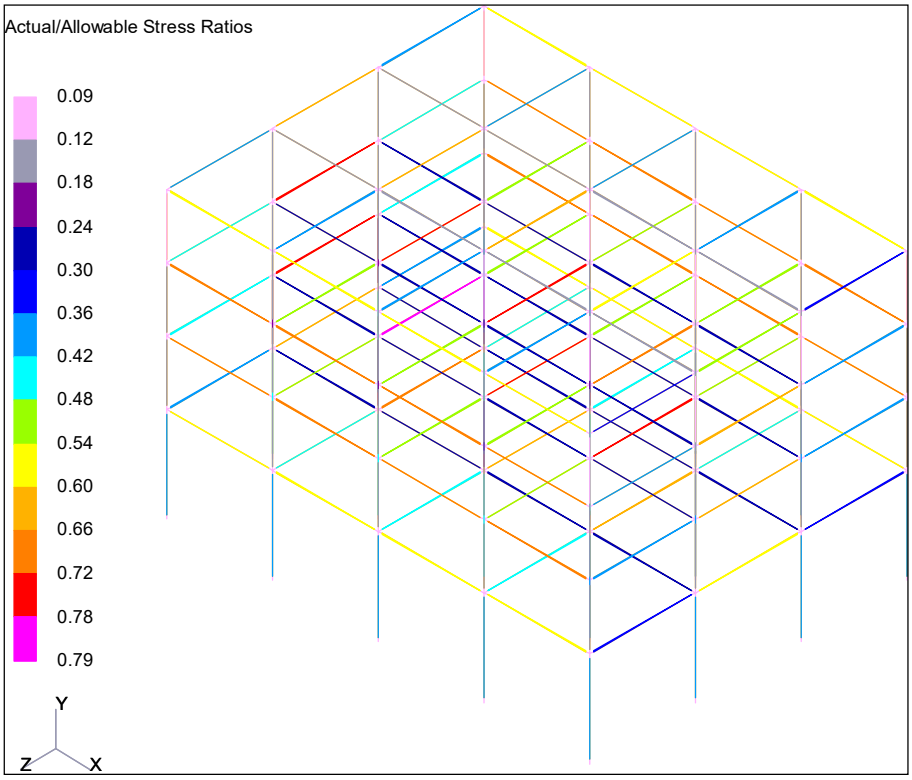


Figura 5.8.Ratios esfuerzos en edificio

5.4.2 Estructura 8 pisos

Los parámetros para la obtención del espectro de diseño para la estructura de 8 pisos son similares a los indicados para la estructura de 4 pisos, considerando obviamente la diferencia en el período:

$$Sa = \frac{I \cdot A_0 \cdot \alpha}{R^*}$$

Donde

I = 1

A_0 = 0,4g

$$\alpha = \frac{1 + 4{,}5 \cdot \left(\frac{T_n}{T_0}\right)^p}{1 + \left(\frac{T_n}{T_0}\right)^3}$$

$$R^* = 1 + \frac{T^*}{0{,}1T_0 + \frac{T^*}{R_0}} = 6{,}997$$

T_0 = 0,75 (parámetro dependiente del tipo de suelo)

p = 1,0 (parámetro dependiente del tipo de suelo)

S = 1,2 (parámetro dependiente del tipo de suelo)

R_0 = 11

T^* = 0,989 (s)

$$V_{min} = \frac{A_0}{6g}$$

$$V_{max} = \frac{0{,}35 \cdot S \cdot A_0}{g}$$

Con lo cual se obtiene el siguiente gráfico:

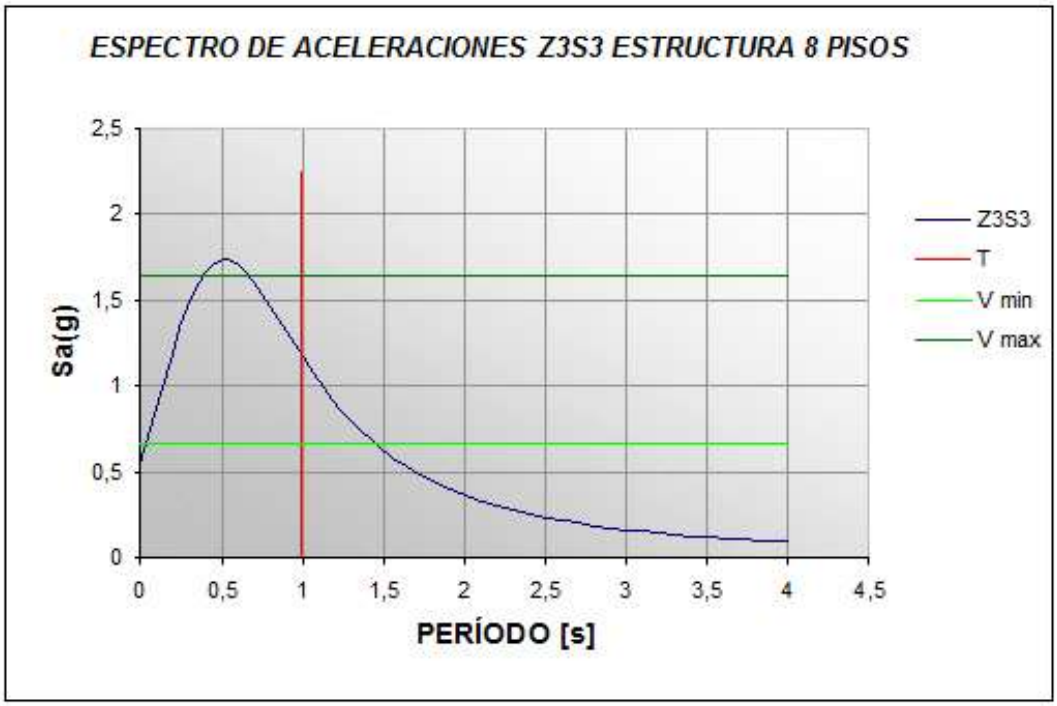


Figura 5.9. Espectro de aceleraciones Estructura 8 pisos.

Del gráfico anterior podemos ver que el período de la estructura induce a que las fuerzas sísmicas se encuentren entre el máximo y el mínimo, por lo tanto no corresponden modificaciones ni a los esfuerzos ni a los desplazamientos. Dado esto, el gráfico de deformaciones de la estructura es el siguiente:

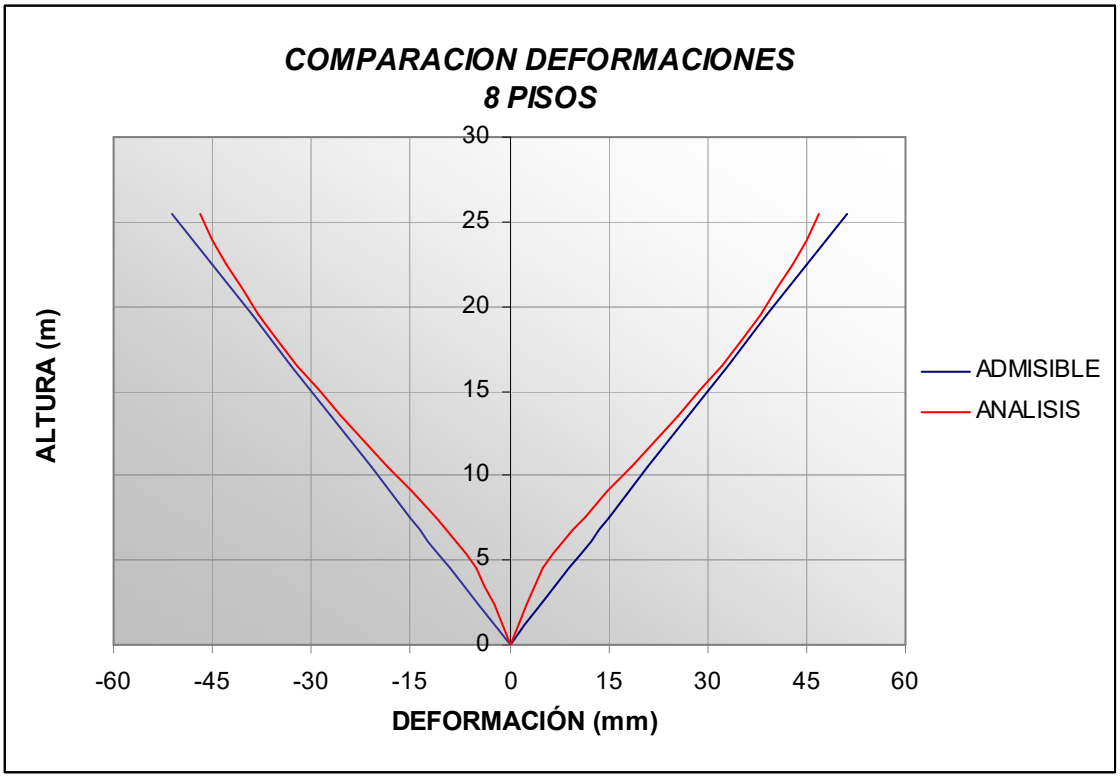


Figura 5.10.Comparación deformación edificio 8 pisos. Deformación de análisis y admisible.

Las tensiones admisibles de la estructura tampoco sobrepasan las máximas admisibles.

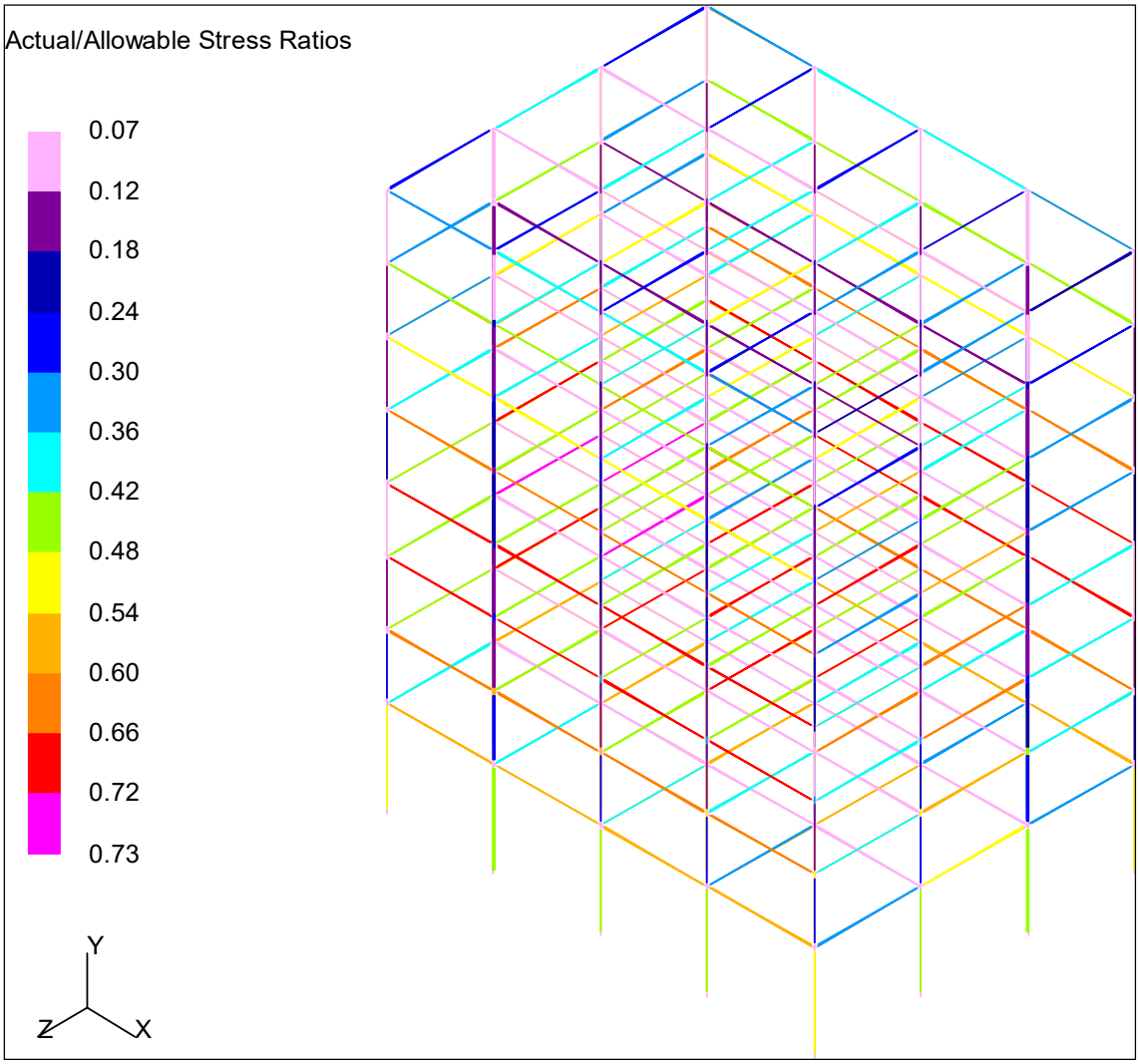


Figura 5.11.Ratios esfuerzos en edificio

5.4.3 Estructura 12 pisos

Al igual que en los modelos anteriores, los parámetros para la obtención del espectro de diseño son:

$$Sa = \frac{I \cdot A_0 \cdot \alpha}{R^*}$$

Donde:

I = 1

A_0 = 0,4g

$$\alpha = \frac{1+4{,}5\cdot\left(\frac{T_n}{T_0}\right)^p}{1+\left(\frac{T_n}{T_0}\right)^3}$$

$$R^* = 1+\frac{T^*}{0{,}1T_0+\frac{T^*}{R_0}} = 7{,}88$$

T_0 = 0,75 (parámetro dependiente del tipo de suelo)

p = 1,0 (parámetro dependiente del tipo de suelo)

S = 1,2 (parámetro dependiente del tipo de suelo)

R_0 = 11

T^* = 1,38 (s)

$$V_{min} = \frac{A_0}{6g}$$

$$V_{max} = \frac{0{,}35\cdot S\cdot A_0}{g}$$

Con lo cual se obtiene el siguiente gráfico:

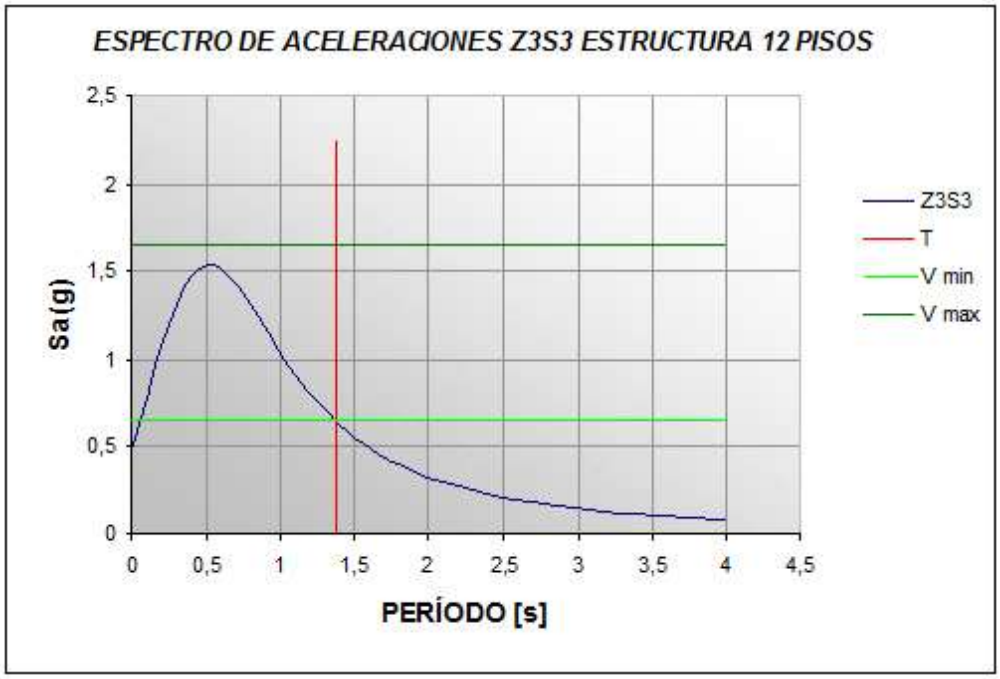


Figura 5.12. Espectro de aceleraciones Estructura 8 pisos.

Aunque se encuentre al límite, el período de la estructura se encuentra por debajo del corte mínimo, por lo cual es necesario amplificar las fuerzas y las deformaciones. La tabla siguiente muestra los valores del análisis, límites y factores correctivos para obtener el corte de diseño

Tabla 5.5 Resultados parámetros diseño edificio 12 pisos

Peso Sísmico	:	1881,9 ton
Corte Mínimo	:	125,5 ton
Corte Máximo	:	316,2 ton
Corte de Análisis	:	111,6 ton
Factor de Corrección	:	1,02 (aplicable a esfuerzos y deformaciones)

El siguiente gráfico muestra las deformaciones ya amplificadas, las cuales aún al límite, se encuentran dentro de lo solicitado por la norma.

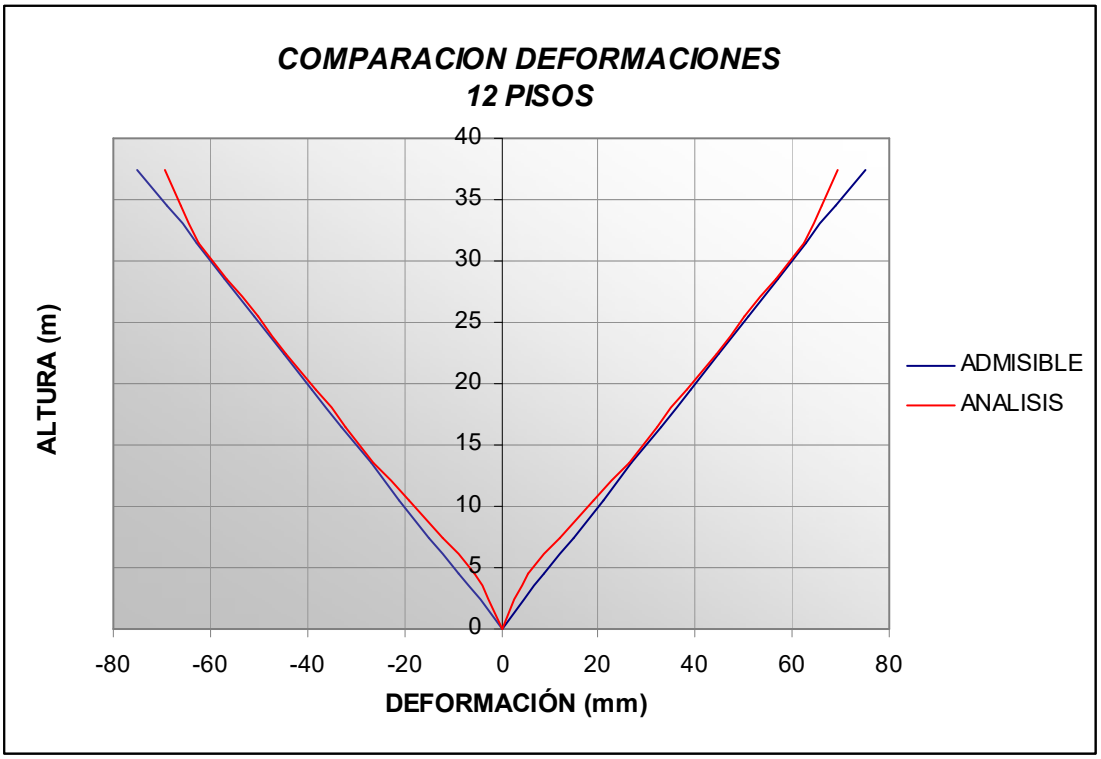


Figura 5.13.Comparación deformación edificio 12 pisos. Deformación de análisis y admisible.

Del mismo modo, a continuación, se presenta la imagen con las tensiones máximas de la estructura, las cuales no sobrepasan las admisibles. Como es posible notar, la condición de diseño de esta estructura se encuentra dada por la limitación de la deformación de entrepiso.

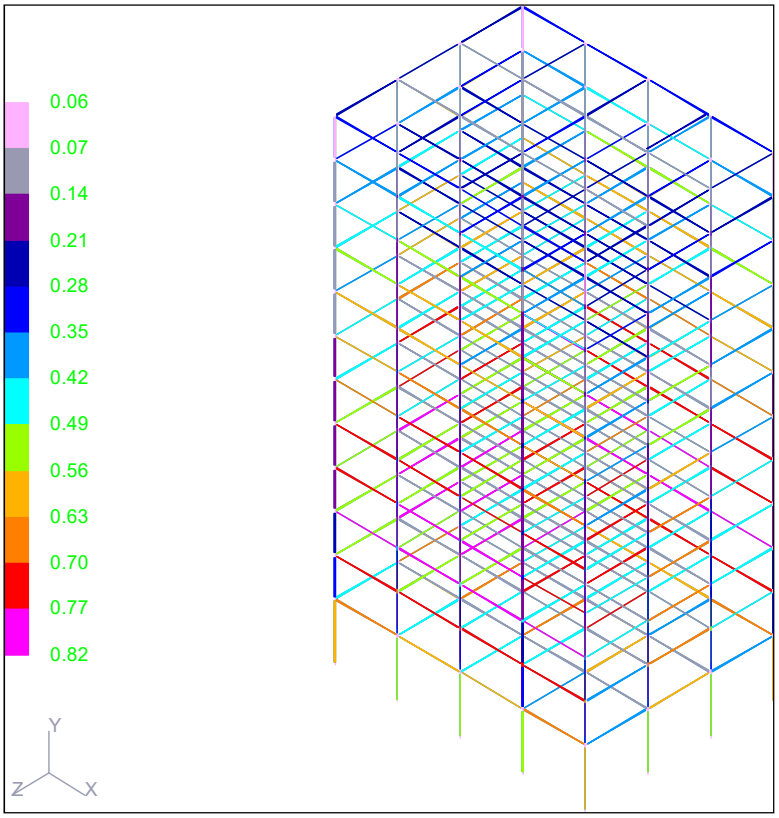


Figura 5.14.Ratios esfuerzos en edificio

En resumen, se puede apreciar que las tres estructuras se encuentran bien diseñadas, en cuanto a resistencia y a deformaciones.

6 DISEÑO DE EDIFICIO CON INFLUENCIA DE LA CONEXIÓN.

6.1 BASES DE DISEÑO

En este capítulo se diseñarán los mismos tres edificios del capítulo anterior, pero en el sentido de los marcos resistentes, Eje X, las uniones de momento entre vigas-columnas, serán consideradas como elementos resistentes a momento equivalentes al 70% del Mp de la viga a conectar, de tal forma de darle a la conexión la rigidez límite con la cual esta se considera como "conexión de momento". De esta forma se verificarán esfuerzos y deformaciones, con los mismos perfiles obtenidos en el caso anterior, y en el capítulo siguiente se compararán las diferencias entre los diseños obtenidos.

Los edificios se han calculado bajo las siguientes hipótesis básicas para diseño elástico.

- Marcos rígidos con conexiones a momento, de acuerdo a gráfico momento - curvatura de estas uniones para cada eje resistente.
- Zona Sísmica 3, de acuerdo a NCh 433 of. 96 Mod. 2009 [INN Chile].
- Suelo tipo III, de acuerdo a NCh 433 of.96 Mod. 2009 [INN Chile].
- Perfiles de material acero A36 con tensión de fluencia Fy 2530 kg/cm2
- Cargas
- Peso Propio: perfiles de forma automática por el programa
- Losa de hormigón 15 cm de espesor como carga distribuida de 375 kg/m2

  Sobrecarga: 250 kg/m2 para piso
  100 kg/m2 para techo
  Sismo: de acuerdo a NCh 433 of. 96 Mod. 2009 [INN Chile].
  Viento: de acuerdo a NCh 432 of. 71
- Combinaciones de carga de acuerdo a NCh 433 of. 96 Mod. 2009 [INN Chile] considerando torsión accidental mediante desplazamiento de centros de masas.

La carga sísmica utilizada para la obtención de las fuerzas sísmicas considera el 100% de los pesos propios y el 25% de la sobrecarga.

Las deformaciones máximas deben estar limitadas a lo que estipula la norma chilena:

'El desplazamiento relativo máximo entre dos pisos consecutivos, medido en el centro de masas en cada una de las direcciones de análisis, no debe ser mayor que la altura de entrepiso multiplicada por 0.002'.

'El desplazamiento relativo máximo entre dos pisos consecutivos, medido en cualquier punto de la planta en cada una de las direcciones de análisis, no debe exceder en más de 0.001h al desplazamiento relativo correspondiente medido en el centro de masa, en que h es la altura de entrepiso'.

6.2 RESULTADOS DEL DISEÑO

6.2.1 Estructura de 4 pisos

Los perfiles de esta estructura son idénticos a los utilizados en el capítulo anterior, de tal forma que solo ha cambiado la unión viga columna en los ejes resistentes en sentido XX.

En este caso la viga a conectar corresponde a W14x38, con lo cual, las propiedades que determinan la rigidez de la conexión son:

Tabla 6.1 Parámetros de unión idealizada viga de diseño

Beam	Material	d	I	Z	Ff	Mp	0.7 Mp	0.2 Mp
		m	m^4	m^3	kg/m^2	KN-m		
W14X38	A36	0,358	0,000167	0,001046	25344000	259,8	181,9	51,96

De los datos anteriores se obtiene la siguiente curva de la unión:

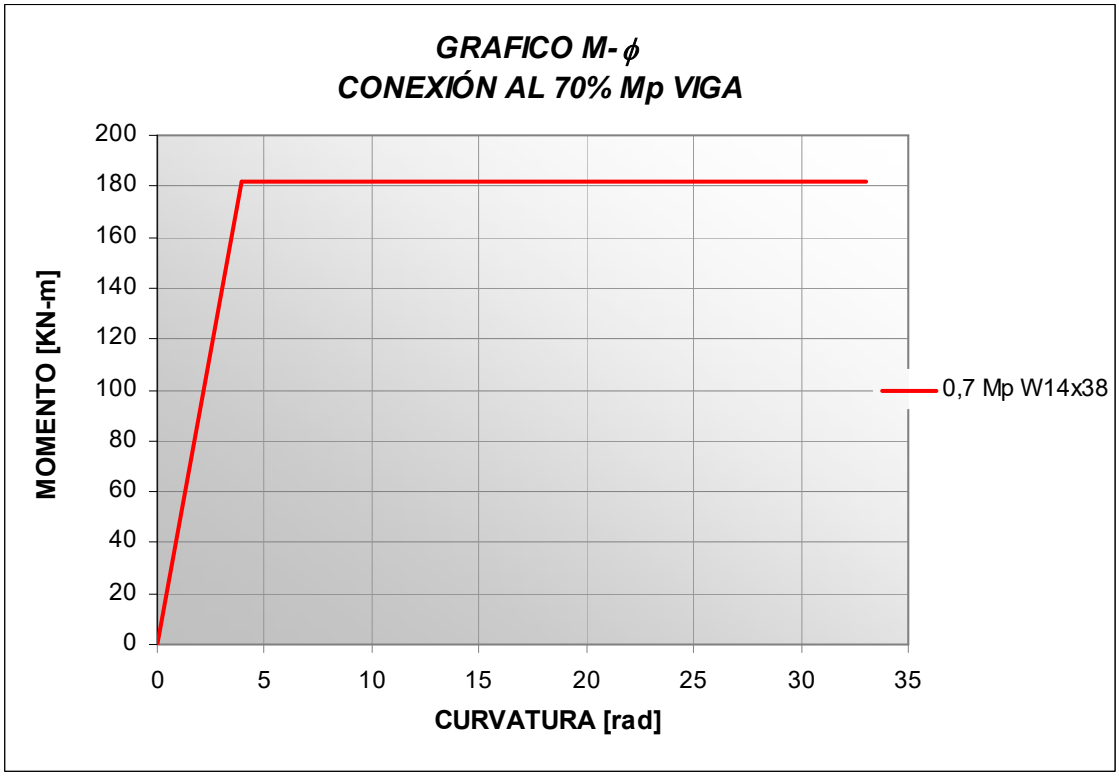


Figura 6.1.Momento curvatura unión al 70% viga de diseño

Los parámetros para la obtención del espectro de diseño para la estructura de 4 pisos son los siguientes:

$$Sa = \frac{I \cdot A_0 \cdot \alpha}{R^*}$$

Donde:

I = 1

A_0 = 0,4g

$$\alpha = \frac{1 + 4{,}5 \cdot \left(\frac{T_n}{T_0}\right)^p}{1 + \left(\frac{T_n}{T_0}\right)^3}$$

$$R^* = 1 + \frac{T^*}{0{,}1T_0 + \frac{T^*}{R_0}} = 5{,}74$$

T_0 = 0,75 (parámetro dependiente del tipo de suelo)

p = 1,0 (parámetro dependiente del tipo de suelo)

S = 1,2 (parámetro dependiente del tipo de suelo)

R_0 = 11

T^* = 0,624(s)

$$V_{min} = \frac{A_0}{6g}$$

$$V_{max} = \frac{0{,}35 \cdot S \cdot A_0}{g}$$

Con lo cual se obtiene el siguiente gráfico:

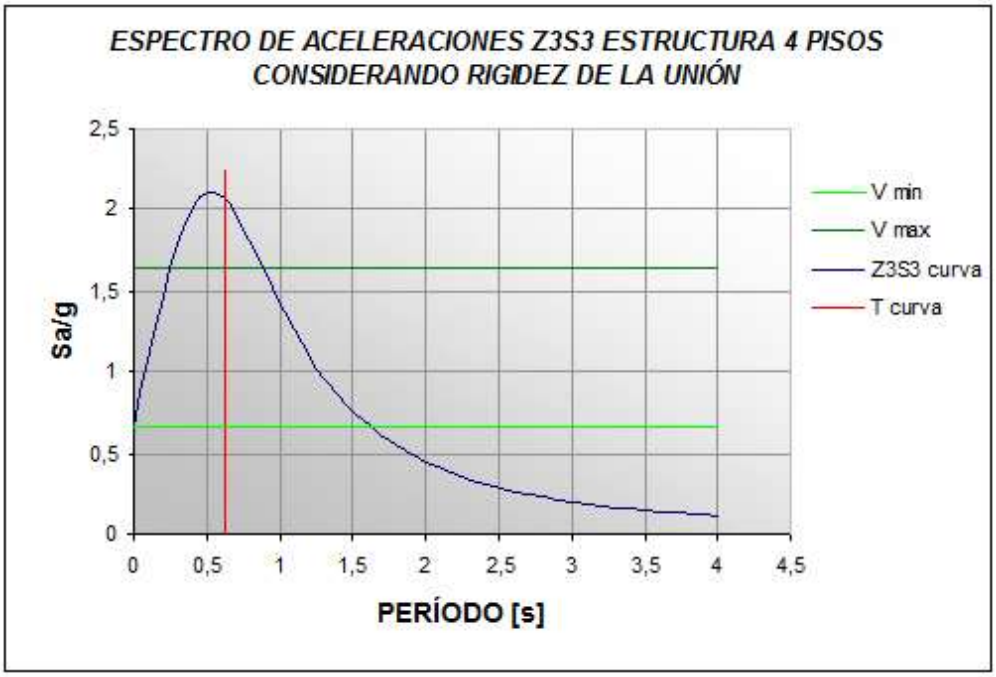


Figura 6.2.Espectro de aceleraciones considerando rigidez de la unión.

Al igual que en el capítulo anterior, el edificio presenta un período bajo, pero mayor al obtenido con la idealización de la unión de momento. La reducción de cargas sísmica debido al corte se ha realizado en las combinaciones de cargas, para el caso de la resistencia de los perfiles. El factor de reducción se encuentra dado por el cociente de los cortes de análisis y máximo, como se indica en la siguiente tabla, y dado que el corte de análisis es menor al obtenido anteriormente, el coeficiente de reducción es menor.

Tabla 6.2 Resultados parámetros diseño edificio 4 pisos incluye rigidez de la unión

Peso Sísmico	:	615,21 ton
Corte Mínimo	:	41,014 ton
Corte Máximo	:	103,36 ton
Corte de Análisis	:	121,13 ton
Factor de Corrección	:	0,853 (aplicable solo a esfuerzos)

El siguiente gráfico muestra la deformación a la que está sujeta la estructura y su comparación con la admisible.

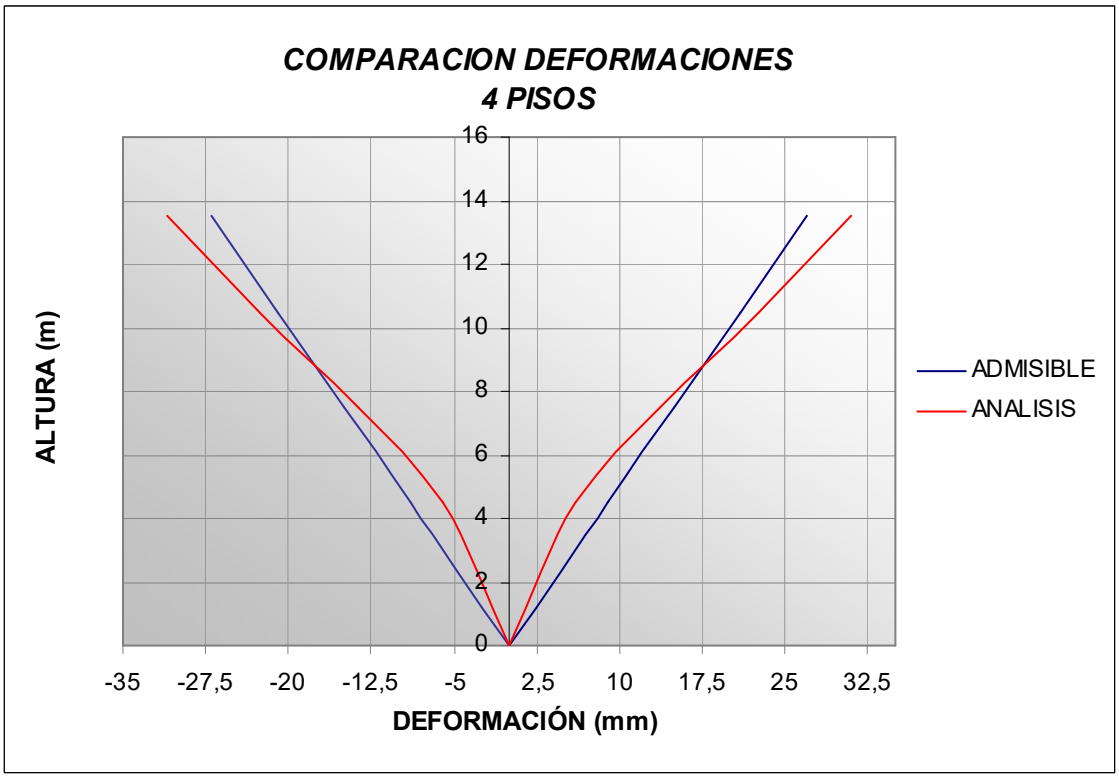


Figura 6.3.Comparación deformación edificio 4 pisos. Deformación de análisis y admisible. Incluye rigidez de la unión

Se presenta a continuación el gráfico de esfuerzos de los elementos.

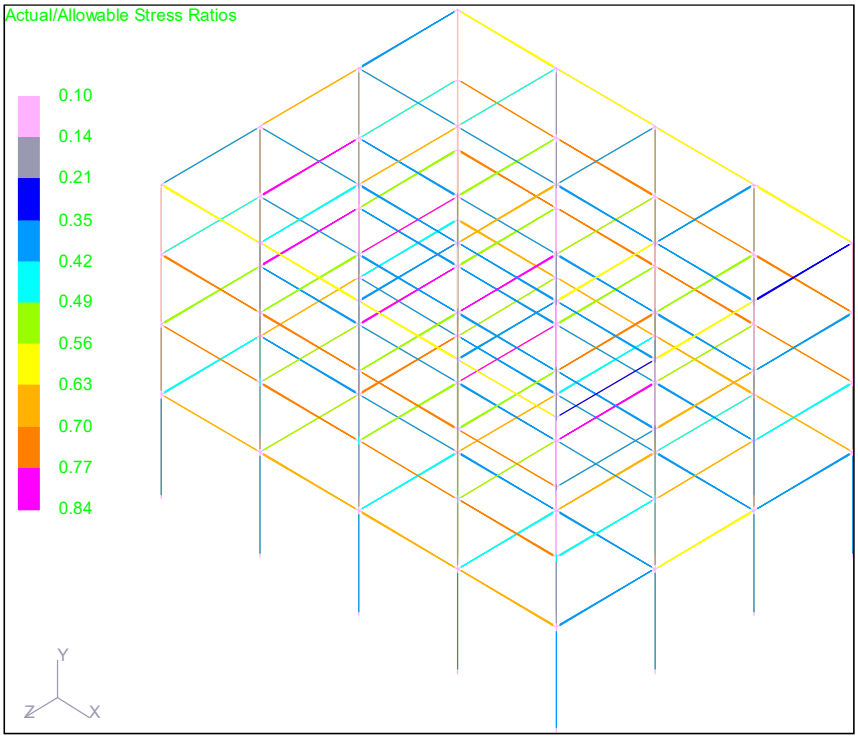


Figura 6.4.Ratios esfuerzos en edificio. Incluye rigidez de la unión.

6.2.2 Estructura de 8 pisos

Los perfiles de esta estructura son idénticos a los utilizados en el capítulo anterior, de tal forma que solo ha cambiado la unión viga columna en los ejes resistentes en sentido XX.

Tabla 6.3 Parámetros de unión idealizada para vigas de diseño

Beam	Material	d	I	Z	Ff	Mp	0.7 Mp	0.2 Mp
		m	m^4	m^3	kg/m^2	KN-m		
W14X43	A36	0,347	0,000178	0,00103	25344000	255,82	179,08	51,16
W14X61	A36	0,353	0,000266	0,00151	25344000	375,041	262,53	75,01
W14X74	A36	0,36	0,000331	0,00184	25344000	457,00	319,90	91,40

De los datos anteriores se obtienen las siguientes curvas de la unión,

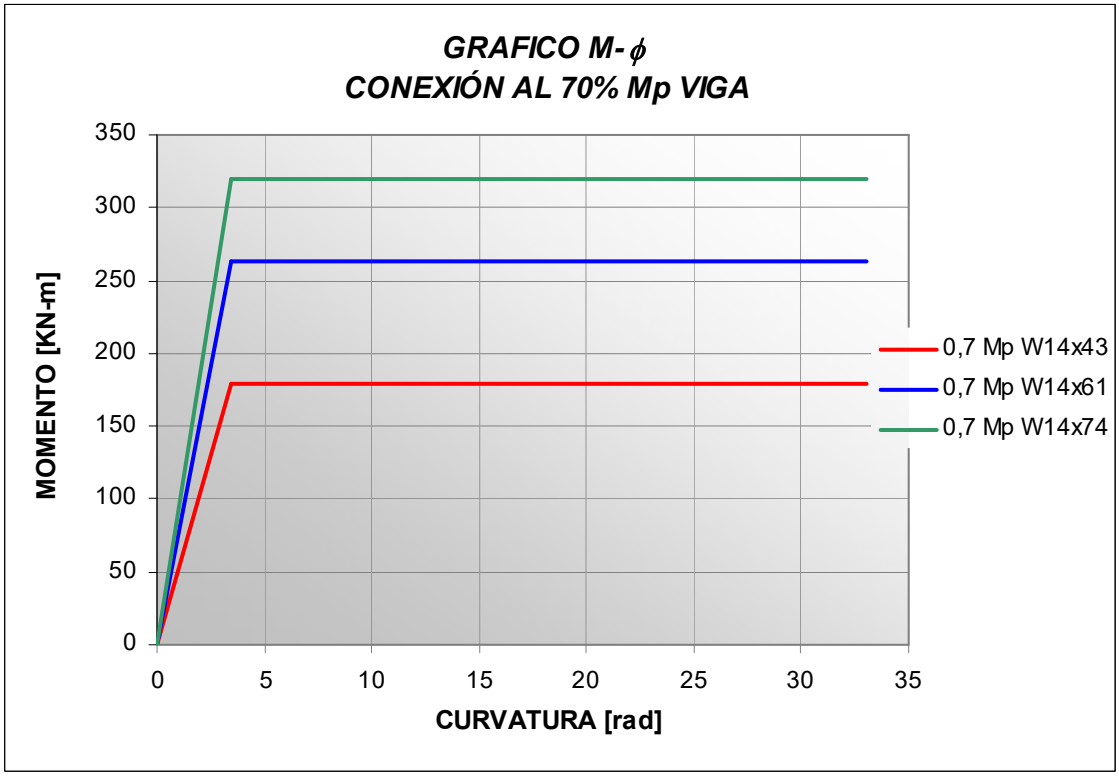


Figura 6.5.Momento curvatura unión al 70% vigas de diseño

Los parámetros para la obtención del espectro de diseño para la estructura de 8 pisos son los siguientes:

$$Sa = \frac{I \cdot A_0 \cdot \alpha}{R^*}$$

Donde:

I = 1

A_0 = 0,4g

$$\alpha = \frac{1 + 4{,}5 \cdot \left(\frac{T_n}{T_0}\right)^p}{1 + \left(\frac{T_n}{T_0}\right)^3}$$

$$R^* = 1 + \frac{T^*}{0{,}1T_0 + \frac{T^*}{R_0}} = 7{,}49$$

T_0 = 0,75 (parámetro dependiente del tipo de suelo)

p = 1,0 (parámetro dependiente del tipo de suelo)

S = 1,2 (parámetro dependiente del tipo de suelo)

R_0 = 11

T^* = 1,19(s)

$$V_{min} = \frac{A_0}{6g}$$

$$V_{max} = \frac{0{,}35 \cdot S \cdot A_0}{g}$$

Con lo cual se obtiene el siguiente gráfico:

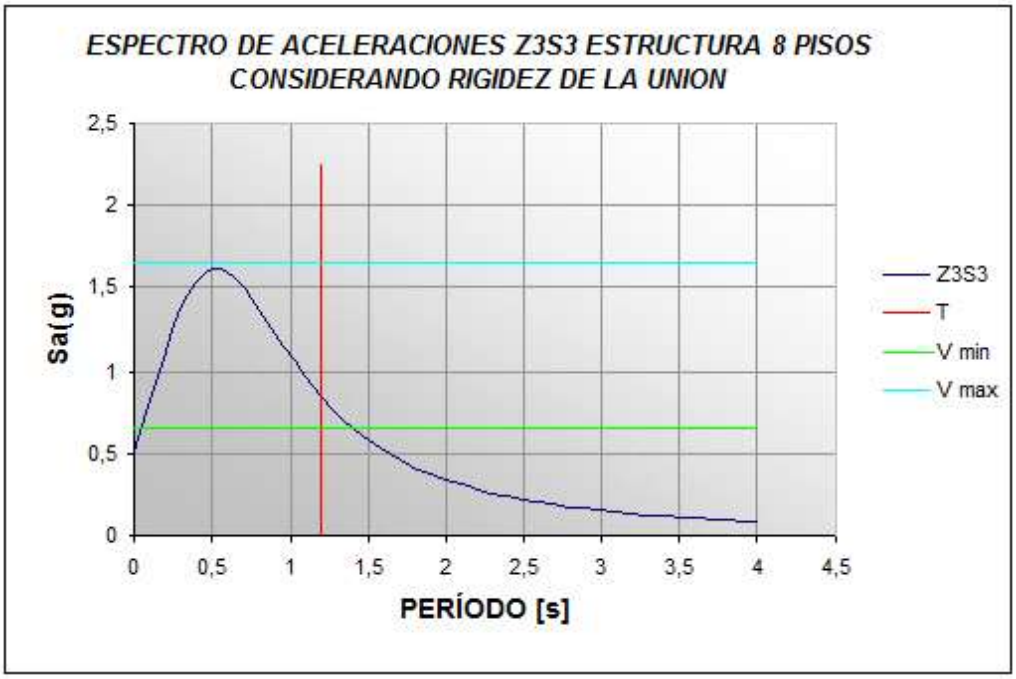


Figura 6.6.Espectro de aceleraciones considerando rigidez de la unión.

En este caso el período de la estructura se encuentra en la zona entre el corte máximo y el corte mínimo, por lo cual no aplican reducciones de esfuerzos, ni amplificaciones a las deformaciones. Los siguientes gráficos presentan las deformaciones correspondientes al análisis y los esfuerzos en los perfiles.

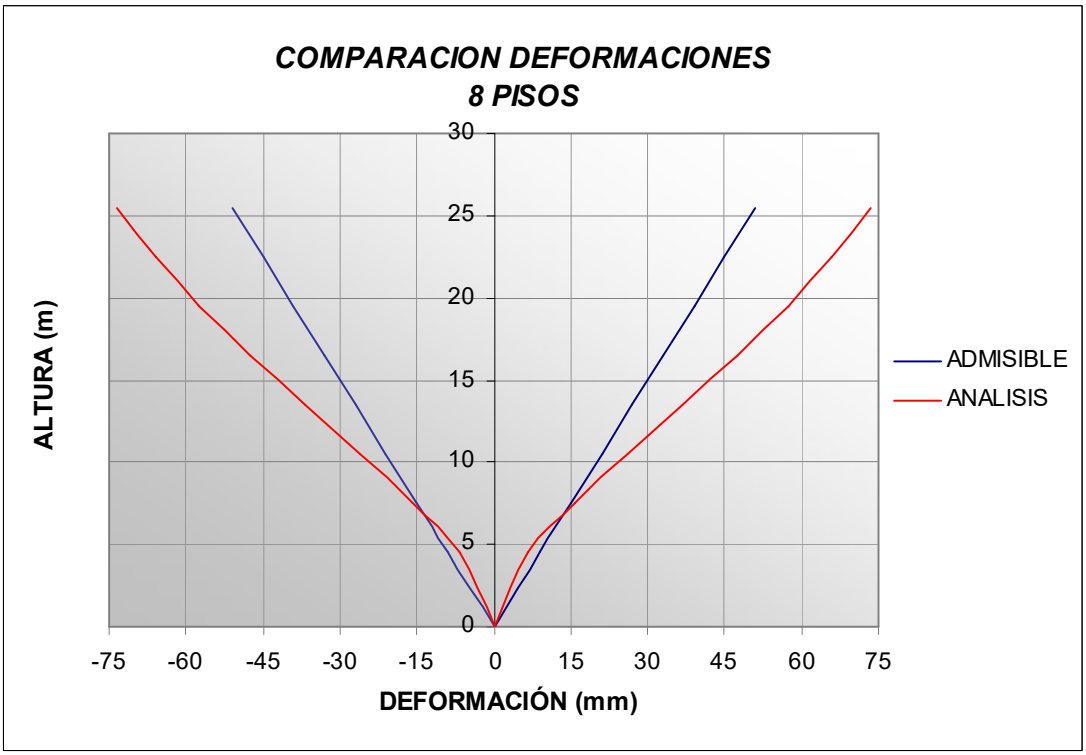


Figura 6.7.Comparación deformación edificio 8 pisos. Deformación de análisis y admisible. Incluye rigidez de la unión

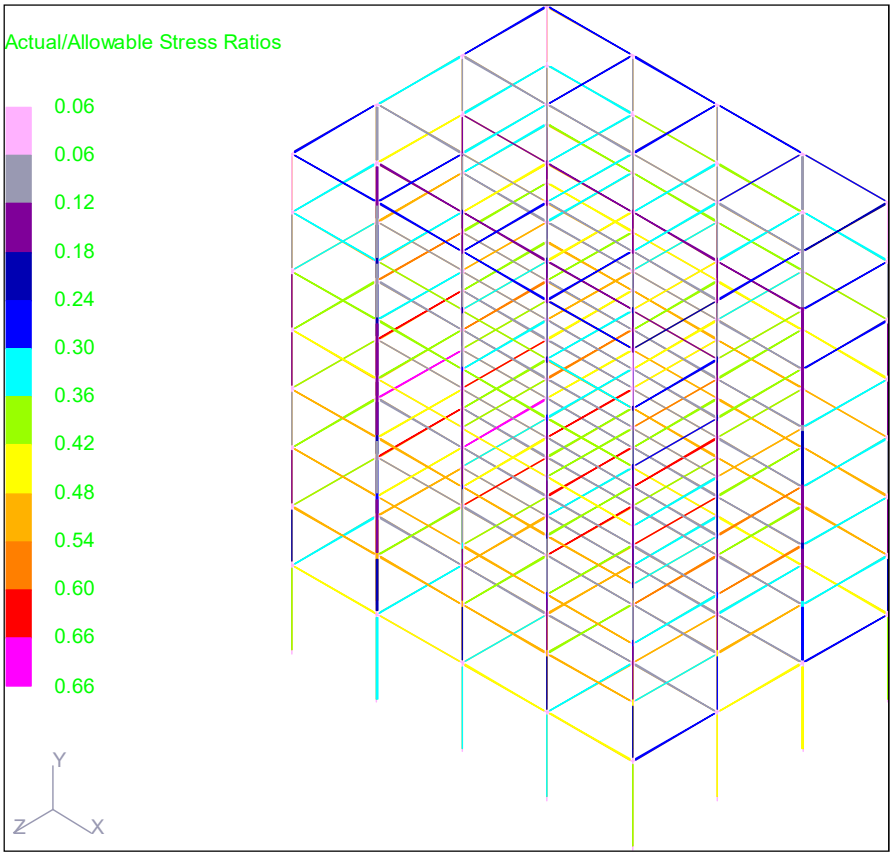


Figura 6.8.Ratios esfuerzos en edificio. Incluye rigidez de la unión.

6.2.3 Estructura de 12 pisos

Los perfiles de esta estructura son idénticos a los utilizados en el capítulo anterior, de tal forma que solo ha cambiado la unión viga columna en los ejes resistentes en sentido del Eje X.

Tabla 6.4 Parámetros de unión idealizada para vigas de diseño

Beam	Material	d	I	Z	Ff	Mp	0.7 Mp	0.2 Mp
		m	m^4	m^3	kg/m^2	KN-m		
W16X45	A36	0,41	0,000244	0,001191	25344000	295,81	207,07	59,16
W16X67	A36	0,42	0,000397	0,00192	25344000	476,87	333,81	95,38
W16X77	A36	0,42	0,000461	0,0022	25344000	546,42	382,49	109,28

De los datos anteriores se obtienen las siguientes curvas de la unión,

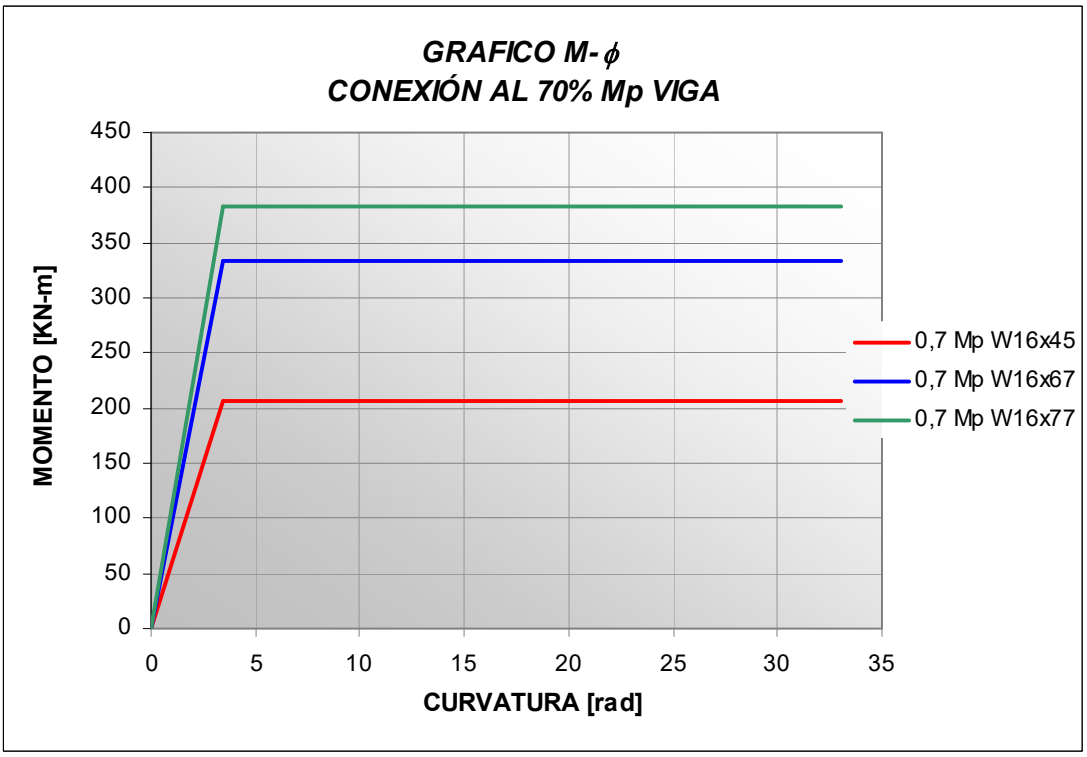


Figura 6.9.Momento curvatura unión al 70% vigas de diseño

Los parámetros para la obtención del espectro de diseño para la estructura de 8 pisos son los siguientes:

$$Sa = \frac{I \cdot A_0 \cdot \alpha}{R^*}$$

Donde

I = 1

A_0 = 0,4g

$$\alpha = \frac{1+4{,}5\cdot\left(\frac{T_n}{T_0}\right)^p}{1+\left(\frac{T_n}{T_0}\right)^3}$$

$$R^* = 1+\frac{T^*}{0{,}1T_0+\frac{T^*}{R_0}} = 8{,}13$$

T_0 = 0,75 (parámetro dependiente del tipo de suelo)

p = 1,0 (parámetro dependiente del tipo de suelo)

S = 1,2 (parámetro dependiente del tipo de suelo)

R_0 = 11

T^* = 1,52(s)

$$V_{min} = \frac{A_0}{6g}$$

$$V_{max} = \frac{0{,}35\cdot S\cdot A_0}{g}$$

Con lo cual se obtiene el siguiente gráfico:

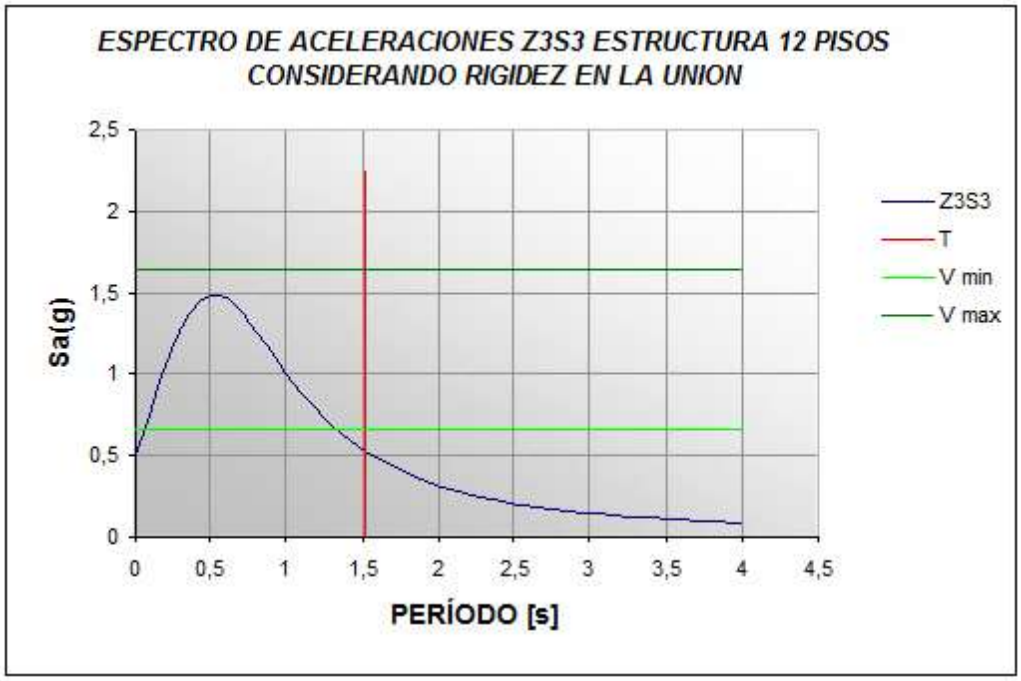


Figura 6.10.Espectro de aceleraciones considerando rigidez de la unión.

En este caso es visible que la estructura presenta un período que ubica el corte de análisis bajo el mínimo

Tabla 6.5 Resultados parámetros diseño edificio 4 pisos incluye rigidez de la unión

Peso Sísmico	:	1881,9359 ton
Corte Mínimo	:	125,46239 ton
Corte Máximo	:	316,16523 ton
Corte de Análisis	:	105,0 ton
Factor de Corrección	:	1,19 (aplicable a esfuerzos y deformaciones)

El siguiente gráfico muestra las deformaciones ya amplificadas:

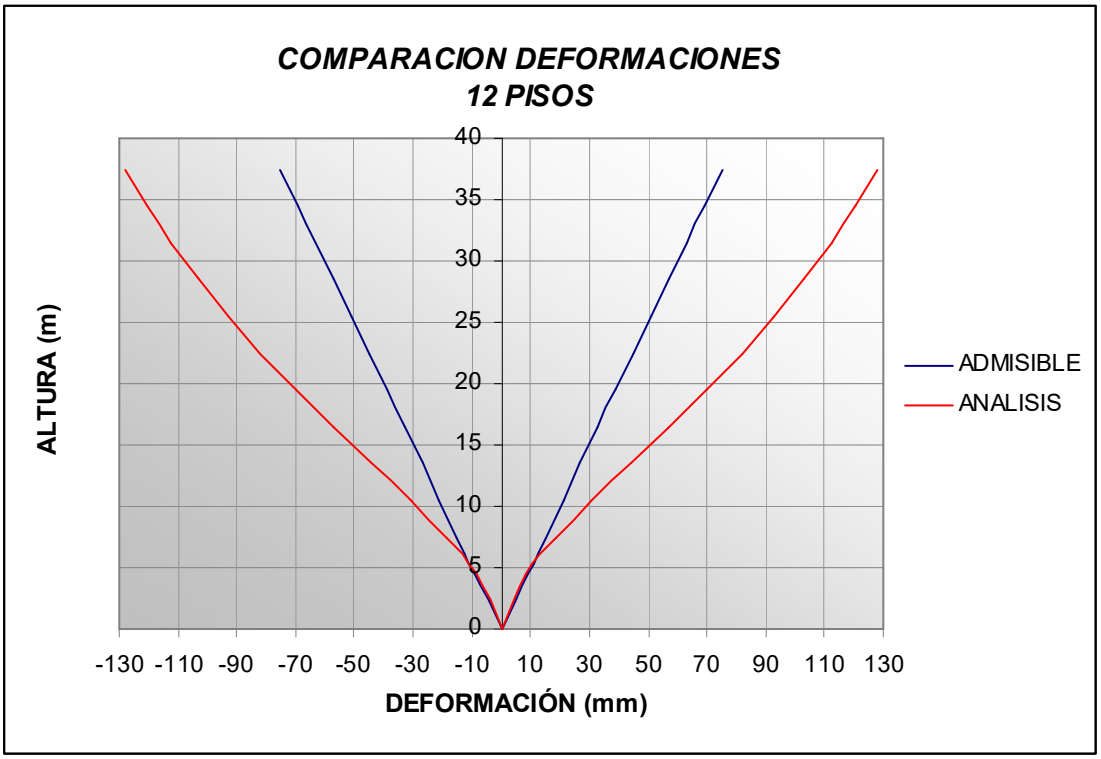


Figura 6.11.Comparación deformación edificio12 pisos. Deformación de análisis y admisible. Incluye rigidez de la unión

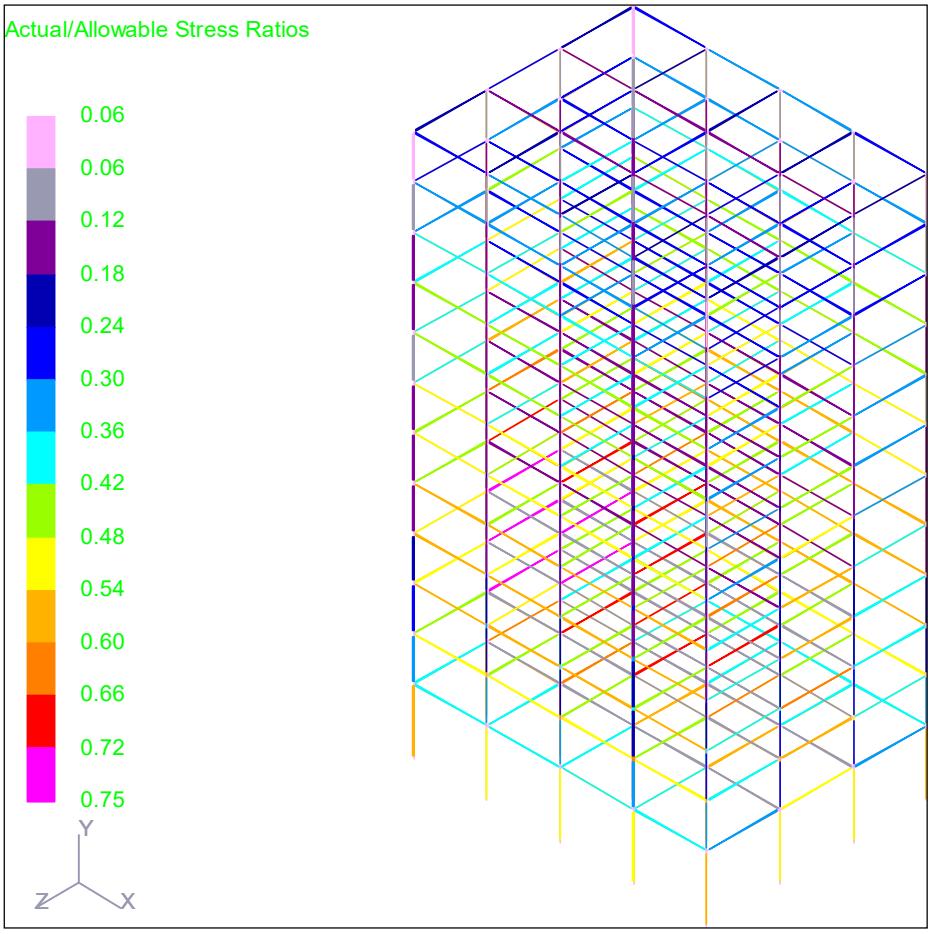


Figura 6.12.Ratios esfuerzos en edificio. Incluye rigidez de la unión.

7 COMPARACIÓN DE DISEÑOS.

En los capítulos 5 y 6, se ha diseñado el mismo edificio, con las mismas propiedades para los perfiles, pero en el segundo caso, se ha decidido incluir la rigidez de la unión viga-columna en el análisis en sentido Eje X de la estructura, de tal forma de ver la influencia de esta en los resultados.

A continuación se analizan comparativamente los gráficos de espectros de cada estructura y por sobre todo las deformaciones, cuyos resultados son muy relevantes.

7.1 COMPARACIÓN ESPECTROS Y DEFORMACIONES

7.1.1 Edificio de 4 pisos

A continuación se presentan los dos gráficos de espectro de aceleraciones, tradicional y con unión, sobrepuestos.

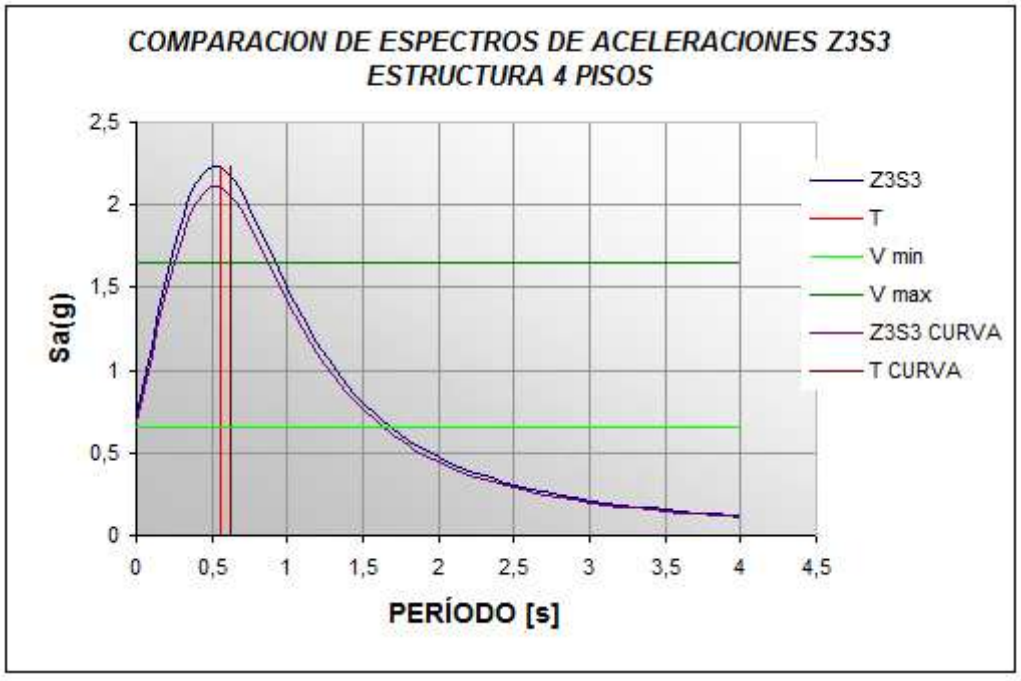


Figura 7.1. Comparación espectros de aceleraciones

Como es posible apreciar, el espectro disminuye su 'valor' ya que al considerar la rigidez de la unión, el período de la estructura varía, lo cual es lógico, ya que se hace más flexible, sin embargo, no logra desplazar el período a la zona fuera del corte máximo. El cambio de rigidez provoca que las deformaciones de entrepiso aumenten, como se puede ver en el gráfico siguiente:

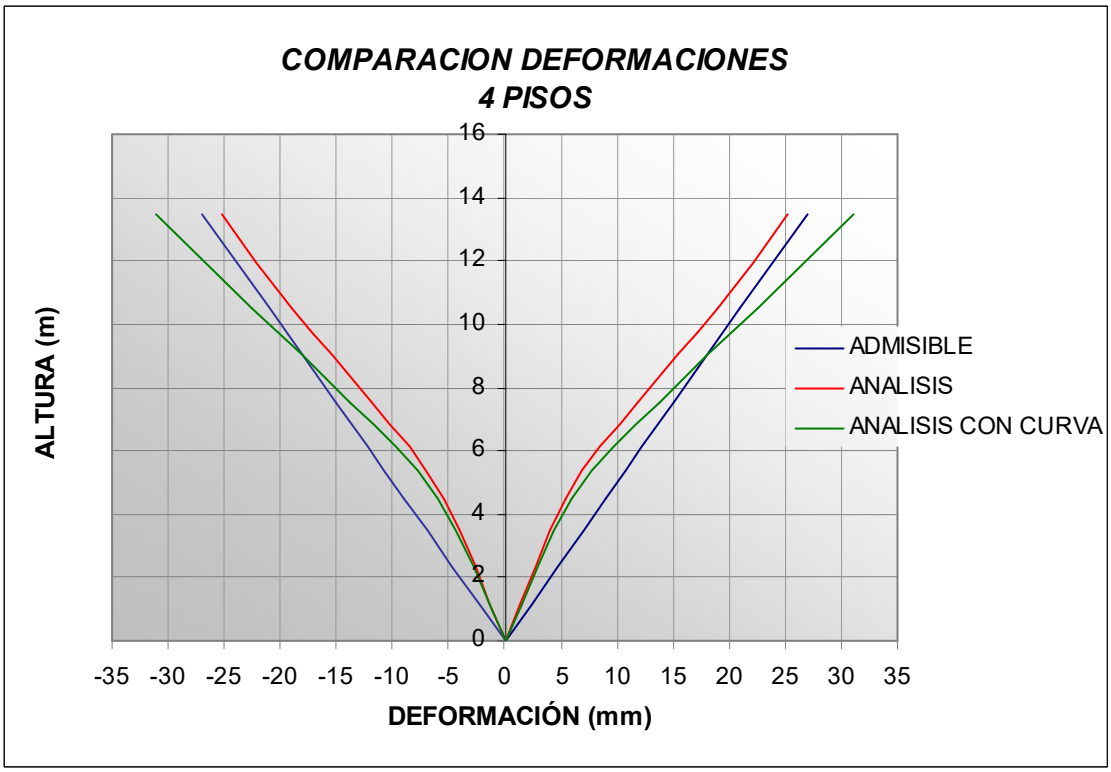


Figura 7.2. Comparación deformaciones

Esto implica que aunque los perfiles se encuentren bien diseñados en cuanto a resistencia, globalmente la estructura se encuentra fuera de norma por deformaciones.

7.1.2 Edificio de 8 pisos

A continuación se presentan los dos gráficos de espectro de aceleraciones, tradicional y con unión, sobrepuestos:

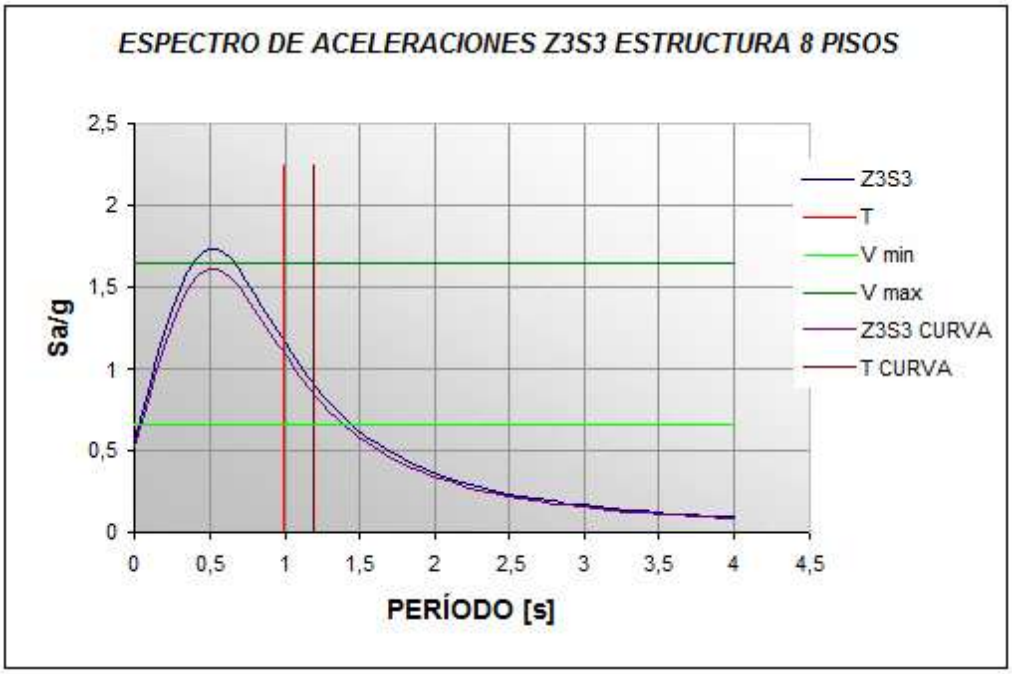


Figura 7.3. Comparación espectros de aceleraciones

Como es posible apreciar, el espectro disminuye su 'valor' ya que al considerar la rigidez de la unión, el período de la estructura varía, lo cual es lógico, ya que se hace más flexible, sin embargo, no logra desplazar el período a la zona fuera del corte mínimo. El cambio de rigidez provoca que las deformaciones de entrepiso aumenten, como se puede ver en el gráfico siguiente.

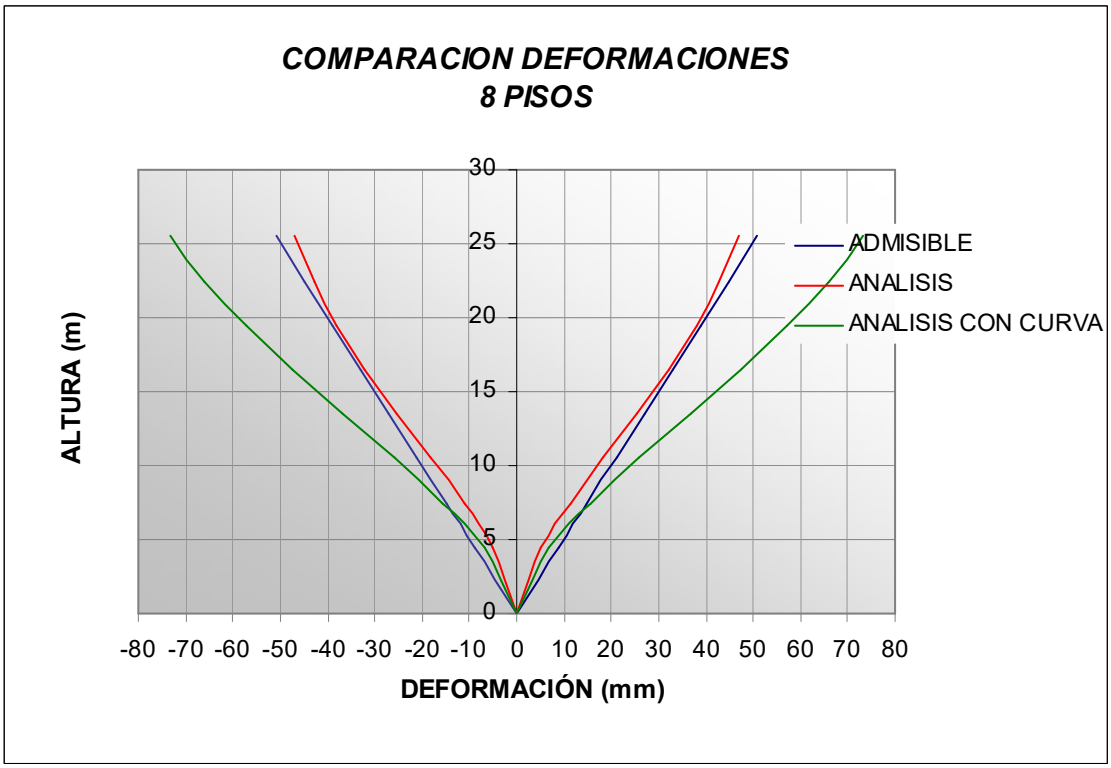


Figura 7.4. Comparación deformaciones

Esto implica que aunque los perfiles se encuentren bien diseñados en cuanto a resistencia, globalmente la estructura se encuentra fuera de norma por deformaciones.

7.1.3 Edificio de 12 pisos

A continuación se presentan los dos gráficos de espectro de aceleraciones, tradicional y con unión, sobrepuestos:

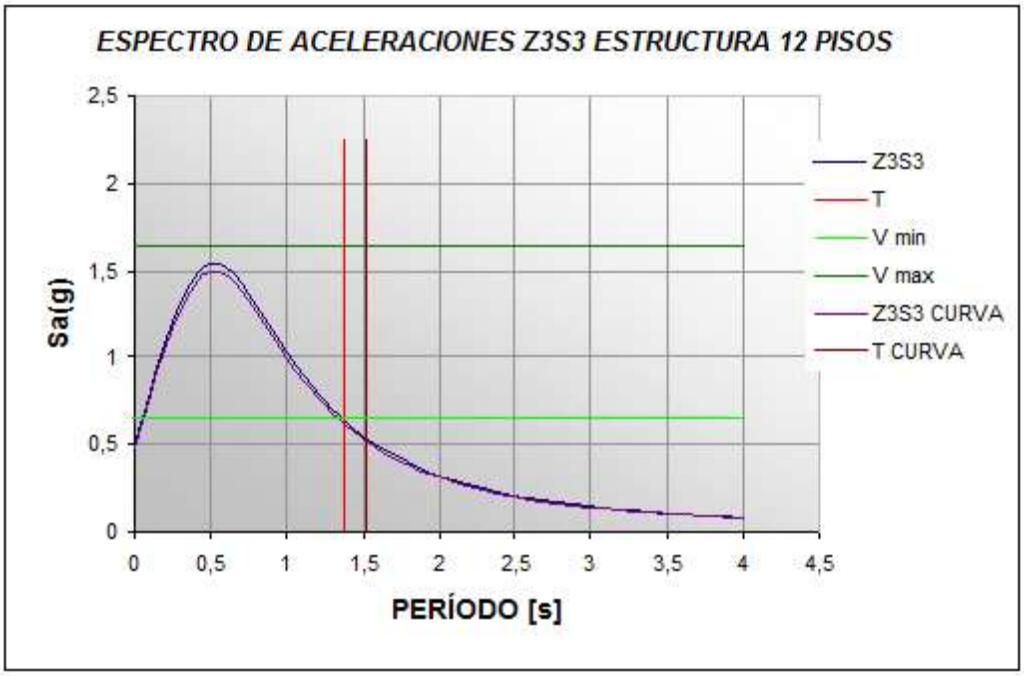


Figura 7.5. Comparación espectros de aceleraciones

En este caso, el período aumenta y se desplaza en la curva, manteniéndose por debajo del corte mínimo. Con la inclusión de la unión en el modelo, la estructura se flexibiliza, pero al estar bajo el corte mínimo, se requiere que las deformaciones y los esfuerzos se amplifiquen para alcanzar el mínimo, esto provoca que las deformaciones se amplifiquen por un factor mayor al considerado en el caso tradicional de diseño, si a eso se le suma el aumento de flexibilidad de la estructura, las deformaciones aumentan considerablemente, manteniéndose muy por fuera de lo que limita la norma. Esto se muestra en la siguiente figura:

7.2 COMPARACIÓN PESOS DE ESTRUCTURAS

A continuación se realiza una comparación en peso para las estructuras de 8 y 12 pisos.

Para esto, se rediseñaron las estructuras incluyendo el efecto de la rigidez de la unión en el análisis y cumpliendo los requerimientos de deformaciones, ya que el tema de esfuerzos no presenta un problema en estos casos. De este análisis se obtiene un nuevo peso de los edificios, el cual se compara con el peso de la estructura diseñada en forma tradicional.

Además, para el caso de la estructura de 12 pisos, se considera el diseño sin efecto de la unión, el diseño considerando una unión al 70% del Mp (considerado el límite inferior de la

clasificación) y una unión al 90% del Mp, como comparación a un caso más favorable de modelación de la estructura.

7.2.1 Edificio de 8 pisos

Para este edificio se realizó un diseño que cumpliera con las deformaciones máximas, pero que sus uniones se consideraran al 70% del Mp, teniendo en cuenta éste como límite inferior en la determinación de una unión Totalmente Restringida, o en otras palabras, unión a momento.

Se obtiene el siguiente gráfico de deformaciones para esta nueva estructura:

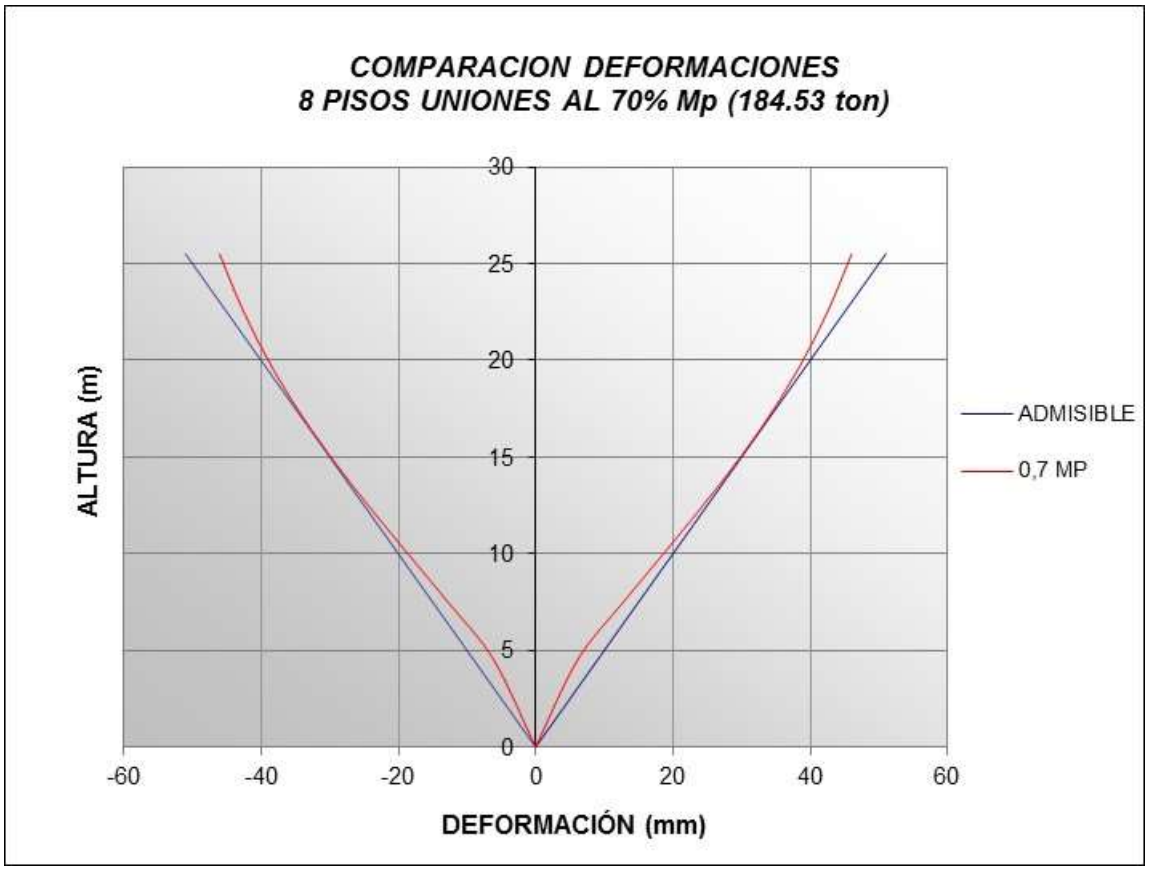


Figura 7.6. Comparación deformación para estructura de 8 pisos, con efecto de unión al 70%Mp

En este caso, la estructura original poseía un peso de 162,5 ton, y la estructura nueva, considerando el efecto de las uniones en el análisis, aumenta su peso a 184,53 ton., es decir aumenta el peso en un 13,6%.

7.2.2 Edificio de 12 pisos

Para este caso, se consideró la comparación con estructuras donde las uniones se modelaron considerando el 70% del Mp y el 90% del Mp, obteniendo los siguientes esquemas de deformaciones.

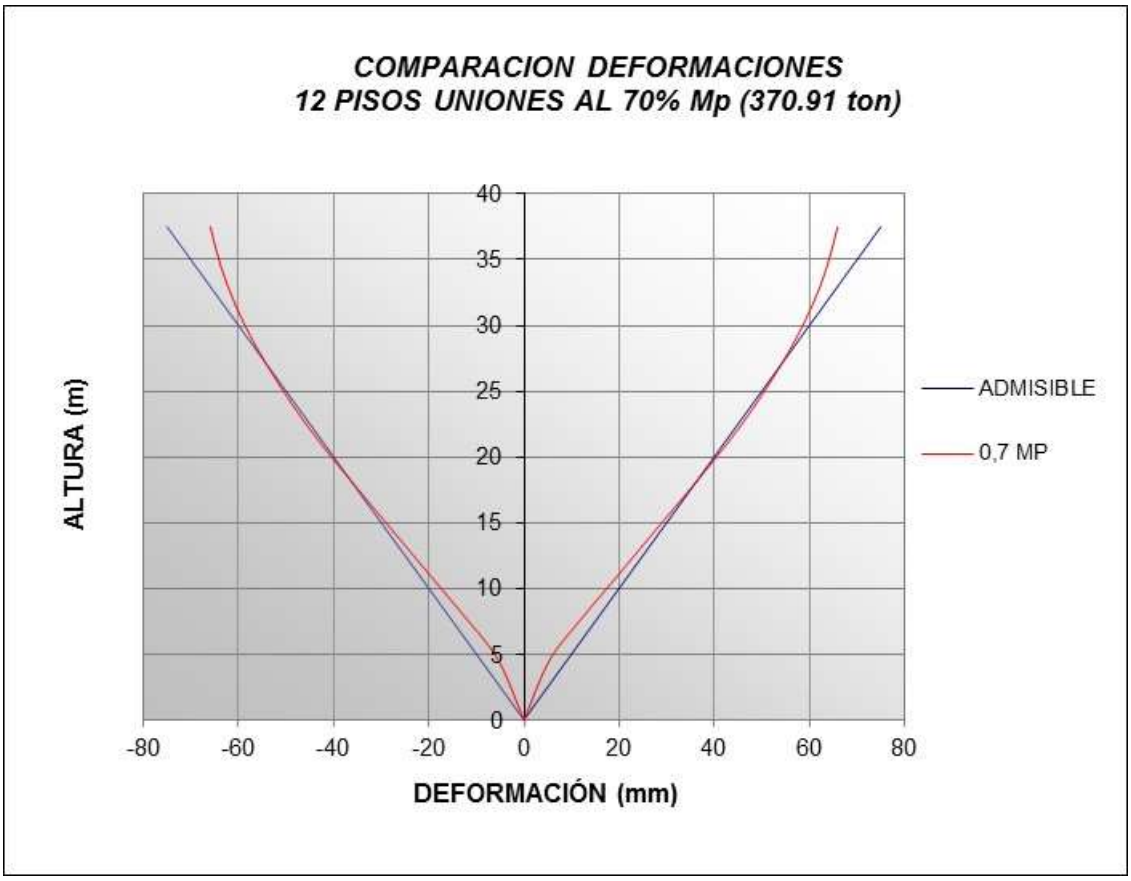


Figura 7.7. Comparación deformación para estructura de 12 pisos, con efecto de unión al 70%Mp

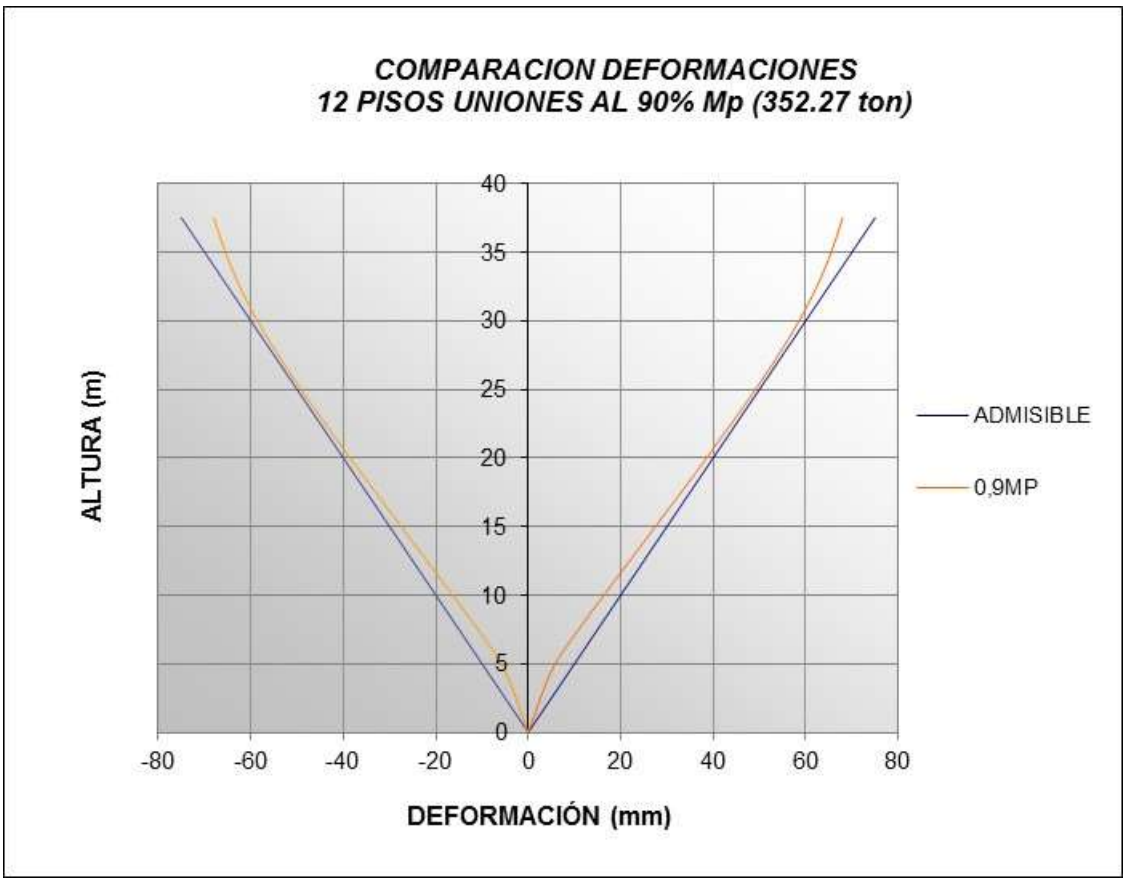


Figura 7.8. Comparación deformación para estructura de 12 pisos, con efecto de unión al 90%Mp

Para poder cumplir con los requerimientos de deformaciones admisibles, las estructuras nuevas han aumentado su peso. Si se consideran las uniones al 70% del Mp, el peso de la estructura es de 370,91 ton. Si se consideran las uniones al 90% Mp, el peso de la estructura es de 352,27 ton. Considerando que la estructura diseñada de modo tradicional presenta un peso en acero de 318,19 ton., se tiene un aumento en peso del 16,57% y 10, 71% respectivamente.

8 CONCLUSIONES

Al empezar con este trabajo, lo primero que se realizó fue una recopilación de información sobre ensayos de uniones en acero. Esta búsqueda dio por resultado una base de datos en formato DOS con ensayos realizados por diversos autores y recopilados en su mayoría por Kishi y Chen, incluyendo información posterior hasta el año 1996. La dificultad en encontrar nuevos ensayos en forma disponible, derivó en la utilización de esta información como base para los análisis y clasificación de curvas. Esto, sin embargo hizo llamar la atención en la poca disponibilidad de información experimental, ya que aunque esta, evidentemente existe y ha ido en aumento desde 1986, sigue siendo un material de difícil acceso. La lógica colaborativa apuntaría a que esta información pudiera ser accesible a todos quienes puedan hacer uso y análisis de ella, compartiendo y nutriendo el campo de la ingeniería, de tal forma que con los avances y nuevos conocimientos, el diseño y la práctica se acerquen cada vez más, con el objetivo de obtener estructuras más seguras y económicas, no solo desde el punto de vista constructivo, si no de la operación en su vida útil, evitando colapsos, deformaciones excesivas o cualquier problema estructural que pueda afectar los procesos y vida útil de éstas.

Con respecto a las uniones propiamente tal, al comenzar con la gráfica y clasificación de los datos conseguidos, diagramas momento-curvaturas de ensayos con carga estática, fue posible apreciar la gran variedad de ‘comportamiento’ de estas uniones.

Las clasificaciones actuales tienden a hablar de rangos de comportamientos de acuerdo a fórmulas teóricas que correlacionan las propiedades de las vigas con las capacidades de rotación de la unión, ante lo cual hablar simplemente de uniones de corte y momento, en forma idealizada, deja de ser la forma más precisa para referirse a ellas. Lo correcto sería hablar de uniones capaces de resistir cierto rango de rotaciones para ciertos niveles de momentos plásticos.

De esta forma, se puede considerar, los ensayos así lo avalan, que las uniones de corte sí transmiten momento, y que la uniones de momento, no son empotramientos perfectos como se asume en teoría. Los parámetros que influyen en que estas uniones varían en su comportamiento, guardan estrecha relación con el tamaño de los componentes de la unión y en la calidad del acero que se utiliza. Detalles de una misma unión pueden hacer que cambie el comportamiento y clasificación de ella. Por ejemplo, en el caso de uniones de corte, uno de los ensayos demostró que al variar el espesor de la pieza de conexión entre viga y columna, se tiene una unión que se comporta en forma totalmente diferente, pasando de ser considerada como de corte PR tipo 2 a unión PR tipo 3. Considerando que el diseño de las uniones en estructuras de acero se realiza principalmente en maestranza y que éstas no se testean ni se incluye su comportamiento en el análisis de las estructuras, un simple cambio de espesor puede variar completamente el comportamiento de una estructura, provocando que ésta se comporte de manera distinta a lo modelado, lo cual puede llevar a distribuciones de esfuerzos no considerados.

Ante esto, el tamaño de los componentes de una unión se convierte en parte fundamental de ésta, y no debiera pensarse que un poco más de espesor o unos pernos más aseguren un mejor comportamiento, si no, que un comportamiento distinto.

Como se indicó en la introducción de este trabajo, se utilizó un modelo simplificado de unión en el diseño de las estructuras. Estas uniones se modelaron de acuerdo a los límites esperados para su comportamiento, es decir, el caso más desfavorable. Esta modelación resulta ser sencilla y de fácil aplicación en oficina, ya que sin necesidad de tener un ensayo de cada unión a realizar, es posible establecer una curva representativa dependiendo de qué tan exigentes queramos ser con la estructura a diseñar. Por ejemplo, si deseáramos saber cuál sería el peor comportamiento en cuanto a deformación de una estructura, podemos considerar una curva de unión de momento con una flexibilidad asociada al 70% Mp de la viga a unir, obteniendo de esta forma un comportamiento límite que nos puede servir para evaluar los resultados del diseño tradicional.

El incluir el efecto de la unión en una modelación estructural no afecta tanto los esfuerzos de los componentes, pero sí es importante en las deformaciones de las estructuras. El usar este tipo de supuesto para las uniones implica, principalmente, tomar en cuenta lo importante que es la unión de elementos en una estructura y entender que el comportamiento de éstas depende del tipo de unión a utilizar, más allá que estas se definan como corte o momento.

El parámetro ‘flexibilidad de la unión’, no considerado, puede llegar a ser fundamental en edificios donde se requieren ciertos límites de deformaciones para el correcto funcionamiento operacional de las instalaciones. En elementos críticos, se debiera considerar este efecto, por ejemplo, en instalaciones industriales donde las tuberías principales o que conduzcan material peligroso, se diseñen considerando deformaciones máximas de operación. También puede ser especialmente útil cuando se deba decidir distanciamiento entre estructuras elevadas, donde se tenga poco espacio, pero se quiera prevenir posibles golpes entre ellas.

Para poder cumplir con las deformaciones máximas, y a la vez considerar el efecto de las uniones, es necesario diseñar estructuras más robustas, de tal forma que al aumentar el tamaño de sus componentes sísmicos, éstos limiten las deformaciones, que serán mayores al considerar la rigidez de la unión. Esto puede incrementar el costo de las estructuras, ya que lleva a un mayor peso para poder cumplir con las limitantes. Para el caso revisado en esta memoria se puede ver que el modelo analisado de forma tradicional, es decir considerando que las uniones son completamente rígidas capaz de desarrollar el 100% Mp da como resultado un edificio de menor peso que al considerar una unión de momento con una flexibilidad asociada al 70% Mp.

El gráfico siguiente muestra la variación del peso final de la estructura diseñada, en función del momento plástico (100% Mp, 90%Mp y 70% Mp) para las uniones consideradas en cada diseño.

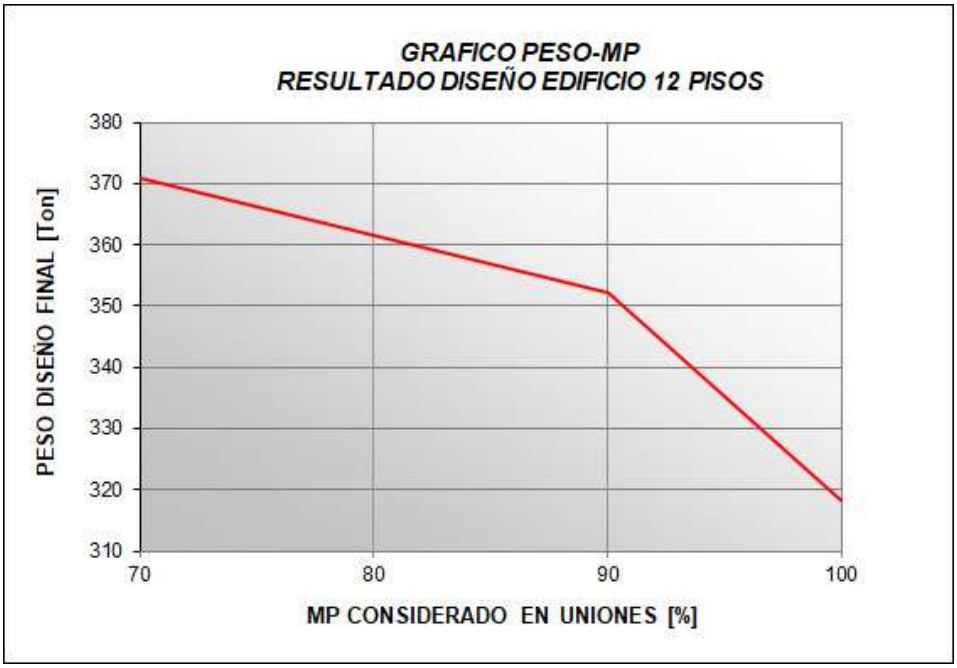


Figura 8.1. Peso de estructura vs Mp de uniones considerado en el diseño

Es también importante considerar que, si bien muchas veces se ha considerado que las limitaciones de deformaciones suelen ser elevadas en las normativas chilenas, éstas se consideran en base a diseños idealizados, donde las uniones de momento se comportan como empotramientos y las de corte como rótulas. Aun así, los resultados en la práctica han sido más bien favorables, tendiendo a diseños que satisfacen de manera adecuada las demandas sísmicas. Sin embargo, el llevar diseños teóricos a límites de lo establecido, o el permitir deformaciones mayores o limitaciones menores, no debiera evaluarse desde el diseño tradicional existente, si no que debiera considerar la flexibilidad de las uniones, al menos en algún grado.

El trabajo en oficina, usualmente limitado por el tiempo, recurre a la idealización típica de uniones. Estas idealizaciones, si bien intentan acercarse al comportamiento de las estructuras, no toma en cuenta el conocimiento actual del comportamiento de las uniones. Un proceso típico de análisis en oficina deriva en la información de perfiles (secciones), materiales y tipo de uniones a considerar en el detallamiento de éstas, y posteriormente incluye un chequeo por parte del ingeniero responsable del cálculo estructural, donde se verifica de forma general, que las uniones entregadas por maestranza se encuentran dentro de lo solicitado, es decir, uniones a momento con alta cantidad de pernos, placas gruesas y posibles soldaduras viga/columna; mientras las uniones de corte normalmente se encuentran conformadas por elementos más simples o de menor tamaño.

Sería importante que el ingeniero al indicar una unión a momento tomara en cuenta, ya sea en el análisis computacional, o al menos como idea general, que ésta tendrá al menos un grado de deformación no considerado, que repercutirá en el comportamiento real de la estructura, y que por lo tanto, diseñar al límite en el papel, puede significar deformaciones

bastante mayores a lo esperado ante la ocurrencia de un sismo. Al momento de revisar la conexión final propuesta por maestranza, éste punto debiera tenerse en cuenta, sobre todo en elementos críticos. Del mismo modo, considerar que una unión no transmitirá momento puede llevar a que los elementos conectados deban soportar una carga no considerada en la modelación.

En general, un análisis típico, en las condiciones tradicionales anteriormente señaladas, tiende a subestimar las secciones de los elementos que componen una unión resistente a momento (viga-columna).

Dado que los programas actuales lo permiten, sería recomendable, que en casos críticos, donde las estructuras soporten elementos vitales, los modelos puedan incluir el efecto de las uniones, de tal forma de obtener valores de deformación más cercanos a lo esperado y poder evaluar la necesidad de realizar refuerzos extras, para cumplir con las normativas actuales.

Los límites establecidos para la clasificación de uniones, sobre el 70% del Mp para uniones a momentos y bajo el 20% del Mp para uniones a corte parece ser adecuado, y refuerza la idea que la mayoría de las uniones se encuentra en la zona intermedia.

I. REFERENCIAS

American Institute of Steel Construction AISC (2011). Manual of Steel Construction 14th Edition.

American Institute of Steel Construction AISC (2003). Manual of Steel Construction Load and Resistance Factor Design, Third Edition.

Bjorhovde, R., Colson, A., and Brozzetti, J. (1990) “Classification System for Beam-to Column Connections “, Journal of Structural Engineering, ASCE, Vol 116, No. 11, pp. 3059 – 3076.

Instituto Nacional de Normalización INN- Chile (2009).NCh 433 Of96 mod 2009 Diseño Sísmico de Edificios.

Instituto Nacional de Normalización INN- Chile (2003). NCh 2369 Of2003 Diseño Sísmico de Estructuras e Instalaciones Industriales.

Kishi, N.,Chen, W (1986) Structural Engineering Report N°CE-ST-86-26, Purdue University, Data Base of Steel Beam-to-Column Connections.

SAC Steel Org. Data Base of Steel Beam-to-Column Connections (1994). Compilación de ensayos de diversos autores.

Structural Engineers Association of California. Seismology Commitee (1990) Recommended Lateral Force Requirements and Commentary.

II. ANEXO 1

II.1 Detalle ensayos unión ángulo simple todo apernado

1.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : AA-2/1

Column :
Beam : W21X62
Angle : 4 X 3.5 X 1/4

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 13.9700	lu = 4.4450	ll = 4.4450	ta = 0.6350
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1.59	37.02
2	0.08	1.38	27	1.63	39.24
3	0.17	2.76	28	1.67	41.46
4	0.22	3.60	29	1.71	43.50
5	0.27	4.44	30	1.75	45.55
6	0.32	5.28	31	1.75	47.36
7	0.37	6.12	32	1.75	49.18
8	0.42	7.23			
9	0.47	8.34			
10	0.53	9.58			
11	0.60	10.82			
12	0.66	12.40			
13	0.72	13.98			
14	0.80	15.66			
15	0.87	17.34			
16	0.95	19.02			
17	1.01	20.59			
18	1.07	22.16			
19	1.14	23.72			
20	1.21	25.16			
21	1.29	26.59			
22	1.37	28.02			
23	1.43	30.17			
24	1.48	32.32			
25	1.54	34.67			

2.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : AA-2/2

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 1/4

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 13.9700	lu = 4.4450	ll = 4.4450	ta = 0.6350
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1.70	25.71
2	0.05	0.64	27	1.72	26.77
3	0.10	1.28	28	1.73	27.82
4	0.17	2.19	29	1.75	28.87
5	0.24	3.10	30	1.83	30.19
6	0.31	3.97	31	1.92	31.50
7	0.38	4.85			
8	0.46	5.72			
9	0.55	6.60			
10	0.63	7.48			
11	0.70	8.33			
12	0.77	9.18			
13	0.84	10.03			
14	0.91	11.04			
15	0.97	12.05			
16	1.04	13.06			
17	1.09	14.48			
18	1.13	15.89			
19	1.20	17.10			
20	1.26	18.31			
21	1.33	19.52			
22	1.40	20.58			
23	1.47	21.63			
24	1.53	22.69			
25	1.62	24.20			

3.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : AA-3/1

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 1/4

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 21.5900	lu = 4.4450	ll = 4.4450	ta = 0.6350
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.94	37.17
2	0.24	1.01	27	5.02	39.21
3	0.49	2.02	28	5.14	41.30
4	0.75	2.97	29	5.26	43.38
5	1.01	3.91	30	5.38	45.12
6	1.28	4.99	31	5.50	46.87
7	1.54	6.07	32	5.58	49.02
8	1.80	7.32	33	5.66	51.16
9	2.06	8.57			
10	2.34	9.95			
11	2.62	11.33			
12	2.84	12.71			
13	3.06	14.09			
14	3.26	15.64			
15	3.46	17.18			
16	3.64	18.83			
17	3.82	20.48			
18	4.00	22.13			
19	4.18	23.77			
20	4.26	25.69			
21	4.35	27.60			
22	4.48	29.68			
23	4.62	31.76			
24	4.74	33.44			
25	4.86	35.12			

4.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : AA-3/2

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 1/4

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 21.5900	lu = 4.4450	ll = 4.4450	ta = 0.6350
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	5.04	17.74
2	0.23	0.65	27	5.23	18.52
3	0.45	1.31	28	5.41	19.40
4	0.68	1.96	29	5.60	20.28
5	0.88	2.53			
6	1.08	3.09			
7	1.29	3.66			
8	1.51	4.27			
9	1.74	4.88			
10	1.97	5.49			
11	2.17	6.14			
12	2.37	6.79			
13	2.57	7.45			
14	2.83	8.43			
15	3.10	9.41			
16	3.27	10.11			
17	3.45	10.80			
18	3.62	11.50			
19	3.83	12.25			
20	4.05	12.99			
21	4.26	13.73			
22	4.40	14.54			
23	4.53	15.35			
24	4.67	16.16			
25	4.85	16.95			

5.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : AA-4/1

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 1/4

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = 4.4450	ll = 4.4450	ta = 0.6350
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 4	nc = 1 X 4

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	7.93	27.00
2	0.37	0.81	27	8.11	28.73
3	0.69	1.39	28	8.30	30.53
4	1.00	1.97	29	8.48	32.34
5	1.30	2.38	30	8.66	34.17
6	1.59	2.79	31	8.83	36.01
7	2.04	3.61	32	8.99	37.94
8	2.56	4.70	33	9.16	39.87
9	2.87	5.24	34	9.31	41.87
10	3.18	5.79	35	9.46	43.87
11	3.48	6.47	36	9.59	45.77
12	3.78	7.14	37	9.71	47.67
13	4.15	8.09	38	9.87	49.54
14	4.53	9.04	39	10.03	51.41
15	4.82	9.95	40	10.24	54.41
16	5.11	10.86	41	10.41	57.01
17	5.39	11.83	42	10.57	58.28
18	5.68	12.81	43	10.72	60.41
19	5.95	14.12			
20	6.23	15.42			
21	6.76	18.37			
22	7.02	20.11			
23	7.28	21.85			
24	7.51	23.55			
25	7.74	25.26			

6.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : AA-4/2

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 1/4

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = 4.4450	ll = 4.4450	ta = 0.6350
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 4	nc = 1 X 4

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	8.65	22.75
2	0.45	0.48	27	8.85	24.05
3	0.75	0.75	28	9.04	25.35
4	1.05	1.03	29	9.25	26.75
5	1.59	1.57	30	9.46	28.15
6	1.92	1.98	31	9.69	29.95
7	2.26	2.39	32	9.92	31.75
8	2.62	2.96	33	10.12	33.42
9	2.98	3.54	34	10.32	35.08
10	3.29	4.01	35	10.53	37.01
11	3.61	4.49	36	10.74	38.94
12	3.93	5.26	37	10.93	40.71
13	4.25	6.03	38	11.12	42.47
14	4.76	7.31	39	11.32	44.47
15	5.33	8.52	40	11.52	46.47
16	5.65	9.42	41	11.68	48.06
17	5.96	10.33	42	11.84	49.66
18	6.28	11.43			
19	6.59	12.54			
20	6.91	13.68			
21	7.24	14.81			
22	7.50	16.25			
23	7.77	17.68			
24	8.24	20.15			
25	8.45	21.45			

7.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : AA-5/1

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 1/4

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 36.8300	lu = 4.4450	ll = 4.4450	ta = 0.6350
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 5	nc = 1 X 5

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	17.66	23.02
2	0.84	0.55	27	18.10	24.58
3	1.68	1.10	28	18.63	26.30
4	2.52	1.66	29	19.15	28.02
5	3.29	2.18	30	19.65	30.08
6	4.06	2.69	31	20.15	32.14
7	4.88	3.14	32	20.56	34.36
8	5.70	3.60	33	20.98	36.59
9	6.45	4.11	34	21.24	38.16
10	7.19	4.63	35	21.50	39.73
11	8.01	5.28	36	21.76	41.31
12	8.83	5.94	37	22.02	42.89
13	9.47	6.59	38	22.29	44.47
14	10.11	7.24	39	22.54	45.82
15	10.75	8.05	40	22.78	47.17
16	11.39	8.87			
17	11.98	9.75			
18	12.56	10.64			
19	13.57	12.74			
20	14.16	13.93			
21	14.74	15.11			
22	15.32	16.53			
23	15.90	17.95			
24	16.55	19.71			
25	17.21	21.47			

8.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : AA-5/2

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 1/4

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 36.8300	lu = 4.4450	ll = 4.4450	ta = 0.6350
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 5	nc = 1 X 5

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	19.27	17.35
2	0.86	0.33	27	19.83	18.64
3	1.72	0.66	28	20.21	19.58
4	2.58	0.99	29	20.60	20.53
5	3.48	1.38	30	20.99	21.48
6	4.38	1.76	31	21.49	22.86
7	5.21	2.21	32	21.99	24.25
8	6.03	2.67	33	22.37	25.43
9	6.93	3.12	34	22.74	26.61
10	7.83	3.57	35	22.97	27.32
11	8.60	4.06	36	23.19	28.03
12	9.37	4.54			
13	10.07	5.03			
14	10.76	5.51			
15	11.61	6.10			
16	12.46	6.68			
17	13.07	7.47			
18	13.68	8.25			
19	14.81	9.55			
20	15.44	10.40			
21	16.08	11.25			
22	16.71	12.40			
23	17.35	13.56			
24	18.03	14.81			
25	18.72	16.07			

9.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : AA-6/1

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 1/4

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 44.4500	lu = 4.4450	ll = 4.4450	ta = 0.6350
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 6	nc = 1 X 6

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	26.89	23.45
2	1.13	0.26	27	27.57	24.94
3	2.27	0.52	28	28.30	26.86
4	3.97	0.82	29	29.03	28.79
5	5.36	1.25	30	29.73	30.72
6	6.81	1.69	31	30.43	32.65
7	7.79	2.04	32	31.05	34.64
8	8.76	2.40	33	31.67	36.63
9	9.87	2.86	34	32.24	38.52
10	10.98	3.32	35	32.82	40.41
11	12.08	3.77	36	33.29	42.10
12	13.19	4.23	37	33.76	43.79
13	14.14	4.86	38	34.63	46.19
14	15.09	5.48	39	35.51	48.59
15	16.78	6.79			
16	18.11	7.89			
17	19.28	9.39			
18	20.55	11.23			
19	21.46	12.93			
20	22.25	14.15			
21	23.04	15.38			
22	23.82	17.01			
23	24.60	18.63			
24	25.41	20.29			
25	26.21	21.95			

10.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : AA-6/2

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 1/4

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 44.4500	lu = 4.4450	ll = 4.4450	ta = 0.6350
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 6	nc = 1 X 6

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	28.00	15.81
2	1.67	0.34	27	28.92	17.24
3	3.35	0.68	28	29.83	18.67
4	5.10	0.92	29	30.61	20.03
5	6.13	1.18	30	31.39	21.39
6	7.16	1.44	31	32.07	22.79
7	8.32	1.76	32	32.75	24.18
8	9.48	2.09	33	33.38	25.64
9	10.59	2.49	34	34.00	27.10
10	11.69	2.88	35	34.71	28.69
11	12.64	3.27	36	35.41	30.29
12	13.59	3.66	37	36.14	32.02
13	14.67	4.12	38	36.86	33.75
14	15.75	4.58	39	37.21	34.96
15	16.73	5.08	40	37.55	36.18
16	17.70	5.57			
17	18.78	6.26			
18	19.85	6.96			
19	20.88	7.76			
20	21.90	8.55			
21	22.94	9.58			
22	23.99	10.61			
23	24.90	11.81			
24	25.82	13.01			
25	26.91	14.41			

11.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : BB-4/1

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = 4.4450	ll = 4.4450	ta = 0.7937
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 4	nc = 1 X 4

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	12.42	30.09
2	0.53	0.55	27	12.75	32.33
3	1.10	1.04	28	13.03	34.63
4	1.76	1.86	29	13.31	36.93
5	2.43	2.41	30	13.64	39.69
6	3.12	3.17	31	13.96	42.46
7	3.52	3.65	32	14.20	45.12
8	3.92	4.13	33	14.45	47.79
9	4.32	4.57	34	14.68	50.25
10	4.73	5.02	35	14.92	52.72
11	5.48	5.98	36	15.09	54.78
12	6.14	7.06	37	15.26	56.84
13	6.69	8.28	38	15.40	58.74
14	7.41	9.96	39	15.54	60.64
15	7.84	11.14			
16	8.28	12.32			
17	8.75	13.79			
18	9.23	15.27			
19	9.67	16.78			
20	10.11	18.29			
21	10.83	21.24			
22	11.16	22.91			
23	11.50	24.58			
24	11.80	26.22			
25	12.09	27.86			

12.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : BB-4/2

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = 4.4450	ll = 4.4450	ta = 0.7937
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 4	nc = 1 X 4

Remark 1) CONNECTION SUBJECT TO PURE MOMENT.
2) HARDENED WASHERS INSTALLED IN BOTH LEGS

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	12.86	27.59
2	0.48	0.41	27	13.29	29.66
3	1.04	0.96	28	13.65	31.60
4	1.56	1.64	29	14.01	33.53
5	2.36	2.26	30	14.39	35.73
6	3.05	3.01	31	14.78	37.93
7	3.72	3.83	32	15.02	39.51
8	4.14	4.27	33	15.27	41.09
9	4.55	4.71	34	15.51	42.67
10	5.28	5.66	35	15.90	44.97
11	6.03	6.62	36	16.30	47.27
12	6.71	7.70			
13	7.52	9.18			
14	7.95	10.12			
15	8.39	11.06			
16	8.80	12.17			
17	9.21	13.28			
18	9.66	14.59			
19	10.11	15.89			
20	10.50	17.33			
21	10.89	18.77			
22	11.26	20.18			
23	11.63	21.58			
24	12.04	23.55			
25	12.44	25.52			

13.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : B2-4

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = 4.4450	ll = 4.4450	ta = 0.7937
gb = 5.7150	gc = 6.5088	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 4	nc = 1 X 4

Remark 1) CONNECTION SUBJECT TO MOMENT AND SHEAR.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	10.54	12.32
2	0.35	0.24	27	10.83	13.16
3	0.69	0.48	28	11.12	14.00
4	1.28	0.97	29	11.32	14.70
5	1.62	1.14	30	11.51	15.40
6	1.96	1.32	31	11.71	16.24
7	2.33	1.59	32	11.90	17.07
8	2.71	1.87	33	12.05	17.98
9	3.12	2.22	34	12.20	18.88
10	3.53	2.56	35	12.36	19.77
11	3.86	2.83	36	12.52	20.66
12	4.18	3.11	37	12.68	21.54
13	4.56	3.52			
14	4.95	3.93			
15	5.43	4.44			
16	5.91	4.95			
17	6.36	5.50			
18	6.81	6.04			
19	7.32	6.72			
20	7.83	7.40			
21	8.35	8.18			
22	8.87	8.96			
23	9.37	9.97			
24	9.86	10.98			
25	10.20	11.65			

14.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : B3-4

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = 4.4450 ll = 4.4450 ta = 0.7937
gb = 5.7150 gc = 6.5088 cu = 3.1750 cl = 3.1750
pb = 7.6200 pc = 7.6200 nb = 1 X 4 nc = 1 X 4

Remark 1) CONNECTION SUBJECT TO MOMENT AND SHEAR.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	11.90	16.47
2	0.60	0.48	27	12.21	17.95
3	1.34	1.17	28	12.53	19.42
4	1.74	1.62	29	12.78	20.69
5	2.15	2.06	30	13.03	21.96
6	2.81	2.68	31	13.27	23.40
7	3.50	3.17	32	13.51	24.83
8	4.01	3.59	33	13.68	25.99
9	4.51	4.00	34	13.86	27.15
10	4.97	4.38	35	14.03	28.30
11	5.43	4.76	36	14.28	29.91
12	6.16	5.52	37	14.52	31.51
13	6.57	5.93	38	14.71	32.98
14	6.98	6.34	39	14.89	34.45
15	7.49	6.99			
16	8.01	7.64			
17	8.39	8.25			
18	8.76	8.86			
19	9.19	9.71			
20	9.62	10.55			
21	10.03	11.39			
22	10.44	12.24			
23	10.81	13.28			
24	11.18	14.32			
25	11.54	15.40			

15.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : C-4

Column : --
Beam : W21X62
Angle : 5 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = 4.4450	ll = 4.4450	ta = 0.7937
gb = 5.7150	gc = 4.9212	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 4	nc = 1 X 4

Remark 1) CONNECTION SUBJECT TO MOMENT AND SHEAR.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	14.79	8.25
2	0.75	0.11	27	15.06	8.79
3	1.49	0.23	28	15.32	9.33
4	2.24	0.34	29	15.59	9.87
5	2.90	0.69	30	15.88	10.50
6	3.56	1.05	31	16.17	11.13
7	4.25	1.16	32	16.46	11.76
8	4.94	1.27	33	16.68	12.41
9	5.64	1.38	34	16.90	13.07
10	6.49	1.67	35	17.12	13.72
11	6.99	1.79	36	17.34	14.38
12	7.48	1.91			
13	8.28	2.33			
14	8.83	2.65			
15	9.38	2.96			
16	10.23	3.32			
17	10.67	3.67			
18	11.12	4.02			
19	11.58	4.46			
20	12.03	4.91			
21	12.54	5.43			
22	13.05	5.94			
23	13.53	6.59			
24	14.01	7.23			
25	14.40	7.74			

16.
Connection type : Single web-angle connections
Mode : All bolted

Tested by : S.L.Lipson (1968) CANADA
Test Id. : D-4

Column : --
Beam : W21X62
Angle : 5 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = 4.4450	ll = 4.4450	ta = 0.7937
gb = 8.2550	gc = 4.9212	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 4	nc = 1 X 4

Remark 1) CONNECTION SUBJECT TO MOMENT AND SHEAR.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	14.21	8.73
2	0.75	0.20	27	14.55	9.22
3	1.50	0.40	28	14.89	9.72
4	2.24	0.60	29	15.12	10.22
5	3.01	0.88	30	15.35	10.73
6	3.78	1.17	31	15.58	11.23
7	4.26	1.28	32	15.81	11.73
8	4.73	1.40	33	16.00	12.29
9	5.36	1.65	34	16.20	12.85
10	5.98	1.90	35	16.39	13.41
11	6.47	2.05			
12	6.96	2.19			
13	7.53	2.54			
14	8.10	2.89			
15	8.65	3.17			
16	9.20	3.45			
17	9.82	3.83			
18	10.44	4.22			
19	11.01	4.80			
20	11.58	5.38			
21	12.09	5.96			
22	12.59	6.53			
23	13.02	7.10			
24	13.44	7.66			
25	13.87	8.23			

II.2 Detalle ensayos unión ángulo simple viga apernada columna soldada

1.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : P1-2/1

Column : --
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 336 MPa
Fu = 494 MPa

Major parameters (cm)

lp = 13.9700 lu = 19.6850 ll = 19.6850 ta = 0.6350
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 2

Remark 1) CONNECTION PLATE WELDED TO 1" MOUNTING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.79	13.23
2	0.24	0.14	27	4.77	14.63
3	0.48	0.28	28	4.74	16.02
4	0.72	0.43	29	4.71	17.42
5	0.96	0.57	30	4.71	18.56
6	1.20	0.71	31	4.70	19.71
7	1.44	0.85	32	4.70	20.86
8	1.69	1.09	33	4.70	22.01
9	1.93	1.34	34	4.77	23.26
10	2.18	1.58	35	4.84	24.51
11	2.42	1.82	36	5.00	25.39
12	2.61	2.19	37	5.16	26.27
13	2.81	2.55	38	5.35	27.29
14	3.00	2.92	39	5.55	28.31
15	3.25	3.43			
16	3.51	3.95			
17	3.70	4.43			
18	3.88	4.90			
19	4.07	5.38			
20	4.28	6.23			
21	4.48	7.08			
22	4.59	8.30			
23	4.70	9.52			
24	4.73	10.76			
25	4.76	11.99			

2.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : P1-2/2

Column : --
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 336 MPa
Fu = 494 MPa

Major parameters (cm)

lp = 13.9700 lu = 19.6850 ll = 19.6850 ta = 0.6350
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 2

Remark 1) CONNECTION PLATE WELDED TO 1" MOUNTING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.65	18.04
2	0.21	0.14	27	4.60	20.49
3	0.42	0.28	28	4.56	22.91
4	0.64	0.42	29	4.51	25.33
5	0.85	0.56	30	4.46	27.76
6	1.06	0.71	31	4.39	30.52
7	1.28	0.90	32	4.32	33.28
8	1.51	1.09	33	4.36	36.04
9	1.74	1.28	34	4.34	38.33
10	1.96	1.47	35	4.54	40.47
11	2.18	1.75	36	4.74	42.61
12	2.40	2.03	37	4.94	44.75
13	2.63	2.30	38	5.01	46.84
14	2.83	2.63	39	5.08	48.93
15	3.03	2.96	40	5.15	51.02
16	3.23	3.28	41	5.07	53.65
17	3.43	3.61	42	4.98	56.27
18	3.67	4.32	43	4.90	58.90
19	3.91	5.04			
20	4.15	5.89			
21	4.39	6.74			
22	4.61	8.83			
23	4.68	10.99			
24	4.75	13.15			
25	4.70	15.59			

3.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : P1-3/1

Column : --
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 336 MPa
Fu = 494 MPa

Major parameters (cm)

lp = 21.5900 lu = 15.8750 ll = 15.8750 ta = 0.6350
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 3

Remark 1) CONNECTION PLATE WELDED TO 1" MOUNTING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	14.87	13.61
2	0.76	0.11	27	15.08	14.78
3	1.51	0.23	28	15.30	15.95
4	2.27	0.34	29	15.52	17.13
5	3.02	0.46	30	15.83	18.33
6	3.78	0.57	31	16.15	19.53
7	4.55	0.83	32	16.47	20.72
8	5.31	1.09	33	16.76	21.92
9	6.12	1.31	34	17.06	23.12
10	6.93	1.54	35	17.35	24.32
11	7.50	1.75	36	17.62	25.49
12	8.07	1.97	37	17.89	26.67
13	8.72	2.22	38	18.15	27.84
14	9.37	2.48	39	18.39	29.15
15	9.86	2.86	40	18.63	30.46
16	10.35	3.25	41	18.87	31.77
17	11.26	4.08			
18	11.78	4.70			
19	12.30	5.32			
20	12.80	6.38			
21	13.31	7.44			
22	13.72	8.73			
23	14.14	10.02			
24	14.38	11.21			
25	14.63	12.41			

4.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : P1-3/2

Column : --
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 336 MPa
Fu = 494 MPa

Major parameters (cm)

lp = 21.5900 lu = 15.8750 ll = 15.8750 ta = 0.6350
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 3

Remark 1) CONNECTION PLATE WELDED TO 1" MOUNTING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	10.18	34.94
2	0.83	0.16	27	10.59	37.41
3	1.66	0.31	28	11.05	39.71
4	2.48	0.47	29	11.51	42.01
5	3.31	0.63	30	12.03	43.88
6	3.87	0.94	31	12.54	45.74
7	4.43	1.24	32	13.10	47.61
8	4.99	1.55	33	13.65	49.48
9	5.66	2.11	34	14.48	52.20
10	6.34	2.67	35	15.31	54.91
11	7.17	3.36	36	15.99	57.69
12	7.62	3.88	37	16.69	59.80
13	8.06	4.40			
14	8.72	5.49			
15	8.77	6.30			
16	8.82	8.85			
17	8.87	11.40			
18	8.91	13.94			
19	8.96	16.49			
20	9.01	19.04			
21	9.12	21.69			
22	9.23	24.34			
23	9.34	27.00			
24	9.55	29.73			
25	9.76	32.47			

5.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : P1-4/1

Column : --
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 336 MPa
Fu = 494 MPa

Major parameters (cm)

lp = 29.2100 lu = 12.0650 ll = 12.0650 ta = 0.6350
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 4

Remark 1) CONNECTION PLATE WELDED TO 1" MOUNTING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	21.03	21.06
2	1.30	0.18	27	22.30	22.48
3	2.60	0.37	28	23.27	23.65
4	3.89	0.55	29	24.23	24.82
5	5.19	0.74	30	25.07	26.06
6	6.49	0.92	31	25.90	27.30
7	7.41	1.12	32	26.73	28.54
8	8.34	1.31	33	27.31	29.83
9	9.10	1.54	34	27.88	31.13
10	9.87	1.76	35	28.45	32.43
11	11.25	2.41	36	28.99	33.91
12	12.46	3.05	37	29.53	35.38
13	13.36	4.08	38	30.07	36.86
14	14.00	5.59			
15	14.27	6.81			
16	14.53	8.03			
17	14.84	9.41			
18	15.15	10.79			
19	15.46	12.17			
20	15.88	13.43			
21	16.30	14.69			
22	17.03	16.02			
23	17.75	17.36			
24	18.76	18.50			
25	19.77	19.64			

6.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : P1-4/2

Column : --
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 336 MPa
Fu = 494 MPa

Major parameters (cm)

lp = 29.2100 lu = 12.0650 ll = 12.0650 ta = 0.6350
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 4

Remark 1) CONNECTION PLATE WELDED TO 1" MOUNTING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	20.93	21.09
2	1.28	0.20	27	21.95	22.24
3	2.56	0.39	28	22.96	23.39
4	3.84	0.59	29	24.26	25.07
5	5.13	0.79	30	25.55	26.76
6	6.41	0.99	31	26.40	28.16
7	7.68	1.33	32	27.24	29.56
8	8.94	1.66	33	27.91	31.27
9	9.71	1.95	34	28.58	32.97
10	10.48	2.25	35	29.08	34.28
11	11.93	2.89	36	29.57	35.60
12	12.83	3.59	37	30.07	36.91
13	13.64	4.76			
14	14.22	5.92			
15	14.47	7.47			
16	14.58	8.65			
17	14.70	9.83			
18	14.96	11.02			
19	15.23	12.20			
20	15.79	13.67			
21	16.36	15.13			
22	16.94	16.22			
23	17.52	17.31			
24	18.72	18.63			
25	19.91	19.94			

7.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : P1-5/1

Column : --
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 336 MPa
Fu = 494 MPa

Major parameters (cm)

lp = 36.8300 lu = 8.2550 ll = 8.2550 ta = 0.6350
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 5

Remark 1) CONNECTION PLATE WELDED TO 1" MOUNTING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	44.66	16.34
2	2.35	0.16	27	45.29	17.51
3	4.71	0.32	28	45.92	18.67
4	7.06	0.48	29	46.55	19.83
5	9.42	0.64	30	47.17	21.24
6	11.77	0.80	31	47.79	22.65
7	13.60	0.99	32	48.41	24.06
8	15.43	1.17	33	48.81	25.13
9	17.26	1.36	34	49.21	26.19
10	19.33	1.58	35	49.61	27.26
11	21.39	1.79	36	49.95	28.39
12	23.45	2.01	37	50.30	29.53
13	25.92	2.55	38	50.65	30.66
14	28.38	3.09			
15	30.91	3.93			
16	33.44	4.78			
17	35.57	5.98			
18	37.70	7.19			
19	38.94	8.44			
20	40.17	9.68			
21	40.96	10.78			
22	41.74	11.88			
23	42.53	12.98			
24	43.24	14.10			
25	43.95	15.22			

8.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : P1-5/2

Column : --
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 336 MPa
Fu = 494 MPa

Major parameters (cm)

lp = 36.8300 lu = 8.2550 ll = 8.2550 ta = 0.6350
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 5

Remark 1) CONNECTION PLATE WELDED TO 1" MOUNTING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	34.08	23.09
2	2.50	0.14	27	35.53	23.67
3	5.00	0.27	28	36.98	24.25
4	7.50	0.41	29	38.58	25.24
5	10.00	0.55	30	40.85	26.92
6	11.77	0.78	31	43.11	28.59
7	13.55	1.01	32	44.95	30.23
8	15.33	1.24	33	46.79	31.86
9	17.25	1.74	34	47.80	33.03
10	19.17	2.24	35	48.80	34.20
11	21.09	2.75	36	49.90	35.98
12	22.74	3.26	37	50.06	37.06
13	24.39	3.78	38	50.21	38.15
14	26.67	5.12			
15	27.11	6.01			
16	27.12	7.69			
17	27.23	8.99			
18	27.33	10.30			
19	27.44	11.60			
20	27.80	13.46			
21	28.16	15.32			
22	28.80	16.86			
23	29.44	18.39			
24	30.77	20.11			
25	32.88	21.98			

9.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : P1-6/1

Column : --
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 336 MPa
Fu = 494 MPa

Major parameters (cm)

lp = 44.4500 lu = 4.4450 ll = 4.4450 ta = 0.6350
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 6

Remark 1) CONNECTION PLATE WELDED TO 1" MOUNTING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	53.30	13.01
2	3.74	0.14	27	54.75	13.81
3	7.48	0.29	28	56.21	14.62
4	11.22	0.43	29	58.97	15.72
5	14.95	0.57	30	61.74	16.82
6	18.69	0.72	31	63.77	17.80
7	21.22	0.93	32	65.80	18.79
8	23.75	1.14	33	67.21	19.59
9	26.29	1.35	34	68.63	20.40
10	29.15	1.50	35	69.90	21.28
11	32.02	1.66	36	71.17	22.15
12	34.03	1.98	37	72.44	23.03
13	36.04	2.29	38	74.04	24.28
14	38.44	2.60	39	75.63	25.52
15	40.75	3.26			
16	42.14	3.82			
17	43.28	4.66			
18	44.65	5.76			
19	45.59	6.59			
20	46.54	7.42			
21	47.83	8.62			
22	49.12	9.83			
23	49.80	10.48			
24	50.48	11.13			
25	51.62	11.97			

10.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : P1-6/2

Column : --
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 336 MPa
Fu = 494 MPa

Major parameters (cm)

lp = 44.4500 lu = 4.4450 ll = 4.4450 ta = 0.6350
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 6

Remark 1) CONNECTION PLATE WELDED TO 1" MOUNTING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	56.29	11.34
2	3.12	0.11	27	59.44	12.55
3	6.23	0.22	28	61.80	13.81
4	9.35	0.33	29	63.36	14.92
5	12.46	0.44	30	64.92	16.03
6	15.58	0.55	31	65.93	17.00
7	19.22	0.61	32	66.93	17.96
8	22.86	0.68	33	67.94	18.93
9	26.51	0.75	34	69.14	20.16
10	30.15	0.81	35	70.35	21.40
11	33.79	0.88	36	71.37	22.52
12	36.37	1.12	37	72.40	23.65
13	38.95	1.35	38	73.43	24.77
14	41.53	1.59	39	74.45	25.70
15	44.93	2.14	40	75.47	26.63
16	47.32	2.59			
17	49.46	3.78			
18	50.25	4.54			
19	51.04	5.30			
20	51.41	6.08			
21	51.77	6.86			
22	52.17	7.71			
23	52.57	8.56			
24	53.39	9.79			
25	54.84	10.56			

11.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : G-2/1

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 355 MPa
Fu = 538 MPa

Major parameters (cm)

lp = 12.0650 lu = 20.6375 ll = 20.6375 ta = 0.7937
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 5.7150
nb = 1 X 2

Remark 1) 1/4" FILLET WELD AT HEEL OF ANGLE.
2) CONNECTION ROTATED UNDER CONSTANT SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	5.52	4.92
2	0.26	0.12	27	5.53	5.90
3	0.51	0.25	28	5.51	6.77
4	0.77	0.37	29	5.25	7.60
5	1.02	0.49	30	5.06	9.01
6	1.28	0.61	31	5.03	10.09
7	1.53	0.74	32	5.17	10.41
8	1.75	0.82	33	5.32	10.73
9	1.98	0.91	34	5.52	11.84
10	2.20	0.99	35	5.56	12.67
11	2.42	1.08	36	5.59	13.49
12	2.64	1.16	37	5.60	14.40
13	2.88	1.29	38	5.62	15.31
14	3.12	1.41	39	5.38	16.74
15	3.36	1.53	40	5.35	17.87
16	3.60	1.66	41	5.32	18.99
17	3.82	1.76	42	5.34	20.42
18	4.04	1.87	43	5.35	21.85
19	4.26	1.97	44	5.40	23.13
20	4.48	2.08	45	5.44	24.41
21	4.73	2.18	46	5.40	25.63
22	4.98	2.29	47	5.37	26.86
23	5.19	2.46	48	5.37	27.85
24	5.39	2.63	49	5.36	28.85
25	5.51	3.95	50	5.36	29.85

12.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : G-3/1

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 355 MPa
Fu = 538 MPa

Major parameters (cm)

lp = 20.3200 lu = 16.5100 ll = 16.5100 ta = 0.7937
gb = 6.3500 cu = 4.4450 cl = 4.4450 pb = 5.7150
nb = 1 X 3

Remark 1) 1/4" FILLET WELD AT HEEL OF ANGLE.
2) CONNECTION ROTATED UNDER CONSTANT SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	10.44	10.07
2	0.58	0.14	27	10.50	11.53
3	1.15	0.28	28	10.55	13.00
4	1.73	0.42	29	10.71	14.30
5	2.31	0.57	30	10.86	15.60
6	2.88	0.71	31	11.03	16.72
7	3.46	0.85	32	11.19	17.84
8	4.07	1.03	33	11.43	19.07
9	4.69	1.21	34	11.66	20.31
10	5.30	1.39	35	11.71	21.37
11	5.83	1.61	36	11.76	22.43
12	6.35	1.82	37	11.88	23.46
13	6.87	2.03	38	12.01	24.49
14	7.41	2.28	39	12.23	25.61
15	7.94	2.53	40	12.45	26.73
16	8.48	2.78	41	12.88	27.77
17	8.93	3.07	42	13.32	28.81
18	9.39	3.37	43	13.75	29.86
19	9.92	3.72			
20	10.30	4.16			
21	10.47	4.67			
22	10.49	5.38			
23	10.58	6.48			
24	10.66	7.58			
25	10.55	8.82			

13.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : G-4/1

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 355 MPa
Fu = 538 MPa

Major parameters (cm)

lp = 30.4800 lu = 12.3825 ll = 12.3825 ta = 0.7937
gb = 6.3500 cu = 5.7150 cl = 5.7150 pb = 5.7150
nb = 1 X 4

Remark 1) 1/4" FILLET WELD AT HEEL OF ANGLE.
2) CONNECTION ROTATED UNDER CONSTANT SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	15.48	11.58
2	1.00	0.12	27	15.62	12.35
3	1.99	0.23	28	15.73	13.26
4	2.99	0.35	29	15.84	14.18
5	3.99	0.46	30	15.86	15.41
6	4.98	0.58	31	15.88	16.64
7	5.91	0.68	32	16.09	17.68
8	6.84	0.79	33	16.28	18.50
9	7.62	0.95	34	16.47	19.31
10	8.40	1.11	35	16.88	20.38
11	9.19	1.27	36	17.30	21.45
12	9.94	1.41	37	17.83	22.45
13	10.69	1.54	38	18.36	23.46
14	11.49	1.89	39	19.16	24.68
15	12.30	2.25	40	19.96	25.91
16	13.41	2.71	41	20.57	27.00
17	14.44	3.34	42	21.18	28.10
18	15.00	3.99	43	21.79	29.07
19	15.33	4.60	44	22.40	30.04
20	15.23	5.27			
21	15.12	6.72			
22	15.11	7.70			
23	15.10	8.67			
24	15.22	9.74			
25	15.35	10.80			

14.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1968) CANADA
Test Id. : G-5/1

Column : --
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 355 MPa
Fu = 538 MPa

Major parameters (cm)

lp = 36.8300 lu = 8.2550 ll = 8.2550 ta = 0.7937
gb = 6.3500 cu = 6.9850 cl = 6.9850 pb = 5.7150
nb = 1 X 5

Remark 1) 1/4" FILLET WELD AT HEEL OF ANGLE.
2) CONNECTION ROTATED UNDER CONSTANT SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	27.54	14.81
2	1.85	0.19	27	28.56	16.30
3	3.71	0.37	28	29.50	17.41
4	5.56	0.56	29	30.44	18.53
5	7.22	0.74	30	31.12	19.82
6	8.89	0.93	31	31.81	21.12
7	10.29	1.15	32	32.50	22.41
8	11.70	1.36	33	33.31	23.64
9	12.84	1.54	34	34.13	24.87
10	13.98	1.71	35	34.95	26.10
11	15.11	2.04	36	35.79	27.37
12	16.25	2.37	37	36.64	28.65
13	17.55	2.78	38	37.48	29.92
14	18.86	3.20			
15	20.02	3.81			
16	21.19	4.42			
17	21.68	4.77			
18	22.01	5.35			
19	22.53	6.24			
20	23.05	7.12			
21	23.73	8.47			
22	24.41	9.81			
23	25.11	10.98			
24	25.81	12.15			
25	26.51	13.33			

15.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1977) CANADA
Test Id. : A1-5

Column : T=44",TW=5/8"
Beam : --
Angle : 4 X 3 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 382 MPa
Fu = 536 MPa

Major parameters (cm)

lp = 36.8300 lu = -- ll = -- ta = 0.9525
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 5

Remark 1) 1/4" FILLET WELD AT HEEL, TOP AND BOTTOM OF ANGLE.
2) CONNECTION SUBJECT TO MOMENT AND SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	10.89	8.32	51	29.37	23.76
2	1.46	0.11	27	10.03	9.13			
3	2.91	0.23	28	9.17	9.95			
4	4.37	0.34	29	10.01	10.72			
5	5.83	0.46	30	10.85	11.48			
6	7.29	0.57	31	12.18	12.16			
7	8.42	0.70	32	13.51	12.83			
8	9.56	0.83	33	14.74	13.27			
9	10.69	0.96	34	15.96	13.71			
10	11.83	1.09	35	17.19	14.15			
11	12.90	1.30	36	18.64	14.59			
12	13.96	1.51	37	20.10	15.03			
13	15.03	1.73	38	21.55	15.46			
14	16.11	1.97	39	22.82	15.82			
15	17.18	2.22	40	24.09	16.18			
16	17.94	2.62	41	25.36	16.54			
17	18.71	3.01	42	26.62	16.90			
18	18.52	3.81	43	27.79	17.59			
19	18.00	4.58	44	28.95	18.28			
20	16.73	5.06	45	29.82	19.22			
21	15.46	5.54	46	30.69	20.15			
22	14.41	6.01	47	30.49	20.86			
23	13.37	6.49	48	30.29	21.57			
24	12.33	6.96	49	29.92	22.25			
25	11.61	7.64	50	29.54	22.92			

16.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1977) CANADA
Test Id. : A1-6

Column : T=44",TW=5/8"
Beam : --
Angle : 4 X 3 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 382 MPa
Fu = 536 MPa

Major parameters (cm)

lp = 44.4500 lu = -- ll = -- ta = 0.9525
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 6

Remark 1) 1/4" FILLET WELD AT HEEL, TOP AND BOTTOM OF ANGLE.
2) CONNECTION SUBJECT TO MOMENT AND SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	53.81	7.75
2	2.90	0.09	27	53.11	8.55
3	5.79	0.18	28	52.42	9.36
4	8.69	0.26	29	53.41	10.02
5	11.58	0.35	30	54.40	10.67
6	14.48	0.44	31	55.59	11.52
7	17.37	0.53	32	56.78	12.36
8	20.27	0.61	33	57.31	13.28
9	23.49	0.78	34	57.84	14.21
10	26.71	0.95	35	57.33	15.07
11	29.93	1.12	36	56.82	15.93
12	33.04	1.27	37	57.68	16.82
13	36.14	1.42	38	58.54	17.71
14	39.24	1.57	39	61.15	18.78
15	42.02	1.80	40	63.69	19.52
16	44.80	2.03	41	66.23	20.25
17	47.58	2.26	42	67.20	20.86
18	50.73	2.65	43	68.18	21.48
19	53.88	3.05	44	67.28	22.09
20	55.67	3.42	45	66.38	22.71
21	57.45	3.78			
22	59.68	4.70			
23	58.49	5.59			
24	55.28	6.58			
25	54.54	7.17			

17.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1977) CANADA
Test Id. : A1-7

Column : T=44",TW=5/8"
Beam : --
Angle : 4 X 3 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 382 MPa
Fu = 536 MPa

Major parameters (cm)

lp = 52.0700 lu = -- ll = -- ta = 0.9525
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 7

Remark 1) 1/4" FILLET WELD AT HEEL, TOP AND BOTTOM OF ANGLE.
2) CONNECTION SUBJECT TO MOMENT AND SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	75.72	9.23
2	5.14	0.10	27	77.79	10.15
3	10.29	0.20	28	79.87	11.07
4	15.43	0.30	29	81.43	12.02
5	20.57	0.40	30	83.00	12.97
6	26.42	0.59	31	83.51	13.74
7	32.26	0.78	32	84.01	14.51
8	36.21	0.86	33	86.23	15.34
9	40.15	0.95	34	88.46	16.17
10	43.78	1.13	35	92.56	17.01
11	47.40	1.30	36	96.67	17.85
12	51.66	1.51	37	100.58	18.56
13	55.91	1.72	38	104.49	19.28
14	60.17	1.93	39	108.05	20.00
15	64.83	2.17	40	111.62	20.72
16	69.49	2.41	41	114.92	21.77
17	74.03	2.89	42	118.22	22.83
18	76.87	3.41			
19	78.02	3.96			
20	76.83	4.79			
21	76.44	5.41			
22	76.06	6.03			
23	75.38	6.81			
24	74.69	7.60			
25	75.20	8.42			

18.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1977) CANADA
Test Id. : A1-8

Column : T=44",TW=5/8"
Beam : --
Angle : 4 X 3 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 382 MPa
Fu = 536 MPa

Major parameters (cm)

lp = 59.6900 lu = -- ll = -- ta = 0.9525
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 8

Remark 1) 1/4" FILLET WELD AT HEEL, TOP AND BOTTOM OF ANGLE.
2) CONNECTION SUBJECT TO MOMENT AND SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	116.84	8.42
2	6.78	0.10	27	113.90	8.98
3	13.55	0.20	28	109.68	9.94
4	20.33	0.29	29	110.37	10.75
5	27.11	0.39	30	111.07	11.56
6	33.88	0.49	31	115.15	12.29
7	40.51	0.63	32	119.24	13.02
8	47.14	0.77	33	126.63	14.05
9	53.76	0.92	34	133.98	14.87
10	59.71	1.08	35	141.32	15.69
11	65.66	1.24	36	146.61	16.43
12	71.61	1.41	37	151.89	17.17
13	77.58	1.65	38	157.05	18.13
14	83.55	1.90	39	162.21	19.09
15	89.52	2.14	40	162.87	19.73
16	96.59	2.51	41	163.52	20.38
17	103.67	2.88	42	162.02	21.27
18	108.54	3.31	43	157.78	22.14
19	113.41	3.73			
20	121.10	4.57			
21	124.74	5.58			
22	124.18	6.15			
23	123.63	6.72			
24	121.71	7.29			
25	119.79	7.86			

19.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1977) CANADA
Test Id. : A1-9

Column : T=44",TW=5/8"
Beam : --
Angle : 4 X 3 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 382 MPa
Fu = 536 MPa

Major parameters (cm)

lp = 67.3100 lu = -- ll = -- ta = 0.9525
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 9

Remark 1) 1/4" FILLET WELD AT HEEL, TOP AND BOTTOM OF ANGLE.
2) CONNECTION SUBJECT TO MOMENT AND SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	230.52	8.34
2	11.81	0.12	27	226.53	8.96
3	23.63	0.24	28	219.80	9.58
4	35.29	0.46	29	209.66	10.21
5	46.95	0.67	30	207.30	10.37
6	55.87	0.87	31	198.64	10.72
7	64.80	1.07	32	189.99	11.07
8	73.72	1.28	33	183.25	11.60
9	84.82	1.52	34	176.49	12.05
10	95.91	1.76	35	171.83	12.73
11	107.01	2.00	36	172.57	13.04
12	119.02	2.29	37	178.49	13.64
13	131.04	2.58	38	188.57	14.61
14	143.05	2.87	39	195.22	15.49
15	153.48	3.16	40	200.53	16.47
16	163.90	3.45	41	204.39	17.02
17	174.32	3.75	42	211.69	17.74
18	183.83	4.06	43	218.28	18.23
19	193.35	4.37	44	225.18	18.59
20	202.86	4.69	45	232.08	18.95
21	209.75	4.99	46	240.76	19.70
22	216.64	5.28	47	244.28	20.27
23	225.64	5.92	48	247.80	20.83
24	229.88	6.71	49	249.10	21.40
25	231.76	7.63	50	250.39	21.96

20.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1977) CANADA
Test Id. : A1-10

Column : T=44",TW=5/8"
Beam : --
Angle : 4 X 3 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 382 MPa
Fu = 536 MPa

Major parameters (cm)

lp = 74.9300 lu = -- ll = -- ta = 0.9525
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 10

Remark 1) 1/4" FILLET WELD AT HEEL, TOP AND BOTTOM OF ANGLE.
2) CONNECTION SUBJECT TO MOMENT AND SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	87.51	7.66
2	8.65	0.04	27	82.60	7.88
3	17.30	0.08	28	75.86	8.44
4	25.94	0.12	29	74.28	9.12
5	34.59	0.16	30	79.56	9.91
6	42.48	0.27	31	88.93	10.58
7	50.37	0.38	32	96.01	10.95
8	58.26	0.50	33	103.10	11.33
9	63.59	0.64	34	110.20	11.78
10	68.93	0.79	35	117.30	12.23
11	74.94	0.92	36	125.78	12.75
12	80.95	1.05	37	134.27	13.28
13	88.01	1.30	38	140.85	13.73
14	95.08	1.55	39	147.44	14.18
15	101.65	1.91	40	156.64	14.89
16	108.22	2.27	41	165.85	15.60
17	117.60	3.05	42	173.33	16.27
18	120.10	3.60	43	180.81	16.93
19	122.60	4.15	44	189.91	17.97
20	121.08	5.11	45	193.79	18.61
21	114.74	5.98	46	197.68	19.25
22	109.18	6.42	47	198.49	19.92
23	103.62	6.86	48	196.61	20.82
24	98.03	7.15			
25	92.43	7.43			

21.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1977) CANADA
Test Id. : A1-11

Column : T=44",TW=5/8"
Beam : --
Angle : 4 X 3 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 382 MPa
Fu = 536 MPa

Major parameters (cm)

lp = 82.5500 lu = -- ll = -- ta = 0.9525
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 11

Remark 1) 1/4" FILLET WELD AT HEEL, TOP AND BOTTOM OF ANGLE.
2) CONNECTION SUBJECT TO MOMENT AND SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	122.62	10.91
2	11.54	0.16	27	127.86	11.58
3	23.07	0.32	28	134.13	12.21
4	34.61	0.47	29	145.54	12.94
5	42.84	0.62	30	155.04	13.51
6	51.07	0.76	31	164.55	14.08
7	59.30	0.90	32	173.71	14.65
8	67.88	1.10	33	182.87	15.22
9	76.46	1.31	34	191.69	15.84
10	84.02	1.54	35	200.52	16.46
11	91.59	1.78	36	207.63	17.03
12	98.64	2.04	37	214.74	17.61
13	105.70	2.31	38	220.32	18.20
14	112.43	2.72	39	225.89	18.79
15	119.17	3.12	40	233.93	19.80
16	128.87	3.82	41	240.24	20.65
17	133.06	4.33	42	245.54	21.60
18	134.16	4.76			
19	135.29	5.32			
20	134.37	5.93			
21	132.47	6.74			
22	129.19	7.54			
23	125.94	8.47			
24	121.67	9.46			
25	121.11	10.11			

22.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : S.L.Lipson (1977) CANADA
Test Id. : A1-12

Column : T=44",TW=5/8"
Beam : --
Angle : 4 X 3 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 382 MPa
Fu = 536 MPa

Major parameters (cm)

lp = 90.1700 lu = -- ll = -- ta = 0.9525
gb = 6.3500 cu = 3.1750 cl = 3.1750 pb = 7.6200
nb = 1 X 12

Remark 1) 1/4" FILLET WELD AT HEEL, TOP AND BOTTOM OF ANGLE.
2) CONNECTION SUBJECT TO MOMENT AND SHEAR.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	184.91	10.06
2	14.72	0.10	27	189.54	11.01
3	29.44	0.20	28	194.61	11.58
4	44.16	0.30	29	199.69	12.16
5	57.53	0.51	30	208.33	12.67
6	70.90	0.72	31	216.98	13.18
7	84.28	0.94	32	225.76	13.50
8	96.75	1.19	33	234.55	13.83
9	109.22	1.43	34	244.38	14.30
10	121.69	1.68	35	254.22	14.78
11	133.59	1.94	36	265.81	15.47
12	145.49	2.21	37	277.40	16.15
13	157.40	2.48	38	287.29	16.88
14	168.41	2.86	39	297.18	17.60
15	179.43	3.24	40	304.35	18.42
16	190.44	3.63	41	311.52	19.24
17	204.62	4.40	42	316.49	20.15
18	214.66	5.03	43	318.16	20.78
19	220.64	5.88	44	319.82	21.41
20	220.43	6.56			
21	214.07	7.22			
22	207.32	7.66			
23	196.81	8.07			
24	186.73	8.95			
25	185.82	9.51			

23.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : F-1 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	69.20	39.74
2	4.86	0.35	27	69.87	42.58
3	9.72	0.70	28	70.53	45.42
4	13.91	1.05	29	71.20	48.26
5	18.11	1.40	30	71.86	51.10
6	21.77	1.75	31	74.35	53.00
7	25.42	2.10	32	76.85	54.90
8	29.95	2.65	33	82.99	55.70
9	34.48	3.20	34	89.14	56.50
10	38.17	3.75	35	95.70	57.30
11	41.87	4.30	36	102.27	58.10
12	46.02	5.10	37	108.33	58.90
13	49.85	6.60	38	114.40	59.70
14	51.92	8.95	39	119.92	60.45
15	54.00	11.30	40	125.45	61.20
16	55.39	13.43	41	129.35	61.75
17	56.77	15.57	42	133.26	62.30
18	58.15	17.70	43	139.15	63.10
19	59.19	20.75			
20	60.23	23.80			
21	61.62	26.13			
22	63.00	28.47			
23	64.39	30.80			
24	66.46	33.85			
25	68.54	36.90			

24.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : F-1 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	71.65	41.10
2	4.86	0.30	27	74.77	44.20
3	9.72	0.60	28	75.29	47.20
4	13.91	0.90	29	75.81	50.20
5	18.11	1.20	30	76.33	53.20
6	21.77	1.50	31	76.85	56.20
7	25.42	1.80	32	79.96	58.90
8	29.95	2.25	33	83.08	61.60
9	34.48	2.70	34	88.95	62.50
10	38.17	3.15	35	94.83	63.40
11	41.87	3.60	36	101.67	64.15
12	45.86	4.30	37	108.50	64.90
13	49.85	5.00	38	114.07	65.60
14	56.08	6.50	39	119.63	66.30
15	60.23	9.60	40	124.62	67.00
16	60.75	12.55	41	129.60	67.70
17	61.27	15.50	42	135.33	69.10
18	61.79	18.45	43	139.15	71.20
19	62.31	21.40			
20	63.00	23.97			
21	63.69	26.53			
22	64.39	29.10			
23	65.77	32.07			
24	67.15	35.03			
25	68.54	38.00			

25.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : G-1 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	73.73	50.40
2	4.78	0.35	27	74.25	53.15
3	9.55	0.70	28	74.77	55.90
4	13.75	1.05	29	79.42	59.30
5	17.94	1.40	30	84.07	62.70
6	21.93	1.80	31	88.31	63.30
7	25.92	2.20	32	92.55	63.90
8	29.99	2.65	33	97.12	64.43
9	34.06	3.10	34	101.69	64.97
10	38.30	3.90	35	106.26	65.50
11	42.54	4.70	36	111.70	66.30
12	45.69	6.20	37	117.14	67.10
13	47.48	9.35	38	118.59	69.70
14	49.26	12.50	39	120.05	72.30
15	50.84	15.87			
16	52.42	19.23			
17	54.00	22.60			
18	55.75	25.65			
19	57.49	28.70			
20	60.48	31.83			
21	63.47	34.97			
22	66.46	38.10			
23	69.58	41.50			
24	72.69	44.90			
25	73.21	47.65			

26.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : G-1 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	76.93	45.70
2	4.78	0.30	27	80.00	49.20
3	9.55	0.60	28	83.08	52.70
4	13.75	0.90	29	83.33	56.02
5	17.94	1.20	30	83.58	59.35
6	21.93	1.50	31	83.82	62.67
7	25.92	1.80	32	84.07	66.00
8	29.99	2.25	33	88.31	66.45
9	34.06	2.70	34	92.55	66.90
10	38.30	3.30	35	97.70	67.40
11	42.54	3.90	36	102.85	67.90
12	45.69	4.60	37	108.00	68.45
13	47.48	8.10	38	113.15	69.00
14	49.26	11.60	39	116.60	69.55
15	50.45	14.35	40	120.05	70.10
16	51.63	17.10			
17	52.82	19.85			
18	54.00	22.60			
19	55.16	25.00			
20	56.33	27.40			
21	57.49	29.80			
22	63.01	33.10			
23	68.54	36.40			
24	71.34	39.50			
25	74.13	42.60			

27.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : H-1 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	66.50	30.40
2	2.95	0.20	27	68.54	32.80
3	5.90	0.40	28	69.54	35.35
4	10.09	0.70	29	70.54	37.90
5	13.54	1.00	30	72.66	39.60
6	18.03	1.40	31	74.77	41.30
7	22.18	1.80	32	75.10	43.88
8	26.25	2.30	33	75.43	46.45
9	30.20	2.70	34	75.77	49.02
10	34.06	3.20	35	76.10	51.60
11	38.30	3.90	36	78.92	52.10
12	42.12	4.60	37	83.16	52.60
13	44.53	5.20	38	86.48	52.90
14	46.94	5.80	39	89.81	53.20
15	47.96	8.07	40	92.40	53.50
16	48.99	10.33	41	95.00	53.80
17	50.01	12.60			
18	51.84	13.95			
19	53.67	15.30			
20	55.16	17.65			
21	56.66	20.00			
22	58.44	21.85			
23	60.23	23.70			
24	62.35	25.85			
25	64.47	28.00			

28.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : H-1 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	68.54	36.60
2	2.95	0.20	27	71.65	39.75
3	5.90	0.40	28	74.77	42.90
4	10.09	0.70	29	76.85	45.43
5	13.54	1.00	30	78.92	47.97
6	18.03	1.40	31	81.00	50.50
7	22.18	1.70	32	81.54	53.83
8	26.25	2.10	33	82.08	57.15
9	30.20	2.50	34	82.62	60.48
10	34.06	2.90	35	83.16	63.80
11	38.30	3.40	36	85.15	65.70
12	42.12	3.90	37	88.73	67.55
13	44.53	4.35	38	92.30	69.40
14	46.94	4.80	39	95.00	72.30
15	50.01	5.70			
16	53.67	8.90			
17	54.17	11.97			
18	54.67	15.03			
19	55.16	18.10			
20	55.66	21.17			
21	56.16	24.23			
22	56.66	27.30			
23	59.61	29.45			
24	62.56	31.60			
25	65.55	34.10			

29.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : F-2-1 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	87.83	57.42
2	5.65	0.40	27	88.98	61.30
3	9.47	0.70	28	95.70	63.20
4	13.29	1.10	29	105.67	65.40
5	17.03	1.80	30	115.23	65.40
6	21.27	2.90	31	125.28	66.80
7	25.01	4.50	32	133.34	67.90
8	29.08	6.30	33	141.81	69.10
9	33.15	8.50	34	149.79	70.30
10	37.63	10.60	35	158.35	71.70
11	42.20	12.70	36	166.15	73.10
12	45.86	14.90	37	174.45	75.10
13	49.85	17.10	38	182.77	77.30
14	54.42	20.10	39	190.83	79.90
15	58.24	22.90	40	199.80	83.10
16	62.39	26.20	41	208.02	86.80
17	66.13	29.70			
18	68.67	32.70			
19	71.21	35.70			
20	73.75	38.70			
21	78.92	41.30			
22	81.67	43.55			
23	84.41	45.80			
24	85.55	49.67			
25	86.69	53.55			

30.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : F-2-1 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	92.34	64.75
2	5.65	0.50	27	94.02	69.78
3	9.47	0.80	28	95.70	74.80
4	13.29	1.20	29	105.67	78.50
5	17.03	1.70	30	115.23	78.50
6	21.27	3.00	31	125.28	79.90
7	23.14	6.20	32	133.34	81.00
8	25.01	9.40	33	141.81	82.30
9	29.08	13.40	34	149.79	83.70
10	33.15	16.20	35	158.35	85.20
11	37.63	20.30	36	166.15	86.80
12	42.20	23.00	37	174.45	88.80
13	45.86	24.80	38	182.77	91.00
14	49.85	26.50	39	190.83	93.50
15	54.42	28.80	40	199.80	96.90
16	58.24	31.10	41	208.02	100.80
17	62.39	33.20			
18	66.13	35.70			
19	69.94	39.45			
20	73.75	43.20			
21	78.92	46.10			
22	81.67	48.70			
23	84.41	51.30			
24	88.98	54.70			
25	90.66	59.73			

31.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : F-2-2 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	135.96	52.90
2	5.81	0.10	27	142.23	53.80
3	13.71	0.80	28	148.13	54.90
4	21.60	1.40	29	154.02	56.00
5	29.49	2.30	30	160.34	57.35
6	37.22	4.40	31	166.65	58.70
7	41.58	7.95	32	172.72	60.25
8	45.94	11.50	33	178.78	61.80
9	50.01	14.30	34	187.09	64.30
10	54.08	17.10	35	195.40	66.20
11	58.20	20.05	36	203.54	69.40
12	62.31	23.00	37	207.69	71.20
13	66.46	25.80	38	212.18	73.30
14	70.62	28.60	39	216.00	75.20
15	75.93	32.10	40	220.32	78.00
16	78.31	36.37	41	224.31	81.10
17	80.70	40.63	42	228.79	85.30
18	83.08	44.90	43	230.12	89.70
19	89.10	46.45			
20	95.12	48.00			
21	104.26	49.10			
22	110.70	49.80			
23	117.14	50.50			
24	123.41	51.25			
25	129.68	52.00			

32.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : F-2-2 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	135.96	55.80
2	5.81	0.30	27	142.23	56.70
3	13.71	1.10	28	148.13	57.65
4	21.60	1.90	29	154.02	58.60
5	29.49	3.10	30	160.34	59.80
6	37.22	5.10	31	166.65	61.00
7	45.94	8.20	32	172.72	62.35
8	54.08	11.70	33	178.78	63.70
9	62.31	15.20	34	187.09	65.80
10	66.46	17.55	35	195.40	68.20
11	70.62	19.90	36	203.54	71.20
12	75.93	23.30	37	207.69	72.80
13	79.51	25.75	38	212.18	74.90
14	83.08	28.20	39	216.00	76.70
15	87.09	31.23	40	220.32	79.10
16	91.11	34.27	41	224.31	81.90
17	95.12	37.30	42	228.79	85.50
18	97.41	40.83	43	230.12	89.20
19	99.69	44.35			
20	101.98	47.88			
21	104.26	51.40			
22	110.70	52.40			
23	117.14	53.40			
24	123.41	54.15			
25	129.68	54.90			

33.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : F-2-3 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	158.26	61.50
2	4.90	0.20	27	164.39	62.80
3	14.62	1.00	28	170.52	64.10
4	21.10	3.10	29	176.35	65.65
5	25.09	5.90	30	182.19	67.20
6	29.08	8.70	31	188.25	69.30
7	37.39	13.50	32	194.32	71.40
8	45.53	17.90	33	203.79	74.90
9	49.47	20.45	34	207.53	76.70
10	53.42	23.00	35	211.93	78.80
11	57.86	25.60	36	216.50	81.40
12	62.31	28.20	37	220.49	84.10
13	70.62	32.40	38	224.52	87.90
14	78.92	36.80	39	225.74	91.55
15	83.49	40.90	40	226.97	95.20
16	88.06	45.00	41	224.31	97.80
17	92.63	49.10			
18	97.20	53.20			
19	107.92	54.20			
20	115.56	55.00			
21	123.20	55.80			
22	133.42	57.40			
23	139.57	58.35			
24	145.72	59.30			
25	151.99	60.40			

34.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : F-2-3 ALT

Column : W10X49
Beam : W21X62
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100 lu = -- ll = -- ta = 1.5875
gb = 5.7150 cu = -- cl = --
pb = 7.6200 qb = -- nb = 2 X -

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	194.32	83.70
2	4.90	0.20	27	203.12	87.40
3	14.62	1.10	28	211.93	91.10
4	21.10	1.90	29	216.21	94.10
5	27.21	7.28	30	220.49	97.10
6	33.31	12.65	31	222.65	100.97
7	39.42	18.02	32	224.81	104.83
8	45.53	23.40	33	226.97	108.70
9	53.42	27.80	34	224.31	111.70
10	62.31	33.00			
11	70.62	37.60			
12	78.92	42.60			
13	86.20	47.20			
14	93.48	51.80			
15	100.77	56.40			
16	104.34	61.65			
17	107.92	66.90			
18	117.99	68.44			
19	128.06	69.98			
20	138.12	71.52			
21	148.19	73.06			
22	158.26	74.60			
23	167.28	76.88			
24	176.29	79.15			
25	185.30	81.42			

35.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : R.M.Richard et al. (1982) U.S.A.
Test Id. : RGKL2

Column : --
Beam : --
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 15.2400 lu = -- ll = -- ta = 0.6350
gb = -- cu = -- cl = -- pb = 7.6200
nb = 1 X 2

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	5.06	35.68
2	0.22	0.27	27	5.18	38.32
3	0.44	0.53	28	5.31	40.96
4	0.66	0.80	29	5.43	43.60
5	0.96	1.12	30	5.56	45.87
6	1.25	1.43	31	5.69	48.13
7	1.55	1.75	32	5.81	50.40
8	1.84	2.07	33	5.91	52.67
9	2.14	2.38	34	6.01	54.93
10	2.43	2.70	35	6.10	57.20
11	2.64	3.20			
12	2.84	3.70			
13	3.05	4.20			
14	3.33	6.65			
15	3.62	9.10			
16	3.82	11.70			
17	4.01	14.30			
18	4.20	16.90			
19	4.31	18.90			
20	4.42	20.90			
21	4.53	22.90			
22	4.62	25.40			
23	4.72	27.90			
24	4.82	30.40			
25	4.94	33.04			

36.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : R.M.Richard et al. (1982) U.S.A.
Test Id. : RGKL3

Column : --
Beam : --
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 22.8600 lu = -- ll = -- ta = 0.6350
gb = -- cu = -- cl = -- pb = 7.6200
nb = 1 X 3

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	13.55	27.95
2	0.74	0.20	27	13.84	30.40
3	1.43	0.30	28	14.04	33.07
4	2.12	0.40	29	14.24	35.73
5	2.76	0.55	30	14.43	38.40
6	3.40	0.70	31	14.57	41.00
7	4.04	1.00	32	14.70	43.60
8	4.68	1.30	33	14.83	46.20
9	5.37	1.60	34	14.93	48.73
10	6.06	1.90	35	15.03	51.25
11	6.75	2.65	36	15.12	53.77
12	7.44	3.40	37	15.22	56.30
13	8.08	4.70	38	15.27	58.25
14	8.72	6.00	39	15.32	60.20
15	9.31	7.60			
16	9.70	8.65			
17	10.10	9.70			
18	10.79	12.30			
19	11.48	14.70			
20	11.82	16.50			
21	12.17	18.30			
22	12.51	19.85			
23	12.86	21.40			
24	13.05	23.45			
25	13.25	25.50			

37.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : R.M.Richard et al. (1982) U.S.A.
Test Id. : RGKL5

Column : --
Beam : --
Angle : --

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 38.1000 lu = -- ll = -- ta = 0.6350
gb = -- cu = -- cl = -- pb = 7.6200
nb = 1 X 5

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	58.18	18.10
2	3.19	0.10	27	59.32	19.60
3	6.37	0.20	28	60.63	21.90
4	9.31	0.40	29	61.94	24.20
5	12.26	0.90	30	62.43	26.40
6	14.22	0.90	31	62.92	28.60
7	16.67	1.10	32	63.24	30.20
8	19.12	1.30	33	63.57	31.80
9	21.57	1.55	34	64.22	34.20
10	24.02	1.80	35	64.88	36.60
11	26.96	2.10	36	65.37	38.90
12	29.91	2.40	37	65.86	41.20
13	32.52	2.85	38	66.18	44.13
14	35.14	3.30	39	66.51	47.07
15	37.10	3.70	40	66.84	50.00
16	39.06	4.10	41	67.16	52.40
17	41.51	4.80	42	67.49	54.80
18	43.96	5.50	43	67.82	57.20
19	46.25	6.65	44	68.14	59.60
20	48.53	7.80			
21	51.48	10.50			
22	52.78	12.00			
23	54.09	13.50			
24	55.56	15.05			
25	57.03	16.60			

38.
Connection type : Single web-angle connections
Mode : Bolted-to-beam and welded-to-column

Tested by : R.M.Richard et al. (1982) U.S.A.
Test Id. : RGKL7

Column : --
Beam : --
Angle : --

Fasteners: A325- -M22.2D
M27.0 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 54.6100 lu = -- ll = -- ta = 0.9525
gb = -- cu = -- cl = -- pb = 7.6200
nb = 1 X 7

Remark 1) SINGLE PLATE CONNECTION.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	127.85	22.00
2	6.06	0.23	27	130.16	23.75
3	12.11	0.47	28	132.47	25.50
4	18.17	0.70	29	133.80	27.60
5	24.12	1.07	30	135.12	29.70
6	30.06	1.43	31	136.11	31.45
7	36.01	1.80	32	137.10	33.20
8	42.40	2.13	33	138.09	34.80
9	48.78	2.47	34	139.08	36.40
10	55.17	2.80	35	140.40	39.03
11	60.90	3.23	36	141.72	41.67
12	66.62	3.67	37	143.05	44.30
13	72.35	4.10	38	143.71	47.07
14	77.30	4.55	39	144.37	49.83
15	82.26	5.00	40	145.03	52.60
16	86.88	5.55	41	145.69	55.20
17	91.51	6.10	42	146.35	57.80
18	96.47	7.30	43	147.01	60.40
19	101.42	8.50			
20	105.38	9.80			
21	109.35	11.10			
22	114.63	13.50			
23	117.94	15.70			
24	120.91	17.35			
25	123.88	19.00			

II.3 Detalle ensayos unión ángulo superior e inferior todo apernado

1.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : A-1/4-1

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/4 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.90	21.30
2	0.20	0.15	27	5.01	23.40
3	0.40	0.30	28	5.08	25.25
4	0.65	0.65	29	5.15	27.10
5	0.90	1.00	30	5.19	28.40
6	1.15	1.40	31	5.24	29.70
7	1.40	1.80	32	5.31	31.40
8	1.62	2.25	33	5.38	33.10
9	1.84	2.70	34	5.45	34.65
10	2.08	3.30	35	5.51	36.20
11	2.32	3.90	36	5.57	37.85
12	2.56	4.45	37	5.63	39.50
13	2.80	5.00	38	5.70	41.40
14	3.08	6.00	39	5.77	43.30
15	3.37	7.00			
16	3.56	8.10			
17	3.76	9.20			
18	3.96	10.60			
19	4.06	11.70			
20	4.17	12.80			
21	4.27	13.90			
22	4.37	15.00			
23	4.56	16.90			
24	4.78	18.70			
25	4.84	20.00			

2.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : A-1/4-2

Column : W5X16 Fasteners: A325- -M19.1D
Beam : W5X16 M20.6 Oversize holes
Angle : 4 X 4 X 1/4 X 5.0 Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.35	14.90
2	0.18	0.17	27	4.46	15.80
3	0.36	0.33	28	4.52	16.57
4	0.54	0.50	29	4.59	17.33
5	0.75	0.90	30	4.65	18.10
6	0.97	1.30	31	4.70	18.93
7	1.15	1.60	32	4.75	19.75
8	1.32	1.90	33	4.80	20.57
9	1.50	2.20	34	4.85	21.40
10	1.66	2.67			
11	1.83	3.13			
12	2.00	3.60			
13	2.24	4.25			
14	2.48	4.90			
15	2.67	5.50			
16	2.87	6.10			
17	3.11	7.15			
18	3.34	8.20			
19	3.47	8.97			
20	3.60	9.73			
21	3.73	10.50			
22	3.86	11.20			
23	3.98	11.90			
24	4.11	12.95			
25	4.24	14.00			

3.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : B-1/4-1

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/4 X 5.0

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.41	8.45
2	0.22	0.00	27	4.48	9.10
3	0.44	0.00	28	4.55	9.75
4	0.66	0.00	29	4.63	10.40
5	0.91	0.05	30	4.70	11.00
6	1.16	0.10	31	4.77	11.60
7	1.40	0.30	32	4.85	12.20
8	1.65	0.50	33	4.89	12.88
9	1.87	0.85	34	4.94	13.55
10	2.09	1.20	35	4.98	14.22
11	2.26	1.30	36	5.02	14.90
12	2.44	1.40	37	5.07	15.70
13	2.60	1.65	38	5.12	16.50
14	2.76	1.90	39	5.17	17.30
15	2.95	2.25			
16	3.15	2.60			
17	3.30	2.95			
18	3.45	3.30			
19	3.56	3.90			
20	3.67	4.50			
21	3.79	5.10			
22	3.91	5.75			
23	4.04	6.40			
24	4.18	7.10			
25	4.33	7.80			

4.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : B-1/4-2

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/4 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.24	21.50
2	0.20	0.07	27	4.35	23.00
3	0.39	0.15	28	4.46	24.50
4	0.59	0.23	29	4.54	25.60
5	0.79	0.30	30	4.62	26.70
6	1.01	0.50	31	4.69	27.80
7	1.23	0.70	32	4.78	29.05
8	1.45	0.90	33	4.87	30.30
9	1.68	1.30	34	4.98	31.30
10	1.91	1.70	35	5.08	32.30
11	2.13	2.10			
12	2.34	3.05			
13	2.55	4.00			
14	2.73	5.50			
15	2.91	7.00			
16	3.05	8.23			
17	3.18	9.47			
18	3.32	10.70			
19	3.47	12.30			
20	3.62	13.90			
21	3.74	15.33			
22	3.86	16.77			
23	3.98	18.20			
24	4.07	19.30			
25	4.15	20.40			

5.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : C1-1/4-2

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/4 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.74	21.70
2	0.25	0.10	27	4.89	23.55
3	0.51	0.20	28	5.03	25.40
4	0.76	0.30	29	5.13	27.35
5	0.99	0.55	30	5.22	29.30
6	1.22	0.80	31	5.29	31.50
7	1.46	1.10	32	5.35	33.70
8	1.70	1.40	33	5.43	35.55
9	1.94	1.65	34	5.51	37.40
10	2.18	1.90	35	5.55	39.30
11	2.41	2.40	36	5.58	41.20
12	2.64	2.90	37	5.63	43.25
13	2.79	3.25	38	5.68	45.30
14	2.93	3.60			
15	3.11	4.50			
16	3.28	5.40			
17	3.46	6.70			
18	3.64	8.00			
19	3.78	9.75			
20	3.92	11.50			
21	4.08	13.25			
22	4.24	15.00			
23	4.37	16.75			
24	4.51	18.50			
25	4.62	20.10			

6.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : C2-1/4-1

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/4 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.62	22.40
2	0.22	0.07	27	4.73	24.10
3	0.45	0.13	28	4.83	25.80
4	0.67	0.20	29	4.97	27.40
5	0.92	0.37	30	5.10	29.00
6	1.16	0.53	31	5.18	30.40
7	1.40	0.70	32	5.26	31.80
8	1.60	1.03	33	5.31	33.05
9	1.80	1.37	34	5.35	34.30
10	2.00	1.70	35	5.41	36.35
11	2.27	2.45	36	5.47	38.40
12	2.55	3.20	37	5.53	39.95
13	2.73	3.70	38	5.58	41.50
14	2.91	4.20	39	5.63	43.25
15	3.09	5.25	40	5.68	45.00
16	3.28	6.30	41	5.75	47.25
17	3.46	7.70	42	5.83	49.50
18	3.64	9.10			
19	3.76	10.65			
20	3.87	12.20			
21	4.00	14.10			
22	4.12	16.00			
23	4.25	17.80			
24	4.37	19.60			
25	4.50	21.00			

7.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : C2-1/4-2

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/4 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.29	20.80
2	0.24	0.17	27	4.42	22.50
3	0.48	0.33	28	4.56	24.20
4	0.72	0.50	29	4.70	25.55
5	0.95	0.75	30	4.83	26.90
6	1.19	1.00	31	4.94	28.45
7	1.43	1.35	32	5.04	30.00
8	1.67	1.70	33	5.12	31.30
9	1.90	2.15	34	5.20	32.60
10	2.13	2.60	35	5.28	34.05
11	2.31	3.30	36	5.36	35.50
12	2.49	4.00	37	5.41	36.95
13	2.65	4.50	38	5.47	38.40
14	2.81	5.00	39	5.55	40.05
15	2.97	5.80	40	5.63	41.70
16	3.13	6.60	41	5.67	43.15
17	3.29	8.15	42	5.72	44.60
18	3.45	9.70	43	5.77	45.90
19	3.56	11.10	44	5.81	47.20
20	3.67	12.50	45	5.86	49.20
21	3.76	14.00			
22	3.85	15.50			
23	3.97	16.90			
24	4.08	18.30			
25	4.19	19.55			

8.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D1-1/4-1

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/4 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.98	25.30
2	0.27	0.50	27	5.08	27.00
3	0.54	1.00	28	5.18	28.70
4	0.73	1.27	29	5.28	30.40
5	0.92	1.53	30	5.39	32.05
6	1.11	1.80	31	5.49	33.70
7	1.32	2.23	32	5.56	35.30
8	1.52	2.67	33	5.63	36.90
9	1.73	3.10			
10	2.01	3.65			
11	2.28	4.20			
12	2.56	4.85			
13	2.83	5.50			
14	3.04	6.25			
15	3.24	7.00			
16	3.46	8.35			
17	3.68	9.70			
18	3.86	11.50			
19	4.05	13.30			
20	4.21	15.00			
21	4.37	16.70			
22	4.51	18.40			
23	4.64	20.10			
24	4.76	21.85			
25	4.87	23.60			

9.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D1-1/4-2

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/4 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.62	25.90
2	0.19	0.33	27	4.70	27.20
3	0.37	0.67	28	4.78	28.50
4	0.56	1.00	29	4.84	30.10
5	0.83	1.75	30	4.90	31.70
6	1.11	2.50	31	4.97	33.45
7	1.35	3.15	32	5.03	35.20
8	1.59	3.80	33	5.10	37.00
9	1.85	4.60	34	5.17	38.80
10	2.11	5.40	35	5.22	40.40
11	2.32	6.05	36	5.26	42.00
12	2.52	6.70	37	5.32	43.45
13	2.67	7.35	38	5.38	44.90
14	2.82	8.00	39	5.41	46.85
15	2.99	9.15	40	5.45	48.80
16	3.16	10.30	41	5.49	50.10
17	3.39	11.65			
18	3.62	13.00			
19	3.78	14.45			
20	3.94	15.90			
21	4.09	17.70			
22	4.24	19.50			
23	4.34	21.20			
24	4.44	22.90			
25	4.53	24.40			

10.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D2-1/4-1

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/4 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.61	22.70
2	0.21	0.27	27	4.76	24.40
3	0.41	0.53	28	4.92	25.65
4	0.62	0.80	29	5.08	26.90
5	0.81	1.13	30	5.18	28.35
6	1.00	1.47	31	5.29	29.80
7	1.19	1.80	32	5.37	30.90
8	1.46	2.25	33	5.45	32.00
9	1.74	2.70	34	5.50	33.30
10	2.01	3.30	35	5.56	34.60
11	2.29	3.90	36	5.62	35.80
12	2.45	4.20	37	5.68	37.00
13	2.61	4.50			
14	2.84	6.05			
15	3.07	7.60			
16	3.27	9.25			
17	3.48	10.90			
18	3.64	12.25			
19	3.80	13.60			
20	3.80	13.60			
21	3.92	14.97			
22	4.04	16.33			
23	4.16	17.70			
24	4.31	19.35			
25	4.46	21.00			

11.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D2-1/4-2

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/4 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	4.67	22.00
2	0.26	0.15	27	4.83	23.05
3	0.53	0.30	28	4.99	24.10
4	0.78	0.85	29	5.10	25.35
5	1.03	1.40	30	5.22	26.60
6	1.27	1.75	31	5.33	28.15
7	1.51	2.10	32	5.45	29.70
8	1.69	2.60	33	5.54	30.95
9	1.88	3.10	34	5.63	32.20
10	2.08	3.60			
11	2.29	4.10			
12	2.49	4.60			
13	2.70	5.30			
14	2.91	6.00			
15	3.08	7.45			
16	3.25	8.90			
17	3.39	10.35			
18	3.52	11.80			
19	3.63	13.15			
20	3.73	14.50			
21	3.84	15.85			
22	3.96	17.20			
23	4.13	18.45			
24	4.30	19.70			
25	4.48	20.85			

12.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D3-1/4-1

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/4 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	3.70	17.00
2	0.16	0.20	27	3.80	18.15
3	0.33	0.40	28	3.90	19.30
4	0.49	0.60	29	3.95	20.43
5	0.63	0.90	30	3.99	21.57
6	0.78	1.20	31	4.04	22.70
7	0.92	1.50	32	4.05	23.70
8	1.10	1.93	33	4.07	24.70
9	1.28	2.37	34	4.08	25.70
10	1.47	2.80	35	4.10	26.87
11	1.67	3.27	36	4.11	28.03
12	1.88	3.73	37	4.13	29.20
13	2.08	4.20			
14	2.23	4.73			
15	2.38	5.27			
16	2.54	5.80			
17	2.67	6.80			
18	2.81	7.80			
19	2.93	9.00			
20	3.05	10.20			
21	3.17	11.40			
22	3.27	12.47			
23	3.37	13.53			
24	3.47	14.60			
25	3.58	15.80			

13.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D3-1/4-2

Column : W5X16 Fasteners: A325- -M19.1D
Beam : W5X16 M20.6 Oversize holes
Angle : 4 X 4 X 1/4 X 5.0 Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 0.6350	ls = 12.7000	ts = 0.6350
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	3.91	26.20
2	0.17	0.60	27	3.96	28.25
3	0.34	1.20	28	4.00	30.30
4	0.50	1.80	29	4.04	32.55
5	0.68	2.63	30	4.07	34.80
6	0.85	3.47	31	4.13	36.75
7	1.03	4.30	32	4.19	38.70
8	1.18	4.97	33	4.24	40.45
9	1.33	5.63	34	4.30	42.20
10	1.49	6.30	35	4.32	43.75
11	1.67	7.03	36	4.35	45.30
12	1.85	7.77	37	4.39	47.70
13	2.04	8.50	38	4.43	49.05
14	2.20	9.17	39	4.46	50.40
15	2.36	9.83			
16	2.52	10.50			
17	2.71	11.50			
18	2.91	12.50			
19	3.09	14.05			
20	3.27	15.60			
21	3.37	17.35			
22	3.48	19.10			
23	3.58	20.95			
24	3.68	22.80			
25	3.80	24.50			

14.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : A-1/2-1

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/2 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	18.07	24.70
2	0.91	0.47	27	18.34	26.55
3	1.82	0.93	28	18.61	28.40
4	2.72	1.40	29	18.82	29.80
5	3.66	1.87	30	19.04	31.20
6	4.60	2.33	31	19.25	32.60
7	5.54	2.80	32	19.47	34.25
8	6.35	3.33	33	19.70	35.90
9	7.17	3.87	34	19.93	37.45
10	7.99	4.40	35	20.15	39.00
11	8.72	5.10	36	20.29	40.05
12	9.44	5.80	37	20.43	41.10
13	10.17	6.50			
14	11.17	7.65			
15	12.17	8.80			
16	13.07	10.20			
17	13.98	11.60			
18	14.62	13.05			
19	15.25	14.50			
20	15.80	15.85			
21	16.34	17.20			
22	16.34	17.20			
23	16.93	18.95			
24	17.52	20.70			
25	17.79	22.70			

15.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : B-1/2-1

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/2 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	16.46	19.00
2	0.69	0.10	27	16.77	20.60
3	1.39	0.20	28	17.09	22.20
4	2.08	0.30	29	17.36	23.65
5	2.08	0.30	30	17.63	25.10
6	3.03	0.75	31	17.99	26.75
7	3.98	1.20	32	18.36	28.40
8	4.61	1.45	33	18.57	29.80
9	5.25	1.70	34	18.78	31.20
10	6.15	2.10	35	18.99	32.60
11	7.05	2.50	36	18.99	32.40
12	7.82	3.00	37	19.17	33.80
13	8.59	3.50	38	19.35	35.20
14	9.45	4.10	39	19.53	36.60
15	10.31	4.70	40	19.71	38.17
16	10.99	5.50	41	19.89	39.73
17	11.66	6.30	42	20.07	41.30
18	12.48	7.30			
19	13.29	8.30			
20	13.88	9.65			
21	14.47	11.00			
22	14.89	12.47			
23	15.31	13.93			
24	15.73	15.40			
25	16.10	17.20			

16.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : B-1/2-2

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/2 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	14.53	12.20
2	0.77	0.15	27	14.80	13.10
3	1.54	0.30	28	15.07	14.00
4	2.33	0.50	29	15.31	14.73
5	3.12	0.70	30	15.56	15.47
6	3.90	0.90	31	15.80	16.20
7	4.48	1.23	32	16.04	16.97
8	5.05	1.57	33	16.28	17.73
9	5.63	1.90	34	16.52	18.50
10	6.20	2.13	35	16.67	19.33
11	6.78	2.37	36	16.83	20.17
12	7.35	2.60	37	16.98	21.00
13	8.13	3.05			
14	8.90	3.50			
15	9.49	4.05			
16	10.08	4.60			
17	10.67	5.15			
18	11.26	5.70			
19	11.89	6.25			
20	12.53	6.80			
21	12.94	7.60			
22	13.35	8.40			
23	13.65	9.37			
24	13.95	10.33			
25	14.25	11.30			

17.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : C1-1/2-1

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/2 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	18.46	19.23
2	0.79	0.20	27	18.79	20.60
3	1.57	0.40	28	19.03	21.93
4	2.36	0.60	29	19.28	23.27
5	3.18	0.77	30	19.52	24.60
6	3.99	0.93	31	19.70	25.83
7	4.81	1.10	32	19.88	27.07
8	5.81	1.55	33	20.06	28.30
9	6.81	2.00	34	20.28	29.57
10	7.81	2.65	35	20.49	30.83
11	8.81	3.30	36	20.70	32.10
12	9.58	4.20	37	20.85	33.53
13	10.35	5.10	38	21.00	34.97
14	11.17	6.10	39	21.15	36.40
15	11.98	7.10			
16	12.71	7.95			
17	13.44	8.80			
18	14.34	9.70			
19	15.25	10.60			
20	16.11	11.70			
21	16.98	12.80			
22	17.25	14.03			
23	17.52	15.27			
24	17.79	16.50			
25	18.13	17.87			

18.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : C1-1/2-2

Column : W5X16 Fasteners: A325- -M19.1D
Beam : W5X16 M20.6 Oversize holes
Angle : 4 X 4 X 1/2 X 5.0 Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	18.39	22.10
2	0.99	0.00	27	18.72	23.40
3	1.99	0.00	28	19.08	25.00
4	3.03	0.00	29	19.44	26.60
5	4.07	0.00	30	19.67	28.25
6	4.88	0.27	31	19.89	29.90
7	5.70	0.53	32	20.12	31.45
8	6.51	0.80	33	20.35	33.00
9	7.55	1.20	34	20.53	34.60
10	8.59	1.60	35	20.71	36.20
11	9.40	2.65	36	20.89	37.30
12	10.22	3.70	37	21.07	38.40
13	10.85	4.65			
14	11.48	5.60			
15	12.12	6.50			
16	12.75	7.40			
17	13.70	8.60			
18	14.65	9.80			
19	15.19	11.25			
20	15.73	12.70			
21	16.28	14.20			
22	16.82	15.70			
23	17.27	17.60			
24	17.72	19.50			
25	18.05	20.80			

19.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : C2-1/2-1

Column : W5X16 Fasteners: A325- -M19.1D
Beam : W5X16 M20.6 Oversize holes
Angle : 4 X 4 X 1/2 X 5.0 Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	17.79	22.40
2	0.82	0.10	27	18.10	23.77
3	1.63	0.20	28	18.40	25.13
4	2.42	0.33	29	18.70	26.50
5	3.21	0.47	30	18.94	27.80
6	3.99	0.60	31	19.19	29.10
7	4.95	1.10	32	19.43	30.40
8	5.90	1.60	33	19.75	32.15
9	6.66	2.07	34	20.06	33.90
10	7.41	2.53	35	20.22	35.23
11	8.17	3.00	36	20.37	36.57
12	9.02	3.67	37	20.52	37.90
13	9.87	4.33			
14	10.71	5.00			
15	11.71	5.95			
16	12.71	6.90			
17	13.35	7.65			
18	13.98	8.40			
19	14.53	10.05			
20	15.07	11.70			
21	15.62	13.35			
22	16.16	15.00			
23	16.52	16.85			
24	16.89	18.70			
25	17.34	20.55			

20.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : C2-1/2-2

Column : W5X16 Fasteners: A325- -M19.1D
Beam : W5X16 M20.6 Oversize holes
Angle : 4 X 4 X 1/2 X 5.0 Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	17.41	23.05
2	1.00	0.40	27	17.78	25.00
3	2.00	0.80	28	18.14	26.55
4	2.96	1.35	29	18.50	28.10
5	3.92	1.90	30	18.72	29.53
6	4.88	2.50	31	18.93	30.97
7	5.83	3.10	32	19.14	32.40
8	6.65	3.60	33	19.42	34.10
9	7.47	4.10	34	19.69	35.80
10	8.20	4.75	35	19.84	37.30
11	8.93	5.40	36	19.99	38.80
12	9.62	5.85	37	20.14	40.30
13	10.30	6.30			
14	11.03	7.25			
15	11.76	8.20			
16	12.40	9.20			
17	13.03	10.20			
18	13.76	11.60			
19	14.49	13.00			
20	14.90	14.20			
21	15.31	15.40			
22	15.72	16.75			
23	16.13	18.10			
24	16.59	19.60			
25	17.05	21.10			

21.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D1-1/2-1

Column : W5X16 Fasteners: A325- -M19.1D
Beam : W5X16 M20.6 Oversize holes
Angle : 4 X 4 X 1/2 X 5.0 Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	19.25	21.50
2	0.91	0.25	27	19.56	23.35
3	1.82	0.50	28	19.88	25.20
4	2.66	0.67	29	20.15	26.85
5	3.51	0.83	30	20.43	28.50
6	4.36	1.00	31	20.70	29.85
7	5.45	1.45	32	20.97	31.20
8	6.54	1.90	33	21.20	32.75
9	7.49	2.40	34	21.43	34.30
10	8.44	2.90	35	21.65	35.80
11	9.31	3.35	36	21.88	37.30
12	10.17	3.80	37	22.06	38.90
13	11.08	4.20	38	22.24	40.50
14	11.98	4.60			
15	12.71	5.40			
16	13.44	6.20			
17	14.21	7.10			
18	14.98	8.00			
19	15.57	9.50			
20	16.16	11.00			
21	16.66	12.60			
22	17.16	14.20			
23	17.70	16.15			
24	18.25	18.10			
25	18.75	19.80			

22.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D1-1/2-2

Column : W5X16 Fasteners: A325- -M19.1D
Beam : W5X16 M20.6 Oversize holes
Angle : 4 X 4 X 1/2 X 5.0 Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	18.97	19.33
2	0.88	0.13	27	19.43	21.20
3	1.76	0.27	28	19.88	23.25
4	2.63	0.40	29	20.34	25.30
5	3.22	0.45	30	20.70	27.30
6	3.81	0.50	31	21.06	29.30
7	4.81	0.95	32	21.38	30.85
8	5.81	1.40	33	21.70	32.40
9	6.63	1.80	34	21.92	33.95
10	7.45	2.20	35	22.15	35.50
11	8.35	2.45	36	22.29	36.55
12	9.26	2.70	37	22.42	37.60
13	10.08	3.15	38	22.74	39.65
14	10.89	3.60	39	23.06	41.70
15	11.80	4.20			
16	12.71	4.80			
17	13.75	5.70			
18	14.80	6.60			
19	15.48	8.05			
20	16.16	9.50			
21	16.66	11.15			
22	17.16	12.80			
23	17.61	14.20			
24	18.07	15.60			
25	18.52	17.47			

23.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D2-1/2-1

Column : W5X16 Fasteners: A325- -M19.1D
Beam : W5X16 M20.6 Oversize holes
Angle : 4 X 4 X 1/2 X 5.0 Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	18.30	20.90
2	1.10	0.10	27	18.72	22.75
3	2.20	0.20	28	19.13	24.60
4	3.25	0.25	29	19.45	26.20
5	4.30	0.30	30	19.77	27.80
6	5.06	0.37	31	20.04	29.20
7	5.83	0.43	32	20.32	30.60
8	6.59	0.50	33	20.59	32.55
9	7.50	0.60	34	20.87	34.50
10	8.42	0.70	35	21.05	36.35
11	9.38	1.05	36	21.23	38.20
12	10.34	1.40	37	21.42	39.85
13	11.03	1.75	38	21.60	41.50
14	11.71	2.10	39	21.69	43.30
15	12.40	2.45	40	21.78	45.10
16	13.09	2.80	41	21.92	46.75
17	13.82	4.50	42	22.06	48.40
18	14.28	5.80			
19	14.74	7.10			
20	15.38	9.40			
21	15.88	11.15			
22	16.38	12.90			
23	16.93	14.75			
24	17.48	16.60			
25	17.89	18.75			

24.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D2-1/2-2

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/2 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	18.42	16.00
2	0.80	0.23	27	18.83	17.05
3	1.61	0.47	28	19.24	18.10
4	2.41	0.70	29	19.56	19.60
5	3.37	1.10	30	19.88	21.10
6	4.32	1.50	31	20.01	22.95
7	5.05	1.83	32	20.15	24.80
8	5.78	2.17	33	20.42	26.65
9	6.50	2.50	34	20.70	28.50
10	7.50	2.90	35	20.83	29.80
11	8.51	3.30	36	20.97	31.10
12	9.32	3.65	37	21.10	32.95
13	10.14	4.00	38	21.24	34.80
14	10.92	4.55	39	21.33	36.10
15	11.69	5.10	40	21.42	37.40
16	12.33	5.75			
17	12.96	6.40			
18	13.69	7.45			
19	14.42	8.50			
20	15.42	10.20			
21	15.97	11.10			
22	16.51	12.00			
23	16.92	12.95			
24	17.33	13.90			
25	17.88	14.95			

25.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D3-1/2-1

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/2 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	16.66	15.30
2	0.86	0.15	27	16.98	16.70
3	1.73	0.30	28	17.52	18.90
4	2.63	0.55	29	17.88	20.70
5	3.54	0.80	30	18.16	21.85
6	4.36	1.20	31	18.43	23.00
7	5.17	1.60	32	18.70	24.65
8	5.76	1.95	33	18.97	26.30
9	6.35	2.30	34	19.25	27.65
10	7.04	2.60	35	19.52	29.00
11	7.72	2.90	36	19.75	30.40
12	8.58	3.35	37	19.97	31.80
13	9.44	3.80	38	20.20	33.25
14	10.21	4.20	39	20.43	34.70
15	10.99	4.60	40	20.56	36.10
16	11.67	5.30	41	20.70	37.50
17	12.35	6.00	42	20.93	38.80
18	13.03	6.60	43	21.15	40.10
19	13.71	7.20	44	21.33	42.05
20	14.25	8.10	45	21.52	44.00
21	14.80	9.00			
22	15.16	10.15			
23	15.52	11.30			
24	15.93	12.60			
25	16.34	13.90			

26.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : M.J.Marley (1982) U.S.A
Test Id. : D3-1/2-2

Column : W5X16
Beam : W5X16
Angle : 4 X 4 X 1/2 X 5.0

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.7000	tt = 1.2700	ls = 12.7000	ts = 1.2700
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 1

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	17.61	19.30
2	0.91	0.30	27	17.98	20.65
3	1.82	0.60	28	18.34	22.00
4	2.63	0.85	29	18.66	23.40
5	3.45	1.10	30	18.97	24.80
6	4.22	1.45	31	19.34	26.15
7	4.99	1.80	32	19.70	27.50
8	5.95	2.25	33	20.02	29.10
9	6.90	2.70	34	20.34	30.70
10	6.90	2.70	35	20.52	32.25
11	7.67	3.15	36	20.70	33.80
12	8.44	3.60	37	20.88	35.10
13	9.17	4.17	38	21.06	36.40
14	9.90	4.73	39	21.24	38.05
15	10.62	5.30	40	21.43	39.70
16	11.39	5.95	41	21.52	41.20
17	12.17	6.60	42	21.61	42.70
18	13.07	8.20			
19	13.48	9.30			
20	13.89	10.40			
21	14.66	11.70			
22	15.43	13.00			
23	15.93	14.50			
24	16.43	16.00			
25	17.02	17.65			

27.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : A1

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 10 X 150 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 15.0000	tt = 1.0000	ls = 15.0000	ts = 1.0000
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	54.25	7.03
2	2.51	0.07	27	55.39	7.37
3	5.01	0.15	28	56.53	7.70
4	7.52	0.23	29	57.81	8.07
5	10.02	0.30	30	59.09	8.43
6	12.90	0.45	31	60.36	8.80
7	15.78	0.60	32	61.64	9.25
8	18.66	0.75	33	62.92	9.70
9	21.54	0.90			
10	23.82	1.13			
11	26.09	1.37			
12	28.37	1.60			
13	31.14	2.05			
14	33.92	2.50			
15	35.84	2.90			
16	37.75	3.30			
17	39.67	3.65			
18	41.59	4.00			
19	43.02	4.33			
20	44.44	4.67			
21	45.86	5.00			
22	47.57	5.40			
23	49.27	5.80			
24	51.19	6.25			
25	53.11	6.70			

28.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : A2

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 10 X 200 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 20.0000	tt = 1.0000	ls = 20.0000	ts = 1.0000
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	78.95	7.07
2	3.28	0.13	27	80.52	7.43
3	6.56	0.27	28	82.08	7.80
4	9.83	0.40	29	83.37	8.13
5	13.40	0.60	30	84.65	8.47
6	16.96	0.80	31	85.93	8.80
7	20.52	1.00	32	86.79	9.13
8	24.80	1.27	33	87.64	9.47
9	29.07	1.53	34	88.50	9.80
10	33.35	1.80			
11	37.19	2.10			
12	41.04	2.40			
13	44.89	2.70			
14	48.17	3.00			
15	51.44	3.30			
16	54.72	3.60			
17	57.57	3.93			
18	60.42	4.27			
19	63.27	4.60			
20	65.98	4.97			
21	68.69	5.33			
22	71.40	5.70			
23	73.39	6.03			
24	75.39	6.37			
25	77.38	6.70			

29.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : A3

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 10 X 150 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 15.0000	tt = 1.0000	ls = 15.0000	ts = 1.0000
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	76.14	8.23
2	3.33	0.17	27	77.14	8.57
3	6.65	0.35	28	78.14	8.90
4	9.98	0.53	29	78.79	9.30
5	13.31	0.70	30	79.43	9.70
6	17.17	0.95			
7	21.04	1.20			
8	24.19	1.47			
9	27.34	1.73			
10	30.48	2.00			
11	34.35	2.30			
12	38.21	2.60			
13	41.86	3.00			
14	45.51	3.40			
15	49.38	3.80			
16	53.24	4.20			
17	57.10	4.65			
18	60.97	5.10			
19	63.12	5.43			
20	65.26	5.77			
21	67.41	6.10			
22	69.77	6.55			
23	72.13	7.00			
24	73.63	7.45			
25	75.14	7.90			

30.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : A4

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 10 X 200 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 20.0000	tt = 1.0000	ls = 20.0000	ts = 1.0000
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	93.20	7.80
2	4.85	0.20	27	95.05	8.13
3	9.69	0.40	28	96.91	8.47
4	14.54	0.60	29	98.76	8.80
5	19.38	0.90	30	100.47	9.25
6	24.23	1.20	31	102.18	9.70
7	29.07	1.50			
8	33.35	1.77			
9	37.62	2.03			
10	41.90	2.30			
11	45.32	2.57			
12	48.74	2.83			
13	52.16	3.10			
14	56.65	3.50			
15	61.14	3.90			
16	66.05	4.35			
17	70.97	4.80			
18	73.96	5.13			
19	76.95	5.47			
20	79.95	5.80			
21	82.23	6.13			
22	84.51	6.47			
23	86.79	6.80			
24	88.92	7.13			
25	91.06	7.47			

31.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : B1

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 12 X 150 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 15.0000	tt = 1.1999	ls = 15.0000	ts = 1.1999
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	84.73	8.80
2	4.12	0.20	27	86.20	9.20
3	8.25	0.40	28	87.88	9.50
4	12.37	0.60	29	89.55	9.80
5	16.57	0.87			
6	20.76	1.13			
7	24.96	1.40			
8	28.73	1.70			
9	32.51	2.00			
10	36.28	2.30			
11	39.92	2.63			
12	43.55	2.97			
13	47.19	3.30			
14	51.38	3.75			
15	55.58	4.20			
16	59.14	4.65			
17	62.71	5.10			
18	65.64	5.55			
19	68.58	6.00			
20	71.31	6.45			
21	74.03	6.90			
22	76.34	7.30			
23	78.65	7.70			
24	80.95	8.05			
25	83.26	8.40			

32.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : B2

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 12 X 200 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 20.0000	tt = 1.1999	ls = 20.0000	ts = 1.1999
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	89.55	8.00
2	3.88	0.25	27	91.23	8.33
3	7.76	0.50	28	92.91	8.67
4	11.53	0.70	29	94.59	9.00
5	15.31	0.90	30	96.26	9.33
6	19.09	1.10	31	97.94	9.67
7	23.91	1.40	32	99.62	10.00
8	28.73	1.70			
9	33.56	2.05			
10	38.38	2.40			
11	41.74	2.65			
12	45.09	2.90			
13	48.66	3.25			
14	52.22	3.60			
15	56.00	3.90			
16	59.77	4.20			
17	63.13	4.55			
18	66.48	4.90			
19	70.05	5.30			
20	73.61	5.70			
21	76.13	6.10			
22	78.65	6.50			
23	81.79	6.90			
24	84.94	7.30			
25	87.25	7.65			

33.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : B3

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 12 X 150 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 15.0000	tt = 1.1999	ls = 15.0000	ts = 1.1999
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	89.95	7.80
2	4.62	0.30	27	92.05	8.25
3	8.97	0.53	28	94.16	8.70
4	13.31	0.77	29	95.42	9.07
5	17.65	1.00	30	96.68	9.43
6	22.14	1.27	31	97.94	9.80
7	26.62	1.53			
8	31.11	1.80			
9	35.31	2.07			
10	39.51	2.33			
11	43.72	2.60			
12	47.36	2.83			
13	51.00	3.07			
14	54.64	3.30			
15	58.64	3.65			
16	62.63	4.00			
17	66.41	4.35			
18	70.20	4.70			
19	73.14	5.05			
20	76.08	5.40			
21	78.81	5.80			
22	81.55	6.20			
23	83.65	6.55			
24	85.75	6.90			
25	87.85	7.35			

34.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : B4

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 12 X 200 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 20.0000	tt = 1.1999	ls = 20.0000	ts = 1.1999
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	100.60	8.03
2	4.96	0.27	27	102.42	8.37
3	9.93	0.53	28	104.23	8.70
4	14.89	0.80	29	105.77	9.03
5	18.81	1.07	30	107.31	9.37
6	22.72	1.33	31	108.85	9.70
7	26.63	1.60			
8	30.41	1.80			
9	34.19	2.00			
10	38.94	2.30			
11	43.69	2.60			
12	48.45	2.90			
13	53.48	3.25			
14	58.51	3.60			
15	63.34	3.90			
16	68.16	4.20			
17	72.57	4.60			
18	76.97	5.00			
19	81.37	5.40			
20	85.78	5.80			
21	88.92	6.25			
22	92.07	6.70			
23	94.31	7.03			
24	96.54	7.37			
25	98.78	7.70			

35.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : C1

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 15 X 150 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 15.0000	tt = 1.5001	ls = 15.0000	ts = 1.5001
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	101.75	7.70
2	3.96	0.25	27	104.75	8.10
3	7.93	0.50	28	107.75	8.50
4	12.21	0.77	29	110.75	8.90
5	16.50	1.03	30	113.11	9.35
6	20.78	1.30	31	115.46	9.80
7	24.78	1.57			
8	28.78	1.83			
9	32.78	2.10			
10	37.63	2.43			
11	42.49	2.77			
12	47.34	3.10			
13	51.91	3.40			
14	56.48	3.70			
15	61.05	4.00			
16	64.91	4.30			
17	68.76	4.60			
18	72.62	4.90			
19	76.90	5.23			
20	81.19	5.57			
21	85.47	5.90			
22	88.62	6.23			
23	91.76	6.57			
24	94.90	6.90			
25	98.33	7.30			

36.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : C2

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 15 X 200 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 20.0000	tt = 1.5001	ls = 20.0000	ts = 1.5001
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	117.35	7.95
2	2.99	0.20	27	117.57	8.20
3	7.70	0.47	28	117.57	8.50
4	12.40	0.73	29	117.57	8.80
5	17.10	1.00	30	117.78	9.10
6	22.87	1.30	31	118.00	9.40
7	28.64	1.60	32	118.00	9.65
8	33.77	1.90	33	118.00	9.90
9	38.90	2.20			
10	44.03	2.45			
11	49.17	2.70			
12	54.94	3.10			
13	60.71	3.50			
14	66.27	3.80			
15	71.82	4.10			
16	76.74	4.45			
17	81.66	4.80			
18	85.93	5.10			
19	90.21	5.40			
20	94.70	5.75			
21	99.19	6.10			
22	103.67	6.45			
23	108.16	6.80			
24	112.65	7.25			
25	117.14	7.70			

37.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : C3

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 15 X 150 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 15.0000	tt = 1.5001	ls = 15.0000	ts = 1.5001
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	104.31	7.70
2	4.48	0.20	27	106.65	8.05
3	8.96	0.40	28	109.00	8.40
4	13.44	0.60	29	111.13	8.85
5	17.28	0.80	30	113.26	9.30
6	21.12	1.00			
7	24.96	1.20			
8	30.50	1.45			
9	36.05	1.70			
10	41.38	2.00			
11	46.71	2.30			
12	52.05	2.60			
13	57.38	2.90			
14	61.86	3.25			
15	66.34	3.60			
16	70.04	3.93			
17	73.73	4.27			
18	77.43	4.60			
19	80.42	4.90			
20	83.40	5.20			
21	87.67	5.65			
22	91.93	6.10			
23	95.13	6.50			
24	98.33	6.90			
25	101.32	7.30			

38.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : S.M.Maxwell et al. (1981) U.S.A
Test Id. : C4

Column : 305 X 305 X UC 97 Fasteners: G8.8- -M20
Beam : 457 X 191 X UB 67 --- Oversize holes
Angle : 150 X 90 X 15 X 200 MM Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 20.0000	tt = 1.5001	ls = 20.0000	ts = 1.5001
gt = --	gt'= --	gs = --	gs'= --
qt = --	rt = --	qs = --	rs = --
pt = --	ps = --		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) GRADE 8.8 BOLTS AT COLUMN
2) HSFG BOLTS IN TWO ROWS AT BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	105.16	5.80
2	4.32	0.17	27	110.07	6.20
3	8.64	0.35	28	114.97	6.60
4	12.96	0.53	29	114.55	6.85
5	17.28	0.70	30	114.12	7.10
6	21.12	0.87	31	114.33	7.40
7	24.96	1.03	32	114.54	7.70
8	28.80	1.20	33	114.76	8.05
9	32.78	1.37	34	114.97	8.40
10	36.76	1.53			
11	40.74	1.70			
12	44.58	1.90			
13	48.42	2.10			
14	52.26	2.30			
15	56.10	2.53			
16	59.94	2.77			
17	63.78	3.00			
18	67.62	3.23			
19	71.46	3.47			
20	75.30	3.70			
21	80.63	4.05			
22	85.96	4.40			
23	90.87	4.75			
24	95.77	5.10			
25	100.47	5.45			

39.
Connection type : Top-and seat-angle connections
Mode : All bolted

Tested by : J.B.Davison et al. (1987) UNITED KINGDOM
Test Id. : JT/08

Column : UC 152x152x23 Fasteners: -- - -M16
Beam : UB 254x102x22 --- Oversize holes
Angle : RSA 80x60x8 TOP Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = 12.1001	tt = 0.8001	ls = 12.1001	ts = 0.8001
gt = 5.5001	gt'= 3.5001	gs = 5.0000	gs'= 4.5009
qt = 5.7000	rt = 7.5999	qs = 5.7000	rs = 7.5999
ps'= 5.0000			
nt = 2 X 1	nt'= 2 X 1	ns = 2 X 1	ns'= 2 X 2

Remark 1) RSA 125x75x8 SEAT
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	15.43	27.98
2	0.95	0.06	27	15.72	29.85
3	1.90	0.12	28	16.00	31.71
4	2.86	0.19	29	16.29	33.58
5	3.57	0.47	30	16.57	35.45
6	4.29	0.75	31	16.86	37.31
7	5.00	0.93	32	17.15	39.18
8	5.72	1.12	33	17.43	41.04
9	6.29	1.49	34	17.72	42.91
10	6.86	1.87	35	18.00	44.77
11	7.72	2.24	36	18.29	46.64
12	8.57	3.17	37	18.58	48.50
13	9.14	4.48	38	18.86	50.37
14	10.00	5.60	39	19.15	51.86
15	10.86	7.46			
16	11.43	8.95			
17	12.15	11.19			
18	12.69	13.06			
19	12.86	14.92			
20	13.43	16.79			
21	13.72	18.66			
22	14.15	20.52			
23	14.43	22.39			
24	14.72	24.25			
25	15.15	26.12			

II.4 Detalle ensayos unión ángulo superior e inferior todo remachado

1.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A
Test Id. : B-8

Column : --
Beam : W12X31.8
Angle : 6 X 6 X 3/8 X 6 (TOP)

Fasteners: -- - -M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 325 MPa
Fu = 433 MPa

Major parameters (cm)

lt = 15.2400	tt = 0.9525	ls = 15.2400	ts = 0.9525
gt = 8.8900	gt'= 8.8900	gs = 8.8900	gs'= 8.8900
qt = 6.9850	rt = 6.9850	qs = 6.9850	rs = 6.9850
pt = 6.3500	pt'= 6.3500	ps = 6.3500	
nt = 2 X 2	nt'= 2 X 2	ns = 2 X 2	ns'= 2 X 1

Remark 1) 6 X 4 X 3/8 X 6 (SEAT)
2) CONNECTION CLEAT RIVETED TO 1" MOUNTING PLATE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	26.24	3.26
2	1.09	0.03	27	26.69	3.43
3	2.18	0.05	28	27.14	3.61
4	3.34	0.09	29	27.71	3.91
5	4.49	0.13	30	28.28	4.21
6	5.64	0.19	31	28.79	4.50
7	6.78	0.24	32	29.30	4.79
8	7.92	0.32	33	29.62	5.00
9	9.06	0.40	34	29.95	5.21
10	10.19	0.48	35	30.27	5.42
11	11.32	0.56	36	30.68	5.70
12	12.45	0.66	37	31.09	5.99
13	13.57	0.75			
14	14.73	0.87			
15	15.88	1.00			
16	17.01	1.16			
17	18.14	1.31			
18	19.25	1.50			
19	20.36	1.69			
20	21.49	1.92			
21	22.62	2.14			
22	23.64	2.42			
23	24.25	2.59			
24	24.87	2.77			
25	25.55	3.01			

2.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A
Test Id. : B-9

Column : --
Beam : W12X31.8
Angle : 6 X 6 X 3/8 X 8 (TOP)

Fasteners: -- - -M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 325 MPa
Fu = 433 MPa

Major parameters (cm)

lt = 20.3200	tt = 0.9525	ls = 20.3200	ts = 0.9525
gt = 8.8900	gt'= 8.8900	gs = 8.8900	gs'= 8.8900
qt = 6.9850	rt = 6.3500	qs = 6.9850	rs = 6.3500
pt = 6.3500	pt'= 6.3500	ps = 6.3500	
nt = 2 X 2	nt'= 3 X 2	ns = 2 X 2	ns'= 3 X 1

Remark 1) 6 X 4 X 3/8 X 8 (SEAT)
2) CONNECTION CLEAT RIVETED TO 1" MOUNTING PLATE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	23.75	4.47
2	1.19	0.04	27	24.20	4.70
3	2.38	0.09	28	24.57	4.96
4	3.61	0.16	29	24.93	5.22
5	4.84	0.22	30	25.29	5.48
6	6.02	0.31	31	25.66	5.73
7	7.19	0.39	32	26.02	5.99
8	8.43	0.51			
9	9.67	0.64			
10	10.88	0.78			
11	12.10	0.93			
12	13.32	1.11			
13	14.54	1.29			
14	15.78	1.53			
15	17.01	1.77			
16	17.80	2.01			
17	18.59	2.25			
18	19.39	2.49			
19	20.00	2.74			
20	20.62	2.98			
21	21.24	3.23			
22	21.85	3.47			
23	22.34	3.73			
24	22.82	3.98			
25	23.30	4.24			

3.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A
Test Id. : B-10

Column : --
Beam : W12X31.8
Angle : 6 X 6 X 3/8 X 14 (TOP)

Fasteners: -- - -M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 325 MPa
Fu = 433 MPa

Major parameters (cm)

lt = 35.5600	tt = 0.9525	ls = 35.5600	ts = 0.9525
gt = 8.8900	gt'= 8.8900	gs = 8.8900	gs'= 8.8900
qt = 6.9850	rt = 13.9700	rt2= 6.3500	
qs = 6.9850	rs = 13.9700	rs2= 6.3500	
pt = 6.3500	pt'= 6.3500	ps = 6.3500	
nt = 2 X 2	nt'= 4 X 2	ns = 2 X 2	ns'= 4 X 1

Remark 1) 6 X 4 X 3/8 X 14 (SEAT)
2) CONNECTION CLEAT RIVETED TO 1" MOUNTING PLATE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	52.76	7.51
2	2.27	0.03	27	54.23	8.12
3	4.54	0.05	28	55.44	8.71
4	6.78	0.12	29	56.64	9.31
5	9.02	0.20	30	57.85	9.91
6	11.28	0.31	31	58.84	10.57
7	13.55	0.42	32	59.83	11.24
8	15.88	0.56	33	60.81	11.90
9	18.22	0.70	34	61.58	12.50
10	20.41	0.87	35	62.34	13.09
11	22.60	1.04	36	63.10	13.68
12	24.88	1.25			
13	27.16	1.45			
14	29.42	1.73			
15	31.68	2.01			
16	33.95	2.38			
17	36.23	2.75			
18	38.55	3.20			
19	40.88	3.66			
20	42.99	4.22			
21	45.11	4.79			
22	46.69	5.29			
23	48.26	5.79			
24	49.83	6.29			
25	51.30	6.90			

4.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 2

Column : W10X49 Fasteners: -- - -M19.1D
Beam : W12X25 M20.6 Oversize holes
Angle : 6 X 4 X 5/8 X 6 3/4 (TOP) Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 17.1450	tt = 1.5875	ls = 17.1450	ts = 1.2700
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 10.7950	rt = 10.7950	qs = 10.7950	rs = 10.7950
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 1/2 X 6 3/4 (SEAT)
2) 2 SHIMS 5 X 1/8 X 7 ARE USED ON TEN. FLANGE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	56.20	14.09
2	2.81	0.29	27	57.08	14.86
3	5.62	0.59	28	58.10	15.73
4	8.34	0.83	29	59.12	16.60
5	11.06	1.08	30	60.09	17.50
6	13.87	1.38	31	61.06	18.41
7	16.68	1.69	32	61.95	19.47
8	19.63	2.05	33	62.84	20.53
9	22.58	2.40	34	63.77	21.65
10	25.62	2.85	35	64.70	22.78
11	28.66	3.30			
12	31.25	3.74			
13	33.84	4.18			
14	36.52	4.80			
15	39.20	5.43			
16	41.44	6.10			
17	43.67	6.78			
18	45.04	7.43			
19	46.42	8.07			
20	47.98	8.88			
21	49.53	9.68			
22	51.05	10.57			
23	52.56	11.45			
24	53.94	12.38			
25	55.32	13.31			

5.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 5

Column : W12X65
Beam : W18X47
Angle : 6 X 4 X 1/2 X 12 (TOP)

Fasteners: -- - -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 30.4800	tt = 1.2700	ls = 19.0500	ts = 2.2225
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 11.4300	rt = 11.4300	rt2= 5.7150	
qs = 11.4300	rs = 11.4300		
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 4 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 7/8 X 7 1/2 (SEAT)
2) 1 SHIMS 5 X 1/8 X 7 IS USED ON TEN. FLANGE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	102.21	11.47
2	5.59	0.26	27	105.21	12.53
3	11.18	0.51	28	108.21	13.59
4	15.42	0.72	29	110.67	14.65
5	19.66	0.93	30	113.13	15.70
6	24.65	1.21	31	114.96	16.52
7	29.64	1.49	32	116.78	17.34
8	34.29	1.80	33	118.60	18.15
9	38.94	2.10	34	120.25	19.01
10	43.65	2.43	35	121.90	19.87
11	48.37	2.76	36	123.54	20.73
12	52.62	3.12	37	125.06	21.80
13	56.87	3.49	38	126.58	22.87
14	61.12	3.93	39	128.10	23.94
15	65.37	4.38			
16	68.61	4.76			
17	71.86	5.14			
18	75.30	5.60			
19	78.75	6.06			
20	82.33	6.66			
21	85.92	7.27			
22	91.07	8.24			
23	93.92	8.99			
24	96.77	9.74			
25	99.49	10.60			

6.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 9

Column : W12X65
Beam : W18X47
Angle : 6 X 4 X 5/8 X 12 (TOP)

Fasteners: -- - -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 30.4800	tt = 1.5875	ls = 19.0500	ts = 2.2225
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 11.4300	rt = 11.4300	rt2= 5.7150	
qs = 11.4300	rs = 11.4300		
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 4 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 7/8 X 7 1/2 (SEAT)
2) 1 SHIMS 5 X 1/8 X 7 IS USED ON TEN. FLANGE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	122.42	12.49
2	5.11	0.12	27	125.87	13.54
3	10.22	0.23	28	129.03	14.69
4	16.04	0.41	29	132.19	15.83
5	21.86	0.59	30	134.64	16.79
6	27.39	0.82	31	137.10	17.76
7	32.92	1.05	32	139.06	18.68
8	38.67	1.34	33	141.02	19.60
9	44.41	1.64	34	143.05	20.64
10	50.29	2.04	35	145.08	21.67
11	56.18	2.44	36	146.19	22.32
12	61.70	2.87	37	147.31	22.97
13	67.23	3.30			
14	72.54	3.78			
15	77.85	4.26			
16	83.02	4.82			
17	88.19	5.39			
18	92.86	6.06			
19	97.52	6.74			
20	102.04	7.61			
21	106.56	8.49			
22	110.02	9.25			
23	113.47	10.02			
24	116.22	10.73			
25	118.97	11.44			

7.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 10

Column : W12X65
Beam : W18X47
Angle : 6 X 4 X 3/4 X 12 (TOP)

Fasteners: -- - -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 30.4800	tt = 1.9050	ls = 19.0500	ts = 2.2225
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 11.4300	rt = 11.4300	rt2= 5.7150	
qs = 11.4300	rs = 11.4300		
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 4 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 7/8 X 7 1/2 (SEAT)
2) 1 SHIMS 5 X 1/8 X 7 IS USED ON TEN. FLANGE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	130.63	11.82
2	6.08	0.09	27	134.79	12.99
3	12.17	0.19	28	137.56	13.89
4	17.25	0.36	29	140.33	14.79
5	22.34	0.54	30	143.34	15.80
6	28.73	0.81	31	146.34	16.80
7	35.12	1.07	32	148.88	17.88
8	40.05	1.38	33	151.43	18.95
9	44.98	1.69	34	153.43	19.93
10	50.60	2.00	35	155.43	20.91
11	56.23	2.31	36	157.13	21.74
12	62.08	2.62	37	158.82	22.58
13	67.93	2.93	38	160.51	23.41
14	73.71	3.41			
15	79.49	3.89			
16	84.72	4.39			
17	89.96	4.89			
18	95.28	5.41			
19	100.59	5.93			
20	108.60	7.09			
21	115.23	8.05			
22	119.08	8.76			
23	122.93	9.48			
24	124.70	10.07			
25	126.47	10.66			

8.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 11

Column : W14X58
Beam : W18X47
Angle : 6 X 4 X 1/2 X 10 (TOP)

Fasteners: -- - -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 25.4000	tt = 1.2700	ls = 19.0500	ts = 2.2225
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 11.4300	rt = 6.3500	rt2= 6.3500	
qs = 11.4300	rs = 11.4300		
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 4 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 7/8 X 7 1/2 (SEAT). 1 SHIMS 5 X 1/8 X 7 IS USED ON TEN. FLANGE.
2) CONNECTION CLEAT RIVETED TO COLUMN WEB.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	108.24	11.57
2	5.67	0.06	27	110.20	12.49
3	11.33	0.13	28	112.16	13.40
4	16.87	0.23	29	114.12	14.32
5	22.41	0.32	30	116.03	15.14
6	27.95	0.46	31	117.94	15.96
7	33.48	0.59	32	119.85	16.77
8	39.02	0.80	33	121.91	17.87
9	44.56	1.02	34	123.96	18.96
10	49.10	1.40	35	126.01	20.05
11	53.63	1.78	36	127.62	20.98
12	58.17	2.15	37	129.22	21.92
13	62.79	2.55	38	130.83	22.85
14	67.41	2.95			
15	73.23	3.46			
16	79.04	3.97			
17	82.74	4.43			
18	86.44	4.88			
19	90.15	5.50			
20	92.87	6.34			
21	95.60	7.17			
22	97.95	7.94			
23	100.30	8.72			
24	102.65	9.49			
25	105.45	10.53			

9.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 16

Column : W10X49 Fasteners: -- - -M19.1D
Beam : W12X25 M20.6 Oversize holes
Angle : 6 X 4 X 1/2 X 6 3/4 (TOP) Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 17.1450	tt = 1.2700	ls = 17.1450	ts = 1.2700
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 10.7950	rt = 10.7950	qs = 10.7950	rs = 10.7950
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 1/2 X 6 3/4 (SEAT)
2) 1 SHIMS 5 X 1/8 X 6 3/4 IS USED ON TEN. FLANGE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	43.50	13.94
2	1.89	0.11	27	44.35	14.98
3	3.78	0.21	28	45.19	16.02
4	5.68	0.32	29	45.80	16.84
5	7.52	0.46	30	46.41	17.66
6	9.37	0.60	31	47.02	18.48
7	11.22	0.75	32	47.52	19.34
8	13.15	0.96	33	48.02	20.20
9	15.08	1.17	34	48.52	21.06
10	17.02	1.39	35	49.08	22.03
11	18.77	1.70	36	49.65	23.00
12	20.53	2.01	37	50.21	23.98
13	22.28	2.32			
14	24.69	2.89			
15	27.09	3.46			
16	29.19	4.19			
17	31.30	4.92			
18	33.17	5.91			
19	35.04	6.90			
20	36.48	7.85			
21	37.93	8.79			
22	39.11	9.75			
23	40.30	10.71			
24	41.48	11.80			
25	42.66	12.89			

10.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 17

Column : W10X49 Fasteners: -- - -M19.1D
Beam : W12X25 M20.6 Oversize holes
Angle : 6 X 4 X 1/2 X 6 3/4 (TOP) Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 17.1450	tt = 1.2700	ls = 17.1450	ts = 1.2700
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 10.7950	rt = 10.7950	qs = 10.7950	rs = 10.7950
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 1/2 X 6 3/4 (SEAT). 1 SHIMS 5 X 1/8 X 6 3/4 IS USED ON TEN. FLANGE.
2) CONNECTION CLEAT RIVETED TO COLUMN WEB.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	41.38	10.00
2	2.24	0.07	27	42.41	11.01
3	4.47	0.13	28	43.45	12.03
4	6.71	0.20	29	44.23	12.85
5	8.95	0.30	30	45.01	13.67
6	11.19	0.40	31	45.78	14.49
7	13.07	0.55	32	46.39	15.41
8	14.96	0.70	33	46.99	16.32
9	16.85	0.85	34	47.60	17.23
10	18.78	1.06	35	48.20	18.14
11	20.71	1.27	36	48.85	19.21
12	22.65	1.48	37	49.51	20.28
13	24.33	1.72	38	50.16	21.35
14	26.01	1.96	39	50.70	22.39
15	27.66	2.31	40	51.24	23.42
16	29.31	2.65			
17	30.59	3.05			
18	31.88	3.46			
19	33.93	4.31			
20	34.80	4.84			
21	36.16	5.69			
22	37.52	6.54			
23	38.38	7.27			
24	39.25	7.99			
25	40.31	9.00			

11.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 18

Column : W10X49
Beam : W12X50
Angle : 6 X 4 X 1/2 X 8 (TOP)

Fasteners: -- - -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 20.3200	tt = 1.2700	ls = 20.3200	ts = 1.2700
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 12.7000	rt = 12.7000	qs = 12.7000	rs = 12.7000
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 1/2 X 8 (SEAT). 1 SHIMS 5 X 1/8 X 8 IS USED ON TEN. FLANGE.
2) CONNECTION CLEAT RIVETED TO COLUMN WEB.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	44.84	10.51
2	2.23	0.06	27	45.76	11.31
3	4.45	0.12	28	46.55	12.20
4	6.68	0.19	29	47.33	13.08
5	8.90	0.27	30	48.12	13.96
6	11.13	0.36	31	48.91	15.04
7	12.98	0.49	32	49.71	16.11
8	14.84	0.62	33	50.50	17.19
9	16.70	0.75	34	51.07	18.14
10	18.64	0.92	35	51.64	19.08
11	20.59	1.08	36	52.21	20.03
12	22.53	1.24	37	52.72	21.11
13	24.73	1.56	38	53.23	22.20
14	26.93	1.87	39	53.74	23.28
15	28.67	2.32			
16	30.42	2.76			
17	32.10	3.24			
18	33.78	3.72			
19	35.57	4.45			
20	37.35	5.17			
21	38.85	6.02			
22	40.34	6.87			
23	41.68	7.88			
24	43.01	8.89			
25	43.93	9.70			

12.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 20

Column : W12X65
Beam : W14X34
Angle : 6 X 4 X 5/8 X 12 (TOP)

Fasteners: -- - -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 30.4800	tt = 1.5875	ls = 18.4150	ts = 1.5875
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 10.7950	rt = 10.7950	rt2= 5.7150	
qs = 10.7950	rs = 10.7950		
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 4 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 5/8 X 7 1/4 (SEAT)
2) 2 SHIMS 5 X 1/8 X 6 3/4 ARE USED ON TEN. FLANGE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	93.02	12.91
2	3.84	0.14	27	95.41	13.91
3	7.69	0.27	28	97.81	14.90
4	11.53	0.41	29	100.10	16.05
5	15.50	0.78	30	102.39	17.19
6	19.47	1.15	31	104.68	18.34
7	24.30	1.55	32	105.98	19.18
8	29.13	1.95	33	107.29	20.02
9	33.56	2.37	34	108.59	20.87
10	37.99	2.78	35	109.89	21.75
11	42.42	3.20	36	111.19	22.64
12	46.74	3.62	37	112.50	23.52
13	51.06	4.03			
14	55.37	4.45			
15	59.78	4.96			
16	64.19	5.46			
17	67.04	5.91			
18	69.90	6.36			
19	73.11	7.04			
20	76.32	7.71			
21	79.72	8.60			
22	83.11	9.48			
23	85.61	10.30			
24	88.12	11.11			
25	90.62	11.92			

13.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 22

Column : W12X65
Beam : W16X40
Angle : 6 X 4 X 5/8 X 12 (TOP)

Fasteners: -- - -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 30.4800	tt = 1.5875	ls = 18.4150	ts = 1.9050
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 10.7950	rt = 10.7950	rt2= 5.7150	
qs = 10.7950	rs = 10.7950		
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 4 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 3/4 X 7 1/4 (SEAT)
2) 2 SHIMS 5 X 1/8 X 6 3/4 ARE USED ON TEN. FLANGE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	114.91	13.92
2	6.03	0.23	27	117.29	14.85
3	12.06	0.45	28	119.56	15.85
4	17.23	0.65	29	121.83	16.84
5	22.40	0.85	30	124.10	17.84
6	28.18	1.10	31	125.84	18.81
7	33.95	1.34	32	127.58	19.78
8	39.57	1.66	33	129.32	20.75
9	45.19	1.98	34	131.06	21.72
10	51.51	2.41	35	132.48	22.60
11	57.83	2.85	36	133.91	23.48
12	62.87	3.35			
13	67.92	3.85			
14	72.10	4.32			
15	76.29	4.78			
16	80.41	5.37			
17	84.53	5.97			
18	88.85	6.78			
19	93.18	7.59			
20	97.80	8.63			
21	102.42	9.68			
22	105.00	10.47			
23	107.58	11.26			
24	110.16	12.06			
25	112.54	12.99			

14.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 23

Column : W14X58
Beam : W18X40
Angle : 6 X 4 X 5/8 X 10 (TOP)

Fasteners: -- - -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 25.4000	tt = 1.5875	ls = 18.4150	ts = 1.9050
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 10.7950	rt = 6.3500	rt2= 6.3500	
qs = 10.7950	rs = 10.7950		
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 4 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 3/4 X 7 1/4 (SEAT). 2 SHIM 5 X 1/8 X 6 3/4 ARE USED ON TEN. FLANGE.
2) CONNECTION CLEAT RIVETED TO COLUMN WEB.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	120.98	11.71
2	5.27	0.04	27	123.04	12.51
3	10.53	0.09	28	125.10	13.31
4	15.80	0.13	29	127.16	14.10
5	21.07	0.18	30	129.22	14.90
6	27.66	0.39	31	131.28	15.70
7	34.26	0.59	32	133.08	16.65
8	39.65	0.82	33	134.89	17.60
9	45.05	1.04	34	136.69	18.54
10	51.30	1.36	35	138.50	19.49
11	57.55	1.67			
12	62.69	1.99			
13	67.83	2.30			
14	71.86	2.59			
15	75.88	2.87			
16	80.60	3.32			
17	85.31	3.77			
18	90.28	4.55			
19	95.17	5.41			
20	100.05	6.27			
21	104.17	7.11			
22	108.28	7.95			
23	111.89	8.87			
24	115.49	9.78			
25	118.23	10.74			

15.
Connection type : Top-and seat-angle connections
Mode : All riveted

Tested by : R.A.Hechtman & B.G.Johnston (U.S.A
Test Id. : NO 24

Column : W12X65 Fasteners: -- - -M22.2D
Beam : W18X47 M23.8 Oversize holes
Angle : 6 X 4 X 5/8 X 12 1/2 (TOP Material : G40.21
Fy = 258 MPa
Fu = 431 MPa

Major parameters (cm)

lt = 31.7500	tt = 1.5875	ls = 19.0500	ts = 2.2225
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 8.8900
qt = 10.7950	rt = 10.7950	rt2= 6.6675	
qs = 10.7950	rs = 10.7950		
pt = 6.3500	ps = 6.3500	ps'= 6.3500	
nt = 2 X 2	nt'= 4 X 1	ns = 2 X 2	ns'= 2 X 2

Remark 1) 6 X 6 X 7/8 X 7 1/2 (SEAT)
2) 2 SHIMS 5 X 1/8 X 7 1/4 ARE USED ON TEN. FLANGE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	134.02	8.80
2	5.72	0.13	27	137.01	9.42
3	11.44	0.26	28	141.25	10.49
4	16.98	0.44	29	145.50	11.57
5	22.52	0.61	30	148.69	12.49
6	28.79	0.79	31	151.88	13.42
7	35.06	0.97	32	155.07	14.34
8	40.23	1.15	33	157.90	15.28
9	45.41	1.32	34	160.72	16.22
10	51.67	1.58	35	163.55	17.15
11	57.94	1.84	36	166.00	18.33
12	63.20	2.06	37	168.46	19.51
13	68.47	2.28	38	170.92	20.69
14	74.91	2.63	39	173.44	21.72
15	81.36	2.99	40	175.96	22.75
16	86.26	3.35	41	178.48	23.78
17	91.16	3.72			
18	97.51	4.18			
19	103.86	4.64			
20	108.84	5.18			
21	113.83	5.72			
22	118.90	6.35			
23	123.98	6.98			
24	127.51	7.58			
25	131.04	8.19			

II.5 Detalle ensayos unión doble ángulo con asiento superior e inferior todo apernado

1.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 8S1

Column : W12X58 Fasteners: A325- -M19.1D
Beam : W8X21 M20.6 Oversize holes
F.Angle: 6 X 3.5 X 5/16 X 6.0 Material : A36
W.Angle: 4 X 3.5 X 1/4 X 5.5 Fy = 280 MPa
Fu = 471 MPa

Major parameters (cm)

lp = 13.9700	lu = 3.4925	ll = 3.4925	ta = 0.6350
gb = 5.0800	gc = 6.6675	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2
lt = 15.2400	tt = 0.7937	ls = 15.2400	ts = 0.7937
gt = 8.8900	gt'= 5.0800	gs = 8.8900	gs'= 5.0800
qt = 6.9850	rt = 8.8900	qs = 6.9850	rs = 8.8900
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	33.90	17.37
2	1.96	0.23	27	34.60	18.53
3	3.18	0.38	28	35.36	20.06
4	4.39	0.53	29	36.13	21.59
5	5.69	0.76	30	36.86	23.14
6	6.99	1.00	31	37.59	24.70
7	8.95	1.32	32	38.07	25.93
8	10.35	1.51	33	38.55	27.17
9	11.74	1.70	34	39.07	28.43
10	13.51	2.09	35	39.58	29.69
11	14.87	2.42	36	39.98	31.03
12	16.23	2.76	37	40.38	32.36
13	17.40	3.10	38	40.83	33.69
14	18.56	3.44	39	41.28	35.01
15	19.68	3.85	40	41.60	36.05
16	20.79	4.26	41	41.91	37.09
17	22.82	5.14	42	42.28	38.24
18	24.72	6.43	43	42.65	39.38
19	26.58	7.93	44	42.88	40.35
20	28.18	9.60			
21	29.87	11.31			
22	30.75	12.63			
23	31.63	13.95			
24	32.42	15.08			
25	33.20	16.21			

2.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 8S2

Column : W12X58 Fasteners: A325- -M19.1D
Beam : W8X21 M20.6 Oversize holes
F.Angle: 6 X 3.5 X 3/8 X 6.0 Material : A36
W.Angle: 4 X 3.5 X 1/4 X 5.5 Fy = 280 MPa
Fu = 471 MPa

Major parameters (cm)

lp = 13.9700	lu = 3.4925	ll = 3.4925	ta = 0.6350
gb = 5.0800	gc = 6.6675	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2
lt = 15.2400	tt = 0.9525	ls = 15.2400	ts = 0.9525
gt = 8.8900	gt'= 5.0800	gs = 8.8900	gs'= 5.0800
qt = 6.9850	rt = 8.8900	qs = 6.9850	rs = 8.8900
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	37.22	7.17
2	1.49	0.05	27	38.36	8.20
3	2.97	0.11	28	39.51	9.23
4	4.46	0.16	29	40.32	10.20
5	5.67	0.21	30	41.13	11.18
6	6.88	0.26	31	41.69	12.12
7	8.45	0.37	32	42.25	13.06
8	10.01	0.48	33	42.79	14.40
9	11.77	0.66	34	43.33	15.74
10	13.53	0.84	35	43.53	16.76
11	15.05	1.01	36	43.72	17.77
12	16.57	1.17	37	43.35	18.77
13	18.09	1.33	38	43.63	19.56
14	19.62	1.49	39	43.91	20.36
15	21.15	1.64	40	44.00	21.39
16	22.68	1.79	41	43.63	22.30
17	24.09	2.02	42	43.60	23.19
18	25.50	2.24	43	43.56	24.09
19	27.33	2.66	44	43.74	25.50
20	28.58	3.09	45	43.92	26.91
21	29.82	3.52	46	44.10	28.32
22	31.91	4.24			
23	33.29	4.96			
24	34.67	5.69			
25	35.94	6.43			

3.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 8S3

Column : W12X58 Fasteners: A325- -M19.1D
Beam : W8X21 M20.6 Oversize holes
F.Angle: 6 X 3.5 X 5/16 X 8.0 Material : A36
W.Angle: 4 X 3.5 X 1/4 X 5.5 Fy = 280 MPa
Fu = 471 MPa

Major parameters (cm)

lp = 13.9700	lu = 3.4925	ll = 3.4925	ta = 0.6350
gb = 5.0800	gc = 6.6675	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2
lt = 20.3200	tt = 0.7937	ls = 20.3200	ts = 0.7937
gt = 8.8900	gt'= 5.0800	gs = 8.8900	gs'= 5.0800
qt = 6.9850	rt = 8.8900	qs = 6.9850	rs = 8.8900
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	43.05	15.42
2	2.23	0.18	27	43.69	16.52
3	4.45	0.36	28	44.38	17.84
4	6.70	0.52	29	45.07	19.15
5	8.94	0.69	30	45.79	20.48
6	11.19	0.96	31	46.52	21.81
7	13.43	1.22	32	47.11	23.33
8	15.77	1.59	33	47.70	24.85
9	18.12	1.96	34	48.27	26.20
10	19.68	2.20	35	48.84	27.54
11	21.25	2.45	36	49.37	28.64
12	23.04	2.77	37	49.89	29.74
13	24.84	3.10	38	50.40	31.36
14	27.10	3.65	39	50.91	32.98
15	29.56	4.28	40	51.38	34.34
16	31.69	5.12	41	51.85	35.70
17	33.08	5.74	42	52.53	37.46
18	34.46	6.37	43	53.20	39.21
19	36.26	7.38			
20	37.76	8.61			
21	39.40	10.18			
22	40.25	11.25			
23	41.11	12.31			
24	41.76	13.32			
25	42.42	14.33			

4.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 8S4

Column : W12X58 Fasteners: A325- -M19.1D
Beam : W8X21 M20.6 Oversize holes
F.Angle: 6 X 6.0 X 3/8 X 6.0 Material : A36
W.Angle: 4 X 3.5 X 1/4 X 5.5 Fy = 280 MPa
Fu = 471 MPa

Major parameters (cm)

lp = 13.9700	lu = 3.4925	ll = 3.4925	ta = 0.6350
gb = 5.0800	gc = 6.6675	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2
lt = 15.2400	tt = 0.9525	ls = 15.2400	ts = 0.9525
gt = 8.8900	gt'= 11.4300	gs = 8.8900	gs'= 11.4300
qt = 6.9850	rt = 8.8900	qs = 6.9850	rs = 8.8900
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	18.24	23.33
2	0.77	0.41	27	18.62	24.77
3	1.55	0.82	28	19.00	26.21
4	2.32	1.24	29	19.21	27.59
5	3.08	1.70	30	19.43	28.97
6	3.83	2.16	31	19.79	29.53
7	4.58	2.62	32	20.07	30.97
8	5.59	3.31	33	20.35	32.41
9	6.59	3.99	34	20.50	34.04
10	7.59	4.67	35	20.64	35.66
11	8.60	5.36	36	20.78	37.29
12	9.63	6.23	37	21.06	38.92
13	10.65	7.10	38	21.34	40.55
14	11.68	7.98			
15	12.46	8.90			
16	13.24	9.83			
17	14.10	11.43			
18	14.97	13.04			
19	15.50	14.15			
20	16.03	15.27			
21	16.37	16.45			
22	16.72	17.62			
23	17.10	19.09			
24	17.48	20.56			
25	17.86	21.94			

5.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 8S5

Column : W12X58 Fasteners: A325- -M19.1D
Beam : W8X21 M20.6 Oversize holes
F.Angle: 6 X 4.0 X 3/8 X 8.0 Material : A36
W.Angle: 4 X 3.5 X 1/4 X 5.5 Fy = 280 MPa
Fu = 471 MPa

Major parameters (cm)

lp = 13.9700	lu = 3.4925	ll = 3.4925	ta = 0.6350
gb = 5.0800	gc = 6.6675	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2
lt = 20.3200	tt = 0.9525	ls = 20.3200	ts = 0.9525
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 6.3500
qt = 6.9850	rt = 13.9700	qs = 6.9850	rs = 13.9700
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	35.81	17.72
2	1.64	0.16	27	36.38	19.16
3	3.28	0.32	28	36.94	20.59
4	4.93	0.48	29	37.42	22.24
5	6.92	0.70	30	37.90	23.88
6	8.92	0.93	31	38.39	25.53
7	10.50	1.23	32	38.82	26.98
8	12.08	1.52	33	39.25	28.43
9	13.66	1.82	34	39.68	29.88
10	15.10	2.13	35	40.39	31.83
11	16.55	2.43	36	41.10	33.78
12	17.99	2.74	37	41.37	35.47
13	20.03	3.35	38	41.65	37.16
14	22.07	3.96	39	42.08	38.60
15	23.65	4.61	40	42.51	40.04
16	25.23	5.27			
17	27.01	6.21			
18	28.79	7.16			
19	30.35	8.46			
20	31.91	9.76			
21	32.83	10.82			
22	33.75	11.87			
23	34.25	13.34			
24	34.75	14.81			
25	35.25	16.28			

6.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 8S6

Column : W12X58 Fasteners: A325- -M19.1D
Beam : W8X21 M20.6 Oversize holes
F.Angle: 6 X 4.0 X 5/16 X 6.0 Material : A36
W.Angle: 4 X 3.5 X 1/4 X 5.5 Fy = 280 MPa
Fu = 471 MPa

Major parameters (cm)

lp = 13.9700	lu = 3.4925	ll = 3.4925	ta = 0.6350
gb = 5.0800	gc = 6.6675	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2
lt = 15.2400	tt = 0.7937	ls = 15.2400	ts = 0.7937
gt = 6.3500	gt'= 6.3500	gs = 6.3500	gs'= 6.3500
qt = 6.9850	rt = 8.8900	qs = 6.9850	rs = 8.8900
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	27.68	22.65
2	1.30	0.19	27	28.31	24.41
3	2.60	0.38	28	28.94	26.17
4	3.58	0.59	29	29.49	28.10
5	4.56	0.79	30	30.04	30.02
6	5.92	1.18	31	30.48	31.66
7	7.29	1.56	32	30.93	33.30
8	8.25	1.82	33	31.30	34.90
9	9.22	2.09	34	31.66	36.50
10	10.66	2.61	35	32.09	38.48
11	12.10	3.12	36	32.52	40.46
12	13.54	3.64			
13	14.81	4.23			
14	16.07	4.82			
15	16.99	5.41			
16	17.90	5.99			
17	19.27	7.25			
18	20.63	8.52			
19	21.63	9.98			
20	22.63	11.45			
21	23.52	13.36			
22	24.42	15.26			
23	25.28	17.23			
24	26.15	19.19			
25	26.91	20.92			

7.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 8S7

Column : W12X58
Beam : W8X21
F.Angle: 6 X 4.0 X 3/8 X 6.0
W.Angle: 4 X 3.5 X 1/4 X 5.5

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 280 MPa
Fu = 471 MPa

Major parameters (cm)

lp = 13.9700	lu = 3.4925	ll = 3.4925	ta = 0.6350
gb = 5.0800	gc = 6.6675	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2
lt = 15.2400	tt = 0.9525	ls = 15.2400	ts = 0.9525
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 6.3500
qt = 6.9850	rt = 8.8900	qs = 6.9850	rs = 8.8900
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	39.85	20.64
2	1.31	0.27	27	40.58	22.61
3	2.62	0.53	28	41.31	24.57
4	4.52	0.80	29	41.84	26.13
5	6.76	1.25	30	42.37	27.69
6	9.00	1.71	31	42.92	29.36
7	10.57	2.06	32	43.47	31.04
8	12.15	2.41	33	44.03	32.68
9	13.72	2.77	34	44.60	34.33
10	15.96	3.33	35	44.99	35.57
11	18.20	3.89	36	45.39	36.82
12	19.82	4.35	37	45.95	38.53
13	21.44	4.81	38	46.52	40.23
14	23.05	5.27			
15	25.05	5.98			
16	27.04	6.68			
17	29.07	7.68			
18	31.12	8.86			
19	32.88	10.09			
20	34.11	11.38			
21	35.08	12.65			
22	36.04	13.91			
23	37.08	15.54			
24	38.13	17.17			
25	38.99	18.91			

8.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 8S8

Column : W12X58 Fasteners: A325- -M22.2D
Beam : W8X21 M23.8 Oversize holes
F.Angle: 6 X 3.5 X 5/16 X 6.0 Material : A36
W.Angle: 4 X 3.5 X 1/4 X 5.5 Fy = 272 MPa
Fu = 468 MPa

Major parameters (cm)

lp = 13.9700	lu = 3.4925	ll = 3.4925	ta = 0.6350
gb = 5.0800	gc = 6.6675	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2
lt = 15.2400	tt = 0.7937	ls = 15.2400	ts = 0.7937
gt = 8.8900	gt'= 5.0800	gs = 8.8900	gs'= 5.0800
qt = 6.9850	rt = 8.8900	qs = 6.9850	rs = 8.8900
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	41.54	21.18
2	1.66	0.24	27	42.46	23.00
3	3.31	0.47	28	43.00	24.35
4	4.92	0.72	29	43.64	25.77
5	6.52	0.97	30	44.14	27.40
6	7.94	1.18	31	45.21	29.35
7	9.37	1.38	32	45.70	30.57
8	10.81	1.65	33	46.24	31.67
9	12.25	1.92	34	46.77	32.77
10	13.66	2.17	35	47.15	33.76
11	15.07	2.42	36	47.52	34.75
12	17.21	2.89	37	47.98	36.17
13	19.13	3.52	38	48.73	37.80
14	21.30	4.24	39	49.52	39.47
15	23.48	5.06			
16	25.72	5.91			
17	27.89	7.10			
18	29.92	8.48			
19	32.38	10.09			
20	34.31	11.78			
21	36.30	13.70			
22	37.69	15.55			
23	38.97	17.22			
24	39.68	18.32			
25	40.40	19.42			

9.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 8S9

Column : W12X58 Fasteners: A325- -M22.2D
Beam : W8X21 M23.8 Oversize holes
F.Angle: 6 X 3.5 X 3/8 X 6.0 Material : A36
W.Angle: 4 X 3.5 X 1/4 X 5.5 Fy = 272 MPa
Fu = 468 MPa

Major parameters (cm)

lp = 13.9700	lu = 3.4925	ll = 3.4925	ta = 0.6350
gb = 5.0800	gc = 6.6675	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2
lt = 15.2400	tt = 0.9525	ls = 15.2400	ts = 0.9525
gt = 8.8900	gt'= 5.0800	gs = 8.8900	gs'= 5.0800
qt = 6.9850	rt = 8.8900	qs = 6.9850	rs = 8.8900
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	43.11	16.71
2	1.88	0.14	27	43.81	17.71
3	3.77	0.29	28	44.40	18.79
4	5.40	0.45	29	45.00	19.86
5	7.04	0.61	30	45.79	21.13
6	8.44	0.77	31	46.59	22.40
7	9.84	0.93	32	47.27	23.59
8	11.32	1.08	33	47.96	24.78
9	12.79	1.22	34	48.76	26.48
10	14.68	1.49	35	49.55	28.19
11	16.56	1.76	36	50.05	29.41
12	18.13	2.09	37	50.54	30.63
13	19.69	2.43	38	51.03	31.65
14	22.29	3.10	39	51.51	32.67
15	24.20	3.71	40	51.86	33.76
16	26.10	4.33	41	52.21	34.86
17	28.78	5.41	42	52.56	35.86
18	31.45	6.58	43	52.90	36.87
19	33.88	8.07	44	53.59	38.50
20	36.45	9.78			
21	38.53	11.43			
22	39.57	12.46			
23	40.61	13.49			
24	41.51	14.60			
25	42.40	15.71			

10.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 8S10

Column : W12X58
Beam : W8X21
F.Angle: 6 X 3.5 X 1/2 X 6.0
W.Angle: 4 X 3.5 X 1/4 X 5.5

Fasteners: A325- -M22.2D
M23.8 Oversize holes
Material : A36
Fy = 272 MPa
Fu = 468 MPa

Major parameters (cm)

lp = 13.9700	lu = 3.4925	ll = 3.4925	ta = 0.6350
gb = 5.0800	gc = 6.6675	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2
lt = 15.2400	tt = 1.2700	ls = 15.2400	ts = 1.2700
gt = 8.8900	gt'= 5.0800	gs = 8.8900	gs'= 5.0800
qt = 6.9850	rt = 8.8900	qs = 6.9850	rs = 8.8900
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	59.24	11.92
2	3.11	0.05	27	60.57	12.82
3	6.22	0.10	28	61.91	13.72
4	9.33	0.15	29	63.24	14.62
5	12.83	0.24	30	64.35	15.69
6	16.32	0.34	31	65.45	16.75
7	19.42	0.48	32	66.13	17.90
8	22.52	0.62	33	66.81	19.05
9	25.10	0.75	34	67.50	20.20
10	27.69	0.89	35	68.18	21.34
11	30.28	1.02	36	70.67	22.51
12	33.77	1.30	37	71.32	23.44
13	37.27	1.58	38	71.96	24.37
14	40.22	2.02	39	72.60	25.30
15	43.18	2.46	40	73.00	26.12
16	45.32	3.06	41	73.39	26.94
17	47.46	3.65			
18	49.35	4.36			
19	51.24	5.06			
20	49.75	5.69			
21	51.53	6.75			
22	53.32	7.80			
23	54.89	8.74			
24	56.46	9.68			
25	57.85	10.80			

11.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 14S1

Column : W12X96
Beam : W14X38
F.Angle: 6 X 4.0 X 3/8 X 8.0
W.Angle: 4 X 3.5 X 1/4 X 8.5

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 280 MPa
Fu = 471 MPa

Major parameters (cm)

lp = 21.5900	lu = 7.1437	ll = 7.1437	ta = 0.6350
gb = 5.0800	gc = 6.5888	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3
lt = 20.3200	tt = 0.9525	ls = 20.3200	ts = 0.9525
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 6.3500
qt = 8.8900	rt = 13.9700	qs = 8.8900	rs = 13.9700
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	64.74	9.57
2	2.91	0.09	27	66.09	10.70
3	5.82	0.18	28	67.44	11.83
4	8.73	0.27	29	68.46	12.94
5	10.90	0.48	30	69.47	14.05
6	14.01	0.60	31	70.25	15.39
7	17.13	0.73	32	71.02	16.72
8	19.99	0.89	33	71.96	18.24
9	22.85	1.05	34	72.89	19.37
10	25.70	1.21	35	73.83	20.50
11	28.45	1.52	36	74.84	21.76
12	30.91	1.77	37	75.86	23.02
13	33.36	2.01	38	76.97	24.43
14	36.44	2.27	39	78.07	25.83
15	39.52	2.53	40	79.01	27.08
16	41.94	2.87	41	79.94	28.32
17	44.35	3.22	42	81.09	29.79
18	46.98	3.58	43	82.24	31.25
19	49.60	3.94			
20	53.11	4.76			
21	55.40	5.37			
22	57.70	5.98			
23	59.79	6.87			
24	61.89	7.76			
25	63.31	8.67			

12.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 14S2

Column : W12X96
Beam : W14X38
F.Angle: 6 X 4.0 X 1/2 X 8.0
W.Angle: 4 X 3.5 X 1/4 X 8.5

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 365 MPa
Fu = 551 MPa

Major parameters (cm)

lp = 21.5900	lu = 7.1437	ll = 7.1437	ta = 0.6350
gb = 5.0800	gc = 6.5888	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3
lt = 20.3200	tt = 1.2700	ls = 20.3200	ts = 1.2700
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 6.3500
qt = 8.8900	rt = 13.9700	qs = 8.8900	rs = 13.9700
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	97.13	12.68
2	5.57	0.11	27	96.05	13.04
3	11.14	0.21	28	97.49	14.21
4	16.67	0.46	29	98.92	15.38
5	22.20	0.72	30	100.52	16.73
6	27.78	0.95	31	102.12	18.08
7	33.35	1.19	32	103.97	19.33
8	37.29	1.41	33	104.06	19.75
9	41.22	1.62	34	102.91	20.39
10	45.16	1.84	35	104.15	21.46
11	50.82	2.28	36	105.39	22.52
12	56.48	2.73	37	106.62	23.59
13	59.60	3.01	38	107.86	24.62
14	62.72	3.30	39	109.10	25.66
15	67.30	3.82	40	110.33	26.69
16	70.30	4.25	41	111.80	27.83
17	73.30	4.69	42	113.26	28.98
18	76.47	5.22	43	114.72	30.12
19	79.64	5.76			
20	85.23	7.10			
21	87.74	7.96			
22	90.24	8.82			
23	92.34	9.92			
24	94.44	11.01			
25	95.78	11.85			

13.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 14S3

Column : W12X96
Beam : W14X38
F.Angle: 6 X 4.0 X 3/8 X 8.0
W.Angle: 4 X 3.5 X 1/4 X 5.5

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 280 MPa
Fu = 471 MPa

Major parameters (cm)

lp = 13.9700	lu = 10.9537	ll = 10.9537	ta = 0.6350
gb = 5.0800	gc = 6.5888	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 2	nc = 1 X 2
lt = 20.3200	tt = 0.9525	ls = 20.3200	ts = 0.9525
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 6.3500
qt = 8.8900	rt = 13.9700	qs = 8.8900	rs = 13.9700
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	64.17	13.83
2	2.93	0.20	27	65.59	15.22
3	5.85	0.41	28	67.01	16.60
4	8.78	0.61	29	68.37	18.12
5	11.82	0.89	30	69.73	19.64
6	14.86	1.16	31	70.70	20.81
7	17.90	1.43	32	71.67	21.97
8	21.07	1.75	33	72.65	23.14
9	24.25	2.07	34	73.87	24.65
10	27.42	2.39	35	75.09	26.15
11	30.44	2.74	36	76.21	27.52
12	33.46	3.09	37	77.34	28.89
13	36.48	3.44	38	78.42	30.15
14	38.87	3.70	39	79.51	31.40
15	40.34	4.05			
16	43.01	4.50			
17	45.67	4.96			
18	47.98	5.57			
19	50.28	6.18			
20	52.39	6.98			
21	54.49	7.77			
22	57.98	9.25			
23	59.59	10.32			
24	61.20	11.38			
25	62.69	12.61			

14.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 14S4

Column : W12X96
Beam : W14X38
F.Angle: 6 X 4.0 X 3/8 X 8.0
W.Angle: 4 X 3.5 X 3/8 X 8.5

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 280 MPa
Fu = 471 MPa

Major parameters (cm)

lp = 21.5900	lu = 7.1437	ll = 7.1437	ta = 0.9525
gb = 5.0800	gc = 6.5888	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3
lt = 20.3200	tt = 0.9525	ls = 20.3200	ts = 0.9525
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 6.3500
qt = 8.8900	rt = 13.9700	qs = 8.8900	rs = 13.9700
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	85.08	15.76
2	4.46	0.18	27	86.23	16.87
3	8.91	0.35	28	87.31	18.01
4	13.44	0.55	29	88.39	19.15
5	17.96	0.74	30	89.47	20.29
6	22.45	0.94	31	90.69	21.54
7	26.95	1.15	32	91.90	22.78
8	31.47	1.47	33	93.12	24.03
9	36.00	1.80	34	94.24	25.20
10	40.49	2.16	35	95.37	26.36
11	44.98	2.53	36	96.50	27.53
12	49.65	3.07	37	97.49	28.59
13	54.31	3.62	38	98.48	29.65
14	58.31	4.31	39	99.47	30.71
15	62.31	5.00			
16	65.28	5.57			
17	68.24	6.15			
18	70.85	6.92			
19	73.45	7.69			
20	77.00	9.08			
21	78.48	10.03			
22	79.95	10.98			
23	81.37	12.25			
24	82.79	13.52			
25	83.93	14.64			

15.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 14S5

Column : W12X96
Beam : W14X38
F.Angle: 6 X 4.0 X 3/8 X 8.0
W.Angle: 4 X 3.5 X 1/4 X 8.5

Fasteners: A325- -M22.2D
M23.8 Oversize holes
Material : A36
Fy = 272 MPa
Fu = 468 MPa

Major parameters (cm)

lp = 21.5900	lu = 7.1437	ll = 7.1437	ta = 0.6350
gb = 5.0800	gc = 6.5888	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3
lt = 20.3200	tt = 0.9525	ls = 20.3200	ts = 0.9525
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 6.3500
qt = 8.8900	rt = 13.9700	qs = 8.8900	rs = 13.9700
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	92.98	12.71
2	5.52	0.09	27	93.70	14.03
3	11.04	0.18	28	93.89	15.04
4	14.74	0.35	29	95.59	16.18
5	18.44	0.52	30	97.29	17.31
6	23.34	0.73	31	99.44	18.73
7	28.24	0.95	32	101.05	19.98
8	32.25	1.18	33	102.66	21.24
9	36.26	1.42	34	104.14	22.22
10	40.18	1.70	35	105.62	23.20
11	44.10	1.98	36	107.85	24.11
12	48.46	2.26	37	109.33	25.24
13	52.83	2.54	38	110.81	26.37
14	56.08	2.86	39	112.15	27.32
15	59.34	3.19	40	113.49	28.26
16	64.77	3.69	41	115.06	29.13
17	70.03	4.47	42	116.62	29.99
18	74.31	5.10	43	117.88	31.22
19	78.15	5.88			
20	81.89	6.67			
21	86.00	7.86			
22	89.04	9.22			
23	89.93	10.05			
24	90.83	10.88			
25	91.91	11.80			

16.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 14S6

Column : W12X96 Fasteners: A325- -M22.2D
Beam : W14X38 M23.8 Oversize holes
F.Angle: 6 X 4.0 X 1/2 X 8.0 Material : A36
W.Angle: 4 X 3.5 X 1/4 X 8.5 Fy = 272 MPa
Fu = 468 MPa

Major parameters (cm)

lp = 21.5900	lu = 7.1437	ll = 7.1437	ta = 0.6350
gb = 5.0800	gc = 6.5888	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3
lt = 20.3200	tt = 1.2700	ls = 20.3200	ts = 1.2700
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 6.3500
qt = 8.8900	rt = 13.9700	qs = 8.8900	rs = 13.9700
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	100.23	11.99
2	4.46	0.15	27	102.22	13.03
3	8.91	0.31	28	104.21	14.07
4	13.73	0.50	29	105.65	14.85
5	18.54	0.69	30	107.10	15.64
6	23.36	0.89	31	108.54	16.46
7	28.17	1.08	32	109.99	17.28
8	32.99	1.33	33	111.35	18.33
9	37.80	1.58	34	112.72	19.39
10	42.44	1.90	35	114.08	20.25
11	47.08	2.23	36	115.43	21.12
12	51.45	2.59	37	116.53	22.17
13	55.83	2.95	38	117.63	23.23
14	60.20	3.36	39	118.81	24.30
15	64.58	3.76	40	120.00	25.37
16	68.51	4.23	41	121.45	26.60
17	72.44	4.70	42	122.91	27.83
18	76.01	5.23	43	124.01	29.07
19	79.59	5.77	44	125.11	30.32
20	85.15	7.09			
21	87.93	7.89			
22	90.71	8.69			
23	93.13	9.47			
24	95.56	10.26			
25	97.90	11.13			

17.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 14S8

Column : W12X96
Beam : W14X38
F.Angle: 6 X 4.0 X 5/8 X 8.0
W.Angle: 4 X 3.5 X 1/4 X 8.5

Fasteners: A325- -M22.2D
M23.8 Oversize holes
Material : A36
Fy = 272 MPa
Fu = 468 MPa

Major parameters (cm)

lp = 21.5900	lu = 7.1437	ll = 7.1437	ta = 0.6350
gb = 5.0800	gc = 6.5888	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3
lt = 20.3200	tt = 1.5875	ls = 20.3200	ts = 1.5875
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 6.3500
qt = 8.8900	rt = 13.9700	qs = 8.8900	rs = 13.9700
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	144.17	8.50
2	6.53	0.10	27	148.12	9.64
3	13.07	0.20	28	152.08	10.79
4	19.60	0.30	29	155.14	11.97
5	26.37	0.42	30	158.20	13.14
6	33.15	0.54	31	159.13	14.34
7	39.92	0.67	32	161.65	15.44
8	46.69	0.81	33	164.18	16.54
9	52.31	0.94	34	166.27	17.92
10	57.92	1.08	35	168.36	19.31
11	64.25	1.26	36	170.11	20.30
12	70.58	1.45	37	171.86	21.30
13	75.48	1.61	38	173.61	22.30
14	80.38	1.78	39	175.43	23.37
15	86.45	2.08	40	177.24	24.45
16	92.51	2.37	41	179.05	25.53
17	98.31	2.68	42	180.70	26.87
18	104.11	2.99	43	182.34	28.21
19	109.29	3.44	44	183.60	28.74
20	114.47	3.89			
21	119.83	4.52			
22	125.19	5.14			
23	130.29	5.86			
24	135.39	6.58			
25	139.78	7.54			

18.
Connection type : Top-and seat-angle connections with double web angle
Mode : All bolted

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 14S9

Column : W12X96
Beam : W14X38
F.Angle: 6 X 4.0 X 1/2 X 8.0
W.Angle: 4 X 3.5 X 1/4 X 8.5

Fasteners: A325- -M22.2D
M23.8 Oversize holes
Material : A36
Fy = 272 MPa
Fu = 468 MPa

Major parameters (cm)

lp = 21.5900	lu = 7.1437	ll = 7.1437	ta = 0.6350
gb = 5.0800	gc = 6.5888	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3
lt = 20.3200	tt = 1.2700	ls = 20.3200	ts = 1.2700
gt = 8.8900	gt'= 6.3500	gs = 8.8900	gs'= 6.3500
qt = 8.8900	rt = 13.9700	qs = 8.8900	rs = 13.9700
pt = 6.3500	ps = 6.3500		
nt = 2 X 2	nt'= 2 X 1	ns = 2 X 2	ns'= 2 X 1

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	102.12	11.71
2	4.28	0.15	27	104.29	12.86
3	8.55	0.31	28	105.74	13.88
4	11.94	0.42	29	107.19	14.90
5	15.32	0.52	30	108.73	15.96
6	21.20	0.77	31	110.27	17.01
7	27.26	1.08	32	111.28	18.18
8	31.90	1.30	33	112.29	19.34
9	36.53	1.51	34	112.49	20.27
10	40.36	1.70	35	112.69	21.20
11	44.19	1.89	36	113.52	22.21
12	47.85	2.13	37	114.34	23.21
13	51.50	2.38	38	115.98	24.35
14	55.52	2.66	39	116.62	25.29
15	59.53	2.94	40	117.27	26.24
16	62.92	3.24	41	118.36	27.05
17	66.31	3.54	42	119.45	27.87
18	70.95	4.07	43	120.54	28.78
19	75.59	4.60	44	121.63	29.70
20	79.61	5.20			
21	83.63	5.79			
22	87.75	6.75			
23	91.87	7.70			
24	96.89	9.12			
25	99.95	10.56			

II.6 Detalle ensayos unión doble ángulo con asiento superior e inferior todo remachado

1.
Connection type : Top-and seat-angle connections with double web angle
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A.
Test Id. : B-11

Column : --
Beam : W12X31.8
F.Angle: 6 X 6.0 X 3/8 X 9 (TOP)
W.Angle: 4 X 3.5 X 3/8 X 9

Fasteners: -- - -M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 325 MPa
Fu = 433 MPa

Major parameters (cm)

lp = 22.8600	lu = 3.8100	ll = 4.0386	ta = 0.9525
gb = 5.7150	gc = 5.7150	cu = 3.8100	cl = 3.8100
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3
lt = 22.8600	tt = 0.3175	ls = 22.8600	ts = 0.3175
gt = 8.8900	gt'= 9.5250	gs = 8.8900	gs'= 6.3500
qt = 6.9850	rt = 13.9700	qs = 6.9850	rs = 13.9700
pt = 6.3500	pt'= 6.3500	ps = 6.3500	
nt = 2 X 2	nt'= 2 X 2	ns = 2 X 2	ns'= 2 X 1

Remark 1) 6 X 4.0 X 3/8 X 9 (SEAT)
2) CONNECTION CLEAT RIVETED TO 1" MOUNTING PLATE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	53.00	4.03
2	2.27	0.04	27	54.47	4.29
3	4.55	0.09	28	55.57	4.48
4	6.82	0.16	29	56.67	4.67
5	9.09	0.22	30	57.78	4.92
6	11.34	0.32	31	58.90	5.16
7	13.58	0.41	32	59.80	5.43
8	15.87	0.52	33	60.70	5.70
9	18.17	0.63	34	61.60	5.97
10	20.39	0.74	35	62.39	6.27
11	22.60	0.86	36	63.17	6.57
12	24.92	0.99			
13	27.23	1.13			
14	29.52	1.29			
15	31.81	1.45			
16	34.15	1.62			
17	36.48	1.80			
18	38.69	2.03			
19	40.90	2.26			
20	43.12	2.53			
21	45.35	2.81			
22	46.91	3.05			
23	48.48	3.29			
24	50.04	3.53			
25	51.52	3.78			

2.
Connection type : Top-and seat-angle connections with double web angle
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A.
Test Id. : B-12

Column : --
Beam : W12X31.8
F.Angle: 6 X 6.0 X 3/8 X 14 (TOP)
W.Angle: 4 X 3.5 X 3/8 X 9

Fasteners: -- - -M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 325 MPa
Fu = 433 MPa

Major parameters (cm)

lp = 22.8600	lu = 3.8100	ll = 4.0386	ta = 0.9525
gb = 5.7150	gc = 5.7150	cu = 3.8100	cl = 3.8100
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3
lt = 35.5600	tt = 0.3175	ls = 35.5600	ts = 0.3175
gt = 8.8900	gt'= 9.5250	gs = 8.8900	gs'= 6.3500
qt = 6.9850	rt = 13.9700	rt2= 6.3500	
qs = 6.9850	rs = 13.9700	rs2= 6.3500	
pt = 6.3500	pt'= 6.3500	ps = 6.3500	
nt = 2 X 2	nt'= 4 X 2	ns = 2 X 2	ns'= 4 X 1

Remark 1) 6 X 4.0 X 3/8 X 14 (SEAT)
2) CONNECTION CLEAT RIVETED TO 1" MOUNTING PLATE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	69.95	6.13
2	2.86	0.05	27	71.80	6.57
3	5.72	0.09	28	73.65	7.00
4	8.44	0.17	29	75.53	7.53
5	11.16	0.24	30	77.40	8.05
6	14.02	0.35	31	79.27	8.58
7	16.88	0.46	32	80.94	9.12
8	19.70	0.60	33	82.61	9.67
9	22.52	0.73	34	83.74	10.11
10	25.34	0.91	35	84.88	10.54
11	28.17	1.09	36	86.01	10.98
12	31.09	1.27			
13	34.01	1.46			
14	36.90	1.70			
15	39.79	1.95			
16	42.61	2.18			
17	45.43	2.42			
18	48.42	2.73			
19	51.40	3.05			
20	54.05	3.40			
21	56.70	3.74			
22	59.79	4.21			
23	62.87	4.68			
24	65.48	5.19			
25	68.10	5.70			

II.7 Detalle ensayos unión doble ángulo con asiento superior e inferior. Viga soldada columna apernada

1.
Connection type : Top-and seat-angle connections with double web angle
Mode : Welded-to-beam and bolted-to-column

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 14WS1

Column : W12X96 Fasteners: A325- -M19.1D
Beam : W14X38 M23.8 Oversize holes
F.Angle: 6 X 4.0 X 3/8 X 8.0 Material : A36
W.Angle: 4 X 3.5 X 1/4 X 8.5 Fy = 272 MPa
Fu = 468 MPa

Major parameters (cm)

lp = 21.5900	lu = 7.1437	ll = 7.1437	ta = 0.6350
gc = 6.5888	cu = 3.1750	cl = 3.1750	pc = 7.6200
nc = 1 X 3			
lt = 20.3200	tt = 0.9525	ls = 20.3200	ts = 0.9525
gt'= 6.3500	gs'= 6.3500	rt = 13.9700	rs = 13.9700
nt'= 2 X 1	ns'= 2 X 1		

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	89.08	13.84
2	4.30	0.01	27	90.83	14.82
3	8.59	0.02	28	92.63	15.97
4	12.89	0.04	29	94.43	17.11
5	16.05	0.28	30	95.96	18.14
6	19.21	0.52	31	97.49	19.18
7	23.57	0.83	32	99.56	20.62
8	28.47	1.16	33	100.64	21.58
9	33.45	1.66	34	101.72	22.53
10	38.26	2.21	35	103.07	23.35
11	41.33	2.47	36	104.42	24.16
12	44.40	2.73	37	106.31	25.63
13	47.21	3.12	38	106.77	26.48
14	50.02	3.51	39	107.23	27.33
15	55.27	4.22	40	108.32	28.77
16	60.00	4.99	41	109.18	29.71
17	65.26	5.92	42	110.04	30.65
18	69.72	6.83			
19	74.63	8.01			
20	77.18	8.84			
21	79.72	9.66			
22	81.74	10.46			
23	83.75	11.26			
24	85.54	12.06			
25	87.33	12.85			

2.
Connection type : Top-and seat-angle connections with double web angle
Mode : Welded-to-beam and bolted-to-column

Tested by : A.Azizinamini et al. (1985) U.S.A.
Test Id. : 14WS2

Column : W12X96
Beam : W14X38
F.Angle: 6 X 4.0 X 1/2 X 8.0
W.Angle: 4 X 3.5 X 1/4 X 8.5

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 272 MPa
Fu = 468 MPa

Major parameters (cm)

lp = 21.5900	lu = 7.1437	ll = 7.1437	ta = 0.6350
gc = 6.5888	cu = 3.1750	cl = 3.1750	pc = 7.6200
nc = 1 X 3			
lt = 20.3200	tt = 1.2700	ls = 20.3200	ts = 1.2700
gt'= 6.3500	gs'= 6.3500	rt = 13.9700	rs = 13.9700
nt'= 2 X 1	ns'= 2 X 1		

Remark 1) HEAVY HEX HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	117.72	11.19
2	6.44	0.03	27	120.63	12.25
3	12.88	0.07	28	123.54	13.31
4	16.57	0.18	29	125.24	14.20
5	20.26	0.30	30	126.94	15.09
6	24.62	0.40	31	128.38	15.86
7	28.97	0.50	32	129.81	16.63
8	33.06	0.60	33	130.67	17.62
9	37.15	0.71	34	131.53	18.60
10	42.35	0.96	35	133.01	19.48
11	47.55	1.22	36	134.49	20.36
12	52.75	1.44	37	135.49	21.22
13	57.95	1.67	38	136.48	22.08
14	62.35	1.94	39	137.78	22.89
15	66.76	2.21	40	139.08	23.71
16	72.54	2.70	41	140.16	24.51
17	77.12	3.15	42	141.24	25.31
18	81.70	3.60	43	141.97	26.28
19	88.82	4.30	44	142.70	27.25
20	95.59	5.17	45	143.52	28.54
21	100.67	6.16			
22	106.29	7.50			
23	109.50	8.42			
24	112.72	9.34			
25	115.22	10.26			

II.8 Detalle ensayos unión doble ángulo todo apernado

1.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : C.W.Lewitt et al. (1966) U.S.A.
Test Id. : FK-4AB-M

Column : W12X65
Beam : W18X50
Angle : 6 X 4 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 286 MPa
Fu = 424 MPa

Major parameters (cm)

lp = 29.2100	lu = 8.2550	ll = 8.2550	ta = 0.9525
gb = 8.8900	gc = 5.2603	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	qb = 6.3500	qc = 5.0800
nb = 2 X 4	nc = 2 X 4		

Remark 1) NO WASHERS USED.
2) HIGH STRENGTH BOLTS USED

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	46.14	45.75
2	2.16	0.18	27	47.07	49.07
3	4.49	0.46	28	48.00	52.39
4	6.82	0.94	29	48.93	55.71
5	8.92	1.23	30	49.86	59.03
6	11.25	1.71	31	50.72	62.04
7	13.64	2.19	32	51.58	65.05
8	15.92	2.74	33	52.44	68.05
9	18.19	3.30	34	53.30	71.06
10	20.47	4.03	35	54.15	74.07
11	22.69	4.66			
12	24.97	5.74			
13	27.25	6.82			
14	29.59	8.58			
15	31.94	10.33			
16	34.13	13.49			
17	36.32	16.64			
18	37.82	19.84			
19	39.33	23.04			
20	40.84	26.24			
21	41.71	29.48			
22	42.59	32.72			
23	43.46	35.96			
24	44.33	39.20			
25	45.21	42.44			

2.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A1-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	0.7937
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	39.46	99.05
2	2.77	1.72	27	41.54	100.20
3	5.54	3.43	28	43.62	101.40
4	8.31	5.15	29	45.69	102.60
5	11.08	6.87	30	47.77	103.00
6	13.85	8.58	31	49.85	103.40
7	16.62	10.30	32	51.92	103.75
8	18.44	15.30	33	54.00	104.10
9	19.83	20.65	34	56.08	105.05
10	21.23	26.00	35	58.15	106.00
11	22.62	31.35	36	60.23	107.30
12	24.01	36.70	37	62.31	108.60
13	25.28	42.05	38	64.39	111.75
14	26.54	47.40	39	66.46	114.90
15	27.81	52.75			
16	29.08	58.10			
17	29.49	63.42			
18	29.91	68.74			
19	30.32	74.06			
20	30.74	79.38			
21	31.15	84.70			
22	32.19	89.75			
23	33.23	94.80			
24	35.31	96.35			
25	37.39	97.90			

3.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A1-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 6.4770	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	37.39	106.60
2	2.77	1.93	27	39.46	107.55
3	5.54	3.87	28	41.54	108.50
4	8.31	5.80	29	43.62	109.60
5	11.08	7.73	30	45.69	110.70
6	13.85	9.67	31	47.77	111.65
7	16.62	11.60	32	49.85	112.60
8	18.44	17.70	33	51.92	113.55
9	19.56	22.88	34	54.00	114.50
10	20.67	28.06	35	56.08	115.75
11	21.78	33.24	36	58.15	117.00
12	22.90	38.42	37	60.23	118.75
13	24.01	43.60	38	62.31	120.50
14	24.64	49.56	39	64.39	123.45
15	25.28	55.52	40	66.46	126.40
16	25.91	61.49			
17	26.54	67.45			
18	27.18	73.41			
19	27.81	79.38			
20	28.44	85.34			
21	29.08	91.30			
22	30.12	96.90			
23	31.15	102.50			
24	33.23	104.80			
25	35.31	105.70			

4.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A1-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 6.4770	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	34.89	70.24
2	2.33	0.55	27	35.31	74.50
3	4.65	1.10	28	36.35	79.00
4	6.81	1.65	29	37.39	83.50
5	8.97	2.20	30	39.46	83.80
6	12.54	3.30	31	41.54	84.80
7	14.54	4.20	32	43.86	85.80
8	16.62	6.00	33	46.13	86.50
9	18.69	8.30	34	48.39	87.20
10	20.77	11.80	35	50.61	89.05
11	22.85	14.50	36	52.84	90.90
12	23.88	17.45	37	56.41	91.10
13	24.92	20.40	38	58.32	91.35
14	25.96	23.70	39	60.23	91.60
15	27.00	27.00	40	62.31	91.80
16	28.04	31.00	41	64.39	92.00
17	29.08	35.00	42	66.46	92.20
18	30.12	38.70	43	68.54	92.40
19	31.15	42.40	44	70.62	92.70
20	31.85	46.00	45	72.69	93.00
21	32.54	49.60			
22	33.23	53.20			
23	33.65	57.46			
24	34.06	61.72			
25	34.48	65.98			

5.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A1-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 6.4770	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	36.14	72.90
2	2.33	0.60	27	36.55	77.60
3	4.65	1.20	28	36.97	82.30
4	6.81	1.70	29	37.39	87.00
5	8.97	2.20	30	38.42	89.90
6	12.54	3.50	31	39.46	92.80
7	14.54	4.70	32	41.54	94.90
8	16.62	6.60	33	43.86	96.30
9	18.69	8.80	34	46.13	97.10
10	20.77	11.80	35	48.39	97.90
11	22.85	14.20	36	50.61	98.85
12	23.88	17.45	37	52.84	99.80
13	24.92	20.70	38	56.41	99.90
14	25.96	24.35	39	58.32	100.05
15	27.00	28.00	40	60.23	100.20
16	29.08	32.80	41	62.31	100.30
17	29.77	36.27	42	64.39	100.40
18	30.46	39.73	43	66.46	100.60
19	31.15	43.20	44	68.54	100.80
20	31.85	46.93	45	70.62	101.15
21	32.54	50.67	46	72.69	101.50
22	33.23	54.40			
23	34.27	58.95			
24	35.31	63.50			
25	35.72	68.20			

6.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A1-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 6.4770	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	36.72	83.35
2	2.51	0.45	27	37.05	88.38
3	5.02	0.90	28	37.39	93.40
4	8.72	1.60	29	38.80	96.85
5	12.46	2.80	30	40.21	100.30
6	14.54	4.00	31	43.37	102.00
7	16.62	5.90	32	45.94	103.10
8	18.69	8.40	33	48.52	104.20
9	20.77	12.70	34	52.26	104.60
10	22.85	17.40	35	54.29	104.80
11	23.88	20.70	36	56.33	105.00
12	24.92	24.00	37	58.53	105.20
13	25.96	28.30	38	60.73	105.40
14	27.00	32.60	39	62.64	105.55
15	28.04	36.65	40	64.55	105.70
16	29.08	40.70	41	66.54	105.95
17	30.16	45.00	42	68.54	106.20
18	31.24	49.30	43	71.86	106.60
19	31.71	54.00	44	75.60	107.10
20	32.19	58.70			
21	33.54	62.85			
22	34.89	67.00			
23	35.47	70.15			
24	36.06	73.30			
25	36.39	78.33			

7.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A1-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 6.4770	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	36.06	92.60
2	2.51	0.40	27	37.39	95.60
3	5.02	0.80	28	40.21	100.90
4	8.72	1.70	29	43.37	102.60
5	12.46	3.10	30	45.94	103.35
6	14.54	4.40	31	48.52	104.10
7	16.62	6.40	32	52.26	104.30
8	18.69	9.40	33	54.29	104.45
9	20.77	14.60	34	56.33	104.60
10	22.85	19.70	35	58.53	104.75
11	23.88	23.20	36	60.73	104.90
12	24.92	26.70	37	62.64	105.05
13	25.96	31.10	38	64.55	105.20
14	27.00	35.50	39	66.54	105.45
15	28.04	39.65	40	68.54	105.70
16	29.08	43.80	41	71.86	106.60
17	30.16	48.35	42	75.60	108.60
18	31.24	52.90			
19	31.71	57.25			
20	32.19	61.60			
21	32.87	66.88			
22	33.54	72.15			
23	34.22	77.42			
24	34.89	82.70			
25	35.47	87.65			

8.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : B1-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	1.2700
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	57.12	73.90
2	4.73	0.40	27	58.15	77.00
3	9.46	0.80	28	60.81	80.00
4	13.50	1.45	29	66.46	81.90
5	17.53	2.10	30	70.82	83.20
6	21.48	2.95	31	75.10	84.40
7	25.42	3.80	32	79.09	85.45
8	31.15	5.50	33	83.08	86.50
9	35.31	7.80	34	87.23	87.75
10	39.54	10.40	35	91.38	89.00
11	43.86	14.60	36	95.54	90.75
12	45.82	17.20	37	99.69	92.50
13	47.77	19.80	38	103.85	94.60
14	48.60	24.22	39	108.00	96.70
15	49.43	28.64	40	112.15	99.10
16	50.26	33.06	41	116.31	101.50
17	51.09	37.48			
18	51.92	41.90			
19	52.96	45.90			
20	54.00	49.90			
21	54.42	54.08			
22	54.83	58.26			
23	55.25	62.44			
24	55.66	66.62			
25	56.08	70.80			

9.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : B1-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 6.4770	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	60.81	91.00
2	4.73	0.35	27	66.46	96.60
3	9.46	0.70	28	70.82	101.10
4	13.50	1.05	29	74.91	102.23
5	17.53	1.40	30	78.99	103.37
6	21.48	2.25	31	83.08	104.50
7	25.42	3.10	32	87.23	105.75
8	31.15	4.70	33	91.38	107.00
9	35.31	6.90	34	95.54	108.65
10	39.54	9.40	35	99.69	110.30
11	43.86	13.70	36	103.85	112.20
12	47.77	19.30	37	108.00	114.10
13	48.54	23.95	38	112.15	116.30
14	49.30	28.60	39	116.31	118.50
15	50.18	33.90			
16	51.05	39.20			
17	51.92	44.50			
18	52.78	48.50			
19	53.64	52.50			
20	54.50	56.50			
21	56.33	62.30			
22	58.15	68.10			
23	58.82	73.83			
24	59.48	79.55			
25	60.15	85.28			

10.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : B1-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 6.4770	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	70.95	84.00
2	4.78	0.35	27	75.06	85.10
3	9.55	0.70	28	79.17	86.20
4	13.58	1.25	29	83.33	87.50
5	17.61	1.80	30	87.48	88.80
6	21.27	2.60	31	91.55	90.35
7	25.17	3.50	32	95.62	91.90
8	29.41	5.00	33	99.73	94.00
9	31.32	9.30	34	103.85	96.10
10	33.52	13.75	35	108.00	99.10
11	35.72	18.20	36	112.15	102.10
12	37.55	23.80	37	116.31	107.05
13	39.71	27.80	38	120.46	112.00
14	40.71	32.60	39	123.23	117.17
15	41.71	37.40	40	126.00	122.33
16	43.86	44.30	41	128.77	127.50
17	45.82	49.45	42	130.15	134.93
18	47.77	54.60	43	131.54	142.37
19	48.60	59.90	44	132.92	149.80
20	49.43	65.20			
21	50.26	70.50			
22	54.08	77.40			
23	58.30	79.45			
24	62.52	81.50			
25	66.73	82.75			

11.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A.
Test Id. : B1-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 6.4770	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	52.47	260.70
2	4.78	0.35	27	54.45	275.40
3	9.55	0.70	28	56.43	290.10
4	13.58	1.15	29	58.40	304.80
5	17.61	1.60	30	62.52	306.10
6	21.27	2.40	31	66.73	307.50
7	25.17	3.20	32	70.95	308.90
8	25.84	6.20	33	75.06	310.10
9	26.52	9.20	34	79.17	311.30
10	27.86	15.10	35	83.33	312.70
11	29.41	27.00	36	87.48	314.10
12	30.36	38.00	37	91.55	315.60
13	31.32	49.00	38	95.62	317.10
14	33.40	66.60	39	99.73	319.85
15	35.47	84.20	40	103.85	322.60
16	37.55	101.80	41	108.00	324.90
17	39.63	119.40	42	112.15	327.20
18	41.71	137.00	43	116.31	330.70
19	42.84	152.72	44	120.46	334.20
20	43.98	168.43	45	124.62	340.85
21	45.11	184.15	46	128.77	347.50
22	46.25	199.87	47	132.92	357.60
23	47.38	215.58			
24	48.52	231.30			
25	50.49	246.00			

12.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : B1-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 6.4770	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	48.87	26.20
2	2.78	0.20	27	49.42	30.15
3	5.57	0.40	28	49.97	34.10
4	7.52	0.55	29	52.26	35.70
5	9.47	0.70	30	53.13	39.65
6	11.22	0.85	31	54.00	43.60
7	12.97	1.00	32	55.04	45.85
8	15.21	1.25	33	56.08	48.10
9	17.45	1.50	34	56.29	52.10
10	19.32	1.80	35	56.49	56.10
11	21.18	2.10	36	56.70	60.10
12	23.22	2.55	37	56.91	64.10
13	25.26	3.00	38	57.12	68.10
14	27.29	3.55	39	57.32	72.10
15	29.33	4.10	40	58.82	75.45
16	31.24	4.80	41	60.31	78.80
17	33.31	5.70	42	62.47	80.00
18	35.47	6.50	43	64.68	80.85
19	37.39	7.50	44	66.88	81.70
20	39.55	9.25			
21	41.71	11.00			
22	43.62	12.90			
23	45.69	15.10			
24	47.77	18.30			
25	48.32	22.25			

13.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : B1-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 6.4770	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	49.24	33.87
2	2.78	0.20	27	49.97	39.50
3	5.57	0.40	28	52.26	41.60
4	7.52	0.60	29	54.00	46.40
5	9.47	0.80	30	54.35	51.17
6	11.22	1.10	31	54.69	55.93
7	12.97	1.40	32	55.04	60.70
8	15.21	1.80	33	55.39	65.47
9	17.45	2.20	34	55.73	70.23
10	19.32	2.65	35	56.08	75.00
11	21.18	3.10	36	56.18	79.35
12	23.22	3.85	37	56.28	83.70
13	25.26	4.60	38	56.39	88.05
14	27.29	5.65	39	56.49	92.40
15	29.33	6.70	40	56.91	97.25
16	31.24	7.90	41	57.32	102.10
17	33.31	9.10	42	58.82	105.80
18	35.47	10.30	43	60.31	109.50
19	37.39	11.50	44	62.47	111.50
20	39.55	13.45	45	64.68	112.45
21	41.71	15.40	46	66.88	113.40
22	43.62	17.40			
23	45.69	19.70			
24	47.77	22.60			
25	48.50	28.23			

14.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D1-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	0.7937
gb =	5.7150	gc =	4.5720	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	38.15	60.67
2	2.66	0.30	27	38.38	64.70
3	5.32	0.60	28	40.04	67.75
4	9.39	1.10	29	41.71	70.80
5	13.04	1.70	30	46.36	72.00
6	17.28	2.60	31	50.51	73.27
7	19.15	3.10	32	54.66	74.53
8	20.77	3.60	33	58.82	75.80
9	22.85	4.40	34	62.85	77.00
10	24.92	5.70	35	66.88	78.20
11	27.17	7.10	36	70.91	79.25
12	29.24	8.70	37	74.93	80.30
13	30.20	12.70	38	79.09	82.25
14	31.15	16.70	39	83.24	84.20
15	32.19	19.15	40	87.31	85.40
16	33.23	21.60	41	91.38	86.60
17	33.66	25.70	42	95.54	88.70
18	34.09	29.80	43	99.69	90.80
19	34.53	33.90			
20	34.96	38.00			
21	35.39	42.10			
22	36.43	45.35			
23	37.47	48.60			
24	37.70	52.62			
25	37.92	56.65			

15.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D1-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	41.71	55.90
2	2.66	0.30	27	41.91	59.48
3	5.32	0.60	28	42.12	63.05
4	9.39	1.30	29	42.33	66.62
5	13.04	2.10	30	42.54	70.20
6	17.28	3.20	31	44.45	73.55
7	19.15	3.70	32	46.36	76.90
8	20.77	4.30	33	50.68	78.80
9	22.85	5.20	34	54.75	79.75
10	24.92	6.70	35	58.82	80.70
11	27.17	8.00	36	62.85	81.70
12	29.24	9.50	37	66.88	82.70
13	31.15	11.90	38	70.91	83.75
14	32.19	14.95	39	74.93	84.80
15	33.23	18.00	40	79.09	86.05
16	33.77	22.27	41	83.24	87.30
17	34.31	26.55	42	87.31	88.95
18	34.85	30.82	43	91.38	90.60
19	35.39	35.10	44	95.54	92.50
20	36.43	38.05	45	99.69	94.40
21	37.47	41.00			
22	37.92	43.55			
23	38.38	46.10			
24	39.49	49.37			
25	40.60	52.63			

16.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D1-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	51.05	72.25
2	5.15	0.60	27	54.33	73.40
3	9.14	1.10	28	58.61	74.60
4	13.29	1.80	29	62.89	75.80
5	16.99	2.70	30	66.88	77.00
6	21.10	3.90	31	70.86	78.20
7	25.01	5.40	32	75.00	79.40
8	29.24	8.40	33	79.13	80.60
9	31.24	10.90	34	83.18	81.95
10	33.23	13.40	35	87.23	83.30
11	35.39	16.65	36	91.38	85.15
12	37.55	19.90	37	95.52	87.00
13	39.54	24.05	38	99.68	89.05
14	41.54	28.20	39	103.85	91.10
15	41.85	32.38			
16	42.15	36.56			
17	42.46	40.74			
18	42.77	44.92			
19	43.08	49.10			
20	43.38	53.28			
21	43.69	57.46			
22	44.00	61.64			
23	44.30	65.82			
24	44.61	70.00			
25	47.77	71.10			

17.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D1-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	51.05	79.65
2	5.15	0.60	27	54.33	81.40
3	9.14	1.10	28	58.61	82.50
4	13.29	1.90	29	62.89	83.60
5	16.99	2.70	30	66.88	84.60
6	21.10	3.90	31	70.86	85.60
7	25.01	5.30	32	75.00	86.70
8	29.24	7.90	33	79.13	87.80
9	33.23	11.70	34	83.18	89.00
10	35.39	14.20	35	87.23	90.20
11	37.55	16.70	36	91.38	92.05
12	39.54	19.80	37	95.52	93.90
13	41.54	22.90	38	99.68	95.70
14	41.92	27.36	39	103.85	97.50
15	42.31	31.82			
16	42.69	36.29			
17	43.08	40.75			
18	43.46	45.21			
19	43.84	49.67			
20	44.23	54.14			
21	44.61	58.60			
22	45.40	63.42			
23	46.19	68.25			
24	46.98	73.08			
25	47.77	77.90			

18.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D1-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	46.11	78.20
2	4.98	0.50	27	50.39	79.45
3	9.14	1.10	28	54.67	80.70
4	13.13	1.80	29	58.65	81.75
5	17.03	2.80	30	62.63	82.80
6	20.77	4.10	31	66.75	83.95
7	25.09	6.60	32	70.86	85.10
8	29.08	9.50	33	75.02	86.30
9	31.15	12.50	34	79.17	87.50
10	31.85	16.60	35	83.20	88.80
11	32.54	20.70	36	87.23	90.10
12	33.23	24.80	37	91.39	91.70
13	34.27	27.65	38	95.54	93.30
14	35.31	30.50	39	99.69	95.60
15	37.39	34.30	40	103.85	97.90
16	38.96	39.00			
17	40.25	41.80			
18	41.54	44.60			
19	42.23	48.43			
20	42.92	52.27			
21	43.62	56.10			
22	44.11	60.52			
23	44.61	64.94			
24	45.11	69.36			
25	45.61	73.78			

19.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D1-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	50.39	74.60
2	4.98	0.60	27	54.67	75.80
3	9.14	1.30	28	58.65	76.80
4	13.13	2.00	29	62.63	77.80
5	17.03	2.90	30	66.75	78.80
6	20.77	4.20	31	70.86	79.80
7	25.09	7.10	32	75.02	80.95
8	29.08	10.40	33	79.17	82.10
9	31.15	14.00	34	83.20	83.50
10	31.67	18.55	35	87.23	84.90
11	32.19	23.10	36	91.39	86.60
12	32.71	27.65	37	95.54	88.30
13	33.23	32.20	38	99.69	90.80
14	34.27	35.30	39	103.85	93.30
15	35.31	38.40			
16	37.39	42.50			
17	38.17	45.85			
18	38.96	49.20			
19	39.61	53.40			
20	40.25	57.60			
21	40.89	61.80			
22	41.54	66.00			
23	42.58	68.60			
24	43.62	71.20			
25	46.11	73.40			

20.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : E1-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	54.91	63.10
2	4.03	0.20	27	58.15	67.10
3	8.06	0.40	28	58.15	67.50
4	12.09	0.70	29	61.14	68.00
5	16.12	1.00	30	68.14	69.15
6	20.00	1.35	31	75.14	70.30
7	23.88	1.70	32	80.63	71.20
8	28.25	2.20	33	86.11	72.10
9	33.73	3.00	34	91.59	73.00
10	37.55	3.80	35	98.76	74.55
11	37.78	5.30	36	105.92	76.10
12	38.01	6.80	37	112.15	78.05
13	38.16	10.80	38	118.38	80.00
14	38.81	13.60	39	125.36	83.20
15	39.46	16.40	40	129.14	85.00
16	41.54	20.15	41	132.92	86.80
17	43.62	23.90	42	137.08	89.30
18	46.94	28.80	43	141.23	92.90
19	49.43	33.45	44	143.31	95.65
20	51.92	38.10	45	145.39	98.40
21	52.96	41.45	46	147.46	102.10
22	54.00	44.80	47	149.54	105.80
23	54.23	49.38			
24	54.46	53.95			
25	54.69	58.52			

21.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : E1-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	59.95	86.78
2	4.03	0.20	27	60.55	93.34
3	8.06	0.40	28	61.14	99.90
4	12.09	0.70	29	68.14	101.35
5	16.12	1.00	30	75.14	102.80
6	20.00	1.35	31	80.63	103.80
7	23.88	1.70	32	86.11	104.80
8	28.25	2.30	33	91.59	105.80
9	33.73	3.10	34	98.76	107.40
10	37.55	3.80	35	105.92	109.00
11	39.46	4.30	36	112.15	111.10
12	43.62	5.70	37	118.38	113.20
13	45.28	12.30	38	125.36	116.60
14	46.94	18.90	39	129.14	118.30
15	49.43	23.35	40	132.92	120.00
16	51.92	27.80	41	137.08	122.60
17	54.00	34.50	42	141.23	126.30
18	54.91	40.30	43	145.39	130.70
19	56.53	45.10	44	149.54	137.10
20	58.15	49.90			
21	58.15	55.63			
22	58.15	61.37			
23	58.15	67.10			
24	58.75	73.66			
25	59.35	80.22			

22.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : E1-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	71.11	88.60
2	4.90	0.30	27	75.27	89.30
3	9.80	0.60	28	83.37	90.65
4	13.91	0.85	29	91.47	92.00
5	18.03	1.10	30	95.58	92.80
6	21.77	1.40	31	99.69	93.60
7	23.34	5.60	32	107.17	95.60
8	24.92	9.80	33	111.74	96.70
9	27.21	13.80	34	116.31	97.80
10	29.49	17.80	35	120.46	99.50
11	37.39	19.10	36	124.62	101.20
12	39.46	25.60	37	128.77	103.10
13	41.54	30.60	38	132.92	105.00
14	43.62	34.00	39	137.08	107.95
15	45.69	39.20	40	141.23	110.90
16	49.85	45.70	41	145.39	114.50
17	51.92	52.80	42	149.03	118.65
18	52.96	57.85	43	152.68	122.80
19	54.00	62.90	44	157.34	128.00
20	54.58	68.55	45	162.00	133.20
21	55.16	74.20	46	166.15	139.80
22	55.75	79.85	47	164.08	147.00
23	56.33	85.50			
24	61.64	86.70			
25	66.96	87.90			

23.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : E1-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	79.51	71.25
2	4.90	0.35	27	83.74	72.00
3	9.80	0.70	28	91.47	73.50
4	13.91	1.00	29	95.58	74.60
5	18.03	1.30	30	99.69	75.70
6	21.77	1.80	31	105.23	77.37
7	22.47	3.80	32	110.77	79.03
8	23.52	6.80	33	116.31	80.70
9	24.92	10.80	34	121.85	83.60
10	29.49	16.80	35	127.38	86.50
11	35.31	23.30	36	132.92	89.40
12	37.39	28.80	37	137.08	93.55
13	41.54	35.10	38	141.23	97.70
14	43.62	39.30	39	145.39	101.40
15	47.77	45.70	40	149.03	105.25
16	49.85	49.10	41	152.68	109.10
17	50.42	55.05	42	157.34	115.60
18	51.00	61.00	43	162.00	122.10
19	51.92	63.00	44	166.15	127.80
20	54.00	65.30	45	165.12	134.15
21	56.33	66.50	46	164.08	140.50
22	61.64	67.95			
23	66.96	69.40			
24	71.11	69.95			
25	75.27	70.50			

24.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : E1-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	75.10	68.30
2	5.30	0.25	27	79.38	69.00
3	10.59	0.50	28	83.66	69.70
4	18.44	1.00	29	87.94	70.85
5	24.09	1.60	30	92.22	72.00
6	30.12	2.20	31	100.11	73.60
7	33.81	2.70	32	108.00	75.40
8	37.39	3.40	33	112.15	76.50
9	39.38	5.20	34	116.31	77.60
10	42.04	5.50	35	120.46	79.05
11	42.99	10.85	36	124.62	80.50
12	43.95	16.20	37	128.77	83.55
13	45.11	20.85	38	132.92	86.60
14	46.27	25.50	39	137.08	89.20
15	48.21	29.97	40	141.23	91.80
16	50.15	34.43	41	145.38	95.45
17	52.09	38.90	42	149.54	99.10
18	53.05	42.45	43	152.31	104.10
19	54.00	46.00	44	155.08	109.10
20	56.08	50.70	45	157.85	114.10
21	56.77	55.57	46	163.91	120.00
22	57.46	60.43			
23	58.15	65.30			
24	62.76	66.15			
25	67.38	67.00			

25.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : E1-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	1.2700
gb =	5.7150	gc =	4.5720	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	79.38	69.35
2	5.30	0.25	27	83.66	69.80
3	10.59	0.50	28	87.94	70.80
4	18.44	1.10	29	92.22	71.80
5	24.09	1.70	30	100.11	73.00
6	30.12	2.60	31	108.00	74.70
7	33.81	3.30	32	112.15	75.95
8	37.39	4.20	33	116.31	77.20
9	38.38	7.55	34	120.46	78.80
10	39.38	10.90	35	124.62	80.40
11	42.04	15.80	36	128.77	81.45
12	43.95	20.50	37	132.92	82.50
13	45.11	23.50	38	137.08	86.20
14	46.27	26.50	39	141.23	89.90
15	49.18	32.05	40	145.38	93.35
16	52.09	37.60	41	149.54	96.80
17	53.05	42.45	42	153.69	101.30
18	54.00	47.30	43	157.85	105.80
19	56.08	51.40	44	160.88	111.35
20	56.77	56.20	45	163.91	116.90
21	57.46	61.00			
22	58.15	65.80			
23	62.76	66.65			
24	67.38	67.50			
25	75.10	68.90			

26.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A2-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	0.7937
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	74.77	133.55
2	4.49	1.10	27	78.92	139.70
3	8.31	3.70	28	82.91	146.50
4	10.38	8.80	29	86.90	153.30
5	12.46	13.90	30	91.22	159.60
6	14.54	20.55	31	95.54	165.90
7	16.62	27.20	32	99.69	171.30
8	18.69	33.40	33	103.85	176.70
9	20.77	39.60	34	108.00	182.70
10	22.56	47.20	35	112.15	188.70
11	24.34	54.80	36	116.31	195.20
12	25.30	62.20	37	120.46	201.70
13	26.25	69.60			
14	27.17	77.00			
15	28.08	84.40			
16	28.99	91.80			
17	33.00	93.90			
18	37.01	96.00			
19	41.48	97.60			
20	45.94	99.20			
21	51.67	102.80			
22	57.41	106.40			
23	62.51	113.30			
24	66.56	120.35			
25	70.62	127.40			

27.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A2-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	0.7937
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	82.91	135.00
2	4.49	1.50	27	86.90	141.00
3	8.31	3.40	28	91.22	147.30
4	10.38	10.50	29	95.54	153.60
5	12.46	17.60	30	99.69	159.45
6	16.62	23.40	31	103.85	165.30
7	20.77	33.00	32	108.00	172.30
8	22.56	41.25	33	112.15	179.30
9	24.34	49.50	34	116.31	187.05
10	25.30	54.70	35	120.46	194.80
11	26.25	59.90			
12	27.17	67.90			
13	28.08	75.90			
14	28.99	83.90			
15	33.00	86.05			
16	37.01	88.20			
17	41.48	89.50			
18	45.94	90.80			
19	51.67	93.15			
20	57.41	95.50			
21	62.51	102.00			
22	66.56	108.95			
23	70.62	115.90			
24	74.77	122.45			
25	78.92	129.00			

28.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A2-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	0.7937
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	86.98	138.60
2	4.57	0.70	27	91.26	145.45
3	8.81	1.70	28	95.54	152.30
4	13.21	3.20	29	99.44	158.15
5	14.66	9.60	30	103.35	164.00
6	16.12	16.00	31	107.54	169.70
7	18.44	21.75	32	111.74	175.40
8	20.77	27.50	33	116.14	181.70
9	22.45	36.85	34	120.55	188.00
10	24.13	46.20	35	124.66	195.00
11	26.98	55.30	36	128.77	202.00
12	29.83	64.40			
13	30.85	74.10			
14	31.87	83.80			
15	32.90	93.50			
16	37.36	95.27			
17	41.82	97.03			
18	46.27	98.80			
19	52.55	100.85			
20	58.82	102.90			
21	64.80	106.00			
22	70.78	109.10			
23	74.85	117.40			
24	78.92	125.70			
25	82.95	132.15			

29.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A2-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	0.7937
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	91.26	132.40
2	4.57	1.00	27	95.54	139.80
3	8.81	2.20	28	99.44	145.95
4	13.21	3.60	29	103.35	152.10
5	16.12	8.20	30	107.54	158.60
6	18.44	13.35	31	111.74	165.10
7	20.77	18.50	32	116.14	172.30
8	22.45	26.65	33	120.55	179.50
9	24.13	34.80	34	124.66	188.35
10	26.98	42.55	35	128.77	197.20
11	29.83	50.30			
12	30.85	57.47			
13	31.87	64.63			
14	32.90	71.80			
15	37.36	74.17			
16	41.82	76.53			
17	46.27	78.90			
18	52.55	81.15			
19	58.82	83.40			
20	64.80	88.20			
21	70.78	93.00			
22	74.85	102.10			
23	78.92	111.20			
24	82.95	118.10			
25	86.98	125.00			

30.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A2-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	0.7937
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	74.64	131.40
2	4.15	1.80	27	78.84	138.10
3	8.47	4.20	28	83.04	144.05
4	12.38	9.00	29	87.23	150.00
5	14.50	16.55	30	91.47	155.60
6	16.62	24.10	31	95.70	161.20
7	18.40	32.35	32	99.78	166.75
8	20.19	40.60	33	103.85	172.30
9	21.31	45.65	34	108.00	178.90
10	22.43	50.70	35	112.15	185.50
11	23.18	58.00	36	115.89	190.65
12	23.93	65.30	37	119.63	195.80
13	25.75	74.33			
14	27.58	83.37			
15	29.41	92.40			
16	33.56	93.93			
17	37.72	95.47			
18	41.87	97.00			
19	45.98	98.55			
20	50.10	100.10			
21	54.17	102.77			
22	58.24	105.43			
23	62.31	108.10			
24	66.38	116.40			
25	70.45	124.70			

31.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : A2-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	0.7937
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	78.84	135.00
2	4.15	2.10	27	83.04	141.75
3	8.47	4.90	28	87.23	148.50
4	10.43	12.35	29	91.47	154.85
5	12.38	19.80	30	95.70	161.20
6	14.50	25.55	31	99.78	166.70
7	16.62	31.30	32	103.85	172.20
8	18.40	38.50	33	108.00	179.70
9	20.19	45.70	34	112.15	187.20
10	21.31	51.65	35	114.65	194.30
11	22.43	57.60	36	117.14	201.40
12	23.18	67.15	37	119.63	208.50
13	23.93	76.70			
14	28.83	79.70			
15	33.73	82.70			
16	37.80	84.25			
17	41.87	85.80			
18	45.98	87.85			
19	50.10	89.90			
20	54.17	94.77			
21	58.24	99.63			
22	62.31	104.50			
23	66.38	112.55			
24	70.45	120.60			
25	74.64	127.80			

32.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : B2-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	95.87	96.70
2	5.07	0.70	27	101.94	104.25
3	8.81	1.80	28	108.00	111.80
4	9.28	3.60	29	111.90	114.90
5	9.76	5.50	30	115.81	118.00
6	11.19	11.00	31	120.21	123.30
7	12.63	16.60	32	124.62	128.60
8	16.78	20.10	33	128.73	132.95
9	20.94	23.60	34	132.84	137.30
10	25.01	27.80	35	136.95	142.50
11	29.08	32.00	36	141.07	147.70
12	33.23	39.00	37	145.22	155.15
13	35.52	45.50	38	149.37	162.60
14	37.80	52.00	39	153.69	172.70
15	40.02	61.50	40	158.01	182.80
16	42.25	71.00	41	156.48	192.50
17	48.25	73.00	42	154.94	202.20
18	54.25	75.00			
19	59.76	76.70			
20	65.27	78.40			
21	70.78	80.10			
22	76.26	82.50			
23	81.75	84.90			
24	87.23	87.30			
25	91.55	92.00			

33.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : B2-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	0.7937
gb =	5.7150	gc =	4.5720	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	91.55	117.45
2	5.07	0.80	27	95.87	122.00
3	8.81	1.40	28	101.94	128.35
4	12.63	2.50	29	108.00	134.70
5	16.78	13.30	30	111.90	139.10
6	18.17	20.73	31	115.81	143.50
7	19.55	28.17	32	120.21	149.65
8	20.94	35.60	33	124.62	155.80
9	22.85	41.45	34	128.73	159.55
10	24.76	47.30	35	132.84	163.30
11	28.99	53.45	36	136.95	169.45
12	33.23	59.60	37	141.07	175.60
13	35.91	66.25	38	145.22	182.80
14	38.59	72.90	39	149.37	190.00
15	39.81	81.17	40	152.25	197.27
16	41.03	89.43	41	155.13	204.53
17	42.25	97.70	42	158.01	211.80
18	48.25	99.50	43	154.94	217.60
19	54.25	101.30			
20	59.76	102.80			
21	65.27	104.30			
22	70.78	105.80			
23	76.26	108.17			
24	81.75	110.53			
25	87.23	112.90			

34.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : B2-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	95.91	104.00
2	4.94	0.60	27	100.02	107.80
3	8.72	1.30	28	104.26	111.50
4	12.79	2.30	29	108.50	115.20
5	13.75	9.43	30	112.44	119.35
6	14.70	16.55	31	116.39	123.50
7	15.66	23.68	32	120.50	128.45
8	16.62	30.80	33	124.62	133.40
9	20.77	38.15	34	128.73	138.55
10	24.92	45.50	35	132.84	143.70
11	30.07	52.95	36	137.24	150.20
12	35.22	60.40	37	141.65	156.70
13	36.80	69.00	38	145.72	164.25
14	38.38	77.60	39	149.79	171.80
15	44.36	79.40	40	153.22	180.50
16	50.35	81.20	41	156.64	189.20
17	54.54	82.30			
18	58.74	83.40			
19	62.89	84.60			
20	67.04	85.80			
21	71.11	87.25			
22	75.18	88.70			
23	82.41	93.60			
24	87.11	96.90			
25	91.80	100.20			

35.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : B2-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	87.11	100.40
2	4.94	1.50	27	91.80	103.00
3	8.72	2.20	28	95.91	106.45
4	12.79	3.10	29	100.02	109.90
5	14.07	9.73	30	104.26	113.55
6	15.34	16.37	31	108.50	117.20
7	16.62	23.00	32	112.44	122.25
8	18.82	28.20	33	116.39	127.30
9	21.02	33.40	34	122.58	134.55
10	24.92	42.90	35	128.77	141.80
11	28.87	49.40	36	135.21	150.70
12	32.82	55.90	37	141.65	159.60
13	35.22	61.60	38	145.72	166.95
14	37.38	69.37	39	149.79	174.30
15	39.54	77.13	40	152.07	181.77
16	41.70	84.90	41	154.36	189.23
17	46.02	86.10	42	156.64	196.70
18	50.35	87.30			
19	54.54	88.40			
20	58.74	89.50			
21	62.89	90.60			
22	67.04	91.70			
23	71.11	93.00			
24	75.18	94.30			
25	82.41	97.80			

36.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : B2-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	95.79	106.90
2	5.23	0.40	27	99.69	110.80
3	8.85	1.00	28	103.97	117.93
4	12.46	2.30	29	108.25	125.07
5	12.99	4.60	30	112.53	132.20
6	13.52	6.90	31	118.61	137.65
7	15.11	13.70	32	124.70	143.10
8	16.70	20.60	33	128.77	148.15
9	20.89	27.20	34	132.84	153.20
10	25.09	33.80	35	139.11	162.25
11	27.21	39.80	36	145.39	171.30
12	29.33	45.80	37	149.58	179.60
13	34.98	53.60	38	153.78	187.90
14	40.62	61.40	39	153.30	196.13
15	42.04	70.20	40	152.83	204.37
16	43.45	79.00	41	152.36	212.60
17	44.86	87.80			
18	51.96	90.05			
19	59.07	92.30			
20	64.44	93.83			
21	69.81	95.37			
22	75.18	96.90			
23	80.75	98.93			
24	86.32	100.97			
25	91.88	103.00			

37.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : B2-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 5/16

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 0.7937
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	95.79	106.15
2	5.23	0.80	27	99.69	110.30
3	8.85	1.50	28	103.85	115.40
4	12.46	2.20	29	108.00	120.50
5	16.70	5.40	30	113.57	127.00
6	19.49	12.53	31	119.13	133.50
7	22.29	19.67	32	124.70	140.00
8	25.09	26.80	33	130.89	147.40
9	29.28	33.20	34	137.08	154.80
10	33.48	39.60	35	141.23	160.95
11	37.05	45.45	36	145.39	167.10
12	40.62	51.30	37	149.58	175.70
13	42.74	58.90	38	153.78	184.30
14	44.86	66.50	39	153.07	189.25
15	46.63	73.83	40	152.36	194.20
16	48.41	81.17			
17	50.18	88.50			
18	55.83	90.13			
19	61.48	91.77			
20	67.13	93.40			
21	72.80	95.10			
22	78.48	96.80			
23	84.16	98.50			
24	88.02	100.25			
25	91.88	102.00			

38.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : C2-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	1.2700
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	95.46	107.30
2	4.40	0.30	27	101.73	114.35
3	8.72	0.90	28	108.00	121.40
4	10.59	3.70	29	112.15	126.35
5	12.46	6.40	30	116.31	131.30
6	14.54	11.50	31	122.54	140.75
7	16.62	16.60	32	128.77	150.20
8	20.81	26.05	33	133.05	157.50
9	25.01	35.50	34	137.33	164.80
10	29.08	41.70	35	141.36	171.40
11	33.23	50.50	36	145.39	178.00
12	35.31	55.70	37	147.49	185.80
13	37.39	60.90	38	149.59	193.60
14	39.71	67.50	39	151.70	201.40
15	40.94	74.57			
16	42.18	81.63			
17	43.41	88.70			
18	50.26	90.50			
19	55.12	91.70			
20	59.98	92.90			
21	65.46	94.50			
22	70.95	96.10			
23	77.14	98.20			
24	83.33	100.30			
25	89.39	103.80			

39.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : C2-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	1.2700
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	112.15	99.65
2	4.40	0.50	27	116.31	104.60
3	8.72	1.20	28	120.46	110.43
4	12.46	2.00	29	124.62	116.27
5	16.62	6.20	30	128.77	122.10
6	21.10	10.50	31	133.05	129.75
7	25.01	14.80	32	137.33	137.40
8	29.08	20.00	33	141.36	143.90
9	33.23	26.20	34	145.39	150.40
10	37.39	33.80	35	148.54	157.45
11	39.71	40.00	36	151.70	164.50
12	41.56	45.35			
13	43.41	50.70			
14	46.83	58.85			
15	50.26	67.00			
16	55.12	68.15			
17	59.98	69.30			
18	65.46	70.65			
19	70.95	72.00			
20	77.14	73.85			
21	83.33	75.70			
22	89.39	78.65			
23	95.46	81.60			
24	101.73	88.15			
25	108.00	94.70			

40.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : C2-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	1.2700
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	83.91	96.70
2	4.57	0.10	27	89.56	99.30
3	8.66	0.60	28	95.21	101.90
4	12.75	1.10	29	101.60	107.20
5	13.80	3.00	30	108.00	112.50
6	14.85	4.90	31	112.15	117.40
7	15.90	6.80	32	116.31	122.30
8	16.95	8.70	33	120.46	129.65
9	18.86	13.60	34	124.62	137.00
10	20.77	18.40	35	128.64	142.90
11	24.92	24.90	36	132.67	148.80
12	29.16	30.40	37	137.41	156.85
13	33.27	37.95	38	142.15	164.90
14	37.39	45.50	39	144.68	170.30
15	39.46	52.45	40	147.21	175.70
16	41.54	59.40			
17	44.11	65.80			
18	46.16	72.90			
19	48.21	80.00			
20	50.26	87.10			
21	54.62	88.25			
22	58.98	89.40			
23	65.38	91.10			
24	71.78	92.80			
25	77.84	94.75			

41.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : C2-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	1.2700
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	112.15	106.90
2	4.57	0.50	27	116.31	113.20
3	8.66	1.10	28	120.46	120.55
4	12.75	1.70	29	124.62	127.90
5	16.95	3.00	30	128.64	135.55
6	20.77	7.50	31	132.67	143.20
7	24.92	12.50	32	137.41	152.30
8	29.16	18.40	33	142.15	161.40
9	33.27	26.25	34	143.83	169.73
10	37.39	34.10	35	145.52	178.07
11	39.46	41.25	36	147.21	186.40
12	41.54	48.40			
13	44.11	56.50			
14	47.19	65.45			
15	50.26	74.40			
16	54.62	75.75			
17	58.98	77.10			
18	65.38	78.95			
19	71.78	80.80			
20	77.84	83.00			
21	83.91	85.20			
22	89.56	87.90			
23	95.21	90.60			
24	101.60	95.60			
25	108.00	100.60			

42.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : C2-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 6.4770	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	91.72	105.50
2	4.90	0.40	27	97.78	109.25
3	8.87	1.25	28	103.85	113.00
4	12.84	2.10	29	108.21	116.40
5	13.78	4.50	30	112.57	119.80
6	14.73	7.00	31	116.60	125.30
7	16.62	11.80	32	120.63	130.80
8	18.65	20.45	33	124.70	137.85
9	20.69	29.10	34	128.77	144.90
10	24.92	33.60	35	132.92	153.50
11	29.08	38.65	36	137.08	162.10
12	33.23	43.70	37	141.31	169.25
13	37.38	51.40	38	145.55	176.40
14	41.54	59.10	39	148.38	181.95
15	44.57	65.55	40	151.20	187.50
16	47.60	72.00			
17	50.46	79.77			
18	53.31	87.53			
19	56.16	95.30			
20	60.36	96.50			
21	64.55	97.70			
22	70.95	99.50			
23	75.56	100.65			
24	80.17	101.80			
25	85.94	103.65			

43.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : C2-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	1.2700
gb =	5.7150	gc =	6.4770	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	108.21	89.95
2	4.90	0.50	27	112.57	95.10
3	8.87	1.15	28	116.60	100.20
4	12.84	1.80	29	120.63	105.30
5	16.62	3.90	30	124.70	110.60
6	20.69	8.10	31	128.77	115.90
7	24.92	13.30	32	132.92	123.95
8	29.08	18.65	33	137.08	132.00
9	33.23	24.00	34	139.90	137.73
10	36.00	29.53	35	142.73	143.47
11	38.77	35.07	36	145.55	149.20
12	41.54	40.60	37	148.38	157.15
13	44.57	46.30	38	151.20	165.10
14	47.60	52.00			
15	51.88	58.05			
16	56.16	64.10			
17	60.36	67.05			
18	64.55	70.00			
19	70.95	71.50			
20	75.56	72.65			
21	80.17	73.80			
22	85.94	75.65			
23	91.72	77.50			
24	97.78	81.15			
25	103.85	84.80			

44.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D2-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	90.43	78.85
2	4.32	0.30	27	96.37	80.00
3	8.64	0.60	28	102.39	81.40
4	16.37	3.00	29	108.42	82.80
5	18.57	6.15	30	114.48	84.65
6	20.77	9.30	31	120.55	86.50
7	24.88	13.75	32	126.73	89.10
8	28.99	18.20	33	132.92	91.70
9	33.23	23.10	34	136.62	95.45
10	37.39	28.90	35	140.32	99.20
11	39.46	32.20	36	144.17	103.33
12	41.54	35.50	37	148.02	107.47
13	45.69	40.60	38	151.86	111.60
14	47.77	44.25	39	157.85	115.80
15	49.85	47.90	40	162.00	119.20
16	51.59	52.00			
17	53.33	56.10			
18	55.74	60.58			
19	58.15	65.05			
20	60.56	69.53			
21	62.97	74.00			
22	67.46	74.60			
23	71.94	75.20			
24	78.22	76.45			
25	84.49	77.70			

45.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D2-1 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	1.2700
gb =	5.7150	gc =	4.5720	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	102.39	74.50
2	4.32	0.40	27	108.42	75.80
3	8.64	0.80	28	114.48	77.65
4	16.37	5.70	29	120.55	79.50
5	20.77	9.20	30	126.73	82.05
6	24.88	14.40	31	132.92	84.60
7	28.99	19.60	32	136.62	88.95
8	33.23	23.00	33	140.32	93.30
9	37.39	27.20	34	144.17	97.43
10	41.54	32.60	35	148.02	101.57
11	45.69	38.00	36	151.86	105.70
12	47.77	41.30	37	154.86	109.15
13	49.85	44.60	38	157.85	112.60
14	50.72	50.05	39	159.92	115.75
15	51.59	55.50	40	162.00	118.90
16	52.46	60.95			
17	53.33	66.40			
18	58.15	67.05			
19	62.97	67.70			
20	67.46	68.40			
21	71.94	69.10			
22	78.22	70.05			
23	84.49	71.00			
24	90.43	72.10			
25	96.37	73.20			

46.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D2-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	108.58	86.30
2	4.15	0.30	27	114.60	88.20
3	8.39	0.90	28	120.63	90.10
4	12.63	1.50	29	124.82	93.40
5	13.40	7.87	30	129.02	96.70
6	14.18	14.23	31	133.05	100.15
7	14.95	20.60	32	137.08	103.60
8	17.86	26.65	33	141.27	106.30
9	20.77	32.70	34	145.47	109.00
10	25.03	36.15	35	149.58	113.00
11	29.29	39.60	36	153.69	117.00
12	35.41	45.50	37	156.93	123.00
13	41.54	51.40	38	160.17	129.00
14	43.57	57.35			
15	45.61	63.30			
16	47.64	69.25			
17	49.68	75.20			
18	56.80	76.37			
19	63.91	77.53			
20	71.03	78.70			
21	77.22	79.75			
22	83.41	80.80			
23	89.93	82.10			
24	96.45	83.40			
25	102.52	84.85			

47.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D2-2 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	96.00	75.50
2	4.15	0.20	27	102.29	76.90
3	8.39	0.60	28	108.58	78.30
4	12.63	1.00	29	114.60	80.00
5	14.95	1.60	30	120.63	81.70
6	17.86	5.60	31	124.82	83.40
7	20.77	9.60	32	129.02	85.10
8	22.97	12.70	33	133.05	87.30
9	25.17	15.80	34	137.08	89.50
10	27.23	19.90	35	141.27	93.95
11	29.29	24.00	36	145.47	98.40
12	33.34	28.40	37	149.58	101.85
13	37.39	32.80	38	153.69	105.30
14	40.58	37.30	39	156.93	108.75
15	43.78	41.80	40	160.17	112.20
16	46.73	46.55			
17	49.68	51.30			
18	52.67	56.90			
19	55.66	62.50			
20	58.65	68.10			
21	64.84	69.25			
22	71.03	70.40			
23	77.22	71.55			
24	83.41	72.70			
25	89.70	74.10			

48.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D2-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 29.2100	lu = --	ll = --	ta = 1.2700
gb = 5.7150	gc = 4.5720	cu = --	cl = --
pb = --	pc = --	qb = --	qc = --
nb = - X 2	nc = - X -		

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	93.79	70.30
2	4.65	0.20	27	99.94	71.80
3	8.56	2.00	28	106.13	73.75
4	12.46	3.80	29	112.32	75.70
5	14.54	8.30	30	118.47	79.45
6	16.62	12.80	31	124.62	83.20
7	20.77	16.30	32	128.77	87.63
8	23.88	19.65	33	132.92	92.07
9	27.00	23.00	34	137.08	96.50
10	30.12	26.95	35	141.23	100.35
11	33.23	30.90	36	145.39	104.20
12	35.86	35.90	37	149.54	107.50
13	38.49	40.90	38	153.69	110.80
14	41.12	45.90			
15	42.65	50.97			
16	44.17	56.03			
17	45.69	61.10			
18	50.14	61.80			
19	54.58	62.50			
20	58.61	63.10			
21	62.64	63.70			
22	68.95	64.95			
23	75.27	66.20			
24	81.46	67.50			
25	87.65	68.80			

49.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : L.E.Thompson et al. (1970) U.S.A
Test Id. : D2-3 ALT

Column : W10X49
Beam : W21X62
Angle : 4 X 3.5 X 1/2

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A441
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp =	29.2100	lu =	--	ll =	--	ta =	1.2700
gb =	5.7150	gc =	4.5720	cu =	--	cl =	--
pb =	--	pc =	--	qb =	--	qc =	--
nb =	- X 2	nc =	- X -				

Remark 1)
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	99.94	74.80
2	4.65	0.30	27	106.13	76.50
3	8.56	0.65	28	112.32	78.20
4	12.46	1.00	29	118.47	80.65
5	16.62	1.50	30	124.62	83.10
6	20.77	3.20	31	130.85	87.45
7	27.00	8.40	32	137.08	91.80
8	30.12	11.80	33	139.85	96.50
9	33.23	15.20	34	142.62	101.20
10	37.18	20.35	35	145.39	105.90
11	41.12	25.50	36	149.54	109.95
12	42.65	29.67	37	153.69	114.00
13	44.17	33.83			
14	45.69	38.00			
15	48.66	42.07			
16	51.62	46.13			
17	54.58	50.20			
18	57.27	55.77			
19	59.95	61.33			
20	62.64	66.90			
21	68.95	68.50			
22	75.27	70.10			
23	81.46	71.15			
24	87.65	72.20			
25	93.79	73.50			

50.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : J.B.Davison et al (1987) UNITED KINGDOM
Test Id. : JT/01B

Column : UC 152x152x23 Fasteners: -- - -M16
Beam : UB 254x102x22 --- Oversize holes
Angle : RSA 80x60x8 Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 16.0000 lu = 3.0000 ll = 3.0000 ta = 0.8001
gb = 5.4991 gc = 3.5100 cu = 3.0000 cl = 3.0000
pb = 10.0000 pc = 10.0000 qc = --
nb = 1 X 2 nc = 2 X 2

Remark 1) BOLTS WERE TIGHTENED TO A TORQUE OF 160 NM
2) RANDOM BOLT TIGHTNESS & MINOR AXIS CONNECTION

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	9.72	60.00
2	2.49	1.15	27	9.72	62.31
3	3.53	2.31	28	9.72	64.00
4	3.89	4.62			
5	4.45	7.50			
6	4.61	9.81			
7	5.00	12.12			
8	5.56	15.00			
9	6.11	17.31			
10	6.67	19.62			
11	7.22	22.50			
12	7.50	24.81			
13	7.72	27.12			
14	8.06	30.00			
15	8.34	32.31			
16	8.75	34.62			
17	8.89	37.50			
18	8.89	39.81			
19	8.89	42.12			
20	8.89	45.00			
21	8.89	47.31			
22	8.89	49.62			
23	9.17	52.50			
24	9.45	54.81			
25	9.72	57.12			

51.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : J.B.Davison et al (1987) UNITED KINGDOM
Test Id. : JT/06

Column : UC 152x152x23 Fasteners: -- - -M16
Beam : UB 254x102x22 --- Oversize holes
Angle : RSA 80x60x8 Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 16.0000 lu = 3.0000 ll = 3.0000 ta = 0.8001
gb = 5.4991 gc = 3.5100 cu = 3.0000 cl = 3.0000
pb = 10.0000 pc = 10.0000 qc = --
nb = 1 X 2 nc = 2 X 2

Remark 1) MINOR AXIS CONNECTION
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	8.06	40.38
2	0.42	0.14	27	8.34	43.27
3	0.83	0.28	28	8.34	46.15
4	1.25	0.42	29	8.61	49.04
5	1.67	0.56	30	8.61	51.92
6	2.04	0.76	31	8.75	54.81
7	2.41	0.96	32	8.89	57.69
8	2.78	1.15	33	9.17	60.58
9	3.29	1.73	34	9.45	62.31
10	3.80	2.31	35	9.72	63.46
11	4.31	2.88	36	10.10	64.04
12	4.67	5.77	37	10.47	64.62
13	4.72	8.65	38	10.84	65.19
14	5.00	11.54			
15	5.28	14.42			
16	5.56	15.87			
17	5.78	17.31			
18	6.08	18.75			
19	6.39	20.19			
20	6.67	23.08			
21	6.95	25.96			
22	7.24	28.85			
23	7.57	31.73			
24	7.72	34.62			
25	7.85	37.50			

52.
Connection type : Double web-angle connections
Mode : All bolted

Tested by : B.Bose (1981) U.K
Test Id. : B-1

Column : 305 X 305 X 97
Beam : 457 X 191 X 67
Angle : 150 X 90 X 15

Fasteners: G8.8- -M20
--- Oversize holes
Material : BS4360
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lp = 39.9999	lu = 2.8499	ll = 2.8499	ta = 1.5001
gb = 9.0000	gc = 6.0449	cu = 5.0000	cl = 5.0000
pb = 7.4999	pc = 7.4999	qb = 6.0000	
nb = 2 X -	nc = 1 X 5		

Remark 1) GRADE 8.8 BOLTS WERE USED.
2) 4 AND 5 BOLTS USED EITHER LINE OF THE CLEAT TO COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	76.45	6.33
2	3.12	0.14	27	77.89	6.63
3	6.24	0.28	28	79.32	6.94
4	9.35	0.42	29	81.45	7.29
5	12.81	0.62	30	83.57	7.65
6	16.28	0.82	31	85.70	8.00
7	19.74	1.03	32	87.55	8.34
8	22.92	1.18	33	89.40	8.68
9	26.11	1.33	34	91.25	9.02
10	29.30	1.48			
11	32.69	1.68			
12	36.08	1.88			
13	39.47	2.07			
14	43.72	2.42			
15	47.97	2.76			
16	51.79	3.14			
17	55.62	3.51			
18	57.79	3.77			
19	59.96	4.04			
20	62.36	4.38			
21	64.77	4.72			
22	67.17	5.07			
23	69.79	5.39			
24	72.40	5.70			
25	75.02	6.02			

II.9 Detalle ensayos unión doble ángulo todo remachado

1.
Connection type : Double web-angle connections
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A.
Test Id. : A-1

Column : --
Beam : W6X12.5
Angle : 6 X 4 X 3/8

Fasteners: -- -X-M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 303 MPa
Fu = 446 MPa

Major parameters (cm)

lp =	6.3500	lu =	4.4450	ll =	4.4450	ta =	0.9525
gb =	8.8900	gc =	6.6675	cu =	3.1750	cl =	3.1750
qb =	6.3500	nb = 2 X	1	nc = 1 X	1		

Remark 1) CONNECTION ANGLE RIVETED TO 1/2" MOUNTING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1.93	19.17
2	0.07	0.60	27	1.98	19.94
3	0.14	1.20	28	2.04	20.85
4	0.21	1.82	29	2.10	21.76
5	0.28	2.44	30	2.18	23.10
6	0.36	3.12	31	2.21	23.98
7	0.45	3.81	32	2.24	24.85
8	0.52	4.41	33	2.26	25.78
9	0.59	5.01	34	2.29	26.71
10	0.71	6.08	35	2.32	28.15
11	0.81	7.02	36	2.34	29.00
12	0.89	7.79	37	2.37	29.84
13	0.98	8.55			
14	1.06	9.31			
15	1.14	10.06			
16	1.22	10.86			
17	1.32	11.80			
18	1.41	12.67			
19	1.49	13.54			
20	1.55	14.21			
21	1.61	14.88			
22	1.68	15.85			
23	1.76	16.82			
24	1.82	17.61			
25	1.88	18.40			

2.
Connection type : Double web-angle connections
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A.
Test Id. : A-2

Column : --
Beam : W8X18.4
Angle : 6 X 4 X 3/8

Fasteners: -- -X-M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 274 MPa
Fu = 429 MPa

Major parameters (cm)

lp = 15.2400	lu = 2.5400	ll = 2.5400	ta = 0.9525
gb = 8.8900	gc = 6.6675	cu = 3.8100	cl = 3.8100
pb = 7.6200	pc = 7.6200	qb = 6.3500	
nb = 2 X 2	nc = 1 X 2		

Remark 1) CONNECTION ANGLE RIVETED TO 1/2" MOUNING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	9.82	11.84
2	0.55	0.16	27	10.11	12.89
3	1.07	0.39	28	10.33	13.75
4	1.39	0.50	29	10.55	14.61
5	1.71	0.62	30	10.76	15.50
6	2.20	0.81	31	10.96	16.39
7	2.50	1.01	32	11.12	17.45
8	2.81	1.20	33	11.27	18.51
9	3.35	1.60	34	11.38	19.33
10	3.66	1.88	35	11.49	20.16
11	3.96	2.16	36	11.57	21.25
12	4.46	2.55	37	11.66	22.34
13	5.02	3.07	38	11.72	23.28
14	5.61	3.60	39	11.78	24.22
15	5.91	3.94			
16	6.20	4.29			
17	6.71	4.91			
18	7.02	5.41			
19	7.34	5.90			
20	7.87	6.86			
21	8.44	7.98			
22	8.70	8.69			
23	8.97	9.40			
24	9.21	10.02			
25	9.44	10.65			

3.
Connection type : Double web-angle connections
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A.
Test Id. : A-3

Column : --
Beam : W8X18.4
Angle : 6 X 6 X 3/8

Fasteners: -- -X-M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 274 MPa
Fu = 429 MPa

Major parameters (cm)

lp = 15.2400	lu = 2.5400	ll = 2.5400	ta = 0.9525
gb = 8.8900	gc = 9.2075	cu = 3.8100	cl = 3.8100
pb = 7.6200	pc = 7.6200	qb = 6.3500	qc = 6.3500
nb = 2 X 2	nc = 2 X 2		

Remark 1) CONNECTION ANGLE RIVETED TO 1/2" MOUNING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	12.59	17.49
2	0.55	0.18	27	12.77	18.69
3	1.10	0.35	28	12.95	19.88
4	1.67	0.63	29	13.15	21.25
5	2.24	0.90	30	13.34	22.62
6	2.80	1.25	31	13.55	23.77
7	3.36	1.59	32	13.76	24.92
8	3.92	1.99	33	13.95	26.29
9	4.48	2.40	34	14.13	27.66
10	5.05	2.91			
11	5.62	3.41			
12	6.18	4.00			
13	6.74	4.59			
14	7.31	5.36			
15	7.87	6.13			
16	8.44	6.92			
17	9.01	7.71			
18	9.58	8.63			
19	10.15	9.55			
20	10.73	10.83			
21	11.31	12.11			
22	11.62	13.20			
23	11.93	14.28			
24	12.17	15.29			
25	12.41	16.29			

4.
Connection type : Double web-angle connections
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A.
Test Id. : A-4

Column : --
Beam : W12X31.8
Angle : 4 X 3 1/2 X 3/8

Fasteners: -- -X-M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 325 MPa
Fu = 434 MPa

Major parameters (cm)

lp = 22.8600	lu = 3.8100	ll = 3.8100	ta = 0.9525
gb = 5.7150	gc = 6.5088	cu = 3.8100	cl = 3.8100
pb = 7.6200	pc = 7.6200	nb = 1 X 3	nc = 1 X 3

Remark 1) CONNECTION ANGLE RIVETED TO 1/2" MOUNING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	19.45	15.71
2	1.12	0.32	27	19.78	16.80
3	2.23	0.64	28	20.11	17.90
4	3.29	1.08	29	20.44	18.99
5	4.35	1.52	30	20.77	20.06
6	5.17	1.84	31	21.10	21.13
7	5.98	2.16	32	21.43	22.20
8	6.79	2.48	33	21.82	23.47
9	7.91	3.03	34	22.21	24.74
10	9.03	3.57	35	22.59	26.01
11	9.79	4.05			
12	10.55	4.54			
13	11.30	5.02			
14	12.07	5.53			
15	12.85	6.05			
16	13.62	6.57			
17	14.24	7.13			
18	14.86	7.69			
19	15.79	8.74			
20	16.51	9.85			
21	17.22	10.95			
22	17.63	11.74			
23	18.04	12.52			
24	18.51	13.58			
25	18.98	14.65			

5.
Connection type : Double web-angle connections
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A.
Test Id. : A-5

Column : --
Beam : W12X31.8
Angle : 6 X 6 X 3/8

Fasteners: -- -X-M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 325 MPa
Fu = 434 MPa

Major parameters (cm)

lp = 22.8600	lu = 3.8100	ll = 3.8100	ta = 0.9525
gb = 8.8900	gc = 9.0488	cu = 3.8100	cl = 3.8100
pb = 7.6200	pc = 7.6200	qb = 6.3500	qc = 6.3500
nb = 2 X 3	nc = 2 X 3		

Remark 1) CONNECTION ANGLE RIVETED TO 1/2" MOUNING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	26.57	13.67
2	1.53	0.09	27	27.10	14.57
3	3.05	0.17	28	27.53	15.42
4	4.58	0.26	29	27.96	16.27
5	5.70	0.40	30	28.39	17.12
6	6.81	0.55	31	28.88	18.15
7	7.94	0.88	32	29.36	19.18
8	9.07	1.21	33	29.81	20.25
9	10.23	1.55	34	30.26	21.32
10	11.40	1.89	35	30.72	22.39
11	12.50	2.32			
12	13.60	2.76			
13	14.76	3.27			
14	15.92	3.78			
15	17.03	4.36			
16	18.14	4.94			
17	19.30	5.72			
18	20.45	6.51			
19	21.54	7.49			
20	22.63	8.47			
21	23.38	9.36			
22	24.13	10.26			
23	24.87	11.16			
24	25.45	11.96			
25	26.03	12.76			

6.
Connection type : Double web-angle connections
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A.
Test Id. : A-6

Column : --
Beam : W18X54.7
Angle : 4 X 3 1/2 X 3/8

Fasteners: -- -X-M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 309 MPa
Fu = 406 MPa

Major parameters (cm)

lp = 38.1000	lu = 3.8100	ll = 3.8100	ta = 0.9525
gb = 5.7150	gc = 6.3500	cu = 3.8100	cl = 3.8100
pb = 7.6200	pc = 7.6200	nb = 1 X 5	nc = 1 X 5

Remark 1) CONNECTION ANGLE RIVETED TO 1/2" MOUNING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	44.30	6.24
2	1.91	0.05	27	45.25	6.60
3	3.83	0.10	28	46.30	7.09
4	5.75	0.14	29	47.36	7.58
5	7.63	0.26	30	48.42	8.07
6	9.52	0.38	31	49.02	8.45
7	11.41	0.49	32	49.61	8.83
8	13.32	0.67	33	50.21	9.21
9	15.22	0.84	34	50.80	9.60
10	17.12	1.02	35	51.78	10.09
11	18.97	1.21			
12	20.81	1.41			
13	22.65	1.60			
14	24.55	1.86			
15	26.45	2.11			
16	28.34	2.36			
17	30.21	2.71			
18	32.08	3.05			
19	33.95	3.39			
20	35.81	3.81			
21	37.68	4.22			
22	39.54	4.64			
23	40.97	5.08			
24	42.40	5.52			
25	43.35	5.88			

7.
Connection type : Double web-angle connections
Mode : All riveted

Tested by : J.C.Rathbun (1936) U.S.A.
Test Id. : A-7

Column : --
Beam : W18X54.7
Angle : 6 X 6 X 3/8

Fasteners: -- -X-M22.2D
M23.8 Oversize holes
Material : G40.21
Fy = 309 MPa
Fu = 406 MPa

Major parameters (cm)

lp = 38.1000	lu = 3.8100	ll = 3.8100	ta = 0.9525
gb = 8.8900	gc = 8.8900	cu = 3.8100	cl = 3.8100
pb = 7.6200	pc = 7.6200	qb = 6.3500	qc = 6.3500
nb = 2 X 5	nc = 2 X 5		

Remark 1) CONNECTION ANGLE RIVETED TO 3/4" MOUNING PLATE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	60.83	4.71
2	2.81	0.06	27	61.93	4.95
3	5.61	0.13	28	63.42	5.28
4	8.39	0.20	29	64.92	5.62
5	11.16	0.28	30	66.30	5.95
6	14.03	0.37	31	67.68	6.28
7	16.89	0.45	32	68.59	6.53
8	19.78	0.57	33	69.50	6.77
9	22.66	0.68	34	70.42	7.01
10	25.48	0.85			
11	28.30	1.01			
12	31.11	1.21			
13	33.92	1.42			
14	36.76	1.64			
15	39.60	1.86			
16	42.42	2.13			
17	45.25	2.39			
18	47.17	2.63			
19	49.08	2.86			
20	51.00	3.10			
21	52.81	3.36			
22	54.62	3.62			
23	56.43	3.88			
24	58.08	4.18			
25	59.74	4.48			

8.
Connection type : Double web-angle connections
Mode : All riveted

Tested by : W.G.Bell et al. (1958) U.S.A.
Test Id. : FK-4R

Column : W12X65
Beam : W18X50
Angle : 6 X 4 X 3/8

Fasteners: -- -X-M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 262 MPa
Fu = 444 MPa

Major parameters (cm)

lp =	29.2100	lu =	8.2550	ll =	8.2550	ta =	0.9525
gb =	11.4300	gc =	6.5354	cu =	3.1750	cl =	3.1750
pb =	7.6200	pc =	7.6200	qb =	7.6200		
nb =	2 X 4	nc =	1 X 4				

Remark 1) HIGH STRENGTH BOLTS USED
2) BOLTS : FY=87.9 KSI, FU=136.6 KSI, RIVETS : FY=36.5 KSI, FU=63.2KSI

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	42.20	53.64
2	2.14	0.75	27	43.25	56.91
3	4.27	1.50	28	44.30	60.17
4	6.23	2.05	29	45.20	63.69
5	8.19	2.61	30	46.10	67.21
6	10.44	3.45	31	46.99	70.72
7	12.70	4.30	32	47.89	74.24
8	14.50	5.11	33	48.98	78.41
9	16.30	5.93	34	50.06	82.57
10	18.53	7.22	35	51.15	86.73
11	20.76	8.52			
12	22.69	9.63			
13	24.63	10.74			
14	26.62	13.71			
15	28.61	16.67			
16	30.65	20.33			
17	32.68	24.00			
18	34.09	27.24			
19	35.50	30.49			
20	36.90	33.73			
21	37.70	37.08			
22	38.50	40.43			
23	39.30	43.77			
24	40.11	47.12			
25	41.16	50.38			

II.10 Detalle ensayos unión doble ángulo viga remachada columna apernada

1.
Connection type : Double web-angle connections
Mode : Riveted-to-beam and bolted-to-column

Tested by : W.G.Bell et al. (1958) U.S.A.
Test Id. : FK-4A

Column : W12X65
Beam : W18X50
Angle : 6 X 4 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 262 MPa
Fu = 444 MPa

Major parameters (cm)

lp = 29.2100	lu = 8.2550	ll = 8.2550	ta = 0.9525
gb = 11.4300	gc = 6.5354	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	qb = 7.6200	
nb = 2 X 4	nc = 1 X 4		

Remark 1) HIGH STRENGTH BOLTS USED
2) BOLTS : FY=87.9 KSI, FU=136.6 KSI, RIVETS : FY=36.5 KSI, FU=63.2KSI

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	46.53	44.27
2	2.18	0.16	27	47.64	47.19
3	4.36	0.32	28	48.74	50.11
4	6.32	0.83	29	49.59	52.94
5	8.27	1.33	30	50.44	55.76
6	10.51	1.49	31	51.29	58.58
7	12.75	1.65	32	52.15	61.41
8	15.43	2.50	33	53.11	64.13
9	18.11	3.34	34	54.07	66.85
10	20.79	4.18	35	55.04	69.58
11	22.97	5.19	36	56.00	72.30
12	25.15	6.20			
13	27.32	7.46			
14	29.50	8.71			
15	31.11	11.17			
16	32.71	13.62			
17	34.66	16.22			
18	36.60	18.82			
19	37.93	21.92			
20	39.25	25.02			
21	40.58	28.12			
22	41.83	31.55			
23	43.08	34.99			
24	44.33	38.42			
25	45.43	41.34			

2.
Connection type : Double web-angle connections
Mode : Riveted-to-beam and bolted-to-column

Tested by : W.G.Bell et al. (1958) U.S.A.
Test Id. : FK-4B

Column : W12X65
Beam : W18X50
Angle : 6 X 4 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 262 MPa
Fu = 444 MPa

Major parameters (cm)

lp = 29.2100	lu = 8.2550	ll = 8.2550	ta = 0.9525
gb = 11.4300	gc = 6.5354	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	qb = 7.6200	
nb = 2 X 4	nc = 1 X 4		

Remark 1) HIGH STRENGTH BOLTS USED
2) BOLTS : FY=87.9 KSI, FU=136.6 KSI, RIVETS : FY=36.5 KSI, FU=63.2KSI

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	39.97	44.37
2	1.96	0.32	27	40.72	47.90
3	3.92	0.63	28	41.46	51.44
4	6.10	0.95	29	42.21	54.97
5	8.28	1.27	30	42.95	58.50
6	10.07	1.73	31	44.14	62.20
7	11.86	2.20	32	45.34	65.90
8	13.75	2.96	33	46.53	69.60
9	15.65	3.73	34	47.72	73.30
10	17.32	4.64	35	48.91	77.00
11	18.99	5.55			
12	20.95	6.17			
13	22.90	6.78			
14	24.74	8.44			
15	26.57	10.10			
16	28.40	11.67			
17	30.23	13.23			
18	32.04	16.48			
19	33.86	19.74			
20	34.90	23.24			
21	35.95	26.74			
22	36.99	30.24			
23	37.74	33.77			
24	38.48	37.30			
25	39.23	40.84			

3.
Connection type : Double web-angle connections
Mode : Riveted-to-beam and bolted-to-column

Tested by : W.G.Bell et al. (1958) U.S.A.
Test Id. : FK-4C

Column : W12X65
Beam : W18X50
Angle : 6 X 4 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 262 MPa
Fu = 444 MPa

Major parameters (cm)

lp = 29.2100	lu = 8.2550	ll = 8.2550	ta = 0.9525
gb = 11.4300	gc = 6.5354	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	qb = 7.6200	
nb = 2 X 4	nc = 1 X 4		

Remark 1) HIGH STRENGTH BOLTS USED
2) BOLTS : FY=87.9 KSI, FU=136.6 KSI, RIVETS : FY=36.5 KSI, FU=63.2KSI

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	46.38	44.97
2	3.03	0.57	27	47.51	48.46
3	4.77	1.01	28	48.65	51.94
4	6.50	1.45	29	51.23	56.09
5	8.12	1.89	30	53.82	60.25
6	9.75	2.33	31	54.45	63.56
7	12.76	3.59	32	55.09	66.86
8	14.44	3.93	33	57.74	68.62
9	16.12	4.27	34	59.34	72.70
10	17.92	4.61	35	60.94	76.78
11	19.71	4.95	36	62.53	80.86
12	21.34	5.24	37	64.13	84.94
13	22.97	5.53			
14	25.75	6.79			
15	28.84	9.06			
16	31.15	10.91			
17	32.83	13.98			
18	34.51	17.05			
19	36.18	20.11			
20	37.08	24.03			
21	37.98	27.94			
22	38.87	31.85			
23	39.77	35.77			
24	42.51	38.62			
25	45.24	41.48			

4.
Connection type : Double web-angle connections
Mode : Riveted-to-beam and bolted-to-column

Tested by : C.W.Lewitt et al. (1966) U.S.A.
Test Id. : FK-3

Column : W10X49
Beam : W12X27
Angle : 6 X 4 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 277 MPa
Fu = 441 MPa

Major parameters (cm)

lp =	21.5900	lu =	4.4450	ll =	4.4450	ta =	0.9525
gb =	8.8900	gc =	6.6853	cu =	3.1750	cl =	3.1750
pb =	7.6200	pc =	7.6200	qb =	6.3500		
nb =	2 X 3	nc =	1 X 3				

Remark 1) HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	22.60	52.99
2	1.31	0.21	27	23.16	56.74
3	2.63	0.41	28	23.73	60.49
4	3.56	0.53	29	24.30	64.24
5	4.48	0.65	30	24.86	67.99
6	5.62	0.96	31	25.31	71.43
7	6.75	1.28	32	25.76	74.87
8	7.89	1.74	33	26.21	78.32
9	9.04	2.20	34	26.66	81.76
10	10.16	3.17	35	27.11	85.20
11	11.28	4.14			
12	12.41	5.91			
13	13.53	7.68			
14	14.67	11.01			
15	15.81	14.33			
16	16.57	17.56			
17	17.33	20.78			
18	18.09	24.00			
19	18.66	27.43			
20	19.23	30.85			
21	19.80	34.27			
22	20.37	37.69			
23	20.93	41.52			
24	21.49	45.34			
25	22.04	49.17			

5.
Connection type : Double web-angle connections
Mode : Riveted-to-beam and bolted-to-column

Tested by : C.W.Lewitt et al. (1966) U.S.A.
Test Id. : FK-4P

Column : W12X65
Beam : W18X50
Angle : 6 X 4 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 277 MPa
Fu = 441 MPa

Major parameters (cm)

lp = 29.2100	lu = 8.2550	ll = 8.2550	ta = 0.9525
gb = 8.8900	gc = 5.2603	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	qb = 6.3500	qc = 5.0800
nb = 2 X 4	nc = 2 X 4		

Remark 1) HIGH STRENGTH BOLTS USED
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	42.60	45.11
2	2.09	0.24	27	43.72	48.40
3	4.41	0.32	28	44.83	51.69
4	6.62	0.76	29	45.73	54.63
5	8.77	1.14	30	46.64	57.57
6	11.09	1.33	31	47.54	60.52
7	13.41	1.87	32	48.45	63.46
8	15.68	2.60	33	49.35	66.40
9	18.00	3.54			
10	20.27	4.52			
11	22.48	6.01			
12	24.76	7.49			
13	27.04	10.28			
14	28.53	12.55			
15	30.01	14.82			
16	31.50	17.09			
17	32.65	19.61			
18	33.80	22.13			
19	34.95	24.64			
20	36.10	27.16			
21	37.17	30.00			
22	38.24	32.84			
23	39.31	35.68			
24	40.37	38.52			
25	41.49	41.82			

6.
Connection type : Double web-angle connections
Mode : Riveted-to-beam and bolted-to-column

Tested by : C.W.Lewitt et al. (1966) U.S.A.
Test Id. : WK-4

Column : W12X65
Beam : W18X50
Angle : 6 X 4 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 277 MPa
Fu = 441 MPa

Major parameters (cm)

lp = 29.2100	lu = 8.2550	ll = 8.2550	ta = 0.9525
gb = 8.8900	gc = 6.5303	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	qb = 6.3500	
nb = 2 X 4	nc = 1 X 4		

Remark 1) NO WASHERS USED.
2) HIGH STRENGTH BOLTS USED

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	39.59	45.42
2	1.24	0.06	27	40.49	48.64
3	2.48	0.11	28	41.62	52.08
4	4.74	0.32	29	42.76	55.51
5	6.88	0.44	30	43.89	58.95
6	8.97	0.50	31	45.03	62.38
7	10.21	0.60	32	46.16	65.41
8	11.46	0.71	33	47.30	68.43
9	13.54	0.97	34	48.44	71.45
10	15.86	1.43	35	49.57	74.48
11	17.94	1.84			
12	20.19	2.75			
13	22.44	3.86			
14	24.91	5.92			
15	27.04	8.72			
16	28.58	11.92			
17	30.12	15.12			
18	31.66	18.32			
19	32.74	21.87			
20	33.82	25.42			
21	34.89	28.96			
22	35.97	32.51			
23	36.87	35.74			
24	37.78	38.96			
25	38.68	42.19			

7.
Connection type : Double web-angle connections
Mode : Riveted-to-beam and bolted-to-column

Tested by : C.W.Lewitt et al. (1966) U.S.A.
Test Id. : FB-4

Column : W12X65
Beam : W18X50
Angle : 6 X 3.5 X 3/8

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 277 MPa
Fu = 441 MPa

Major parameters (cm)

lp = 29.2100	lu = 8.2550	ll = 8.2550	ta = 0.9525
gb = 5.7150	gc = 6.5303	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	nb = 1 X 4	nc = 1 X 4

Remark 1) NO WASHERS USED.
2) HIGH STRENGTH BOLTS USED

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	41.75	42.25
2	2.31	0.16	27	42.89	45.79
3	1.80	0.36	28	44.03	49.33
4	3.49	0.38	29	45.16	52.87
5	5.19	0.41	30	45.92	55.94
6	6.88	0.43	31	46.67	59.02
7	9.08	0.79	32	47.42	62.10
8	11.44	1.00	33	48.18	65.17
9	13.58	1.51	34	48.93	68.25
10	15.84	2.02	35	49.68	71.33
11	18.15	2.58			
12	20.29	3.34			
13	22.59	4.15			
14	24.90	5.41			
15	27.15	7.02			
16	29.39	9.57			
17	31.74	12.88			
18	32.84	15.81			
19	33.93	18.74			
20	35.03	21.67			
21	36.13	24.59			
22	37.25	28.12			
23	38.37	31.65			
24	39.49	35.18			
25	40.62	38.71			

8.
Connection type : Double web-angle connections
Mode : Riveted-to-beam and bolted-to-column

Tested by : C.W.Lewitt et al. (1966) U.S.A.
Test Id. : FK-5

Column : W12X65
Beam : W18X50
Angle : 6 X 4 X 7/16

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : G40.21
Fy = 253 MPa
Fu = 439 MPa

Major parameters (cm)

lp = 36.8300	lu = 8.2550	ll = 8.2550	ta = 1.1125
gb = 8.8900	gc = 6.4770	cu = 3.1750	cl = 3.1750
pb = 7.6200	pc = 7.6200	qb = 6.3500	
nb = 2 X 5	nc = 1 X 5		

Remark 1) NO WASHERS USED.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	69.13	10.75
2	4.19	0.18	27	72.16	12.19
3	6.54	0.30	28	73.98	13.64
4	8.89	0.41	29	75.80	15.09
5	11.15	0.55	30	77.62	16.54
6	13.41	0.69	31	79.43	17.99
7	17.89	0.88	32	81.25	19.44
8	20.15	1.07	33	82.58	20.82
9	22.42	1.26	34	83.90	22.21
10	24.68	1.40	35	85.23	23.60
11	26.94	1.54	36	86.56	24.98
12	29.21	1.73	37	87.88	26.37
13	31.47	1.92	38	89.21	27.76
14	33.74	2.09	39	90.53	29.14
15	36.00	2.25			
16	40.47	2.84			
17	42.74	3.10			
18	45.00	3.37			
19	47.30	3.86			
20	49.59	4.35			
21	51.86	4.77			
22	54.13	5.19			
23	58.60	6.52			
24	63.08	7.86			
25	66.11	9.30			

II.11 Detalle ensayos union doble ángulo viga soldada coumna apernada

1.
Connection type : Double web-angle connections
Mode : Welded-to-beam and bolted-to-column

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST21

Column : --
Beam : W18X45
Angle : 3.5 X 3 X 3/8

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 344 MPa
Fu = 524 MPa

Major parameters (cm)

lp = 22.8600 lu = 3.8100 ll = 18.7325 ta = 0.9525
gc = 4.6546 cu = 3.8100 cl = 3.8100 pc = 7.6200
nc = 1 X 3

Remark 1) ACTUAL STRENGTH FY = 50.0 KSI, FU = 76.1 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	106.36	59.20
2	7.63	3.10	27	111.96	59.75
3	13.34	5.30	28	117.55	60.30
4	18.65	7.60	29	125.46	62.15
5	24.08	10.60	30	133.37	64.00
6	29.61	14.00	31	139.78	66.70
7	32.51	17.07	32	146.19	69.40
8	35.42	20.13	33	152.59	72.10
9	38.32	23.20	34	159.37	75.50
10	40.24	26.95	35	166.15	78.90
11	42.16	30.70			
12	44.08	34.45			
13	46.00	38.20			
14	46.91	41.20			
15	47.81	44.20			
16	48.72	47.20			
17	50.13	50.55			
18	51.54	53.90			
19	57.02	54.70			
20	62.51	55.50			
21	70.64	56.00			
22	77.54	56.75			
23	84.43	57.50			
24	91.74	58.07			
25	99.05	58.63			

2.
Connection type : Double web-angle connections
Mode : Welded-to-beam and bolted-to-column

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST22

Column : --
Beam : W18X45
Angle : 3.5 X 3 X 3/8

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 344 MPa
Fu = 524 MPa

Major parameters (cm)

lp = 30.4800 lu = 3.8100 ll = 11.1125 ta = 0.9525
gc = 4.6546 cu = 3.8100 cl = 3.8100 pc = 7.6200
nc = 1 X 4

Remark 1) ACTUAL STRENGTH FY = 50.0 KSI, FU = 76.1 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	117.49	76.80
2	6.22	0.93	27	123.20	78.00
3	12.43	1.87	28	128.29	78.95
4	18.65	2.80	29	133.37	79.90
5	26.84	4.30	30	140.16	81.30
6	35.04	5.80	31	146.94	82.70
7	43.29	7.90	32	154.29	84.40
8	51.54	10.00	33	161.63	86.10
9	57.02	12.15	34	166.72	87.85
10	62.51	14.30	35	171.81	89.60
11	67.97	18.37	36	172.94	93.10
12	73.43	22.43	37	171.81	95.65
13	78.90	26.50	38	170.67	98.20
14	81.66	30.05			
15	84.43	33.60			
16	87.15	38.00			
17	89.86	42.40			
18	91.69	47.27			
19	93.51	52.13			
20	95.34	57.00			
21	97.17	61.87			
22	99.00	66.73			
23	100.82	71.60			
24	104.10	74.00			
25	111.79	75.60			

3.
Connection type : Double web-angle connections
Mode : Welded-to-beam and bolted-to-column

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST23

Column : --
Beam : W24X76
Angle : 4 X 3 X 3/8

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 355 MPa
Fu = 537 MPa

Major parameters (cm)

lp = 38.1000 lu = 3.8100 ll = 18.7325 ta = 0.9525
gc = 6.4262 cu = 3.8100 cl = 3.8100 pc = 7.6200
nc = 1 X 5

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	140.16	69.40
2	8.57	1.10	27	146.94	69.90
3	16.84	2.30	28	153.72	70.40
4	24.98	3.40	29	163.33	71.00
5	33.23	4.70	30	172.94	71.60
6	41.48	6.00	31	185.37	72.70
7	49.68	7.95	32	197.80	73.80
8	57.87	9.90	33	210.24	74.90
9	63.35	12.40	34	222.67	76.00
10	68.84	14.90	35	233.41	79.05
11	73.58	18.77	36	244.14	82.10
12	78.33	22.63	37	255.45	86.10
13	83.08	26.50	38	258.27	88.50
14	86.38	30.43	39	261.10	90.90
15	89.69	34.35			
16	93.00	38.27			
17	96.30	42.20			
18	99.04	46.20			
19	101.78	50.20			
20	104.52	54.20			
21	107.27	58.20			
22	110.15	62.60			
23	113.03	67.00			
24	123.20	68.10			
25	131.68	68.75			

4.
Connection type : Double web-angle connections
Mode : Welded-to-beam and bolted-to-column

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST24

Column : --
Beam : W24X76
Angle : 4 X 3 X 3/8

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 355 MPa
Fu = 537 MPa

Major parameters (cm)

lp = 45.7200 lu = 3.8100 ll = 11.1125 ta = 0.9525
gc = 6.4262 cu = 3.8100 cl = 3.8100 pc = 7.6200
nc = 1 X 6

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	157.68	58.85
2	8.66	0.80	27	161.35	62.08
3	15.69	1.45	28	165.02	65.30
4	22.72	2.10	29	167.28	67.50
5	29.27	2.70	30	169.55	69.70
6	35.83	3.30	31	178.59	73.30
7	44.08	4.05	32	188.76	74.80
8	52.33	4.80	33	198.37	76.00
9	62.17	6.05	34	207.97	77.20
10	72.00	7.30	35	214.76	78.65
11	81.27	9.40	36	221.54	80.10
12	90.54	11.50	37	228.32	83.70
13	98.79	14.65			
14	107.04	17.80			
15	112.30	20.70			
16	117.55	23.60			
17	123.20	27.15			
18	128.85	30.70			
19	131.68	34.20			
20	134.51	37.70			
21	138.46	41.38			
22	142.42	45.05			
23	146.37	48.73			
24	150.33	52.40			
25	154.00	55.62			

II.12 Detalle ensayos unión placa de cabezera todo apernado con atiesador de columna

1.
Connection type : Header plate connections
Mode : All bolted with column stiffener

Tested by : A.K.Aggarwal (1989) PAPUA NEW GUIN
Test Id. : M 2

Column : UC 203x203x46 Fasteners: -- - -M20
Beam : UB 203x133x25 --- Oversize holes
Plate thickness : 16 mm Material : G40.21
Fy = 248 MPa
Fu = -- MPa

Major parameters (cm)

lt = 2.6599 ct = 4.0000 p = 7.0000 cc = 4.0000
lc = 2.6599 g = 10.0000 lp = 15.0000 tp = 1.5999
tbw= 0.5801
n = 2 X 2

Remark 1) FAILED WITH BUCKLING OF THE COMPRESSION FLANGE OF THE BEAM
2) PLATE WELDED AFTER COPING THE BEAM WEB

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	44.94	51.28
2	2.12	0.51	27	46.21	54.36
3	4.24	1.03	28	46.21	57.95
4	6.36	1.54	29	46.21	61.54
5	8.48	2.05	30	46.21	64.96
6	10.60	2.97	31	46.21	68.38
7	12.72	3.90	32	46.21	71.80
8	14.84	5.03	33	46.21	76.93
9	16.96	6.15	34	46.21	82.05
10	19.08	6.67	35	46.21	85.47
11	21.20	7.18	36	46.21	88.89
12	23.32	7.90	37	46.21	92.31
13	25.44	8.62	38	47.06	97.44
14	27.56	9.44	39	47.91	102.56
15	29.68	10.26			
16	31.80	12.31			
17	33.92	14.36			
18	34.77	17.44			
19	35.61	20.51			
20	36.46	23.93			
21	37.31	27.35			
22	38.16	30.77			
23	40.06	35.90			
24	41.97	41.03			
25	43.45	46.15			

2.
Connection type : Header plate connections
Mode : All bolted with column stiffener

Tested by : A.K.Aggarwal (1989) PAPUA NEW GUIN
Test Id. : M 3

Column : UC 203x203x46 Fasteners: -- - -M20
Beam : UB 203x133x25 --- Oversize holes
Plate thickness : 12 mm Material : G40.21
Fy = 248 MPa
Fu = -- MPa

Major parameters (cm)

lt = 2.6599 ct = 4.0000 p = 7.0000 cc = 4.0000
lc = 2.6599 g = 10.0000 lp = 15.0000 tp = 1.1999
tbw= 0.5801
n = 2 X 2

Remark 1) FAILED AT 7.194 kip SHEAR
2) FAILED BY EXCESSIVE DEFORMATION OF END PLATE AND LATERAL BENDING

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	19.84	47.86
2	1.06	0.51	27	20.01	51.28
3	2.12	1.03	28	20.12	54.70
4	3.18	1.54	29	20.24	58.12
5	4.24	2.05	30	20.35	61.54
6	5.30	2.56	31	20.52	65.64
7	6.36	3.08	32	20.69	69.74
8	7.42	3.59	33	20.86	73.85
9	8.48	4.10	34	21.03	77.95
10	9.54	5.13	35	21.20	82.05
11	10.60	6.15	36	21.29	86.29
12	11.66	6.67	37	21.38	90.53
13	12.72	7.18	38	21.48	94.77
14	13.33	8.72			
15	13.93	10.26			
16	14.83	13.68			
17	15.72	17.09			
18	16.62	20.51			
19	17.44	23.93			
20	18.26	27.35			
21	19.08	30.77			
22	19.22	34.19			
23	19.36	37.61			
24	19.50	41.03			
25	19.67	44.45			

3.
Connection type : Header plate connections
Mode : All bolted with column stiffener

Tested by : A.K.Aggarwal (1989) PAPUA NEW GUIN
Test Id. : M 4

Column : UC 203x203x46 Fasteners: -- - -M20
Beam : UB 203x133x25 --- Oversize holes
Plate thickness : 12 mm Material : G40.21
Fy = 248 MPa
Fu = -- MPa

Major parameters (cm)

lt = 2.6599 ct = 4.0000 p = 7.0000 cc = 4.0000
lc = 2.6599 g = 10.0000 lp = 15.0000 tp = 1.1999
tbw= 0.5801
n = 2 X 2

Remark 1) (A) FAILED AT 13.5 kip SHEAR (B) WELDED AFTER COPING THE BEAM WEB
2) FAILED BY EXCESSIVE DEFORMATION OF THE END PLATE AND LATERAL BENDING

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	33.70	76.93
2	1.41	0.34	27	34.76	82.05
3	2.83	0.68	28	35.19	87.18
4	4.24	1.03	29	35.61	92.31
5	5.30	1.54	30	36.04	97.44
6	6.36	2.05	31	36.46	102.56
7	7.77	3.08	32	36.88	107.69
8	9.19	4.10	33	37.31	112.82
9	10.60	5.13	34	37.73	117.95
10	12.01	6.84	35	38.16	123.08
11	13.43	8.55	36	38.58	128.21
12	14.84	10.26	37	39.00	133.34
13	15.90	12.82	38	39.64	138.47
14	16.96	15.39	39	40.28	143.59
15	18.23	17.95	40	40.49	147.70
16	19.50	20.51	41	40.70	151.80
17	21.20	25.64			
18	23.18	32.14			
19	25.15	38.63			
20	27.13	45.13			
21	28.40	51.28			
22	29.68	56.41			
23	30.52	61.54			
24	31.58	66.67			
25	32.64	71.80			

4.
Connection type : Header plate connections
Mode : All bolted with column stiffener

Tested by : A.K.Aggarwal (1989) PAPUA NEW GUIN
Test Id. : M 5

Column : UC 203x203x46 Fasteners: -- - - -
Beam : UB 203x133x25 --- Oversize holes
Plate thickness : 16 mm Material : G40.21
Fy = 248 MPa
Fu = -- MPa

Major parameters (cm)

lt = 2.6599 ct = 4.0000 p = 7.0000 cc = 4.0000
lc = 2.6599 g = 10.0000 lp = 15.0000 tp = 1.5999
tbw= 0.5801
n = 2 X 2

Remark 1) LARGE DEFORMATION OF THE COLUMN FLANGE AND STIFFENER WERE OBSERVED
2) (A) WELDED AFTER COPING THE BEAM WEB (B) THE COMP. FLA. BUCKLED

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	33.26	33.66
2	1.39	0.35	27	34.29	35.01
3	2.77	0.69	28	35.33	36.37
4	4.16	1.04	29	36.37	37.92
5	5.40	1.56	30	37.41	39.48
6	6.65	2.08	31	38.38	41.56
7	8.31	3.33	32	39.35	43.64
8	9.35	4.26	33	40.32	45.72
9	10.39	5.20			
10	11.85	6.23			
11	13.30	7.27			
12	14.97	8.83			
13	16.63	10.39			
14	18.01	12.12			
15	19.40	13.85			
16	20.79	15.59			
17	22.17	17.32			
18	23.56	19.05			
19	24.94	20.78			
20	26.60	22.86			
21	27.85	24.94			
22	29.10	27.01			
23	30.14	29.09			
24	31.18	31.17			
25	32.22	32.41			

5.
Connection type : Header plate connections
Mode : All bolted with column stiffener

Tested by : A.K.Aggarwal (1989) PAPUA NEW GUIN
Test Id. : M 6

Column : UC 203x203x46 Fasteners: -- - -M16
Beam : UB 203x133x25 --- Oversize holes
Plate thickness : 16 mm Material : G40.21
Fy = 248 MPa
Fu = -- MPa

Major parameters (cm)

lt = 2.6599 ct = 4.0000 p = 7.0000 cc = 4.0000
lc = 2.6599 g = 10.0000 lp = 15.0000 tp = 1.5999
tbw= 0.5801
n = 2 X 2

Remark 1) LARGE DEFORMATION AT THE COLUMN FLANGE
2) WELDED AFTER COPING THE BEAM WEB

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	29.10	62.34
2	1.39	0.55	27	29.72	65.45
3	2.77	1.11	28	30.35	68.57
4	4.16	1.66	29	31.80	70.65
5	5.20	2.08	30	33.26	72.73
6	6.24	2.49	31	33.88	76.89
7	7.28	3.33	32	34.50	81.04
8	8.31	4.16	33	34.78	85.20
9	9.35	4.66	34	35.06	89.35
10	10.39	5.16	35	35.33	93.51
11	11.85	5.70	36	35.75	98.71
12	13.30	6.23	37	36.17	103.90
13	14.97	8.31	38	36.58	109.10
14	16.63	10.39	39	37.00	114.29
15	17.67	14.54			
16	18.71	18.70			
17	19.33	22.34			
18	19.95	25.98			
19	20.79	31.17			
20	21.82	36.37			
21	22.86	41.56			
22	23.90	44.16			
23	24.94	46.76			
24	26.61	51.95			
25	27.85	57.15			

II.13 Detalle ensayos unión placa de cabezera todo apernado

1.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 5

Column : --
Beam : W18X45
Plate thickness : 1/4"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 345 MPa
Fu = 527 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 3.4925 g = 10.1600 lp = 38.1000 tp = 0.6350
tbw= 0.8509
n = 2 X 5

Remark 1) ACTUAL STRENGTH FY = 50.0 KSI, FU = 76.1 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	90.99	61.60
2	2.10	0.20	27	93.70	63.30
3	4.84	0.40	28	96.41	64.70
4	7.56	0.80	29	99.13	66.10
5	13.00	1.10	30	105.68	68.80
6	18.42	1.40	31	111.22	71.00
7	23.91	2.05	32	115.52	72.90
8	29.39	2.70	33	119.81	74.80
9	33.46	3.60	34	123.77	76.90
10	37.53	4.50	35	127.72	79.00
11	43.80	8.65	36	132.81	82.95
12	50.07	12.80	37	137.90	86.90
13	54.20	17.00	38	140.72	89.95
14	58.32	21.20	39	143.55	93.00
15	61.41	25.20	40	145.24	96.05
16	64.50	29.20	41	146.94	99.10
17	67.59	33.20			
18	70.83	36.87			
19	74.07	40.53			
20	77.31	44.20			
21	79.50	47.57			
22	81.68	50.93			
23	83.87	54.30			
24	86.69	57.60			
25	89.41	60.10			

2.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 6

Column : --
Beam : W24X76
Plate thickness : 1/4"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 340 MPa
Fu = 514 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 33.9725 g = 10.1600 lp = 22.8600 tp = 0.6350
tbw= 1.1201
n = 2 X 3

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	86.81	27.40
2	2.96	2.50	27	92.35	28.20
3	4.60	4.50	28	97.88	29.00
4	6.24	6.50	29	102.24	30.15
5	7.87	8.35	30	106.59	31.30
6	9.51	10.20	31	112.07	33.10
7	11.69	12.47	32	117.55	34.90
8	13.87	14.73	33	122.64	36.80
9	16.05	17.00	34	127.72	38.70
10	17.86	19.13	35	129.98	40.65
11	19.67	21.27	36	132.25	42.60
12	21.48	23.40	37	137.33	44.35
13	23.85	23.70	38	142.42	46.10
14	27.13	24.20	39	145.81	48.13
15	31.99	24.80	40	149.20	50.17
16	35.72	25.00	41	152.59	52.20
17	41.14	25.20	42	154.29	54.15
18	46.79	25.40	43	155.98	56.10
19	51.60	25.55	44	151.46	56.70
20	56.40	25.70	45	146.26	57.02
21	60.81	25.85	46	141.06	57.34
22	65.22	26.00	47	135.86	57.66
23	70.64	26.20	48	130.66	57.98
24	76.07	26.40	49	125.46	58.30
25	81.44	26.90			

3.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 7

Column : --
Beam : W24X76
Plate thickness : 1/4"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 340 MPa
Fu = 514 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 26.3525 g = 10.1600 lp = 30.4800 tp = 0.6350
tbw= 1.1176
n = 2 X 4

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	90.65	25.30	51	149.76	56.33
2	2.97	0.40	27	96.15	25.57	52	143.55	56.85
3	6.26	1.60	28	101.65	25.83	53	137.33	57.38
4	9.55	2.80	29	107.15	26.10	54	131.12	57.90
5	12.86	3.45	30	112.35	26.60			
6	16.16	4.10	31	117.55	27.10			
7	20.01	5.40	32	123.20	28.33			
8	23.85	6.70	33	128.85	29.57			
9	26.59	8.90	34	134.51	30.80			
10	29.33	11.10	35	140.16	32.50			
11	32.07	13.30	36	145.81	34.20			
12	34.81	15.50	37	150.90	35.90			
13	36.45	17.30	38	155.98	37.60			
14	38.09	19.10	39	161.63	39.25			
15	40.80	20.50	40	167.28	40.90			
16	43.52	21.50	41	172.94	43.20			
17	47.92	23.10	42	178.59	45.50			
18	53.46	23.50	43	180.28	47.80			
19	57.25	23.70	44	181.98	50.10			
20	61.04	23.90	45	181.41	51.90			
21	64.88	24.10	46	180.85	53.70			
22	68.72	24.30	47	174.63	54.23			
23	74.20	24.55	48	168.41	54.75			
24	79.69	24.80	49	162.20	55.27			
25	85.17	25.05	50	155.98	55.80			

4.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 8

Column : --
Beam : W24X76
Plate thickness : 1/4"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 348 MPa
Fu = 511 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 18.7325 g = 10.1600 lp = 38.1000 tp = 0.6350
tbw= 1.1201
n = 2 X 5

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	34	99.43	29.23
2	2.98	0.30	35	103.01	29.47
3	5.05	0.50	36	106.59	29.70
4	8.43	0.80	37	110.37	30.10
5	11.98	1.10	38	114.16	30.50
6	15.71	1.60	39	117.93	30.70
7	19.44	2.10	40	121.70	30.90
8	22.21	2.50	41	125.46	31.10
9	24.98	2.90	42	129.98	31.50
10	27.64	3.30	43	134.51	31.90
11	30.29	3.70	44	139.03	32.30
12	33.00	4.35	45	143.55	32.77
13	35.72	5.00	46	148.07	33.23
14	38.43	5.85	47	152.59	33.70
15	41.14	6.70	48	155.42	35.25
16	43.86	7.55	49	158.24	36.80
17	46.57	8.40	50	160.50	39.15
18	50.64	10.35	51	162.76	41.50
19	54.71	12.30	52	162.76	43.50
20	57.81	14.40	53	157.99	43.69
21	60.92	16.50	54	153.22	43.88
22	62.96	18.50	55	148.45	44.07
23	65.61	20.85	56	143.67	44.26
24	68.27	23.20	57	138.90	44.44
25	69.46	24.55	58	134.13	44.63
26	70.64	25.90	59	129.36	44.82
27	73.92	27.10	60	124.58	45.01
28	76.69	27.50	61	119.81	45.20
29	79.46	27.90	62	115.29	47.40
30	83.56	28.18	63	111.08	47.95
31	87.65	28.45	64	106.87	48.50
32	91.75	28.73	65	102.66	49.05
33	95.85	29.00	66	98.45	49.60

5.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 9

Column : --
Beam : W24X76
Plate thickness : 1/4"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 326 MPa
Fu = 504 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 11.1125 g = 10.1600 lp = 45.7200 tp = 0.6350
tbw= 1.1201
n = 2 X 6

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	102.74	21.67
2	3.01	0.20	27	106.02	23.90
3	6.30	0.40	28	107.89	25.20
4	10.78	0.60	29	109.75	26.50
5	15.15	0.90	30	113.09	28.30
6	20.68	1.20	31	116.42	30.10
7	24.47	1.45	32	118.68	31.70
8	28.26	1.70	33	120.94	33.30
9	32.16	2.05	34	124.90	34.30
10	36.06	2.40	35	128.85	35.30
11	40.35	2.90	36	134.51	36.10
12	44.65	3.40	37	140.16	36.90
13	48.49	3.90	38	145.81	38.10
14	52.33	4.40	39	151.46	39.30
15	56.23	5.00	40	157.68	40.65
16	60.13	5.60	41	163.89	42.00
17	64.48	6.40	42	158.81	43.50
18	68.84	7.20	43	153.72	45.00
19	74.43	8.75	44	147.79	45.42
20	80.03	10.30	45	141.85	45.85
21	85.22	12.20	46	135.92	46.27
22	88.88	13.87	47	129.98	46.70
23	92.53	15.53			
24	96.19	17.20			
25	99.47	19.43			

6.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 10

Column : --
Beam : W18X45
Plate thickness : 3/8"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 394 MPa
Fu = 522 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 18.7325 g = 10.1600 lp = 22.8600 tp = 0.9525
tbw= 0.8509
n = 2 X 3

Remark 1) ACTUAL STRENGTH FY = 50.0 KSI, FU = 76.1 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	90.05	31.13
2	2.75	0.60	27	96.45	31.57
3	7.12	1.60	28	102.86	32.00
4	9.86	2.20	29	108.51	32.45
5	12.55	2.90	30	114.16	32.90
6	18.08	4.70	31	119.25	33.90
7	20.80	5.70	32	124.33	34.90
8	23.51	7.00	33	129.98	36.70
9	26.22	8.60	34	135.64	39.40
10	28.94	10.60	35	138.46	41.05
11	30.35	12.10	36	141.29	42.70
12	31.76	13.60	37	144.11	44.55
13	33.12	15.90	38	146.94	46.40
14	34.47	18.20	39	147.16	49.06
15	35.83	21.00	40	147.39	51.72
16	37.19	23.80	41	147.62	54.38
17	40.46	25.10	42	147.84	57.04
18	43.18	26.90	43	148.07	59.70
19	48.15	28.20			
20	52.22	28.55			
21	56.29	28.90			
22	63.13	29.35			
23	69.97	29.80			
24	76.80	30.25			
25	83.64	30.70			

7.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 11

Column : --
Beam : W18X45
Plate thickness : 3/8"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 394 MPa
Fu = 522 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 11.1125 g = 10.1600 lp = 30.4800 tp = 0.9525
tbw= 0.8509
n = 2 X 4

Remark 1) ACTUAL STRENGTH FY = 50.0 KSI, FU = 76.1 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	79.69	46.90
2	2.14	0.10	27	87.49	47.40
3	7.82	0.50	28	92.91	48.10
4	9.19	0.60	29	99.35	49.20
5	16.62	1.20	30	104.89	49.90
6	21.93	1.70	31	111.45	50.60
7	26.28	2.20	32	119.02	51.20
8	30.63	2.70	33	126.59	51.80
9	36.06	3.60	34	132.62	53.17
10	43.74	5.20	35	138.65	54.53
11	48.15	6.80	36	144.68	55.90
12	51.43	8.90	37	151.84	57.57
13	54.71	11.00	38	159.00	59.23
14	57.98	13.90	39	166.15	60.90
15	60.36	16.85	40	169.55	63.80
16	62.73	19.80	41	173.31	66.90
17	64.71	22.55	42	177.08	70.00
18	66.69	25.30	43	180.85	73.10
19	68.12	27.90	44	172.94	76.50
20	69.55	30.50			
21	70.98	33.10			
22	72.87	36.33			
23	74.75	39.57			
24	76.63	42.80			
25	78.16	44.85			

8.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 12

Column : --
Beam : W18X45
Plate thickness : 3/8"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 355 MPa
Fu = 524 MPa

Major parameters (cm)

lt = 3.8100	ct = 3.8100	p = 7.6200	cc = 3.8100
lc = 3.4925	g = 10.1600	lp = 38.1000	tp = 0.9525
tbw= 0.8509			

n = 2 X 5

Remark 1) ACTUAL STRENGTH FY = 50.0 KSI, FU = 76.1 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	90.27	13.57
2	2.14	0.20	27	94.19	15.73
3	5.14	0.30	28	98.11	17.90
4	7.87	0.45	29	100.77	20.40
5	10.60	0.60	30	103.42	22.90
6	13.21	0.75	31	106.08	25.40
7	15.82	0.90	32	108.74	27.90
8	18.54	1.10	33	110.09	29.93
9	21.25	1.30	34	111.45	31.95
10	25.66	1.70	35	112.80	33.98
11	30.07	2.10	36	114.16	36.00
12	34.14	2.45	37	115.86	38.65
13	38.20	2.80	38	117.55	41.30
14	41.77	3.20	39	116.42	43.53
15	45.33	3.60	40	115.29	45.77
16	49.06	4.03	41	114.16	48.00
17	52.79	4.47	42	110.06	49.45
18	56.52	4.90	43	105.97	50.90
19	61.19	5.63	44	101.87	52.35
20	65.86	6.37	45	97.77	53.80
21	70.53	7.10			
22	73.92	7.80			
23	77.31	8.50			
24	81.83	9.95			
25	86.36	11.40			

9.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 13

Column : --
Beam : W24X76
Plate thickness : 3/8"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 394 MPa
Fu = 522 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 33.9725 g = 10.1600 lp = 22.8600 tp = 0.9525
tbw= 1.1201
n = 2 X 3

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	159.37	30.05
2	4.19	1.40	27	166.15	30.30
3	8.39	2.80	28	172.94	30.60
4	13.79	4.80	29	179.72	30.90
5	19.22	7.30	30	186.50	31.35
6	24.64	9.60	31	193.28	31.80
7	28.26	11.77	32	200.06	32.80
8	31.87	13.93	33	206.84	33.80
9	35.49	16.10	34	213.63	35.15
10	38.63	18.88	35	220.41	36.50
11	41.77	21.65	36	227.19	38.60
12	44.90	24.43	37	233.97	40.70
13	48.04	27.20	38	240.75	43.45
14	54.48	27.50	39	247.54	46.20
15	63.98	27.65	40	250.17	48.53
16	73.47	27.80	41	252.81	50.87
17	84.32	28.20	42	255.45	53.20
18	95.17	28.40	43	255.45	55.60
19	103.31	28.55			
20	111.45	28.70			
21	122.07	29.10			
22	130.55	29.25			
23	139.03	29.40			
24	145.81	29.60			
25	152.59	29.80			

10.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 14

Column : --
Beam : W24X76
Plate thickness : 3/8"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 394 MPa
Fu = 522 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 26.3525 g = 10.1600 lp = 30.4800 tp = 0.9525
tbw= 1.1176
n = 2 X 4

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	194.41	35.60
2	13.90	2.30	27	209.11	36.00
3	22.15	3.80	28	218.15	36.40
4	30.41	4.90	29	227.19	36.80
5	44.08	7.00	30	235.67	37.15
6	50.92	8.70	31	244.14	37.50
7	57.76	10.40	32	254.88	38.65
8	61.41	12.33	33	265.62	39.80
9	65.07	14.27	34	276.92	42.10
10	68.72	16.20	35	288.23	44.40
11	70.92	18.54	36	294.73	47.12
12	73.11	20.88	37	301.23	49.85
13	75.30	23.22	38	307.72	52.58
14	77.49	25.56	39	314.22	55.30
15	79.69	27.90			
16	81.10	29.55			
17	82.51	31.20			
18	92.91	32.00			
19	103.87	32.50			
20	118.06	33.00			
21	132.25	33.50			
22	142.98	33.85			
23	153.72	34.20			
24	167.28	34.67			
25	180.85	35.13			

11.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 15

Column : --
Beam : W24X76
Plate thickness : 3/8"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 404 MPa
Fu = 518 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 18.7325 g = 13.9700 lp = 38.1000 tp = 0.9525
tbw= 1.1201
n = 2 X 5

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	166.91	46.23
2	8.52	0.60	27	177.83	47.17
3	14.02	1.40	28	188.76	48.10
4	24.87	2.70	29	200.06	49.80
5	35.83	3.80	30	211.37	51.50
6	44.03	4.95	31	220.41	53.95
7	52.22	6.10	32	229.45	56.40
8	60.41	9.15	33	239.06	59.60
9	68.61	12.20	34	248.67	62.80
10	71.91	15.42	35	255.45	65.80
11	75.21	18.64	36	262.23	68.80
12	78.51	21.86	37	265.62	72.00
13	81.81	25.08	38	269.01	75.20
14	85.11	28.30			
15	87.41	31.70			
16	89.71	35.10			
17	92.01	38.50			
18	95.96	40.80			
19	101.50	41.30			
20	108.96	42.00			
21	116.42	42.70			
22	125.46	43.40			
23	134.51	44.10			
24	145.24	44.70			
25	155.98	45.30			

12.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 16

Column : --
Beam : W24X76
Plate thickness : 3/8"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 422 MPa
Fu = 523 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 11.1125 g = 13.9700 lp = 45.7200 tp = 0.9525
tbw= 1.1201
n = 2 X 6

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	177.46	56.20
2	12.43	0.55	27	185.93	57.20
3	24.87	1.10	28	194.41	58.20
4	35.83	1.80	29	202.89	59.15
5	44.03	2.35	30	211.37	60.10
6	52.22	2.90	31	219.28	61.20
7	65.90	4.30	32	227.19	62.30
8	79.57	5.70	33	235.67	63.45
9	87.77	7.35	34	244.14	64.60
10	95.96	9.00	35	254.88	66.50
11	103.16	12.43	36	265.62	68.40
12	110.36	15.87	37	276.36	71.15
13	117.55	19.30	38	287.10	73.90
14	121.79	22.60	39	293.31	77.75
15	126.03	25.90	40	299.53	81.60
16	130.27	29.20			
17	134.51	32.50			
18	137.90	36.10			
19	141.29	39.70			
20	144.68	43.30			
21	147.69	46.03			
22	150.71	48.77			
23	153.72	51.50			
24	159.37	53.30			
25	167.28	54.70			

13.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 17

Column : --
Beam : W24X76
Plate thickness : 1/4"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 340 MPa
Fu = 514 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 26.3525 g = 13.9700 lp = 45.7200 tp = 0.6350
tbw= 1.1201
n = 2 X 4

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	73.81	31.80
2	4.20	2.00	27	77.91	33.17
3	8.41	4.10	28	82.00	34.55
4	11.16	5.15	29	86.10	35.92
5	13.90	6.20	30	90.20	37.30
6	16.62	9.10	31	93.85	39.13
7	19.33	12.00	32	97.51	40.97
8	20.76	14.30	33	101.16	42.80
9	22.19	16.60	34	104.78	44.70
10	23.62	18.90	35	108.40	46.60
11	25.26	21.55	36	112.01	48.50
12	26.90	24.20	37	114.22	50.45
13	29.16	25.60	38	116.42	52.40
14	33.46	27.10	39	119.81	55.20
15	36.23	27.65	40	121.51	56.75
16	39.00	28.20	41	123.20	58.30
17	41.71	28.60	42	118.79	58.67
18	44.42	29.00	43	114.39	59.03
19	48.21	29.35	44	109.98	59.40
20	51.99	29.70	45	105.57	59.77
21	55.65	30.03	46	101.16	60.13
22	59.30	30.37	47	96.75	60.50
23	62.96	30.70			
24	66.58	31.07			
25	70.19	31.43			

14.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 18

Column : --
Beam : W24X76
Plate thickness : 1/4"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 340 MPa
Fu = 514 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 18.7325 g = 13.9700 lp = 38.1000 tp = 0.6350
tbw= 1.1201
n = 2 X 5

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	145.81	56.30
2	8.41	2.80	27	152.59	58.30
3	13.90	4.60	28	159.37	60.75
4	19.33	6.70	29	166.15	63.20
5	26.90	11.50	30	172.94	65.30
6	31.31	15.90	31	179.72	67.40
7	35.72	20.30	32	186.50	70.60
8	38.43	23.70	33	193.28	73.80
9	41.14	27.10	34	194.98	77.67
10	44.42	29.60	35	196.67	81.55
11	48.72	30.50	36	198.37	85.42
12	51.99	31.10	37	200.06	89.30
13	57.48	31.85	38	195.54	94.00
14	62.96	32.60	39	190.46	97.85
15	68.38	33.35	40	185.37	101.70
16	73.81	34.10			
17	79.29	34.80			
18	84.77	35.50			
19	92.97	38.10			
20	101.16	40.70			
21	109.36	43.65			
22	117.55	46.60			
23	125.46	50.40			
24	132.25	52.35			
25	139.03	54.30			

15.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 19

Column : --
Beam : W24X76
Plate thickness : 1/2"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 352 MPa
Fu = 524 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 26.3525 g = 13.9700 lp = 30.4800 tp = 1.2700
tbw= 1.1201
n = 2 X 4

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	161.63	50.70
2	14.02	2.20	27	171.24	51.10
3	22.21	3.85	28	180.85	51.50
4	30.41	5.50	29	190.46	51.85
5	41.37	9.30	30	200.06	52.20
6	49.62	12.00	31	211.37	52.80
7	57.87	14.70	32	222.67	53.40
8	60.61	18.20	33	236.23	55.00
9	63.35	21.70	34	245.84	56.70
10	66.09	25.20	35	255.45	58.40
11	68.84	28.70	36	262.61	61.40
12	71.55	31.90	37	269.77	64.40
13	74.26	35.10	38	276.92	67.40
14	75.62	37.60	39	279.18	71.30
15	76.97	40.10	40	281.44	75.20
16	78.39	42.90	41	282.58	78.30
17	79.80	45.70	42	283.71	81.40
18	85.00	46.90			
19	87.94	47.40			
20	96.19	47.90			
21	104.44	48.30			
22	112.69	48.70			
23	126.42	49.30			
24	140.16	49.90			
25	150.90	50.30			

16.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 20

Column : --
Beam : W24X76
Plate thickness : 1/2"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 373 MPa
Fu = 534 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 18.7325 g = 13.9700 lp = 38.1000 tp = 1.2700
tbw= 1.1201
n = 2 X 5

Remark 1) ACTUAL STRENGTH FY = 51.5 KSI, FU = 77.9 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	133.37	48.90
2	6.95	0.45	27	144.68	49.60
3	13.90	0.90	28	155.98	50.30
4	24.87	1.50	29	166.72	50.85
5	35.72	2.40	30	177.46	51.40
6	43.91	3.10	31	188.19	52.10
7	52.11	3.80	32	198.93	52.80
8	60.30	4.95	33	209.86	53.60
9	68.50	6.10	34	220.79	54.40
10	76.63	8.10	35	231.71	55.20
11	84.77	10.10	36	239.06	56.30
12	90.24	13.13	37	246.41	57.40
13	95.70	16.17	38	248.95	60.10
14	101.16	19.20	39	251.49	62.80
15	103.90	22.00	40	254.04	65.50
16	106.64	24.80	41	256.58	68.20
17	109.39	27.60			
18	112.13	30.40			
19	114.84	33.80			
20	117.55	37.20			
21	119.06	39.70			
22	120.57	42.20			
23	122.07	44.70			
24	124.33	47.50			
25	127.72	48.40			

17.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 25

Column : --
Beam : W18X45
Plate thickness : 1/4"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 340 MPa
Fu = 514 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 11.1125 g = 10.1600 lp = 30.4800 tp = 0.6350
tbw= 0.8509
n = 2 X 4

Remark 1) ACTUAL STRENGTH FY = 50.0 KSI, FU = 76.1 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	67.71	53.00
2	3.23	0.85	27	71.28	54.00
3	6.47	1.70	28	74.86	55.00
4	8.76	2.45	29	78.44	56.00
5	11.05	3.20	30	82.10	58.83
6	14.80	4.60	31	85.75	61.67
7	18.54	6.00	32	89.41	64.50
8	21.25	7.45	33	90.58	67.00
9	23.96	8.90	34	91.74	69.50
10	26.68	12.22	35	92.91	72.00
11	29.39	15.55	36	88.99	72.63
12	32.10	18.88	37	85.07	73.27
13	34.81	22.20	38	81.16	73.90
14	36.62	25.83			
15	38.43	29.47			
16	40.24	33.10			
17	41.71	36.03			
18	43.18	38.97			
19	44.65	41.90			
20	47.36	45.25			
21	50.07	48.60			
22	53.35	49.30			
23	56.63	50.00			
24	60.32	51.00			
25	64.01	52.00			

18.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 26

Column : --
Beam : W18X45
Plate thickness : 1/4"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 340 MPa
Fu = 514 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 18.7325 g = 10.1600 lp = 22.8600 tp = 0.6350
tbw= 0.8509
n = 2 X 3

Remark 1) ACTUAL STRENGTH FY = 50.0 KSI, FU = 76.1 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	52.33	29.60
2	1.92	0.60	27	54.88	31.43
3	3.83	1.20	28	57.42	33.27
4	5.75	1.85	29	59.96	35.10
5	7.66	2.50	30	62.51	36.93
6	10.33	4.80	31	65.05	38.77
7	13.00	7.10	32	67.59	40.60
8	14.08	9.92	33	69.17	42.65
9	15.17	12.74	34	70.76	44.70
10	16.25	15.56	35	72.23	47.73
11	17.34	18.38	36	73.70	50.77
12	18.42	21.20	37	75.17	53.80
13	21.25	23.90	38	74.71	56.37
14	23.25	24.67	39	74.26	58.93
15	25.24	25.43	40	73.81	61.50
16	27.24	26.20	41	71.34	61.67
17	29.95	26.60	42	68.87	61.83
18	32.67	27.00	43	66.41	62.00
19	35.19	27.30	44	63.94	62.17
20	37.71	27.60	45	61.47	62.33
21	40.24	27.90	46	59.00	62.50
22	42.66	28.24			
23	45.08	28.58			
24	47.50	28.92			
25	49.91	29.26			

19.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 27

Column : --
Beam : W12X27
Plate thickness : 1/4"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 340 MPa
Fu = 514 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 3.8100 g = 10.1600 lp = 22.8600 tp = 0.6350
tbw= 0.6071
n = 2 X 3

Remark 1) ACTUAL STRENGTH FY = 48.4 KSI, FU = 74.0 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	31.54	47.25
2	1.17	0.63	27	32.89	48.77
3	2.34	1.27	28	34.25	50.30
4	3.50	1.90	29	35.15	54.17
5	4.67	2.57	30	36.06	58.03
6	5.84	3.23	31	36.96	61.90
7	7.01	3.90	32	37.53	65.90
8	8.36	5.10	33	38.09	69.90
9	9.72	6.30	34	38.66	74.65
10	11.08	7.50	35	39.22	79.40
11	12.43	8.70	36	39.48	83.22
12	13.90	11.63	37	39.73	87.05
13	15.37	14.57	38	39.98	90.88
14	16.84	17.50	39	40.24	94.70
15	17.56	21.47	40	38.88	96.06
16	18.27	25.43	41	37.53	97.42
17	18.99	29.40	42	36.17	98.78
18	20.46	31.60	43	34.81	100.14
19	21.93	33.80	44	33.46	101.50
20	23.40	36.00			
21	24.75	38.05			
22	26.11	40.10			
23	27.47	42.15			
24	28.82	44.20			
25	30.18	45.73			

20.
Connection type : Header plate connections
Mode : All bolted

Tested by : W.H.Sommer (1969) CANADA
Test Id. : TEST 28

Column : --
Beam : W12X27
Plate thickness : 1/4"

Fasteners: A325-X-M19.1D
M23.8 Oversize holes
Material : G40.12
Fy = 340 MPa
Fu = 514 MPa

Major parameters (cm)

lt = 3.8100 ct = 3.8100 p = 7.6200 cc = 3.8100
lc = 11.4300 g = 10.1600 lp = 15.2400 tp = 0.6350
tbw= 0.6071
n = 2 X 2

Remark 1) ACTUAL STRENGTH FY = 48.4 KSI, FU = 74.0 KSI FOR BEAM WEB.
2) NO WASHERS WERE USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	37.53	88.30
2	1.55	2.50	27	38.62	92.80
3	2.78	7.60	28	39.71	97.30
4	4.00	12.70	29	40.80	101.80
5	5.23	17.80	30	41.91	106.53
6	6.45	22.90	31	43.01	111.25
7	7.11	27.05	32	44.11	115.97
8	7.77	31.20	33	45.21	120.70
9	8.64	37.00	34	45.21	125.00
10	10.03	38.60			
11	11.42	40.20			
12	13.56	41.45			
13	15.71	42.70			
14	17.52	43.73			
15	19.33	44.77			
16	21.14	45.80			
17	22.98	48.83			
18	24.83	51.87			
19	26.68	54.90			
20	28.31	58.75			
21	29.95	62.60			
22	31.59	68.15			
23	33.23	73.70			
24	35.38	77.70			
25	36.45	83.00			

21.
Connection type : Header plate connections
Mode : All bolted

Tested by : J.B.Davison et al (1987) UNITED KINGDOM
Test Id. : JT/14

Column : UC 152x152x23 Fasteners: -- - -M16
Beam : UB 254x102x22 --- Oversize holes
Plate thickness : 12 mm Material : 43A
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

lt = -- ct = 5.5001 p = 10.0000 cc = 6.0000
lc = -- g = 7.5997 lp = 26.5001 tp = 1.1999
tbw= 0.5801
n = 2 X 3

Remark 1) FLUSH END PLATE WELDED TO THE WEB OF THE BEAM
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	34.18	5.77
2	1.39	0.09	27	35.22	6.25
3	2.78	0.19	28	36.26	6.73
4	4.17	0.28	29	37.51	7.69
5	5.56	0.32	30	38.55	8.65
6	6.95	0.35	31	39.59	9.62
7	8.34	0.38	32	40.01	10.58
8	9.72	0.51	33	40.43	11.54
9	11.11	0.64	34	40.88	12.50
10	12.50	0.77	35	41.33	13.46
11	13.89	0.83	36	41.68	14.42
12	15.28	0.90	37	41.68	15.20
13	16.67	0.96	38	41.55	15.77
14	18.06	1.04	39	41.43	16.35
15	19.45	1.12	40	40.01	17.31
16	20.84	1.19	41	39.59	18.27
17	22.23	1.44	42	39.18	19.23
18	23.62	1.68	43	39.01	20.18
19	25.01	1.92	44	39.01	21.16
20	26.67	2.40	45	37.51	21.72
21	28.34	2.88	46	35.84	22.11
22	29.59	3.37			
23	30.84	3.85			
24	32.09	4.81			
25	33.13	5.29			

II.14 Detalle ensayos unión placa extendida todo apernado con atiesador de columna

1.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : A.N.Sherbourne (1961) ENGLAND
Test Id. : TEST A2

Column : 8 x 8 UC 35 Fasteners: A325- -M19.1D
Beam : 15 x 5 RSJ 42 M23.8 Oversize holes
Plate thickness : 1 1/4" Material : G40.21
Stiffener thickness : 0.7937cm Fy = 256 MPa
Fu = 453 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.8100 pt = 8.8900 li = 27.9400 pc = 5.7150
cc = 0.6350 pit= 6.3500 pi = 7.6200 pic= 6.3500
gt = 10.1600 gi = 10.1600 gc = 10.1600
tp = 3.1750 nt = 2 X 2 ni = 2 X 3 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	473.24	6.30
2	22.87	0.05	27	489.14	7.00
3	45.73	0.10	28	497.10	8.10
4	68.60	0.15	29	513.00	9.20
5	91.47	0.20	30	520.96	9.95
6	107.37	0.20	31	528.91	10.70
7	123.28	0.20	32	536.86	11.70
8	143.16	0.37	33	544.82	12.70
9	163.05	0.53	34	548.79	13.55
10	182.93	0.70	35	552.77	14.40
11	200.83	0.80	36	556.75	15.05
12	218.72	0.90	37	560.72	15.70
13	234.63	1.10	38	564.70	16.40
14	250.54	1.30	39	568.68	17.10
15	278.37	1.30	40	572.65	17.85
16	294.28	1.40	41	576.63	18.60
17	310.19	1.50	42	580.61	19.45
18	338.03	2.20	43	584.58	20.30
19	353.93	2.40	44	584.58	20.10
20	369.84	2.60	45	588.56	20.95
21	385.75	2.95	46	592.54	21.80
22	401.65	3.30	47	592.54	21.60
23	421.54	3.80	48	592.54	22.35
24	437.44	4.50	49	592.54	23.10
25	457.33	5.30	50	592.54	23.75
			51	592.54	24.40

2.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : A.N.Sherbourne (1961) ENGLAND
Test Id. : TEST A3

Column : 8 x 8 UC 35 Fasteners: A325- -M19.1D
Beam : 15 x 5 RSJ 42 M23.8 Oversize holes
Plate thickness : 3/4" Material : G40.21
Stiffener thickness : 1.5875cm Fy = 257 MPa
Fu = 446 MPa

Major parameters (cm)

End plate extended on tension side only.

ct = 3.8100	pt = 8.8900	li = 27.9400	pc = 5.7150
cc = 0.6350	pit= 6.3500	pi = 7.6200	pic= 6.3500
gt = 10.1600	gi = 10.1600	gc = 10.1600	
tp = 1.9050	nt = 2 X 2	ni = 2 X 3	nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	562.64	13.00
2	32.15	0.20	27	578.71	14.60
3	60.28	0.20	28	586.75	15.65
4	88.41	0.50	29	594.79	16.70
5	120.57	0.70	30	602.83	17.90
6	152.72	0.70	31	608.85	18.85
7	176.83	0.70	32	614.88	19.80
8	194.91	0.80	33	620.91	20.95
9	213.00	0.90	34	626.94	22.10
10	245.15	0.90	35	630.96	23.50
11	273.28	0.90	36	634.98	24.90
12	301.41	1.10	37	639.00	25.85
13	333.56	1.80	38	643.02	26.80
14	361.70	2.00	39	647.03	27.75
15	379.78	2.20	40	651.05	28.70
16	397.87	2.40	41	653.06	29.55
17	430.02	3.30	42	655.07	30.40
18	462.17	4.80	43	661.10	31.55
19	474.22	5.30	44	667.13	32.70
20	486.28	6.60			
21	506.37	7.30			
22	522.45	8.50			
23	528.48	9.45			
24	534.51	10.40			
25	550.58	11.50			

3.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : A.N.Sherbourne (1961) ENGLAND
Test Id. : TEST B1

Column : 8 x 8 UC 35 Fasteners: A325- -M22.2D
Beam : 15 x 5 RSJ 42 M27.0 Oversize holes
Plate thickness : 1" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct = 3.8100	pt = 12.7000	li = 22.8600	pc = 8.8900
cc = 0.0000	pit= 7.6200	pi = 7.6200	pic= 7.6200
gt = 10.1600	gi = 10.1600	gc = 10.1600	
tp = 2.5400	nt = 2 X 2	ni = 2 X 2	nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	481.19	12.00
2	29.83	0.10	27	489.00	13.40
3	59.65	0.20	28	496.82	14.80
4	85.50	0.35	29	513.00	17.70
5	111.35	0.50	30	520.96	19.40
6	131.23	0.60	31	528.91	21.10
7	151.12	0.70	32	528.91	21.10
8	169.01	0.80	33	540.84	23.60
9	186.91	0.90	34	548.79	25.50
10	206.79	0.95	35	552.46	27.40
11	226.67	1.00	36	557.97	29.20
12	244.57	1.10	37	561.34	30.80
13	262.47	1.20	38	564.70	32.40
14	278.37	1.30	39	576.63	35.30
15	294.28	1.40	40	576.63	37.30
16	322.12	1.90	41	580.61	38.90
17	338.03	2.20	42	584.58	40.50
18	365.86	2.80	43	586.57	42.10
19	381.77	3.60	44	588.56	43.70
20	397.68	4.40	45	596.51	46.50
21	413.72	5.45	46	596.51	49.40
22	429.76	6.50	47	600.49	51.70
23	441.86	7.70	48	604.47	54.70
24	458.36	9.30	49	612.42	57.70
25	469.77	10.70	50	612.42	60.60
			51	616.40	61.60

4.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : A.N.Sherbourne (1961) ENGLAND
Test Id. : TEST B2

Column : 8 x 8 UC 35 Fasteners: A325- -M22.2D
Beam : 15 x 5 RSJ 42 M27.0 Oversize holes
Plate thickness : 3/4" Material : G40.21
Stiffener thickness : 1.2700cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct = 3.8100	pt = 12.7000	li = 22.8600	pc = 8.8900
cc = 0.0000	pit= 7.6200	pi = 7.6200	pic= 7.6200
gt = 10.1600	gi = 10.1600	gc = 10.1600	
tp = 1.9050	nt = 2 X 2	ni = 2 X 2	nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	509.03	10.90
2	22.54	0.06	27	520.96	12.60
3	45.07	0.13	28	532.89	14.20
4	67.61	0.21	29	536.86	15.70
5	88.81	0.30	30	542.83	16.85
6	110.02	0.40	31	548.79	18.00
7	131.23	0.51	32	552.77	19.40
8	151.12	0.63	33	556.75	20.80
9	175.97	0.76	34	560.72	21.75
10	200.83	0.90	35	564.70	22.70
11	225.68	1.05	36	568.68	24.40
12	250.54	1.21	37	568.68	25.40
13	266.44	1.38	38	568.68	26.40
14	282.35	1.56	39	572.65	28.10
15	310.19	1.75	40	576.63	29.80
16	338.03	1.95	41	580.61	31.30
17	365.86	2.30	42	584.58	33.00
18	383.76	2.75	43	584.58	34.25
19	401.65	3.40	44	584.58	35.50
20	425.51	4.30			
21	445.40	5.20			
22	465.28	6.40			
23	477.21	7.60			
24	493.12	9.00			
25	501.07	9.95			

5.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.G.Johnson et al. (1960) ENGLAND
Test Id. : TEST 5

Column : 8 x 8 UC 45
Beam : 10 x 4 1/2 RSJ 2
Plate thickness : 1/2"
Stiffener thickness : 1.2700cm

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	3.1750	pt =	9.5250	li =	15.2400	pc =	5.0800
cc =	1.9050	pit=	7.6200	pi =	0.0000	pic=	7.6200
gt =	8.8900	gi =	8.8900	gc =	8.8900		
tp =	1.2700	nt =	2 X 2	ni =	2 X 1	nc =	2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	110.53	6.75
2	4.78	0.17	27	113.31	7.30
3	9.57	0.33	28	115.03	7.80
4	14.35	0.50	29	116.53	8.40
5	19.06	0.67	30	118.03	9.00
6	23.78	0.83	31	118.45	9.45
7	28.49	1.00	32	118.88	9.90
8	33.20	1.17	33	120.60	10.45
9	37.91	1.33	34	122.31	11.00
10	42.63	1.50	35	122.74	11.65
11	47.62	1.70	36	123.17	12.30
12	52.62	1.90	37	124.02	12.77
13	57.62	2.10	38	124.88	13.23
14	62.48	2.33	39	125.74	13.70
15	67.33	2.57			
16	72.19	2.80			
17	76.61	3.13			
18	81.04	3.47			
19	85.47	3.80			
20	89.54	4.10			
21	93.61	4.40			
22	97.46	4.85			
23	101.32	5.30			
24	104.53	5.75			
25	107.74	6.20			

6.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : B4-L

Column : 8 x 8 UC 40 Fasteners: -- - -M22.2D
Beam : 12 x 5 UB 32 M27.0 Oversize holes
Plate thickness : 1 1/4" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.7940	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	206.28	9.20
2	7.90	0.25	27	216.81	10.80
3	15.79	0.50	28	224.47	12.80
4	15.79	0.40	29	231.17	14.80
5	23.93	0.60	30	235.00	16.70
6	32.07	0.80	31	240.74	18.80
7	42.12	1.00	32	242.66	20.40
8	52.17	1.20	33	246.49	22.30
9	59.35	1.50	34	248.40	23.90
10	66.53	1.80	35	250.31	25.80
11	73.71	2.10	36	252.23	27.90
12	80.89	2.40	37	255.10	29.70
13	88.07	2.50	38	256.06	31.10
14	95.24	2.60	39	257.97	32.70
15	104.34	2.90	40	258.93	34.60
16	113.43	3.20	41	259.89	36.30
17	121.09	3.30	42	260.85	38.30
18	128.75	3.40	43	261.80	40.30
19	137.84	3.70	44	261.80	42.40
20	146.93	4.00			
21	159.38	4.20			
22	167.04	4.90			
23	179.48	5.50			
24	190.01	6.60			
25	198.63	7.70			

7.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : B4-R

Column : 8 x 8 UC 40 Fasteners: -- - -M22.2D
Beam : 12 x 5 UB 32 M27.0 Oversize holes
Plate thickness : 1 1/4" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.7940	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	219.75	11.90
2	11.94	0.30	27	222.61	13.20
3	23.89	0.60	28	226.43	14.60
4	31.53	0.65	29	229.30	16.20
5	39.17	0.70	30	233.12	18.00
6	47.29	0.95	31	236.95	19.80
7	55.41	1.20	32	239.81	21.80
8	64.49	1.35	33	242.68	23.60
9	73.57	1.50	34	246.50	25.60
10	80.73	1.65	35	248.41	27.50
11	87.90	1.80	36	251.28	29.80
12	95.54	2.05	37	253.19	31.50
13	103.19	2.30	38	254.14	33.20
14	109.87	2.35	39	256.05	35.30
15	116.56	2.40	40	257.01	37.00
16	124.68	2.60	41	257.96	39.00
17	132.80	2.80	42	257.96	40.90
18	145.22	3.20	43	258.92	42.70
19	156.69	3.50	44	259.87	44.20
20	164.33	4.10	45	260.83	45.70
21	174.84	5.20	46	260.83	47.50
22	187.26	6.60	47	260.83	48.80
23	196.82	7.70			
24	206.37	9.00			
25	212.10	10.40			

8.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : B5-L

Column : 8 x 8 UC 40 Fasteners: -- - -M19.1D
Beam : 14 x 5 UB 26 M23.8 Oversize holes
Plate thickness : 1" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 10.7950	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.5400	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	201.40	12.20
2	8.63	0.35	27	206.19	13.80
3	17.26	0.70	28	210.03	15.50
4	26.37	0.95	29	213.87	17.60
5	35.49	1.20	30	217.70	19.60
6	43.16	1.45	31	219.62	20.85
7	50.83	1.70	32	221.54	22.10
8	60.42	2.00	33	223.46	24.10
9	70.01	2.30	34	223.94	25.20
10	78.16	2.60	35	224.42	26.30
11	86.31	2.90	36	225.38	28.20
12	94.47	3.10	37	225.38	30.10
13	102.62	3.30	38	225.38	31.20
14	112.21	3.60	39	225.38	32.30
15	121.80	3.90	40	227.29	34.20
16	128.99	4.20	41	227.29	35.55
17	136.18	4.50	42	227.29	36.90
18	141.94	4.85	43	227.29	38.60
19	147.69	5.20	44	227.29	40.50
20	155.36	5.90	45	228.25	42.20
21	163.04	6.60	46	229.21	43.50
22	168.79	7.20			
23	174.55	7.80			
24	185.10	9.30			
25	193.73	10.80			

9.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : B5-R

Column : 8 x 8 UC 40 Fasteners: -- - -M19.1D
Beam : 14 x 5 UB 26 M23.8 Oversize holes
Plate thickness : 1" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 10.7950	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.5400	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	192.65	7.30
2	8.17	0.13	27	197.46	8.20
3	16.34	0.27	28	202.26	9.30
4	24.50	0.40	29	206.10	10.60
5	31.71	0.60	30	208.99	12.10
6	38.92	0.80	31	213.79	13.30
7	47.56	1.00	32	216.67	14.90
8	56.21	1.20	33	217.63	16.50
9	65.82	1.40	34	220.52	17.80
10	75.43	1.60	35	222.44	19.90
11	81.19	1.70	36	223.40	21.80
12	86.96	1.80	37	224.36	23.60
13	94.64	2.05	38	225.32	25.40
14	102.33	2.30	39	225.32	27.30
15	110.02	2.25	40	225.32	29.20
16	117.71	2.20	41	226.28	31.10
17	127.31	2.50	42	226.28	33.00
18	136.92	2.80	43	226.28	34.40
19	143.17	3.00	44	226.28	36.00
20	149.41	3.20	45	227.24	38.00
21	156.14	3.50	46	227.24	39.20
22	162.87	3.80	47	228.20	40.70
23	169.59	4.50	48	227.24	42.70
24	177.28	5.50	49	227.24	44.30
25	185.93	6.40	50	228.20	46.10

10.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : B6-L

Column : 8 x 8 UC 40 Fasteners: -- - -M25.4D
Beam : 14 x 6 3/4 UB 45 M31.8 Oversize holes
Plate thickness : 1 3/8" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.7475	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	3.1496	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	354.26	13.80
2	17.33	0.65	27	359.08	14.95
3	34.66	1.30	28	363.91	16.10
4	54.87	1.75	29	373.53	17.90
5	75.09	2.20	30	377.38	19.60
6	89.53	2.50	31	381.22	21.10
7	103.97	2.80	32	388.92	22.70
8	117.45	3.15	33	392.77	24.50
9	130.93	3.50	34	394.69	26.30
10	145.37	3.80	35	397.58	27.50
11	159.81	4.10	36	400.47	28.70
12	173.28	4.45	37	402.42	30.60
13	186.76	4.80	38	403.38	31.80
14	198.31	5.05	39	404.34	33.00
15	209.87	5.30	40	410.11	35.10
16	220.46	5.65	41	411.07	36.25
17	231.05	6.00	42	412.04	37.40
18	247.41	6.70	43	417.81	39.40
19	263.77	7.40	44	423.58	41.40
20	275.33	7.80	45	423.58	43.30
21	286.89	8.20	46	423.58	45.10
22	304.20	9.50			
23	314.80	10.25			
24	325.40	11.00			
25	338.87	12.30			

11.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : B6-R

Column : 8 x 8 UC 40
Beam : 14 x 6 3/4 UB 45
Plate thickness : 1 3/8"
Stiffener thickness : 0.7937cm

Fasteners: -- - -M25.4D
M31.8 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.7475	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	3.1496	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	377.86	14.40
2	14.71	0.33	27	381.71	16.20
3	29.41	0.67	28	389.38	17.80
4	44.12	1.00	29	398.97	20.00
5	64.26	1.20	30	400.87	22.10
6	84.40	1.40	31	404.72	24.10
7	97.82	1.80	32	410.47	25.70
8	111.25	2.20	33	410.47	27.90
9	129.47	2.60	34	414.32	30.20
10	147.69	3.00	35	416.21	32.00
11	166.87	3.35	36	420.06	34.10
12	186.05	3.70	37	421.02	35.30
13	198.52	4.05	38	421.99	36.50
14	210.99	4.40	39	421.99	38.20
15	223.46	4.65	40	425.81	39.80
16	235.93	4.90	41	423.89	41.00
17	252.23	5.40	42	421.99	42.80
18	268.53	5.90	43	423.89	44.20
19	281.96	6.55	44	423.89	45.70
20	295.39	7.20	45	425.81	46.50
21	306.90	7.90			
22	318.41	8.60			
23	335.68	9.70			
24	354.84	11.10			
25	366.36	12.60			

12.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : B7-L

Column : 8 x 8 UC 40 Fasteners: -- - -M25.4D
Beam : 12 x 6 1/2 UB 36 M31.8 Oversize holes
Plate thickness : 1 1/4" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.9464	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	260.42	15.20
2	12.66	0.50	27	262.23	16.80
3	25.32	1.00	28	267.65	18.90
4	36.77	1.37	29	269.46	21.10
5	48.23	1.73	30	273.08	23.50
6	59.68	2.10	31	276.70	25.70
7	72.34	2.55	32	277.60	26.95
8	85.00	3.00	33	278.51	28.20
9	95.85	3.35	34	280.31	30.50
10	106.70	3.70	35	283.93	32.90
11	118.46	3.90	36	283.93	34.80
12	130.21	4.10	37	283.03	36.25
13	141.06	4.35	38	282.12	37.70
14	151.91	4.60	39	285.74	39.70
15	161.86	5.10	40	285.74	41.50
16	171.81	5.60	41	289.36	43.40
17	181.75	6.05	42	287.55	45.40
18	191.70	6.50	43	287.55	46.90
19	201.65	7.20	44	289.36	48.30
20	211.59	7.90			
21	218.83	8.65			
22	226.06	9.40			
23	235.10	10.40			
24	244.14	11.40			
25	255.00	13.50			

13.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : B7-R

Column : 8 x 8 UC 40 Fasteners: -- - -M25.4D
Beam : 12 x 6 1/2 UB 36 M31.8 Oversize holes
Plate thickness : 1 1/4" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.9464	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	270.43	14.30
2	10.28	0.33	27	274.97	15.30
3	20.57	0.67	28	279.50	16.30
4	30.85	1.00	29	283.13	17.45
5	44.47	1.40	30	286.76	18.60
6	58.08	1.80	31	287.67	19.85
7	70.78	2.10	32	288.58	21.10
8	83.49	2.40	33	291.30	22.25
9	94.38	2.60	34	294.02	23.40
10	105.27	2.80	35	295.84	25.00
11	116.16	3.13	36	295.84	26.10
12	127.05	3.47	37	295.84	27.20
13	137.94	3.80	38	295.84	28.15
14	148.83	4.17	39	295.84	29.10
15	159.72	4.53	40	296.75	30.40
16	170.61	4.90	41	297.65	31.70
17	181.50	5.45	42	299.47	33.40
18	192.39	6.00	43	299.47	34.60
19	205.09	6.70	44	299.47	35.80
20	217.79	7.40	45	299.47	37.10
21	232.31	8.70			
22	246.83	10.00			
23	255.00	11.10			
24	263.17	12.20			
25	266.80	13.25			

14.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : B8-L

Column : 8 x 8 UC 40 Fasteners: -- - -M19.1D
Beam : 8 x 5 1/4 UB 20 M23.8 Oversize holes
Plate thickness : 3/4" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.3368	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	105.49	7.90
2	4.48	0.17	27	106.93	8.60
3	8.95	0.33	28	108.37	9.30
4	13.43	0.50	29	109.33	10.10
5	17.58	0.60	30	110.29	10.90
6	21.74	0.70	31	110.77	11.55
7	25.89	0.80	32	111.25	12.20
8	31.65	0.95	33	111.89	12.90
9	37.40	1.10	34	112.53	13.60
10	42.20	1.30	35	113.17	14.30
11	46.99	1.50	36	113.65	15.00
12	51.79	1.57	37	114.13	15.70
13	56.58	1.65	38	114.77	16.37
14	61.38	1.73	39	115.40	17.03
15	66.17	1.80	40	116.04	17.70
16	71.45	2.05			
17	76.72	2.30			
18	82.48	3.10			
19	88.23	3.90			
20	91.11	4.40			
21	93.99	4.90			
22	96.86	5.40			
23	99.74	5.90			
24	100.70	6.50			
25	101.66	7.10			

15.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : B8-R

Column : 8 x 8 UC 40 Fasteners: -- - -M19.1D
Beam : 8 x 5 1/4 UB 20 M23.8 Oversize holes
Plate thickness : 3/4" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.3368	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	94.29	12.10
2	3.59	0.45	27	96.20	12.90
3	7.18	0.90	28	98.12	13.70
4	11.01	1.23	29	100.03	14.75
5	14.84	1.57	30	101.95	15.80
6	18.67	1.90	31	102.90	16.65
7	22.50	2.13	32	103.86	17.50
8	26.32	2.37	33	105.29	18.40
9	30.15	2.60	34	106.73	19.30
10	34.62	2.87	35	108.17	20.15
11	39.09	3.13	36	109.60	21.00
12	43.55	3.40	37	109.60	22.00
13	47.38	3.85	38	109.60	23.00
14	51.21	4.30	39	110.56	23.75
15	56.48	4.80	40	111.52	24.50
16	61.74	5.30	41	112.00	25.40
17	67.01	5.75	42	112.47	26.30
18	72.27	6.20	43	112.95	27.25
19	75.14	6.80	44	113.43	28.20
20	78.01	7.40			
21	81.36	8.15			
22	84.71	8.90			
23	87.59	9.45			
24	90.46	10.00			
25	92.37	11.05			

16.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : C9-L

Column : 8 x 8 UC 40 Fasteners: -- - -M15.9D
Beam : 8 x 5 1/4 UB 20 M20.6 Oversize holes
Plate thickness : 3/4" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.2225	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	68.81	7.10
2	3.84	0.35	27	70.49	7.60
3	7.67	0.70	28	71.69	7.90
4	11.51	1.00	29	72.89	8.20
5	15.34	1.30	30	74.09	8.70
6	18.70	1.60	31	75.28	9.20
7	22.06	1.90	32	76.48	9.75
8	24.46	2.05	33	77.68	10.30
9	26.85	2.20	34	78.64	10.77
10	29.49	2.30	35	79.60	11.23
11	32.13	2.40	36	80.56	11.70
12	35.00	2.70			
13	37.88	3.00			
14	40.52	3.15			
15	43.16	3.30			
16	46.03	3.55			
17	48.91	3.80			
18	51.31	4.00			
19	53.71	4.20			
20	55.62	4.50			
21	57.54	4.80			
22	60.42	5.20			
23	63.30	5.60			
24	65.22	6.10			
25	67.13	6.60			

17.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : C9-R

Column : 8 x 8 UC 40
Beam : 8 x 5 1/4 UB 20
Plate thickness : 3/4"
Stiffener thickness : 0.7937cm

Fasteners: -- - -M15.9D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.2225	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	70.97	9.80
2	2.88	0.30	27	72.17	10.40
3	5.75	0.60	28	73.37	11.00
4	8.87	0.85	29	74.81	11.60
5	11.99	1.10	30	76.24	12.20
6	15.34	1.40	31	77.20	13.05
7	18.70	1.70	32	78.16	13.90
8	21.58	1.95	33	79.12	14.70
9	24.46	2.20	34	80.08	15.50
10	27.09	2.45	35	80.32	16.30
11	29.73	2.70	36	80.56	17.10
12	32.13	2.90	37	81.04	17.95
13	34.53	3.10	38	81.52	18.80
14	37.88	3.40	39	81.76	19.50
15	41.24	3.70	40	82.00	20.20
16	44.36	3.95	41	82.00	21.20
17	47.47	4.20			
18	50.59	4.50			
19	53.71	4.80			
20	56.58	5.30			
21	59.46	5.80			
22	62.10	6.55			
23	64.73	7.30			
24	68.57	8.30			
25	69.77	9.05			

18.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : C10-L

Column : 8 x 8 UC 40 Fasteners: -- - -M19.1D
Beam : 12 x 5 UB 32 M23.8 Oversize holes
Plate thickness : 13/16" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.4384	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	176.84	7.10
2	10.63	0.20	27	181.68	7.65
3	21.26	0.40	28	186.51	8.20
4	29.96	0.55	29	189.08	8.73
5	38.65	0.70	30	191.66	9.27
6	45.42	0.80	31	194.24	9.80
7	52.18	0.90	32	198.10	10.50
8	59.43	1.10	33	201.97	11.20
9	66.68	1.30	34	204.55	11.77
10	74.41	1.35	35	207.12	12.33
11	82.14	1.40	36	209.70	12.90
12	90.36	1.60	37	212.12	13.60
13	98.57	1.80	38	214.53	14.30
14	105.33	2.05	39	216.95	15.05
15	112.10	2.30	40	219.36	15.80
16	118.38	2.40			
17	124.66	2.50			
18	132.39	3.00			
19	140.12	3.50			
20	145.92	4.00			
21	151.72	4.50			
22	160.42	5.20			
23	164.77	5.60			
24	169.11	6.00			
25	172.98	6.55			

19.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : C10-R

Column : 8 x 8 UC 40
Beam : 12 x 5 UB 32
Plate thickness : 13/16"
Stiffener thickness : 0.7937cm

Fasteners: -- - -M19.1D
M23.8 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.4384	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	175.39	8.35
2	8.38	0.20	27	180.71	9.20
3	16.75	0.40	28	183.13	9.85
4	25.13	0.60	29	185.54	10.50
5	34.31	0.80	30	189.41	11.25
6	43.49	1.00	31	193.27	12.00
7	51.22	1.30	32	196.66	12.95
8	58.95	1.60	33	200.04	13.90
9	69.58	1.70	34	202.45	14.90
10	76.34	1.95	35	204.87	15.90
11	83.11	2.20	36	206.80	16.80
12	89.39	2.35	37	208.73	17.70
13	95.67	2.50	38	210.67	18.70
14	102.92	2.75	39	212.60	19.70
15	110.16	3.00	40	212.60	20.45
16	115.48	3.15	41	212.60	21.20
17	120.80	3.30			
18	126.59	3.55			
19	132.39	3.80			
20	139.64	4.35			
21	146.89	4.90			
22	152.69	5.50			
23	158.48	6.10			
24	164.28	6.80			
25	170.08	7.50			

20.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : C11-L

Column : 8 x 8 UC 40 Fasteners: -- - -M15.9D
Beam : 14 x 5 UB 26 M20.6 Oversize holes
Plate thickness : 7/8" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 10.7950	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.0955	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	138.85	4.40
2	6.97	0.15	27	140.77	4.70
3	13.93	0.30	28	142.69	5.00
4	20.66	0.55	29	143.65	5.27
5	27.38	0.80	30	144.61	5.53
6	33.63	0.95	31	145.57	5.80
7	39.88	1.10	32	148.45	6.15
8	46.12	1.25	33	151.34	6.50
9	52.37	1.40	34	153.26	6.80
10	58.61	1.65	35	155.18	7.10
11	64.86	1.90	36	156.14	7.45
12	69.66	2.00	37	157.10	7.80
13	74.47	2.10			
14	80.23	2.25			
15	86.00	2.40			
16	92.24	2.60			
17	98.49	2.80			
18	102.81	3.00			
19	107.14	3.20			
20	111.46	3.25			
21	115.78	3.30			
22	120.59	3.50			
23	125.39	3.70			
24	132.12	4.00			
25	135.48	4.20			

21.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : C11-R

Column : 8 x 8 UC 40
Beam : 14 x 5 UB 26
Plate thickness : 7/8"
Stiffener thickness : 0.7937cm

Fasteners: -- - -M15.9D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 10.7950	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.0955	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	137.24	5.17
2	7.21	0.27	27	139.81	5.40
3	14.41	0.53	28	142.21	5.70
4	21.62	0.80	29	144.61	6.00
5	27.70	1.00			
6	33.79	1.20			
7	39.88	1.40			
8	46.60	1.65			
9	53.33	1.90			
10	58.61	2.05			
11	63.90	2.20			
12	69.18	2.40			
13	74.47	2.60			
14	79.27	2.80			
15	84.08	3.00			
16	91.28	3.15			
17	98.49	3.30			
18	104.73	3.55			
19	110.98	3.80			
20	114.82	4.00			
21	118.67	4.20			
22	122.51	4.40			
23	127.31	4.55			
24	132.12	4.70			
25	134.68	4.93			

22.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : C12-L

Column : 8 x 8 UC 40 Fasteners: -- - -M22.2D
Beam : 12 x 6 1/2 UB 36 M27.0 Oversize holes
Plate thickness : 1 1/16" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct = 4.2862	pt = 11.1125	li = 18.5738	pc = 6.3500
cc = 1.9050	pit= 9.6837	pi = 0.0000	pic= 8.8900
gt = 10.1600	gi = 10.1600	gc = 10.1600	
tp = 2.4130	nt = 2 X 2	ni = 2 X 1	nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	288.13	19.50
2	10.53	0.37	27	293.87	21.20
3	21.06	0.73	28	293.87	23.30
4	31.59	1.10	29	299.61	25.10
5	44.99	1.40	30	301.53	27.40
6	58.39	1.70	31	303.44	29.60
7	69.88	2.10	32	305.36	31.10
8	81.36	2.50	33	306.31	32.35
9	94.77	2.95	34	307.27	33.60
10	108.17	3.40	35	307.27	35.50
11	120.61	3.70	36	309.18	37.30
12	133.05	4.00	37	309.18	39.20
13	144.54	4.45	38	309.18	41.20
14	156.03	4.90	39	313.01	43.40
15	170.39	5.40	40	311.10	45.20
16	184.75	5.90	41	314.93	47.40
17	195.28	6.45	42	313.01	48.50
18	205.80	7.00			
19	215.38	7.70			
20	224.95	8.40			
21	240.26	9.90			
22	255.58	11.50			
23	265.15	13.30			
24	274.73	15.60			
25	280.47	17.70			

23.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : C12-R

Column : 8 x 8 UC 40 Fasteners: -- - -M22.2D
Beam : 12 x 6 1/2 UB 36 M27.0 Oversize holes
Plate thickness : 1 1/16" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct = 4.2862	pt = 11.1125	li = 18.5738	pc = 6.3500
cc = 1.9050	pit= 9.6837	pi = 0.0000	pic= 8.8900
gt = 10.1600	gi = 10.1600	gc = 10.1600	
tp = 2.4130	nt = 2 X 2	ni = 2 X 1	nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	308.06	15.90
2	16.37	0.35	27	315.76	17.90
3	32.73	0.70	28	321.54	20.10
4	48.13	1.05	29	322.50	21.30
5	63.54	1.40	30	323.46	22.50
6	77.98	1.65	31	329.24	24.70
7	92.42	1.90	32	331.16	26.80
8	106.86	2.20	33	333.09	28.60
9	121.30	2.50	34	333.09	30.40
10	132.85	2.75	35	333.09	32.40
11	144.40	3.00	36	336.94	34.20
12	154.99	3.40	37	336.94	36.50
13	165.58	3.80	38	338.87	38.30
14	180.02	4.05	39	338.87	40.20
15	194.46	4.30	40	336.94	42.10
16	206.02	4.80	41	340.79	44.20
17	217.57	5.30	42	340.79	45.90
18	226.23	5.90	43	340.79	47.20
19	234.90	6.50			
20	246.45	7.35			
21	258.00	8.20			
22	266.66	9.00			
23	275.33	9.80			
24	290.73	11.90			
25	300.36	13.70			

24.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : C13-L

Column : 8 x 8 UC 40 Fasteners: -- - -M25.4D
Beam : 14 x 6 3/4 UB 45 M31.8 Oversize holes
Plate thickness : 1 1/4" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.7475	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.8956	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	257.96	7.40
2	4.78	0.10	27	273.25	8.20
3	9.55	0.20	28	284.72	9.00
4	14.33	0.30	29	291.40	9.60
5	19.11	0.40	30	298.09	10.20
6	23.89	0.50	31	302.87	10.70
7	28.66	0.60	32	307.65	11.20
8	33.03	0.70	33	311.47	11.70
9	37.40	0.80	34	315.29	12.20
10	46.13	1.00	35	319.11	12.80
11	59.24	1.30	36	322.93	13.40
12	72.61	1.70	37	325.80	13.95
13	85.99	2.10	38	328.67	14.50
14	101.27	2.50	39	329.62	15.10
15	116.56	2.90	40	330.58	15.70
16	131.85	3.30	41	331.53	16.25
17	147.14	3.70	42	332.49	16.80
18	160.51	4.00			
19	173.89	4.30			
20	186.31	4.55			
21	198.73	4.80			
22	214.01	5.30			
23	227.39	5.80			
24	240.77	6.60			
25	249.37	7.00			

25.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : C13-R

Column : 8 x 8 UC 40 Fasteners: -- - -M25.4D
Beam : 14 x 6 3/4 UB 45 M31.8 Oversize holes
Plate thickness : 1 1/4" Material : G40.21
Stiffener thickness : 0.7937cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.7475	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.8956	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) MATERIAL GRADE 43A (BS15)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	287.86	10.70
2	14.73	0.20	27	293.56	11.45
3	29.45	0.40	28	299.26	12.20
4	43.70	0.80	29	303.06	13.05
5	57.95	1.20	30	306.86	13.90
6	72.20	1.50	31	310.66	14.65
7	86.45	1.80	32	314.47	15.40
8	100.70	2.05	33	316.37	16.20
9	114.96	2.30	34	318.27	17.00
10	126.36	2.60	35	319.22	17.85
11	137.76	2.90	36	320.17	18.70
12	149.16	3.15	37	320.17	19.50
13	160.56	3.40	38	320.17	20.30
14	175.76	3.70			
15	184.31	3.95			
16	192.86	4.20			
17	202.36	4.80			
18	215.66	5.40			
19	227.06	5.90			
20	242.26	6.90			
21	251.76	7.60			
22	261.26	8.30			
23	267.91	8.95			
24	274.56	9.60			
25	281.21	10.15			

26.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : J.O.Surtees & A.P.Mann (1970) ENGLAND
Test Id. : TEST C6

Column : 10 x 10 UC 89
Beam : 18 x 6 UB 55
Plate thickness : 1 1/8"
Stiffener thickness : 1.2700cm

Fasteners: -- - -M28.6D
M36.5 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 7.6200 pt = 15.2400 li = 25.4000 pc = 12.7000
cc = 0.0000 gt = 15.2400 gc = 15.2400
tp = 2.8575 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) HSFG BOLTS USED EITHER SIDE OF BEAM TENSION FLANGE.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	530.81	6.10
2	23.46	0.15	27	548.41	7.10
3	46.92	0.30	28	558.67	8.40
4	64.52	0.50	29	564.54	9.90
5	82.12	0.70	30	571.87	11.50
6	108.51	0.95	31	574.80	13.20
7	134.90	1.20	32	580.67	14.80
8	156.17	1.40	33	585.07	16.10
9	177.43	1.60	34	589.47	17.60
10	196.49	1.80	35	590.93	19.10
11	215.55	2.00	36	593.87	20.90
12	239.75	2.25	37	595.33	22.20
13	263.94	2.50	38	596.80	23.70
14	285.20	2.70	39	598.26	25.70
15	306.46	2.90	40	602.66	27.20
16	327.73	3.10	41	604.13	28.90
17	348.99	3.30	42	605.60	30.20
18	365.12	3.50	43	608.53	31.30
19	381.25	3.70	44	610.00	32.60
20	400.31	3.85	45	611.46	33.90
21	419.37	4.00	46	612.93	35.10
22	440.63	4.20	47	615.86	36.30
23	461.89	4.40	48	617.33	37.50
24	489.76	4.80	49	618.79	38.60
25	510.28	5.20	50	621.73	40.00

27.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : N.D.Johnstone & W.R.Walpole (NEW-GEALAND
Test Id. : TEST 1-L

Column : 250 UC 89
Beam : 310 UB 46
Plate thickness : 32 mm
Stiffener thickness : 1.6002cm

Fasteners: G8.8- -M30
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = --	pt = 17.7998	li = --	pc = 17.7998
cc = --	gt = 14.0000	gc = 14.0000	
tp = 3.2004	nt = 2 X 2	nc = 2 X 2	

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2) 16 mm WEB DOUBLER PLATES ON BOTH SIDES OF COLUMN USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	257.47	21.70
2	11.38	0.05	27	260.31	24.00
3	22.76	0.10	28	263.16	26.30
4	34.14	0.35	29	265.29	28.60
5	45.52	0.60	30	267.42	30.90
6	56.90	0.87	31	268.13	33.00
7	68.28	1.13	32	268.85	35.10
8	79.66	1.40	33	270.27	38.70
9	93.17	1.35	34	273.11	42.00
10	106.68	1.30	35	273.82	43.90
11	117.35	1.50	36	274.53	45.80
12	128.02	1.70	37	275.96	49.40
13	140.11	2.30	38	277.38	53.10
14	152.20	2.90	39	278.80	55.45
15	162.87	3.50	40	280.22	57.80
16	173.54	4.10	41	283.07	61.30
17	184.92	4.65	42	283.78	63.70
18	196.30	5.20	43	284.49	66.10
19	204.12	6.05	44	285.20	68.35
20	211.95	6.90	45	285.91	70.60
21	224.75	9.70	46	286.63	72.60
22	233.28	12.00	47	287.34	74.60
23	240.40	14.65			
24	247.51	17.30			
25	252.49	19.50			

28.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : N.D.Johnstone & W.R.Walpole (NEW-GEALAND
Test Id. : TEST 1-R

Column : 250 UC 89
Beam : 310 UB 46
Plate thickness : 32 mm
Stiffener thickness : 1.6002cm

Fasteners: G8.8- -M30
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct =	--	pt = 17.7998	li =	--	pc = 17.7998
cc =	--	gt = 14.0000	gc = 14.0000		
tp =	3.2004	nt = 2 X 2	nc = 2 X 2		

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2) 16 mm WEB DOUBLER PLATES ON BOTH SIDES OF COLUMN USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	268.80	23.15
2	12.98	0.12	27	271.65	25.60
3	25.95	0.24	28	273.08	27.85
4	38.93	0.36	29	274.51	30.10
5	51.91	0.48	30	276.65	32.25
6	64.88	0.60	31	278.78	34.40
7	78.43	0.75	32	280.21	36.25
8	91.98	0.90	33	281.64	38.10
9	104.10	1.10	34	284.49	40.35
10	116.22	1.30	35	287.34	42.60
11	126.20	1.55	36	290.19	44.50
12	136.18	1.80	37	293.04	46.40
13	151.16	2.25	38	295.90	48.70
14	166.13	2.70	39	298.75	51.00
15	181.10	3.40	40	301.60	53.45
16	196.08	4.10	41	304.45	55.90
17	206.77	4.75	42	305.17	58.10
18	217.47	5.40	43	305.88	60.30
19	227.45	7.25	44	311.58	63.90
20	237.43	9.10	45	311.58	67.50
21	251.69	12.30	46	309.44	70.40
22	255.97	14.30	47	307.31	73.30
23	260.25	16.30			
24	263.10	18.50			
25	265.95	20.70			

29.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : N.D.Johnstone & W.R.Walpole (NEW-GEALAND
Test Id. : TEST 2-L

Column : 250 UC 89
Beam : 310 UB 46
Plate thickness : 32 mm
Stiffener thickness : 1.6002cm

Fasteners: G8.8- -M30
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = --	pt = 17.7998	li = --	pc = 17.7998
cc = --	gt = 14.0000	gc = 14.0000	
tp = 3.2004	nt = 2 X 2	nc = 2 X 2	

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2) 16 mm WEB DOUBLER PLATES ON BOTH SIDES OF COLUMN USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	263.57	27.97
2	13.90	0.40	27	265.95	31.00
3	27.81	0.80	28	268.80	34.25
4	39.69	1.00	29	271.65	37.50
5	51.57	1.20	30	272.37	40.45
6	63.46	1.40	31	273.08	43.40
7	76.29	1.80	32	274.51	46.55
8	89.13	2.20	33	275.93	49.70
9	101.96	2.60	34	278.07	52.65
10	113.37	2.90	35	280.21	55.60
11	124.78	3.20	36	281.16	58.47
12	136.18	3.50	37	282.11	61.33
13	146.17	3.90	38	283.06	64.20
14	156.15	4.30	39	284.96	66.87
15	166.13	4.70	40	286.87	69.53
16	178.96	5.25	41	288.77	72.20
17	191.80	5.80	42	290.19	75.15
18	204.63	6.75	43	291.62	78.10
19	217.47	7.70	44	293.04	80.00
20	229.59	10.45			
21	241.71	13.20			
22	247.41	16.10			
23	253.12	19.00			
24	258.82	21.90			
25	261.20	24.93			

30.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : N.D.Johnstone & W.R.Walpole (NEW-GEALAND
Test Id. : TEST 2-R

Column : 250 UC 89
Beam : 310 UB 46
Plate thickness : 32 mm
Stiffener thickness : 1.6002cm

Fasteners: G8.8- -M30
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = --	pt = 17.7998	li = --	pc = 17.7998
cc = --	gt = 14.0000	gc = 14.0000	
tp = 3.2004	nt = 2 X 2	nc = 2 X 2	

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2) 16 mm WEB DOUBLER PLATES ON BOTH SIDES OF COLUMN USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	245.79	24.40
2	12.76	0.20	27	245.79	24.50
3	25.51	0.40	28	248.65	27.40
4	38.27	0.60	29	251.52	30.30
5	51.02	0.80	30	253.67	33.30
6	63.78	1.00	31	255.82	36.30
7	73.33	1.43	32	257.25	40.00
8	82.88	1.87	33	258.68	43.70
9	92.44	2.30	34	260.12	46.50
10	102.95	2.80	35	261.55	49.30
11	113.46	3.30	36	260.12	52.30
12	123.97	3.80	37	258.68	55.30
13	133.52	4.33	38	258.21	58.40
14	143.08	4.87	39	257.73	61.50
15	152.63	5.40	40	257.25	64.60
16	164.10	5.95	41	257.97	68.35
17	175.56	6.50	42	258.68	72.10
18	184.64	7.23	43	260.12	74.35
19	193.71	7.97	44	261.55	76.60
20	202.79	8.70	45	261.55	79.90
21	214.97	10.95			
22	227.16	13.20			
23	232.89	15.85			
24	238.62	18.50			
25	242.20	21.45			

31.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : N.D.Johnstone & W.R.Walpole (NEW-GEALAND
Test Id. : TEST 3-L

Column : 250 UC 89
Beam : 310 UB 46
Plate thickness : 24 mm
Stiffener thickness : 1.1989cm

Fasteners: G8.8- -M24
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct =	--	pt = 10.2006	li =	--	pc = 10.2006
cc =	--	gt = 12.9997	gc = 12.9997		
tp =	2.4000	nt = 2 X 2	nc = 2 X 2		

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2) 12 mm WEB DOUBLER PLATES ON BOTH SIDES OF COLUMN USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	240.28	36.30
2	9.74	0.23	27	243.13	41.00
3	19.49	0.47	28	245.99	46.75
4	29.23	0.70	29	248.84	52.50
5	39.69	0.87	30	250.98	58.05
6	50.15	1.03	31	253.12	63.60
7	60.60	1.20	32	253.83	67.30
8	70.59	1.70	33	254.54	71.00
9	80.57	2.20	34	257.39	77.25
10	90.55	2.70	35	260.25	83.50
11	100.06	3.23	36	261.67	88.33
12	109.57	3.77	37	263.10	93.17
13	119.07	4.30	38	264.52	98.00
14	128.58	5.00	39	268.09	103.65
15	138.09	5.70	40	271.65	109.30
16	147.59	6.40	41	272.37	114.05
17	160.43	7.85	42	273.08	118.80
18	173.26	9.30	43	272.60	123.30
19	183.95	10.85	44	272.13	127.80
20	194.65	12.40	45	271.65	132.30
21	206.06	15.60			
22	217.47	18.80			
23	230.30	24.70			
24	233.86	28.15			
25	237.43	31.60			

32.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : N.D.Johnstone & W.R.Walpole (NEW-GEALAND
Test Id. : TEST 3-R

Column : 250 UC 89 Fasteners: G8.8- -M24
Beam : 310 UB 46 --- Oversize holes
Plate thickness : 24 mm Material : G40.21
Stiffener thickness : 1.1989cm Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = -- pt = 10.2006 li = -- pc = 10.2006
cc = -- gt = 12.9997 gc = 12.9997
tp = 2.4000 nt = 2 X 2 nc = 2 X 2

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2) 12 mm WEB DOUBLER PLATES ON BOTH SIDES OF COLUMN USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	218.58	23.13
2	9.01	0.20	27	221.90	25.00
3	18.02	0.40	28	225.22	27.33
4	27.03	0.60	29	228.54	29.67
5	35.09	0.70	30	231.86	32.00
6	43.15	0.80	31	234.23	34.13
7	51.21	0.90	32	236.60	36.27
8	62.59	1.35	33	238.97	38.40
9	73.97	1.80	34	238.97	40.20
10	84.64	2.65	35	238.97	42.00
11	95.30	3.50	36	238.50	43.80
12	106.68	4.20	37	238.02	45.60
13	118.06	4.90	38	237.55	47.40
14	126.12	5.40	39	238.97	48.50
15	134.19	5.90			
16	142.25	6.40			
17	152.20	7.65			
18	162.16	8.90			
19	172.12	10.25			
20	182.08	11.60			
21	190.61	13.40			
22	199.14	15.20			
23	205.55	17.30			
24	211.95	19.40			
25	215.27	21.27			

33.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : N.D.Johnstone & W.R.Walpole (NEW-GEALAND
Test Id. : TEST 4-L

Column : 250 UC 89
Beam : 310 UB 46
Plate thickness : 16 mm
Stiffener thickness : 1.1989cm

Fasteners: G8.8- -M24
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct =	--	pt = 11.4986	li =	--	pc = 11.4986
cc =	--	gt = 12.9997	gc = 12.9997		
tp =	1.6002	nt = 2 X 2	nc = 2 X 2		

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2) 12 mm WEB DOUBLER PLATES ON BOTH SIDES OF COLUMN USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	229.37	40.90
2	11.02	0.13	27	233.64	44.75
3	22.05	0.27	28	237.91	48.60
4	33.07	0.40	29	243.77	52.55
5	46.41	1.05	30	249.64	56.50
6	59.74	1.70	31	251.78	60.15
7	68.99	2.23	32	253.91	63.80
8	78.24	2.77	33	257.64	68.40
9	87.48	3.30	34	261.38	73.00
10	99.75	3.85	35	265.11	77.00
11	112.02	4.40	36	268.85	81.00
12	120.02	5.45	37	270.45	84.40
13	128.02	6.50	38	272.05	87.80
14	137.09	8.15	39	270.98	92.60
15	146.16	9.80	40	269.91	97.40
16	155.23	11.35	41	269.91	100.10
17	164.29	12.90	42	269.91	102.80
18	173.90	15.25			
19	183.50	17.60			
20	195.23	21.80			
21	201.63	24.45			
22	208.03	27.10			
23	214.44	30.55			
24	220.84	34.00			
25	225.10	37.45			

34.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : N.D.Johnstone & W.R.Walpole (NEW-GEALAND
Test Id. : TEST 4-R

Column : 250 UC 89
Beam : 310 UB 46
Plate thickness : 16 mm
Stiffener thickness : 1.1989cm

Fasteners: G8.8- -M24
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct =	--	pt = 11.4986	li =	--	pc = 11.4986
cc =	--	gt = 12.9997	gc = 12.9997		
tp =	1.6002	nt = 2 X 2	nc = 2 X 2		

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2) 12 mm WEB DOUBLER PLATES ON BOTH SIDES OF COLUMN USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	183.63	26.20
2	9.13	0.60	27	185.42	28.00
3	18.26	1.20	28	187.21	29.80
4	27.38	1.80	29	189.00	31.60
5	36.51	2.40	30	191.50	33.93
6	45.46	2.93	31	194.01	36.27
7	54.41	3.47	32	196.52	38.60
8	63.36	4.00	33	197.23	40.27
9	71.23	4.70	34	197.95	41.93
10	79.11	5.40	35	198.66	43.60
11	86.98	6.10	36	195.44	45.75
12	94.50	6.97	37	192.22	47.90
13	102.02	7.83			
14	109.53	8.70			
15	116.69	9.80			
16	123.85	10.90			
17	131.01	12.00			
18	137.45	12.63			
19	143.90	13.27			
20	150.34	13.90			
21	157.32	15.55			
22	164.30	17.20			
23	170.21	19.50			
24	176.11	21.80			
25	179.87	24.00			

35.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF4-S12x87

Column : W12x87
Beam : W24x100
Plate thickness : 1"
Stiffener thickness : 0.9525cm

Fasteners: A325- -M22.2D
M23.8 Oversize holes
Material : A36
Fy = 391 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 10.4775	pt = 8.8900	li = 50.1650	pc = 8.8900
cc = 10.4775	pit= 6.6675	pi = 36.8300	pic= 6.6675
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 2.5400	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	913.18	1.28
2	45.66	0.02	27	933.05	1.41
3	91.32	0.03	28	952.92	1.53
4	136.98	0.05	29	972.78	1.66
5	170.10	0.07	30	992.57	1.80
6	203.23	0.08	31	1012.35	1.95
7	237.12	0.10	32	1032.14	2.10
8	271.02	0.12	33	1041.98	2.24
9	306.44	0.16	34	1051.82	2.39
10	341.87	0.19	35	1061.67	2.53
11	374.28	0.22	36	1071.51	2.68
12	406.69	0.25	37	1081.35	2.83
13	442.17	0.30	38	1091.19	2.97
14	477.64	0.35	39	1101.04	3.12
15	510.83	0.39	40	1110.88	3.26
16	544.01	0.43			
17	578.00	0.49			
18	611.99	0.55			
19	647.47	0.60			
20	682.96	0.66			
21	716.22	0.73			
22	749.48	0.80			
23	794.88	0.90			
24	844.85	1.03			
25	879.01	1.16			

36.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF5-S10x68

Column : W10x68 Fasteners: A325- -M25.4D
Beam : W27x114 M27.0 Oversize holes
Plate thickness : 1" Material : A36
Stiffener thickness : 0.9525cm Fy = 269 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.1125	pt = 9.9822	li = 56.8709	pc = 9.9822
cc = 11.1125	pit= 6.7734	pi = 43.3240	pic= 6.7734
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 2.5400	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	775.27	1.26
2	31.93	0.01			
3	63.85	0.02			
4	109.53	0.04			
5	132.41	0.06			
6	155.28	0.08			
7	187.29	0.12			
8	225.44	0.16			
9	290.27	0.22			
10	310.88	0.25			
11	350.59	0.30			
12	382.69	0.35			
13	420.90	0.41			
14	453.02	0.46			
15	489.77	0.53			
16	514.28	0.58			
17	544.89	0.64			
18	575.50	0.70			
19	603.82	0.75			
20	632.14	0.80			
21	665.81	0.87			
22	699.48	0.93			
23	717.19	0.99			
24	734.90	1.05			
25	755.08	1.15			

37.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF5-S12x96

Column : W12x96 Fasteners: A325- -M25.4D
Beam : W27x114 M27.0 Oversize holes
Plate thickness : 1" Material : A36
Stiffener thickness : 0.9525cm Fy = 275 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.1125	pt = 9.9822	li = 56.8709	pc = 9.9822
cc = 11.1125	pit= 6.7734	pi = 43.3240	pic= 6.7734
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 2.5400	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1141.06	1.77
2	40.81	0.02	27	1164.48	1.91
3	81.63	0.05	28	1187.89	2.06
4	139.29	0.09	29	1205.77	2.21
5	198.34	0.13	30	1223.65	2.35
6	252.86	0.17	31	1241.53	2.50
7	302.13	0.21	32	1253.21	2.64
8	351.40	0.25	33	1264.88	2.78
9	405.20	0.30	34	1276.56	2.92
10	459.01	0.34	35	1288.24	3.06
11	510.58	0.39	36	1297.63	3.19
12	562.15	0.44	37	1307.02	3.33
13	614.52	0.50	38	1316.42	3.46
14	666.89	0.56	39	1325.81	3.60
15	717.04	0.62			
16	767.18	0.69			
17	817.43	0.78			
18	867.67	0.86			
19	906.65	0.95			
20	945.62	1.05			
21	980.06	1.14			
22	1014.50	1.23			
23	1046.79	1.35			
24	1079.08	1.46			
25	1110.07	1.61			

38.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF6-S12x79

Column : W12x79 Fasteners: A325- -M25.4D
Beam : W27x114 M27.0 Oversize holes
Plate thickness : 1 1/4" Material : A36
Stiffener thickness : 0.9525cm Fy = 274 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.7475	pt = 12.5222	li = 54.3306	pc = 12.5222
cc = 11.7475	pit= 7.6200	pi = 39.0906	pic= 7.6200
gt = 16.5100	gi = 16.5100	gc = 16.5100	
tp = 3.1750	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	815.82	2.18
2	49.13	0.01	27	832.97	2.36
3	98.25	0.03	28	848.74	2.57
4	136.14	0.06	29	864.52	2.78
5	174.04	0.09	30	880.29	2.98
6	208.17	0.12	31	895.69	3.21
7	242.31	0.15	32	911.08	3.44
8	277.22	0.19	33	926.48	3.66
9	312.14	0.23	34	937.70	3.88
10	346.36	0.28	35	948.92	4.10
11	380.57	0.32	36	960.14	4.32
12	411.08	0.38	37	969.56	4.54
13	441.58	0.44	38	978.97	4.75
14	471.35	0.50	39	988.38	4.97
15	501.12	0.56			
16	550.16	0.69			
17	580.05	0.77			
18	609.94	0.85			
19	647.08	1.01			
20	684.21	1.17			
21	706.09	1.30			
22	727.97	1.43			
23	754.74	1.62			
24	781.52	1.82			
25	798.67	2.00			

39.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF8-S14x145

Column : W14x145 Fasteners: A325- -M28.6D
Beam : W24x162 M31.8 Oversize holes
Plate thickness : 1 3/4" Material : A36
Stiffener thickness : 1.2700cm Fy = 253 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 12.3825	pt = 13.8938	li = 46.5074	pc = 13.8938
cc = 12.3825	pit= 8.5725	pi = 29.3624	pic= 8.5725
gt = 16.5100	gi = 16.5100	gc = 16.5100	
tp = 4.4450	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1418.67	3.17
2	56.43	0.02	27	1442.13	3.40
3	112.87	0.04	28	1465.59	3.63
4	169.30	0.07	29	1489.06	3.86
5	238.22	0.09	30	1510.58	4.10
6	307.13	0.12	31	1532.10	4.34
7	375.42	0.17	32	1553.63	4.58
8	443.71	0.22	33	1568.00	4.78
9	515.03	0.28	34	1582.36	4.99
10	586.34	0.34	35	1596.73	5.19
11	653.32	0.44	36	1608.57	5.38
12	720.30	0.53	37	1620.42	5.58
13	776.59	0.63	38	1632.26	5.77
14	832.87	0.73			
15	889.16	0.83			
16	961.71	1.00			
17	1034.27	1.17			
18	1095.05	1.38			
19	1155.83	1.60			
20	1200.94	1.82			
21	1246.06	2.04			
22	1294.30	2.29			
23	1342.53	2.54			
24	1367.91	2.75			
25	1393.29	2.96			

40.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF8-S14x158

Column : W14x158 Fasteners: A325- -M28.6D
Beam : W24x162 M31.8 Oversize holes
Plate thickness : 1 3/4" Material : A36
Stiffener thickness : 1.2700cm Fy = 257 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 12.3825	pt = 13.8938	li = 46.5074	pc = 13.8938
cc = 12.3825	pit= 8.5725	pi = 29.3624	pic= 8.5725
gt = 16.5100	gi = 16.5100	gc = 16.5100	
tp = 4.4450	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1487.61	2.18
2	66.23	0.02	27	1516.96	2.31
3	132.47	0.04	28	1543.36	2.44
4	216.96	0.10	29	1569.75	2.57
5	301.46	0.16	30	1596.15	2.71
6	371.69	0.22	31	1621.60	2.87
7	441.92	0.28	32	1647.05	3.03
8	512.17	0.34	33	1672.51	3.20
9	582.42	0.40	34	1697.96	3.36
10	646.68	0.47			
11	710.93	0.53			
12	778.20	0.59			
13	845.47	0.66			
14	910.67	0.75			
15	975.87	0.85			
16	1030.54	0.94			
17	1085.21	1.03			
18	1143.86	1.16			
19	1202.51	1.29			
20	1255.19	1.42			
21	1307.87	1.55			
22	1348.22	1.68			
23	1388.56	1.80			
24	1428.90	1.92			
25	1458.25	2.05			

41.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : K1B

Column : 460UB67.1 Fasteners: G8.8- -M30
Beam : 460UB67.1 M31.8 Oversize holes
Plate thickness : 32 mm Material : G250
Stiffener thickness : 1.5999cm Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 3.1999 nt = 2 X 2 nc = 2 X 2

Remark 1) 32 mm Doubler plates were welded to flange on both sides of column web.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	390.74	13.47
2	16.18	0.24	27	397.84	14.20
3	32.36	0.49	28	402.32	15.08
4	49.52	0.68	29	406.81	15.97
5	66.58	0.88	30	411.30	16.85
6	83.65	1.08	31	414.03	17.92
7	100.71	1.28	32	416.76	18.99
8	117.91	1.87	33	419.49	20.06
9	135.11	2.46	34	420.35	20.98
10	152.30	3.05	35	421.21	21.89
11	169.20	3.44	36	422.07	22.80
12	186.10	3.84	37	422.94	23.71
13	202.99	4.23			
14	219.90	4.76			
15	235.84	5.40			
16	251.78	6.03			
17	268.94	6.29			
18	285.87	7.00			
19	303.91	7.67			
20	317.45	8.16			
21	335.80	9.00			
22	351.19	9.88			
23	366.59	10.76			
24	375.12	11.75			
25	383.65	12.74			

42.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : K9

Column : 460UB67.1 Fasteners: G8.8- -M30
Beam : 460UB67.1 M31.8 Oversize holes
Plate thickness : 20 mm Material : G250
Stiffener thickness : 1.5999cm Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 2.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) 32 mm Doubler plates were welded to flange on both sides of column web.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	367.47	15.17
2	17.31	0.30	27	373.82	16.13
3	34.62	0.61	28	380.17	17.08
4	52.36	0.95	29	388.92	18.74
5	70.10	1.30	30	393.72	20.15
6	86.79	1.72			
7	103.48	2.14			
8	120.16	2.56			
9	136.85	2.98			
10	153.55	3.52			
11	170.25	4.06			
12	186.95	4.59			
13	203.65	5.13			
14	220.72	5.95			
15	237.79	6.76			
16	254.86	7.58			
17	271.93	8.39			
18	289.00	9.21			
19	306.07	10.02			
20	316.15	10.70			
21	326.23	11.37			
22	336.30	12.05			
23	344.10	12.83			
24	351.89	13.61			
25	359.68	14.39			

43.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : K4

Column : 460UB67.1 Fasteners: G8.8- -M30
Beam : 460UB67.1 M31.8 Oversize holes
Plate thickness : 20 mm Material : G250
Stiffener thickness : 1.5999cm Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 2.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) 32 mm Doubler plates were welded to flange on both sides of column web.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	368.74	11.15
2	16.24	0.20	27	373.76	11.81
3	32.81	0.55	28	378.78	12.46
4	51.31	0.83	29	383.80	13.12
5	69.81	1.12	30	385.94	13.80
6	84.55	1.43	31	388.09	14.47
7	99.29	1.74	32	397.31	15.53
8	116.32	2.08	33	401.50	16.51
9	133.35	2.43	34	394.32	16.82
10	150.38	2.77	35	398.08	17.27
11	167.89	3.20			
12	185.41	3.63			
13	202.92	4.06			
14	218.95	4.47			
15	234.97	4.88			
16	252.16	5.46			
17	270.19	6.05			
18	284.84	6.55			
19	302.34	7.25			
20	319.85	8.00			
21	328.65	8.51			
22	337.44	9.01			
23	345.52	9.47			
24	353.61	9.94			
25	361.17	10.55			

44.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : K7

Column : 460UB67.1
Beam : 460UB67.1
Plate thickness : 20 mm
Stiffener thickness : 1.5999cm

Fasteners: G8.8- -M30
M31.8 Oversize holes
Material : G250
Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 2.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) 20 mm Doubler plates were welded to flange on both sides of column web.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	383.50	13.76
2	16.28	0.30	27	388.15	15.03
3	32.56	0.60	28	391.49	16.30
4	49.13	0.92	29	393.53	17.57
5	65.69	1.24			
6	81.83	1.52			
7	97.97	1.80			
8	115.51	2.09			
9	133.05	2.38			
10	149.89	2.71			
11	167.03	3.17			
12	184.18	3.63			
13	200.60	3.94			
14	217.02	4.24			
15	234.73	4.74			
16	252.44	5.24			
17	269.87	5.78			
18	287.30	6.33			
19	304.19	6.99			
20	321.08	7.66			
21	336.03	8.50			
22	350.99	9.34			
23	357.78	9.90			
24	368.86	11.10			
25	376.34	12.56			

45.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : K5A

Column : 460UB67.1 Fasteners: G8.8- -M24
Beam : 460UB67.1 M27.0 Oversize holes
Plate thickness : 20 mm Material : G250
Stiffener thickness : 1.5999cm Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 2.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) 20 mm Doubler plates were welded to flange on both sides of column web.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	368.12	11.52
2	16.20	0.17	27	371.86	12.35
3	31.85	0.41	28	375.59	13.18
4	48.77	0.72	29	379.33	14.01
5	65.69	1.02	30	383.06	14.84
6	81.91	1.33	31	383.97	15.66
7	100.07	1.58	32	384.88	16.49
8	115.17	1.84	33	385.79	17.31
9	133.07	2.18	34	389.59	18.18
10	149.55	2.38	35	393.40	19.13
11	166.35	2.75	36	393.78	19.60
12	182.03	3.15			
13	200.19	3.38			
14	217.26	3.72			
15	232.35	3.96			
16	250.01	4.50			
17	266.40	4.92			
18	282.78	5.35			
19	297.94	5.90			
20	316.76	6.61			
21	332.81	7.47			
22	342.29	8.19			
23	351.77	8.91			
24	358.08	9.80			
25	364.39	10.69			

46.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : K8

Column : 460UB67.1
Beam : 460UB67.1
Plate thickness : 20 mm
Stiffener thickness : 1.5999cm

Fasteners: G8.8- -M30
M31.8 Oversize holes
Material : G250
Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 2.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) 20 mm Doubler plates were welded to flange on both sides of column web.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	361.51	16.83
2	16.30	0.35	27	366.66	17.67
3	32.61	0.70	28	371.81	18.51
4	48.49	1.03	29	376.97	19.35
5	64.37	1.37	30	379.81	20.46
6	75.05	1.62	31	382.66	21.56
7	85.74	1.87	32	385.51	22.67
8	101.06	2.21	33	390.73	24.03
9	116.38	2.54			
10	133.67	2.99			
11	150.97	3.44			
12	168.00	4.00			
13	185.03	4.55			
14	201.79	5.20			
15	218.56	5.85			
16	234.47	6.46			
17	250.39	7.07			
18	267.46	8.00			
19	284.54	8.93			
20	301.23	10.11			
21	317.92	11.29			
22	328.15	12.35			
23	338.37	13.42			
24	348.60	14.48			
25	355.05	15.66			

47.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : K10

Column : 460UB67.1
Beam : 460UB67.1
Plate thickness : 20 mm
Stiffener thickness : 1.5999cm

Fasteners: G8.8- -M24
M27.0 Oversize holes
Material : G250
Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 2.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) 20 mm Doubler plates were welded to flange on both sides of column web.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	380.24	18.36
2	16.64	0.18	27	385.19	19.88
3	33.27	0.36	28	390.14	21.41
4	50.19	0.54	29	395.09	22.93
5	67.10	0.71	30	399.41	24.66
6	83.81	1.33	31	403.74	26.38
7	100.52	1.95	32	408.06	28.11
8	119.08	1.86	33	410.63	29.60
9	135.16	2.08	34	413.21	31.09
10	152.48	2.94	35	415.78	32.58
11	169.40	3.17	36	418.36	34.07
12	186.16	4.04	37	419.92	35.54
13	201.48	4.78	38	421.48	37.00
14	221.05	5.67	39	423.04	38.47
15	237.45	6.11			
16	254.43	6.70			
17	268.28	7.00			
18	285.37	8.24			
19	302.96	9.04			
20	319.82	9.88			
21	333.06	10.82			
22	343.44	12.12			
23	355.86	13.85			
24	364.50	15.12			
25	372.37	16.74			

48.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : K11

Column : 460UB67.1 Fasteners: G8.8- -M24
Beam : 460UB67.1 M27.0 Oversize holes
Plate thickness : 20 mm Material : G250
Stiffener thickness : 1.5999cm Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 2.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) The beam, 3 deg. to horizontal was subjected to cantilever loading.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	301.37	24.08
2	16.36	0.30	27	306.42	25.74
3	32.72	0.60	28	311.47	27.40
4	49.08	0.90	29	315.81	29.04
5	65.44	1.20	30	320.15	30.68
6	82.76	1.74	31	324.49	32.31
7	102.00	1.93	32	328.83	33.95
8	118.14	2.18			
9	135.43	2.51			
10	151.90	3.06			
11	168.06	3.47			
12	184.04	4.51			
13	200.36	5.98			
14	215.69	7.42			
15	231.02	8.86			
16	239.85	10.29			
17	248.68	11.73			
18	256.52	13.12			
19	264.35	14.51			
20	269.81	15.76			
21	275.27	17.00			
22	280.73	18.24			
23	285.93	19.64			
24	291.13	21.03			
25	296.32	22.43			

49.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : K12

Column : 460UB67.1
Beam : 460UB67.1
Plate thickness : 20 mm

Fasteners: G8.8- -M24
M27.0 Oversize holes
Material : G250
Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 2.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) The beam, 3 deg. to horizontal was subjected to cantilever loading.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	200.28	23.70
2	10.11	0.37	27	205.21	25.26
3	20.22	0.73	28	210.14	26.82
4	30.33	1.10	29	215.07	28.38
5	39.74	1.38	30	218.76	30.00
6	49.16	1.66	31	222.46	31.61
7	58.57	1.95	32	226.15	33.23
8	67.99	2.23	33	229.84	34.84
9	76.06	2.48			
10	84.13	2.73			
11	91.96	3.25			
12	99.79	3.77			
13	108.07	4.49			
14	116.35	5.20			
15	121.86	6.86			
16	127.37	8.53			
17	132.88	10.19			
18	141.79	11.35			
19	150.70	12.51			
20	158.99	14.20			
21	167.27	15.88			
22	174.42	17.50			
23	181.56	19.12			
24	187.80	20.64			
25	194.04	22.17			

50.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : B1

Column : 310UC96.8 Fasteners: G8.8- -M24
Beam : 460UB67.1 M27.0 Oversize holes
Plate thickness : 20 mm Material : G250
Stiffener thickness : 1.1999cm Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 2.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) The beam stub, 3 deg. to horizontal was subjected to cantilever loading.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	358.27	23.26
2	17.15	0.32	27	364.03	25.11
3	34.30	0.65	28	368.25	26.41
4	50.32	0.96	29	372.47	27.70
5	66.34	1.28	30	377.67	29.18
6	82.93	1.66	31	382.87	30.67
7	99.51	2.04	32	385.26	32.23
8	117.22	2.37	33	387.65	33.78
9	134.93	2.70	34	391.58	35.76
10	151.80	3.43	35	395.52	37.74
11	168.66	4.16	36	398.05	39.82
12	184.97	4.87			
13	201.27	5.57			
14	216.87	6.47			
15	232.48	7.38			
16	251.31	8.65			
17	266.63	10.23			
18	281.95	11.80			
19	294.60	13.23			
20	307.25	14.66			
21	319.90	16.10			
22	327.91	17.31			
23	335.92	18.52			
24	344.21	19.96			
25	352.51	21.40			

51.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : C1

Column : 310UB40.4 Fasteners: G8.8- -M20
Beam : 310UB40.4 M20.6 Oversize holes
Plate thickness : 20 mm Material : G250
Stiffener thickness : 1.0000cm Fy = 253 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.5000 pt = 10.0200 li = 14.8600 pc = 14.5199
cc = 4.5001 gt = 10.0000 gc = 10.0000
tp = 2.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) 12 mm Doubler plates were welded to flange on both sides of column web.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	166.43	19.21
2	9.09	0.38	27	168.23	21.39
3	18.19	0.76	28	173.45	23.30
4	26.44	1.10	29	174.84	25.48
5	34.69	1.45	30	176.33	26.86
6	41.93	1.98	31	184.06	27.91
7	49.17	2.52			
8	58.26	2.94			
9	67.35	3.36			
10	73.34	3.77			
11	79.34	4.18			
12	86.02	4.70			
13	92.70	5.23			
14	100.20	5.93			
15	107.69	6.63			
16	114.20	7.38			
17	120.71	8.14			
18	127.01	9.38			
19	133.31	10.62			
20	139.91	11.72			
21	146.51	12.82			
22	150.71	13.93			
23	154.92	15.03			
24	159.12	16.14			
25	163.33	17.25			

52.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : C2

Column : 310UB40.4 Fasteners: G8.8- -M16
Beam : 310UB40.4 M20.6 Oversize holes
Plate thickness : 10 mm Material : G250
Fy = 253 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.5000 pt = 10.0200 li = 14.8600 pc = 14.5199
cc = 4.5001 gt = 10.0000 gc = 10.0000
tp = 1.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) The beam, 3 deg. to horizontal was subjected to cantilever loading.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	75.32	26.13
2	2.77	0.33	27	76.54	27.99
3	5.55	0.67	28	77.76	29.85
4	8.32	1.00	29	78.19	31.53
5	12.30	1.30	30	78.62	33.21
6	16.28	1.60	31	79.06	34.89
7	20.25	1.90	32	79.49	36.58
8	24.23	2.20	33	79.92	38.26
9	27.72	2.43	34	80.35	39.94
10	31.22	2.65			
11	34.71	2.88			
12	38.20	3.10			
13	41.98	4.70			
14	45.75	6.29			
15	49.53	7.88			
16	53.30	9.47			
17	57.07	11.06			
18	60.85	12.66			
19	64.62	14.25			
20	66.38	15.82			
21	68.15	17.40			
22	69.91	18.98			
23	71.67	20.56			
24	72.89	22.41			
25	74.11	24.27			

53.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : R.Zandonini & P.Zanon (1987) ITALY
Test Id. : EP 1-1

Column : ----
Beam : IPE 300
Plate thickness : 12 mm

Fasteners: -- - -M20
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 5.0000 pt = 12.0000 li = 18.0000 pc = 6.0000
cc = 1.0000 gt = 10.5001 gc = 10.5001
tp = 1.1999 nt = 2 X 2 nc = 2 X 1

Remark 1) THE SPECIMEN WAS CONNECTED TO A COUNTER BEAM WITH NEGLIGIBLE DEFORMATION
2) END-PLATE EXTENDED ON BOTH TENSION & COMPRESSION SIDES

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	165.59	43.09
2	8.41	0.28	27	168.11	45.53
3	16.81	0.48	28	169.79	48.78
4	25.22	0.72	29	172.31	52.84
5	33.62	0.98	30	174.84	56.91
6	42.03	1.36	31	176.52	60.98
7	50.43	1.76	32	178.20	65.04
8	58.84	2.20	33	178.53	69.11
9	67.24	2.68	34	178.87	73.17
10	75.65	3.15	35	180.22	77.23
11	84.06	3.70	36	181.56	81.30
12	89.10	4.55	37	181.56	85.36
13	94.98	5.74	38	181.56	89.43
14	100.87	6.95			
15	109.27	8.46			
16	117.68	10.13			
17	126.08	12.20			
18	134.49	16.26			
19	137.85	18.70			
20	141.21	21.14			
21	146.26	24.39			
22	151.30	28.45			
23	154.66	32.52			
24	159.71	36.59			
25	163.07	40.65			

54.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : R.Zandonini & P.Zanon (1987) ITALY
Test Id. : EP 1-2

Column : --- Fasteners: -- - -M20
Beam : IPE 300 --- Oversize holes
Plate thickness : 15 mm Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 5.0000 pt = 12.0000 li = 18.0000 pc = 6.0000
cc = 1.0000 gt = 10.5001 gc = 10.5001
tp = 1.5001 nt = 2 X 2 nc = 2 X 1

Remark 1) THE SPECIMEN WAS CONNECTED TO A COUNTER BEAM WITH NEGLIGIBLE DEFORMABILITY
2) END-PLATE EXTENDED ON TENSION SIDE ONLY

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	178.20	22.36
2	9.17	0.14	27	179.88	24.39
3	18.34	0.29	28	182.40	26.02
4	27.51	0.45	29	184.92	27.64
5	36.68	0.62	30	187.95	30.08
6	45.85	0.80	31	190.98	32.52
7	55.02	0.99	32	192.99	34.96
8	64.19	1.19	33	195.01	37.40
9	73.36	1.40	34	195.35	39.02
10	82.53	1.63	35	195.68	40.65
11	91.70	1.86	36	197.03	42.68
12	100.87	2.09	37	198.37	44.72
13	109.27	2.35	38	198.71	46.75
14	117.68	2.60	39	199.04	48.78
15	122.72	3.27	40	198.26	51.49
16	127.76	3.95	41	197.48	54.20
17	134.49	4.88	42	196.69	56.91
18	141.21	6.50	43	195.01	58.95
19	147.94	8.13	44	193.33	60.98
20	152.98	9.76			
21	158.03	11.38			
22	161.39	13.82			
23	164.75	16.26			
24	168.11	17.89			
25	176.52	20.32			

55.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : R.Zandonini & P.Zanon (1987) ITALY
Test Id. : EP 1-3

Column : ----
Beam : IPE 300
Plate thickness : 18 mm

Fasteners: -- - -M20
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 5.0000 pt = 12.0000 li = 18.0000 pc = 6.0000
cc = 1.0000 gt = 10.5001 gc = 10.5001
tp = 1.8001 nt = 2 X 2 nc = 2 X 1

Remark 1) THE SPECIMEN WAS CONNECTED TO A COUNTER BEAM WITH NEGLIGIBLE DEFORMABILITY
2) END-PLATE EXTENDED ON TENSION SIDE ONLY

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	190.53	14.63
2	8.41	0.06	27	193.33	16.26
3	16.81	0.13	28	195.85	17.43
4	25.22	0.21	29	198.37	18.60
5	33.62	0.30	30	200.05	20.28
6	42.03	0.40	31	201.73	21.95
7	50.43	0.51	32	202.57	23.17
8	58.84	0.63	33	203.42	24.39
9	67.24	0.77	34	203.97	25.75
10	75.65	0.92	35	204.53	27.10
11	84.06	1.08	36	205.09	28.45
12	92.46	1.26	37	206.21	29.81
13	100.87	1.46	38	207.34	31.16
14	109.27	1.68	39	208.46	32.52
15	117.68	1.93	40	208.46	34.15
16	126.08	2.21	41	208.46	35.77
17	134.49	2.52			
18	142.90	2.96			
19	151.30	3.25			
20	159.71	4.88			
21	168.11	6.50			
22	176.52	8.13			
23	180.72	9.76			
24	184.92	11.38			
25	187.72	13.01			

56.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : R.Zandonini & P.Zanon (1987) ITALY
Test Id. : EP 1-4

Column : ----
Beam : IPE 300
Plate thickness : 22 mm

Fasteners: -- - -M20
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 5.0000 pt = 12.0000 li = 18.0000 pc = 6.0000
cc = 1.0000 gt = 10.5001 gc = 10.5001
tp = 2.1999 nt = 2 X 2 nc = 2 X 1

Remark 1) THE SPECIMEN WAS CONNECTED TO A COUNTER BEAM WITH NEGLIGIBLE DEFORMABILITY
2) END-PLATE EXTENDED ON TENSION SIDE ONLY

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	205.10	8.94
2	10.70	0.04	27	208.46	9.76
3	21.40	0.10	28	210.98	10.98
4	32.09	0.18	29	213.50	12.20
5	42.79	0.28	30	216.02	13.41
6	53.49	0.40	31	218.55	14.63
7	64.19	0.54	32	218.88	15.45
8	74.89	0.60	33	219.22	16.26
9	85.58	0.78	34	220.31	17.48
10	96.28	0.98	35	221.40	18.70
11	106.98	1.20	36	222.50	19.92
12	117.68	1.44	37	223.59	21.14
13	126.08	1.70	38	223.11	22.53
14	134.49	1.98	39	222.63	23.93
15	142.90	2.28	40	222.15	25.32
16	151.30	2.60	41	221.67	26.71
17	159.71	2.94	42	221.19	28.11
18	168.11	3.30	43	220.71	29.50
19	176.52	3.68	44	220.23	30.89
20	180.72	4.07			
21	184.92	4.88			
22	189.97	5.69			
23	195.01	6.50			
24	198.37	7.32			
25	201.73	8.13			

57.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : R.Zandonini & P.Zanon (1987) ITALY
Test Id. : EP 1-5

Column : ----
Beam : IPE 300
Plate thickness : 25 mm

Fasteners: -- - -M20
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 5.0000 pt = 12.0000 li = 18.0000 pc = 6.0000
cc = 1.0000 gt = 10.5001 gc = 10.5001
tp = 2.5001 nt = 2 X 2 nc = 2 X 1

Remark 1) THE SPECIMEN WAS CONNECTED TO A COUNTER BEAM WITH NEGLIGIBLE DEFORMABILITY
2) END-PLATE EXTENDED ON TENSION SIDE ONLY

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	213.50	10.57
2	10.70	0.03	27	216.02	11.79
3	21.40	0.07	28	218.55	13.01
4	32.09	0.12	29	220.23	14.09
5	42.79	0.18	30	221.91	15.18
6	53.49	0.25	31	223.59	16.26
7	64.19	0.33	32	224.60	17.56
8	74.89	0.42	33	225.61	18.86
9	85.58	0.52	34	226.62	20.16
10	96.28	0.63	35	227.62	21.46
11	106.98	0.85	36	228.63	22.76
12	117.68	0.93	37	228.30	23.58
13	126.08	1.06	38	227.96	24.39
14	134.49	1.21	39	227.15	25.69
15	142.90	1.36	40	226.35	26.99
16	151.30	1.63	41	225.54	28.29
17	159.71	2.03	42	224.73	29.59
18	168.11	2.44	43	223.92	30.89
19	176.52	3.25			
20	184.92	3.58			
21	193.33	5.04			
22	201.73	6.50			
23	205.10	7.32			
24	208.46	8.13			
25	210.98	9.35			

58.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : R.Zandonini & P.Zanon (1987) ITALY
Test Id. : EPB 1-2

Column : ----
Beam : IPE 300
Plate thickness : 15 mm

Fasteners: -- - -M20
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 5.0000 pt = 12.0000 li = 18.0000 pc = 12.0000
cc = 5.0000 gt = 10.5001 gc = 10.5001
tp = 1.5001 nt = 2 X 2 nc = 2 X 2

Remark 1) END-PLATE EXTENDED ON BOTH TENSION & COMPRESSION SIDES
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	188.29	21.82
2	9.61	0.02	27	191.65	24.24
3	19.21	0.06	28	193.33	26.26
4	28.82	0.14	29	195.01	28.28
5	38.43	0.24	30	195.85	30.30
6	48.03	0.36	31	196.69	32.32
7	57.64	0.50	32	198.37	35.01
8	67.24	0.66	33	200.05	37.71
9	75.65	0.84	34	201.73	40.40
10	84.06	1.05	35	201.73	43.09
11	92.46	1.26	36	201.73	45.79
12	100.87	1.62	37	201.73	48.48
13	109.27	2.02	38	200.61	51.17
14	117.68	2.42	39	199.49	53.87
15	126.08	2.83	40	198.37	56.56
16	134.49	3.23			
17	142.90	4.44			
18	151.30	5.66			
19	160.38	8.08			
20	164.25	9.70			
21	168.11	11.31			
22	172.31	13.74			
23	176.52	16.16			
24	180.72	17.78			
25	184.92	19.39			

59.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : R.Zandonini & P.Zanon (1987) ITALY
Test Id. : EPB 1-3

Column : ----
Beam : IPE 300
Plate thickness : 18 mm

Fasteners: -- - -M20
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 5.0000 pt = 12.0000 li = 18.0000 pc = 12.0000
cc = 5.0000 gt = 10.5001 gc = 10.5001
tp = 1.8001 nt = 2 X 2 nc = 2 X 2

Remark 1) END-PLATE EXTENDED ON BOTH TENSION & COMPRESSION SIDES
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	184.92	9.70
2	9.61	0.13	27	187.72	10.77
3	19.21	0.15	28	190.53	11.85
4	28.82	0.17	29	193.33	12.93
5	38.43	0.19	30	195.68	13.90
6	48.03	0.23	31	198.04	14.87
7	57.64	0.28	32	200.39	15.84
8	67.24	0.33	33	202.74	16.81
9	75.65	0.50	34	205.10	17.78
10	84.06	0.65	35	204.42	18.75
11	92.46	0.75	36	203.75	19.72
12	100.87	0.89	37	203.08	20.68
13	109.27	1.04	38	202.41	21.65
14	117.68	1.22	39	201.73	22.62
15	126.08	1.42			
16	134.49	1.62			
17	142.90	2.42			
18	151.30	3.23			
19	159.71	4.04			
20	168.11	4.85			
21	170.91	5.66			
22	173.72	6.46			
23	176.52	7.27			
24	179.32	8.08			
25	182.12	8.89			

60.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : R.Zandonini & P.Zanon (1987) ITALY
Test Id. : EPB 1-4

Column : ----
Beam : IPE 300
Plate thickness : 22 mm

Fasteners: -- - -M20
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 5.0000 pt = 12.0000 li = 18.0000 pc = 12.0000
cc = 5.0000 gt = 10.5001 gc = 10.5001
tp = 2.1999 nt = 2 X 2 nc = 2 X 2

Remark 1) END-PLATE EXTENDED ON BOTH TENSION & COMPRESSION SIDES
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	193.33	5.25
2	10.09	0.02	27	197.53	5.86
3	20.17	0.05	28	201.73	6.46
4	30.26	0.06	29	204.42	7.11
5	40.35	0.09	30	207.11	7.76
6	50.43	0.12	31	209.80	8.40
7	60.52	0.15	32	212.49	9.05
8	70.61	0.18	33	215.18	9.70
9	80.69	0.22	34	216.02	10.30
10	90.78	0.26	35	216.86	10.91
11	100.87	0.30	36	217.71	11.51
12	109.27	0.35	37	218.55	12.12
13	117.68	0.40	38	217.99	12.66
14	126.08	0.49	39	217.42	13.20
15	131.10	0.58	40	216.86	13.74
16	137.24	0.75			
17	144.75	0.97			
18	154.64	1.45			
19	162.51	1.94			
20	168.11	2.42			
21	172.31	2.83			
22	176.52	3.23			
23	180.72	3.64			
24	184.92	4.04			
25	189.13	4.65			

61.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : R.Zandonini & P.Zanon (1987) ITALY
Test Id. : EPB 1-5

Column : ----
Beam : IPE 300
Plate thickness : 25 mm

Fasteners: -- - -M20
--- Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 5.0000 pt = 12.0000 li = 18.0000 pc = 12.0000
cc = 5.0000 gt = 10.5001 gc = 10.5001
tp = 2.5001 nt = 2 X 2 nc = 2 X 2

Remark 1) END-PLATE EXTENDED ON BOTH TENSION & COMPRESSION SIDES
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	216.62	9.00
2	11.21	0.09	27	218.07	9.93
3	22.41	0.12	28	219.51	10.85
4	33.62	0.16	29	220.95	11.77
5	44.83	0.18	30	222.39	12.70
6	56.03	0.21	31	223.83	13.62
7	67.24	0.24	32	225.27	14.54
8	78.45	0.28	33	225.94	15.51
9	89.65	0.33	34	226.61	16.48
10	100.86	0.36	35	227.29	17.45
11	109.27	0.40	36	227.96	18.42
12	117.68	0.44	37	228.63	19.39
13	128.89	0.53			
14	140.09	0.72			
15	151.30	0.91			
16	159.71	1.21			
17	168.11	1.82			
18	176.52	2.42			
19	184.92	3.23			
20	189.13	4.04			
21	193.33	4.85			
22	201.73	5.66			
23	206.22	6.46			
24	210.70	7.27			
25	215.18	8.08			

62.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1A-1

Column : CVS350x105 Fasteners: A325- -M15.9D
Beam : VS250x37 --- Oversize holes
Plate thickness : 1.25" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.1759 pt = 7.6020 li = 16.1481 pc = 3.8011
cc = 1.7729 gt = 6.3520 gc = 6.3520
tp = 3.1750 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	7.50	0.04
3	15.38	0.09
4	22.50	0.14
5	30.38	0.29
6	38.26	0.42
7	45.01	0.54
8	52.70	0.70
9	60.20	0.86
10	67.70	1.04
11	75.39	1.25
12	82.33	1.44
13	89.83	1.67
14	98.46	2.02
15	106.14	2.39
16	114.21	2.93
17	121.15	3.43
18	128.46	4.56
19	131.09	5.66
20	133.71	6.76

63.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1A-2

Column : CVS350x105 Fasteners: A325- -M15.9D
Beam : VS250x37 --- Oversize holes
Plate thickness : 1.00" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.1759 pt = 7.6020 li = 16.1481 pc = 3.8011
cc = 1.7729 gt = 6.3520 gc = 6.3520
tp = 2.5400 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	7.75	0.03
3	16.08	0.11
4	23.45	0.18
5	31.39	0.29
6	39.14	0.39
7	46.31	0.49
8	53.87	0.61
9	61.62	0.74
10	69.76	0.86
11	77.71	1.03
12	85.46	1.20
13	94.57	1.46
14	101.16	1.68
15	108.71	1.97
16	112.69	2.37
17	116.66	2.76
18	120.53	3.10
19	124.41	3.45

64.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1A-3

Column : CVS350x105 Fasteners: A325- -M15.9D
Beam : VS250x37 --- Oversize holes
Plate thickness : 1.00" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.1759 pt = 7.6020 li = 16.1481 pc = 3.8011
cc = 1.7729 gt = 6.3520 gc = 6.3520
tp = 2.5400 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	7.75	0.03
3	15.50	0.09
4	23.25	0.16
5	31.20	0.23
6	38.56	0.31
7	46.90	0.40
8	54.26	0.51
9	61.82	0.64
10	69.76	0.81
11	77.32	0.98
12	85.46	1.22
13	93.40	1.52
14	101.35	1.87
15	109.49	2.29
16	116.27	2.67
17	124.41	3.24
18	131.97	4.00
19	136.91	4.71
20	141.85	5.43
21	144.66	6.12
22	147.47	6.81

65.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1A-4

Column : CVS350x105 Fasteners: A325- -M15.9D
Beam : VS250x37 --- Oversize holes
Plate thickness : 0.875" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.1759 pt = 7.6020 li = 16.1481 pc = 3.8011
cc = 1.7729 gt = 6.3520 gc = 6.3520
tp = 2.2230 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	7.55	0.05
3	15.48	0.14
4	23.60	0.25
5	31.34	0.37
6	37.76	0.45
7	45.87	0.57
8	53.99	0.72
9	60.98	0.85
10	68.34	1.01
11	76.65	1.21
12	82.88	1.37
13	91.75	1.67
14	97.98	1.97
15	106.85	2.36
16	114.03	2.85
17	122.14	3.50
18	124.88	4.03
19	127.62	4.56
20	131.39	5.13

66.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1A-5

Column : CVS350x105 Fasteners: A325- -M15.9D
Beam : VS250x37 --- Oversize holes
Plate thickness : 0.875" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.1759 pt = 7.6020 li = 16.1481 pc = 3.8011
cc = 1.7729 gt = 6.3520 gc = 6.3520
tp = 2.2230 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	7.74	0.04
3	15.29	0.11
4	23.03	0.20
5	30.58	0.31
6	38.32	0.44
7	45.69	0.60
8	52.86	0.77
9	62.68	1.05
10	68.15	1.22
11	75.51	1.45
12	84.01	1.81
13	91.37	2.10
14	98.36	2.45
15	105.72	2.85
16	114.40	3.56
17	120.82	3.99
18	127.62	4.84
19	132.34	5.59
20	135.92	6.06
21	139.32	7.17
22	142.34	8.59

67.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1A-6

Column : CVS350x105 Fasteners: A325- -M19.1D
Beam : VS250x37 M20.6 Oversize holes
Plate thickness : 0.75" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.8101 pt = 8.8699 li = 14.8801 pc = 4.4351
cc = 2.0051 gt = 7.6200 gc = 7.6200
tp = 1.9050 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	8.87	0.04
3	15.67	0.13
4	23.22	0.23
5	30.58	0.37
6	38.13	0.54
7	45.12	0.78
8	53.24	1.15
9	61.17	1.52
10	69.09	1.87
11	76.08	2.09
12	83.82	2.38
13	90.62	2.62
14	99.30	3.02
15	106.47	3.42
16	113.46	3.74
17	120.82	4.33
18	128.75	4.94
19	136.68	5.70
20	143.29	6.57
21	149.71	7.37
22	153.04	8.45
23	155.18	9.50
24	158.01	10.80

68.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1B-1

Column : CVS350x105 Fasteners: A325- -M15.9D
Beam : VS250x37 --- Oversize holes
Plate thickness : 1.25" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.1759 pt = 7.6020 li = 16.1481 pc = 3.8011
cc = 1.7729 gt = 6.3520 gc = 6.3520
tp = 3.1750 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	22.50	0.03
3	33.76	0.08
4	45.76	0.15
5	56.82	0.24
6	67.89	0.36
7	78.76	0.55
8	90.02	0.84
9	101.08	1.19
10	112.71	1.66
11	119.46	2.09
12	129.21	2.97
13	133.90	4.10
14	138.02	5.18
15	139.71	6.46
16	140.09	8.04

69.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1B-2

Column : CVS350x105 Fasteners: A325- -M19.1D
Beam : VS250x37 M20.6 Oversize holes
Plate thickness : 1.00" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.8101 pt = 8.8699 li = 14.8801 pc = 4.4351
cc = 2.0051 gt = 7.6200 gc = 7.6200
tp = 2.5400 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	11.82	0.03
3	24.03	0.11
4	35.08	0.20
5	47.09	0.33
6	58.52	0.49
7	69.96	0.69
8	81.58	0.90
9	100.96	1.31
10	116.66	1.67
11	127.90	1.92
12	143.40	2.33
13	155.61	2.73
14	163.75	3.14
15	175.18	3.67
16	183.51	4.10
17	191.85	4.76
18	194.95	5.42
19	201.54	6.04
20	203.86	6.56
21	205.61	7.01

70.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1B-3

Column : CVS350x105 Fasteners: A325- -M19.1D
Beam : VS250x37 M20.6 Oversize holes
Plate thickness : 1.00" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.8101 pt = 8.8699 li = 14.8801 pc = 4.4351
cc = 2.0051 gt = 7.6200 gc = 7.6200
tp = 2.5400 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	15.89	0.07
3	31.78	0.20
4	48.06	0.37
5	62.98	0.61
6	78.48	0.89
7	93.40	1.20
8	108.91	1.57
9	123.83	2.03
10	140.11	2.59
11	150.18	3.05
12	160.45	3.67
13	167.43	4.30
14	173.24	5.12
15	173.63	6.19
16	175.57	7.45
17	177.70	9.24
18	179.83	11.03
19	182.55	12.56
20	183.32	13.96

71.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1B-4

Column : CVS350x105 Fasteners: A325- -M19.1D
Beam : VS250x37 M20.6 Oversize holes
Plate thickness : 0.875" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.8101 pt = 8.8699 li = 14.8801 pc = 4.4351
cc = 2.0051 gt = 7.6200 gc = 7.6200
tp = 2.2230 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	16.61	0.18
3	31.15	0.42
4	46.44	0.70
5	61.17	1.01
6	75.89	1.34
7	90.43	1.73
8	106.47	2.25
9	121.39	2.84
10	135.92	3.68
11	150.46	4.88
12	160.09	6.08
13	168.58	7.73
14	173.68	9.27
15	180.86	10.55
16	184.06	12.08

72.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1B-5

Column : CVS350x105 Fasteners: A325- -M19.1D
Beam : VS250x37 M20.6 Oversize holes
Plate thickness : 0.875" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.8101 pt = 8.8699 li = 14.8801 pc = 4.4351
cc = 2.0051 gt = 7.6200 gc = 7.6200
tp = 2.2230 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	0.19	0.07
3	16.24	0.10
4	31.34	0.27
5	45.87	0.47
6	60.79	0.74
7	76.46	1.06
8	91.56	1.45
9	106.85	1.90
10	121.01	2.41
11	136.30	3.26
12	150.27	4.66
13	156.69	5.87
14	164.81	7.91
15	169.91	9.56
16	173.49	11.64
17	175.38	13.52
18	176.70	15.58
19	178.02	17.64

73.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT1B-6

Column : CVS350x105 Fasteners: A325- -M19.1D
Beam : VS250x37 M20.6 Oversize holes
Plate thickness : 0.75" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.8101 pt = 8.8699 li = 14.8801 pc = 4.4351
cc = 2.0051 gt = 7.6200 gc = 7.6200
tp = 1.9050 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	12.27	0.08
3	23.60	0.21
4	34.17	0.35
5	46.44	0.58
6	58.15	0.83
7	68.72	1.09
8	80.04	1.45
9	91.18	1.93
10	102.51	2.58
11	113.46	3.38
12	126.30	4.75
13	136.87	6.51
14	143.66	7.73
15	151.97	9.75
16	156.50	11.03
17	161.41	12.61
18	167.83	14.88
19	174.81	17.17
20	176.23	19.37
21	177.65	21.57

74.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2A-1

Column : CVS350x128 Fasteners: A325- -M22.2D
Beam : VS350x58 M23.8 Oversize holes
Plate thickness : 1.5" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4459 pt = 10.4920 li = 22.9080 pc = 5.2461
cc = 1.9080 gt = 8.8920 gc = 8.8920
tp = 3.8100 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	22.80	0.13
3	46.54	0.34
4	67.66	0.55
5	90.46	0.82
6	113.27	1.09
7	131.77	1.30
8	149.90	1.51
9	169.71	1.60
10	187.28	1.97
11	206.72	2.22
12	224.66	2.46
13	243.54	2.78
14	262.98	3.14
15	279.62	3.47
16	300.18	3.97
17	313.82	4.30
18	330.08	4.99
19	345.59	5.87
20	356.43	6.75
21	367.46	7.80
22	374.75	9.03

75.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2A-2

Column : CVS350x128 Fasteners: A325- -M22.2D
Beam : VS350x58 M23.8 Oversize holes
Plate thickness : 1.25" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4459 pt = 10.4920 li = 22.9080 pc = 5.2461
cc = 1.9080 gt = 8.8920 gc = 8.8920
tp = 3.1750 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	19.69	0.08
3	38.63	0.21
4	57.20	0.35
5	75.39	0.48
6	94.33	0.64
7	114.02	0.81
8	134.02	1.00
9	151.34	1.16
10	168.78	1.34
11	188.66	1.56
12	208.16	1.81
13	224.85	2.04
14	243.98	2.44
15	262.55	2.82
16	281.11	3.24
17	299.87	3.79
18	318.99	4.43
19	336.81	5.34
20	344.31	5.76
21	355.38	6.96
22	363.82	7.56
23	370.75	8.78
24	376.94	9.94

76.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2A-3

Column : CVS350x128 Fasteners: A325- -M22.2D
Beam : VS350x58 M23.8 Oversize holes
Plate thickness : 1.25" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4459 pt = 10.4920 li = 22.9080 pc = 5.2461
cc = 2.9080 gt = 8.8920 gc = 8.8920
tp = 3.1750 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	18.75	0.17
3	37.88	0.42
4	56.82	0.63
5	76.33	0.84
6	93.95	1.08
7	112.33	1.31
8	131.84	1.57
9	154.90	1.85
10	170.28	2.06
11	187.53	2.30
12	206.66	2.66
13	224.85	3.22
14	243.23	3.71
15	262.55	4.29
16	279.99	4.85
17	301.18	5.48
18	315.81	5.97
19	337.00	6.69
20	351.81	7.35
21	364.75	7.93
22	383.13	8.90
23	393.45	9.67
24	395.79	11.01
25	398.13	12.35

77.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2A-4

Column : CVS350x128 Fasteners: A325- -M22.2D
Beam : VS350x58 M23.8 Oversize holes
Plate thickness : 1.00" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4459 pt = 10.4920 li = 22.9080 pc = 5.2461
cc = 1.9080 gt = 8.8920 gc = 8.8920
tp = 2.5400 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	19.19	0.07
3	37.82	0.21
4	57.95	0.38
5	76.58	0.53
6	95.40	0.71
7	112.90	0.91
8	132.84	1.27
9	151.09	1.71
10	169.15	2.09
11	188.16	2.59
12	206.97	3.10
13	226.73	3.64
14	249.69	4.43
15	266.62	5.95
16	278.10	7.45
17	285.63	8.56
18	292.21	9.70
19	297.86	10.72
20	302.37	11.78
21	308.58	12.83
22	314.04	13.94
23	323.26	15.32

78.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2A-5

Column : CVS350x128 Fasteners: A325- -M25.4D
Beam : VS350x58 M27.0 Oversize holes
Plate thickness : 1.00" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 5.0801 pt = 11.7599 li = 21.6400 pc = 5.8801
cc = 1.6401 gt = 10.1600 gc = 10.1600
tp = 2.5400 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	424.11	14.54
2	20.32	0.11			
3	39.89	0.25			
4	57.20	0.38			
5	76.77	0.52			
6	94.27	0.68			
7	113.65	0.87			
8	132.46	1.07			
9	150.72	1.28			
10	171.04	1.54			
11	188.91	1.78			
12	207.16	2.05			
13	225.60	2.44			
14	245.74	2.96			
15	265.87	3.61			
16	286.00	4.20			
17	302.75	4.81			
18	322.50	5.68			
19	340.94	6.52			
20	349.79	7.33			
21	372.18	8.56			
22	393.06	9.84			
23	402.66	10.63			
24	410.19	11.85			
25	422.42	13.33			

79.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2A-6

Column : CVS350x128 Fasteners: A325- -M25.4D
Beam : VS350x58 M27.0 Oversize holes
Plate thickness : 0.875" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 5.0801 pt = 11.7599 li = 21.6400 pc = 5.8801
cc = 1.6401 gt = 10.1600 gc = 10.1600
tp = 2.2230 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	399.93	13.93
2	21.07	0.10	27	404.17	16.39
3	38.76	0.23	28	410.00	17.95
4	57.76	0.39			
5	79.40	0.57			
6	95.21	0.72			
7	114.21	0.93			
8	133.22	1.14			
9	152.03	1.37			
10	170.10	1.59			
11	188.72	1.80			
12	208.10	1.97			
13	229.55	2.17			
14	244.98	2.33			
15	263.61	2.55			
16	282.05	2.80			
17	303.31	3.12			
18	320.43	3.46			
19	338.87	3.90			
20	352.99	4.39			
21	363.15	5.30			
22	366.35	6.31			
23	378.20	8.10			
24	390.05	9.70			
25	395.70	11.47			

80.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2B-1

Column : CVS350x128 Fasteners: A325- -M22.2D
Beam : VS350x58 M23.8 Oversize holes
Plate thickness : 1.5" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4459 pt = 10.4920 li = 22.9080 pc = 5.2461
cc = 1.9080 gt = 8.8920 gc = 8.8920
tp = 3.8100 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	354.57	6.45
2	15.70	0.09	27	359.80	6.98
3	30.47	0.19	28	364.10	7.61
4	45.04	0.30	29	367.46	8.37
5	60.56	0.43	30	368.21	9.19
6	75.51	0.55			
7	89.72	0.71			
8	105.04	0.88			
9	119.81	1.04			
10	135.88	1.21			
11	149.71	1.36			
12	165.79	1.54			
13	180.93	1.72			
14	194.95	1.89			
15	211.05	2.08			
16	225.97	2.29			
17	239.24	2.48			
18	255.32	2.75			
19	269.15	3.00			
20	284.10	3.32			
21	299.61	3.72			
22	313.82	4.14			
23	323.91	4.54			
24	333.82	5.01			
25	344.10	5.64			

81.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2B-2

Column : CVS350x128 Fasteners: A325- -M22.2D
Beam : VS350x58 M23.8 Oversize holes
Plate thickness : 1.25" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4459 pt = 10.4920 li = 22.9080 pc = 5.2461
cc = 1.9080 gt = 8.8920 gc = 8.8920
tp = 3.1750 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	19.88	0.14
3	38.63	0.33
4	56.82	0.52
5	75.95	0.71
6	93.77	0.96
7	112.52	1.19
8	131.27	1.42
9	150.96	1.67
10	168.59	1.89
11	187.53	2.18
12	206.29	2.45
13	226.17	2.82
14	244.92	3.24
15	262.55	3.70
16	281.30	4.14
17	300.05	4.67
18	320.68	5.37
19	334.56	6.00
20	347.12	6.70
21	359.31	7.65
22	363.25	8.47
23	368.88	9.55
24	371.69	10.54
25	372.82	11.29

82.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2B-3

Column : CVS350x128 Fasteners: A325- -M22.2D
Beam : VS350x58 M23.8 Oversize holes
Plate thickness : 1.25" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4459 pt = 10.4920 li = 22.9080 pc = 5.2461
cc = 2.9080 gt = 8.8920 gc = 8.8920
tp = 3.1750 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	401.70	10.49
2	20.82	0.12	27	405.07	11.07
3	39.01	0.27	28	411.45	11.75
4	58.32	0.42			
5	75.20	0.56			
6	93.77	0.75			
7	114.21	0.99			
8	131.27	1.18			
9	150.03	1.41			
10	168.97	1.68			
11	188.85	1.95			
12	206.29	2.20			
13	227.67	2.56			
14	245.29	2.88			
15	263.30	3.25			
16	283.87	3.75			
17	300.05	4.26			
18	320.31	4.74			
19	333.81	5.22			
20	352.75	5.94			
21	364.19	6.50			
22	379.38	7.16			
23	387.63	7.96			
24	392.88	8.77			
25	398.13	9.80			

83.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2B-4

Column : CVS350x128 Fasteners: A325- -M22.2D
Beam : VS350x58 M23.8 Oversize holes
Plate thickness : 1.00" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4459 pt = 10.4920 li = 22.9080 pc = 5.2461
cc = 1.9080 gt = 8.8920 gc = 8.8920
tp = 2.5400 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	19.76	0.11
3	39.70	0.26
4	57.39	0.41
5	76.58	0.57
6	95.21	0.78
7	114.02	1.00
8	132.28	1.22
9	151.09	1.46
10	169.53	1.69
11	188.16	1.97
12	207.73	2.36
13	228.61	2.79
14	244.79	3.11
15	265.12	3.61
16	282.99	3.96
17	301.99	4.64
18	321.75	5.33
19	333.04	5.89
20	341.70	6.53
21	351.10	7.33
22	362.39	8.41
23	369.54	9.52
24	371.61	10.53

84.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2B-5

Column : CVS350x128 Fasteners: A325- -M25.4D
Beam : VS350x58 M27.0 Oversize holes
Plate thickness : 1.00" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 5.0801 pt = 11.7599 li = 21.6400 pc = 5.8801
cc = 1.6401 gt = 10.1600 gc = 10.1600
tp = 2.5400 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	409.43	23.05
2	19.57	0.07			
3	38.95	0.18			
4	57.20	0.29			
5	76.77	0.42			
6	94.83	0.58			
7	113.46	0.77			
8	133.22	0.96			
9	150.72	1.14			
10	170.10	1.38			
11	189.10	1.63			
12	207.35	1.91			
13	226.36	2.24			
14	246.30	2.65			
15	264.74	3.14			
16	282.80	3.88			
17	301.43	4.83			
18	319.87	6.68			
19	338.87	8.80			
20	350.54	9.97			
21	366.72	12.52			
22	376.69	13.99			
23	388.36	16.31			
24	397.20	18.44			
25	404.67	20.74			

85.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : L.F.L.Ribeiro & R.M.Goncalves Brazil
Test Id. : CT2B-6

Column : CVS350x128 Fasteners: A325- -M25.4D
Beam : VS350x58 M27.0 Oversize holes
Plate thickness : 0.875" Material : A36
Fy = 249 MPa
Fu = 399 MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 5.0801 pt = 11.7599 li = 21.6400 pc = 5.8801
cc = 1.6401 gt = 10.1600 gc = 10.1600
tp = 2.2230 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	398.90	18.59
2	20.51	0.19	27	400.97	20.39
3	38.95	0.42			
4	57.76	0.68			
5	75.64	0.90			
6	94.64	1.23			
7	114.02	1.74			
8	132.46	2.23			
9	151.09	2.81			
10	169.15	3.32			
11	189.48	3.88			
12	209.61	4.40			
13	227.48	4.90			
14	244.42	5.35			
15	264.93	6.03			
16	282.24	6.56			
17	302.37	7.42			
18	319.68	8.28			
19	338.50	9.60			
20	349.22	10.70			
21	357.50	11.69			
22	365.78	12.85			
23	374.06	14.12			
24	385.54	15.85			
25	392.88	17.00			

86.
Connection type : Extended end-plate connections
Mode : All bolted with column stiffener

Tested by : A.Mazroi (1983) U.S.A
Test Id. : CF3-S12x65

Column : W12x65 Fasteners: A325- -M22.2D
Beam : W24x100 M23.8 Oversize holes
Plate thickness : 3/4" Material : A36
Stiffener thickness : 0.9525cm Fy = 409 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 10.4775	pt = 8.8900	li = 50.1650	pc = 8.8900
cc = 10.4775	pit= 6.6675	pi = 36.8300	pic= 6.6675
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 1.9050	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	590.72	1.71
2	31.55	0.02	27	608.02	1.81
3	63.09	0.04	28	625.32	1.92
4	86.38	0.07	29	638.36	2.00
5	109.68	0.10	30	651.39	2.08
6	138.23	0.15	31	664.43	2.16
7	166.78	0.20	32	677.47	2.24
8	194.58	0.26	33	690.51	2.32
9	222.39	0.33	34	703.55	2.40
10	246.44	0.40			
11	270.49	0.47			
12	294.53	0.53			
13	319.33	0.60			
14	344.13	0.67			
15	365.18	0.74			
16	386.22	0.81			
17	412.53	0.90			
18	438.84	0.99			
19	460.64	1.07			
20	482.44	1.16			
21	501.24	1.25			
22	520.04	1.34			
23	537.33	1.44			
24	554.63	1.53			
25	572.68	1.62			

II.15 Detalle ensayos unión placa extendida todo apernado sin atiesador de columna

1.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : S.A.Ioannides (1978) U.S.A.
Test Id. : TEST 1

Column : W8x35
Beam : W14x22
Plate thickness : 5/8"

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.1275 pt = 8.8900 li = 26.0350 pc = 8.8900
cc = 4.1275 gt = 13.9700 gc = 13.9700
tp = 1.5875 nt = 2 X 2 nc = 2 X 2

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDES.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	92.73	14.44
2	4.71	0.19	27	94.94	15.69
3	9.42	0.38	28	97.15	16.93
4	14.13	0.57	29	98.69	17.94
5	18.67	0.79	30	100.22	18.94
6	23.22	1.00	31	101.76	19.95
7	27.76	1.21	32	103.30	20.95
8	31.54	1.36	33	104.59	22.02
9	35.32	1.51	34	105.88	23.10
10	39.09	1.65	35	107.17	24.17
11	43.61	1.84	36	108.46	25.24
12	48.13	2.02			
13	52.57	2.40			
14	56.26	2.72			
15	59.96	3.04			
16	64.57	3.63			
17	69.35	4.76			
18	72.98	5.85			
19	76.61	6.98			
20	79.01	7.86			
21	81.41	8.73			
22	83.47	9.71			
23	85.54	10.69			
24	88.03	11.94			
25	90.51	13.19			

2.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : S.A.Ioannides (1978) U.S.A.
Test Id. : TEST 2

Column : W10x49 Fasteners: A325- -M22.2D
Beam : W18x35 M23.8 Oversize holes
Plate thickness : 3/4" Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.1275 pt = 9.5250 li = 35.5600 pc = 9.5250
cc = 4.1275 gt = 13.9700 gc = 13.9700
tp = 1.9050 nt = 2 X 2 nc = 2 X 2

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDES.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	220.01	11.86
2	12.63	0.02	27	224.00	12.68
3	25.26	0.04	28	227.50	13.54
4	37.90	0.07	29	230.99	14.41
5	50.53	0.12	30	234.49	15.27
6	63.16	0.17	31	238.11	16.04
7	74.27	0.24	32	241.73	16.82
8	85.38	0.39	33	245.34	17.59
9	95.18	0.52	34	248.41	18.41
10	104.99	0.65	35	251.48	19.23
11	114.78	0.87	36	254.54	20.04
12	125.55	1.13	37	258.51	21.12
13	135.98	1.52	38	262.47	22.19
14	146.40	1.98			
15	158.43	2.62			
16	169.78	3.49			
17	178.83	4.43			
18	183.99	5.09			
19	189.15	5.75			
20	193.64	6.50			
21	198.14	7.24			
22	202.77	8.18			
23	207.41	9.11			
24	211.71	10.08			
25	216.01	11.05			

3.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : S.A.Ioannides (1978) U.S.A.
Test Id. : TEST 3

Column : W14x48 Fasteners: A325- -M25.4D
Beam : W24x55 M27.0 Oversize holes
Plate thickness : 7/8" Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.1275 pt = 10.1600 li = 48.8950 pc = 10.1600
cc = 4.1275 gt = 13.9700 gc = 13.9700
tp = 2.2225 nt = 2 X 2 nc = 2 X 2

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	252.36	4.63
2	11.06	0.02	27	259.26	5.09
3	22.12	0.05	28	266.15	5.55
4	33.18	0.07	29	272.58	6.10
5	42.86	0.09	30	279.00	6.66
6	52.54	0.12	31	284.05	7.15
7	62.44	0.15	32	289.10	7.64
8	72.35	0.19	33	292.53	8.20
9	81.80	0.25	34	295.96	8.76
10	91.24	0.31	35	298.70	9.34
11	100.92	0.41	36	301.44	9.92
12	110.59	0.51	37	303.72	10.44
13	121.19	0.64	38	306.00	10.95
14	131.78	0.78	39	307.37	11.36
15	143.99	1.00	40	308.73	11.77
16	156.19	1.22			
17	169.08	1.46			
18	181.98	1.70			
19	192.33	2.06			
20	202.69	2.41			
21	210.51	2.69			
22	218.33	2.97			
23	226.84	3.35			
24	235.35	3.74			
25	243.86	4.18			

4.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : S.A.Ioannides (1978) U.S.A.
Test Id. : TEST 4

Column : W8x35
Beam : W14x22
Plate thickness : 7/8"

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.1275 pt = 8.8900 li = 26.0350 pc = 8.8900
cc = 4.1275 gt = 13.9700 gc = 13.9700
tp = 2.2225 nt = 2 X 2 nc = 2 X 2

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	125.82	22.57
2	6.10	0.08	27	128.65	24.63
3	12.85	0.17	28	131.48	26.69
4	19.60	0.27	29	134.31	28.75
5	26.35	0.38	30	137.15	30.81
6	30.46	0.50	31	139.98	32.87
7	34.58	0.63	32	142.81	34.92
8	41.67	0.77	33	145.64	36.98
9	48.42	0.93	34	148.47	39.04
10	55.69	1.20	35	149.94	40.52
11	60.07	1.55	36	151.41	42.00
12	64.45	1.90			
13	68.84	2.50			
14	73.23	3.09			
15	77.80	4.13			
16	82.38	5.18			
17	87.72	6.74			
18	93.06	8.29			
19	97.74	9.90			
20	102.43	11.52			
21	106.54	13.30			
22	110.66	15.09			
23	114.69	16.96			
24	118.73	18.83			
25	122.27	20.70			

5.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : S.A.Ioannides (1978) U.S.A.
Test Id. : TEST 5

Column : W10x49 Fasteners: A325- -M22.2D
Beam : W18x35 M23.8 Oversize holes
Plate thickness : 1 1/4" Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.1275 pt = 9.5250 li = 35.5600 pc = 9.5250
cc = 4.1275 gt = 13.9700 gc = 13.9700
tp = 3.1750 nt = 2 X 2 nc = 2 X 2

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	241.04	18.85
2	11.07	0.14	27	247.56	20.46
3	22.14	0.29	28	254.08	22.07
4	33.20	0.43	29	258.95	23.77
5	45.03	0.66	30	263.82	25.47
6	56.87	0.89	31	268.85	27.32
7	69.52	1.24	32	273.88	29.17
8	82.16	1.59	33	277.23	30.55
9	92.84	1.99	34	280.58	31.92
10	103.51	2.39	35	283.92	33.29
11	114.84	2.88	36	287.64	35.01
12	126.17	3.37	37	291.36	36.72
13	136.84	4.02	38	293.62	37.86
14	147.50	4.66	39	295.88	39.01
15	157.83	5.50			
16	168.16	6.33			
17	177.01	7.22			
18	185.86	8.10			
19	193.21	9.30			
20	200.57	10.50			
21	208.57	11.90			
22	216.58	13.30			
23	223.60	14.81			
24	230.61	16.32			
25	235.83	17.58			

6.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : S.A.Ioannides (1978) U.S.A.
Test Id. : TEST 6

Column : W14x48 Fasteners: A325- -M25.4D
Beam : W24x55 M27.0 Oversize holes
Plate thickness : 1 1/4" Material : A36
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.1275 pt = 10.1600 li = 48.8950 pc = 10.1600
cc = 4.1275 gt = 13.9700 gc = 13.9700
tp = 3.1750 nt = 2 X 2 nc = 2 X 2

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	334.32	8.33
2	170.85	0.12	27	339.60	8.85
3	181.43	0.15	28	344.64	9.39
4	186.94	0.24	29	349.68	9.93
5	193.34	0.34	30	354.05	10.43
6	199.27	0.45	31	358.42	10.92
7	206.11	0.63	32	363.44	11.50
8	213.82	0.90	33	368.46	12.08
9	223.35	1.23			
10	232.38	1.64			
11	240.99	1.98			
12	247.06	2.30			
13	253.14	2.62			
14	263.92	3.22			
15	269.96	3.60			
16	276.01	3.97			
17	282.95	4.41			
18	289.89	4.84			
19	295.46	5.24			
20	301.04	5.64			
21	307.26	6.11			
22	313.49	6.58			
23	318.67	6.99			
24	323.86	7.40			
25	329.04	7.81			

7.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : R.J.Dews (1979) U.S.A.
Test Id. : TEST 1

Column : W8x31
Beam : W14x22
Plate thickness : 1"

Fasteners: A325- -M19.1D
M23.8 Oversize holes
Material : A36
Fy = 331 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.2469 pt = 8.8900 li = 25.7962 pc = 8.8900
cc = 4.2469 gt = 13.9700 gc = 13.9700
tp = 2.4613 nt = 2 X 2 nc = 2 X 2

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	105.35	38.83
2	4.32	0.68	27	107.58	41.63
3	8.63	1.37	28	109.82	44.44
4	12.49	2.00	29	111.69	47.07
5	16.36	2.61	30	113.57	49.71
6	22.26	3.57	31	115.45	52.35
7	28.16	4.53	32	117.18	54.99
8	33.69	5.53	33	118.90	57.63
9	39.22	6.33	34	120.63	60.28
10	43.98	7.13	35	122.22	63.17
11	48.75	7.93	36	123.81	66.06
12	53.90	8.76	37	125.40	68.95
13	59.05	9.65	38	126.77	71.57
14	63.12	9.95	39	128.15	74.19
15	68.44	11.16	40	129.52	76.80
16	71.79	12.22			
17	74.86	13.65			
18	79.35	16.46			
19	84.31	19.63			
20	89.13	23.00			
21	91.79	25.23			
22	94.44	27.47			
23	97.29	30.40			
24	100.13	33.33			
25	102.74	36.08			

8.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : R.J.Dews (1979) U.S.A.
Test Id. : TEST 2

Column : W8x31 Fasteners: A325- -M19.1D
Beam : W14x22 M23.8 Oversize holes
Plate thickness : 1" Material : A36
Fy = 254 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.1072 pt = 8.8900 li = 26.0756 pc = 8.8900
cc = 4.1072 gt = 14.0487 gc = 14.0487
tp = 2.3825 nt = 2 X 2 nc = 2 X 2

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	96.90	28.18
2	4.56	0.46	27	99.65	30.77
3	9.12	0.92	28	102.10	33.20
4	13.68	1.38	29	104.56	35.64
5	18.44	1.81	30	107.01	38.07
6	23.20	2.24	31	109.46	40.50
7	27.96	2.67	32	112.67	43.23
8	34.20	3.37	33	115.87	45.96
9	40.44	4.06	34	119.08	48.69
10	44.95	4.52	35	122.29	51.42
11	49.46	4.99	36	125.15	54.39
12	53.97	5.45	37	128.01	57.36
13	58.63	5.88	38	130.88	60.32
14	63.29	6.31			
15	68.40	6.92			
16	72.17	8.01			
17	75.35	9.38			
18	77.26	10.96			
19	79.17	12.53			
20	81.91	14.70			
21	84.66	16.88			
22	86.90	18.91			
23	89.15	20.95			
24	91.39	22.99			
25	94.14	25.58			

9.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : R.J.Dews (1979) U.S.A.
Test Id. : TEST 3

Column : W10x33 Fasteners: A325- -M25.4D
Beam : W16x26 M31.8 Oversize holes
Plate thickness : 1 1/2" Material : A36
Fy = 291 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 3.9891 pt = 9.5250 li = 30.4394 pc = 9.5250
cc = 3.9891 gt = 13.6525 gc = 13.6525
tp = 3.9675 nt = 2 X 2 nc = 2 X 2

Remark 1) END PLATE EXTENDED ON TENSION AND COMPRESSION SIDE.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	98.13	0.50
3	116.58	1.36
4	123.80	2.34
5	128.12	3.37
6	132.44	4.39
7	136.75	5.42
8	141.20	6.83
9	145.65	8.25
10	148.22	9.41
11	150.80	10.57
12	153.37	11.74
13	156.05	13.09
14	158.74	14.45
15	161.42	15.80
16	164.11	17.16
17	166.35	18.50
18	168.60	19.85
19	170.84	21.19
20	173.08	22.54
21	175.33	23.88
22	177.26	25.27
23	179.20	26.65
24	181.14	28.03
25	183.07	29.42

10.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.N.Sherbourne (1961) ENGLAND
Test Id. : TEST A1

Column : 8 x 8 UC 35 Fasteners: A325- -M19.1D
Beam : 15 x 5 RSJ 42 M23.8 Oversize holes
Plate thickness : 1 1/4" Material : G40.21
Fy = 243 MPa
Fu = 445 MPa

Major parameters (cm)

End plate extended on tension side only.

ct = 3.8100	pt = 8.8900	li = 27.9400	pc = 5.7150
cc = 0.6350	pit= 6.3500	pi = 7.6200	pic= 6.3500
gt = 10.1600	gi = 10.1600	gc = 10.1600	
tp = 3.1750	nt = 2 X 2	ni = 2 X 3	nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	304.62	7.10
2	15.82	0.15	27	306.59	7.65
3	31.65	0.30	28	308.57	8.20
4	47.47	0.40	29	312.53	8.85
5	63.30	0.50	30	316.48	9.50
6	79.12	0.65	31	319.12	10.07
7	94.95	0.80	32	321.76	10.63
8	108.79	1.00	33	324.40	11.20
9	122.64	1.20	34	325.39	11.78
10	138.46	1.30	35	326.37	12.35
11	154.29	1.40	36	327.36	12.93
12	170.11	1.65	37	328.35	13.50
13	185.93	1.90			
14	201.76	2.10			
15	217.58	2.30			
16	231.43	2.75			
17	245.27	3.20			
18	255.17	3.65			
19	265.06	4.10			
20	270.99	4.50			
21	276.92	4.90			
22	280.88	5.30			
23	284.84	5.70			
24	288.79	6.15			
25	292.75	6.60			

11.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : TEST A1-L

Column : 8 x 8 UC 48
Beam : 12 x 5 RSJ 32
Plate thickness : 1"

Fasteners: -- - -M22.2D
M27.0 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.5908	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) TWO 7/8" BOLTS USED ON EITHER SIDE OF TENSION FLANGE.
2) FOUR 1" BOLTS IN COMPRESSION. MATERIAL GRADE 50B (BS968).

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	183.18	9.20
2	4.08	0.30	27	192.77	10.00
3	8.15	0.60	28	204.28	11.20
4	12.23	0.90	29	212.91	12.50
5	16.30	1.20	30	220.58	13.50
6	21.42	1.40	31	227.29	14.90
7	26.53	1.60	32	233.05	16.60
8	31.65	1.80	33	238.80	18.10
9	39.32	2.15	34	241.20	19.05
10	46.99	2.50	35	243.60	20.00
11	54.67	2.85	36	246.47	21.60
12	62.34	3.20	37	247.91	22.50
13	72.41	3.65	38	249.35	23.40
14	82.48	4.10	39	250.31	24.30
15	90.15	4.45	40	251.27	25.20
16	97.82	4.80	41	252.23	26.50
17	105.97	5.20	42	253.19	27.90
18	114.13	5.60	43	253.19	29.60
19	123.72	6.05	44	253.67	30.70
20	133.31	6.50	45	254.15	31.80
21	140.02	6.85	46	255.11	33.40
22	146.73	7.20	47	256.06	34.80
23	153.93	7.65	48	255.11	35.30
24	161.12	8.10			
25	172.63	8.80			

12.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : TEST A1-R

Column : 8 x 8 UC 48
Beam : 12 x 5 RSJ 32
Plate thickness : 1"

Fasteners: -- - -M22.2D
M27.0 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.4300	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.5908	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) TWO 7/8" BOLTS USED ON EITHER SIDE OF TENSION FLANGE.
2) FOUR 1" BOLTS IN COMPRESSION. MATERIAL GRADE 50B (BS968).

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	217.97	10.20
2	9.04	0.20	27	222.73	11.40
3	18.08	0.40	28	229.39	12.70
4	29.51	0.80	29	233.20	13.70
5	36.65	1.00	30	235.58	14.50
6	43.78	1.20	31	237.96	15.30
7	51.88	1.45	32	241.77	16.60
8	59.97	1.70	33	245.57	18.00
9	72.34	2.20	34	247.48	19.40
10	79.48	2.35	35	249.38	20.90
11	86.62	2.50	36	250.81	21.80
12	97.09	2.70	37	252.24	22.70
13	109.46	3.20	38	253.19	24.10
14	116.12	3.40	39	254.14	25.40
15	122.79	3.60	40	254.14	26.50
16	129.93	3.80	41	255.09	27.70
17	137.06	4.00	42	256.04	28.80
18	144.68	4.20	43	256.04	29.60
19	152.29	4.40	44	256.04	30.60
20	160.86	4.80	45	256.04	31.40
21	172.28	5.30			
22	182.75	5.90			
23	195.13	6.80			
24	203.69	7.80			
25	212.26	9.00			

13.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : TEST A2-L

Column : 8 x 8 UC 40 Fasteners: -- - -M15.9D
Beam : 10 x 4 UB 17 M20.6 Oversize holes
Plate thickness : 3/4" Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.1125	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.0447	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) TWO 5/8" BOLTS USED ON EITHER SIDE OF TENSION FLANGE.
2) FOUR 7/8" BOLTS IN COMPRESSION. MATERIAL GRADE 50B (BS968).

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	28	98.12	5.70
2	1.01	0.10	29	101.95	6.00
3	2.02	0.20	28	107.69	6.90
4	3.03	0.30	29	111.52	7.30
5	4.04	0.40	30	115.35	7.70
6	5.05	0.50	31	120.13	8.90
7	6.06	0.60	32	123.96	9.80
8	9.09	0.90	33	126.83	11.00
9	13.19	1.10	34	128.75	12.30
10	17.30	1.30	35	130.18	13.10
11	23.45	1.60	36	131.62	13.90
12	27.28	1.80	37	133.05	14.65
13	31.11	2.00	38	134.49	15.40
14	36.85	2.20	39	135.93	16.10
15	42.60	2.40	40	137.36	16.80
16	47.38	2.55	41	137.36	17.55
17	52.17	2.70	42	137.36	18.30
18	56.00	3.00	43	137.84	19.15
19	59.83	3.30	44	138.32	20.00
20	64.61	3.65	45	138.32	20.75
21	69.40	4.00	46	138.32	21.50
22	73.23	4.20	47	140.23	22.50
23	77.06	4.40	48	140.23	23.30
24	81.84	4.60	49	140.23	24.10
25	86.63	4.80	50	141.19	25.30
26	90.46	5.10	51	140.23	24.10
27	94.29	5.40	52	141.19	25.30
			53	140.23	26.10

14.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : TEST A2-R

Column : 8 x 8 UC 40
Beam : 10 x 4 UB 17
Plate thickness : 3/4"

Fasteners: -- - -M15.9D
M20.6 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.1125	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.0447	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) TWO 5/8" BOLTS USED ON EITHER SIDE OF TENSION FLANGE.
2) FOUR 7/8" BOLTS IN COMPRESSION. MATERIAL GRADE 50B (BS968).

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	110.56	8.00
2	4.63	0.30	27	115.35	9.20
3	9.25	0.60	28	120.13	10.60
4	13.88	0.90	29	123.00	11.90
5	19.62	1.25	30	123.96	12.65
6	25.37	1.60	31	124.92	13.40
7	30.63	1.75	32	125.88	14.15
8	35.90	1.90	33	126.83	14.90
9	40.68	2.10	34	128.75	16.20
10	45.47	2.30	35	129.23	17.20
11	51.21	2.35	36	129.70	18.20
12	56.95	2.40	37	129.70	18.95
13	60.31	2.65	38	129.70	19.70
14	63.66	2.90	39	130.18	20.65
15	67.48	3.15	40	130.66	21.60
16	71.31	3.40	41	130.66	22.40
17	74.66	3.60	42	130.66	23.20
18	78.01	3.80	43	131.14	24.00
19	82.32	4.10	44	131.62	24.80
20	86.63	4.40	45	131.14	25.65
21	92.37	5.20	46	130.66	26.50
22	95.72	5.70	47	131.62	27.55
23	99.07	6.20	48	132.58	28.60
24	102.42	6.65			
25	105.77	7.10			

15.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : TEST A3-L

Column : 8 x 8 UC 40
Beam : 10 x 4 UB 19
Plate thickness : 3/4"

Fasteners: -- - -M19.1D
M23.8 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.1125	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.1590	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) TWO 3/4" BOLTS USED ON EITHER SIDE OF TENSION FLANGE.
2) FOUR 7/8" BOLTS IN COMPRESSION. MATERIAL GRADE 50B (BS968).

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	125.87	7.55
2	2.21	0.20	27	131.16	8.10
3	4.42	0.40	28	135.00	8.70
4	6.63	0.60	29	138.85	9.30
5	8.84	0.80	30	141.73	10.15
6	11.05	1.00	31	144.61	11.00
7	17.78	1.35	32	147.01	11.60
8	24.50	1.70	33	149.41	12.20
9	30.75	2.00	34	150.86	12.95
10	36.99	2.30	35	152.30	13.70
11	42.28	2.55	36	153.26	14.55
12	47.56	2.80	37	154.22	15.40
13	51.89	3.10	38	155.18	16.20
14	56.21	3.40	39	156.14	17.00
15	61.66	3.63	40	156.46	17.80
16	67.10	3.87	41	156.78	18.60
17	72.54	4.10	42	157.10	19.40
18	78.79	4.45	43	156.62	20.20
19	85.04	4.80	44	156.14	21.00
20	90.32	5.10			
21	95.61	5.40			
22	101.85	5.85			
23	108.10	6.30			
24	114.34	6.65			
25	120.59	7.00			

16.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Bailey (1970) ENGLAND
Test Id. : TEST A3-R

Column : 8 x 8 UC 40
Beam : 10 x 4 UB 19
Plate thickness : 3/4"

Fasteners: -- - -M19.1D
M23.8 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.

ct =	--	pt = 11.1125	li =	--	pc = --
cc =	--	pit= --	pi =	--	pic= --
gt =	--	gi = --	gc =	--	
tp =	2.1590	nt = 2 X 2	ni = 2 X 1		nc = 2 X 1

Remark 1) TWO 3/4" BOLTS USED ON EITHER SIDE OF TENSION FLANGE.
2) FOUR 7/8" BOLTS IN COMPRESSION. MATERIAL GRADE 50B (BS968).

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	133.53	7.30
2	5.58	0.23	27	133.53	7.30
3	11.17	0.47	28	141.19	8.40
4	16.75	0.70	29	143.58	9.05
5	22.49	1.00	30	145.98	9.70
6	28.24	1.30	31	150.76	10.80
7	33.98	1.60	32	152.20	11.45
8	39.73	1.90	33	153.63	12.10
9	45.47	2.15	34	154.59	12.95
10	51.21	2.40	35	155.55	13.80
11	56.96	2.55	36	156.51	14.55
12	62.70	2.70	37	157.46	15.30
13	67.49	2.95	38	158.90	15.95
14	72.27	3.20	39	160.34	16.60
15	72.27	3.20	40	160.81	17.55
16	77.54	3.50	41	161.29	18.50
17	82.80	3.80	42	160.81	19.50
18	88.07	4.05	43	160.34	20.50
19	93.33	4.30	44	161.29	21.35
20	98.59	4.50	45	162.25	22.20
21	103.86	4.70	46	161.93	23.03
22	108.65	5.00	47	161.61	23.87
23	113.43	5.30	48	161.29	24.70
24	119.65	5.70			
25	125.88	6.10			

17.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.O.Surtees & A.P.Mann (1970) ENGLAND
Test Id. : TEST C1

Column : 8 x 8 UC 48
Beam : 12 x 5 UB 25
Plate thickness : 3/4"

Fasteners: -- - -M19.1D
M23.8 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 3.8100 pt = 11.4300 li = 17.7800 pc = 6.9850
cc = 0.6350 gt = 8.8900 gc = 8.8900
tp = 1.9050 nt = 2 X 2 nc = 2 X 1

Remark 1) 7" X 3" SHEAR PLATE WELDED TO COLUMN TO SUPPORT END PLATE.
2) HALF LENGTH COLUMN WEB STIFFNER USED IN COMPRESSION REGION.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	131.11	8.53
2	5.49	0.10	27	134.04	9.07
3	10.99	0.20	28	136.97	9.60
4	16.85	0.40	29	138.92	10.00
5	22.71	0.60	30	140.88	10.40
6	28.57	0.80	31	142.83	10.80
7	34.91	1.00	32	145.03	11.30
8	41.26	1.20	33	147.22	11.80
9	47.61	1.40			
10	52.98	1.63			
11	58.35	1.87			
12	63.72	2.10			
13	71.05	2.50			
14	78.37	2.90			
15	85.70	3.45			
16	93.02	4.00			
17	97.91	4.50			
18	102.79	5.00			
19	107.67	5.50			
20	112.55	5.93			
21	117.44	6.37			
22	122.32	6.80			
23	124.27	7.20			
24	126.23	7.60			
25	128.18	8.00			

18.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.O.Surtees & A.P.Mann (1970) ENGLAND
Test Id. : TEST C2

Column : 10 x 10 UC 60
Beam : 15 x 6 UB 40
Plate thickness : 3/4"

Fasteners: -- - -M19.1D
M23.8 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4450 pt = 11.4300 li = 25.4000 pc = 6.9850
cc = 0.6350 gt = 8.8900 gc = 8.8900
tp = 1.9050 nt = 2 X 2 nc = 2 X 1

Remark 1) 7" X 3" SHEAR PLATE WELDED TO COLUMN TO SUPPORT END PLATE.
2) HALF LENGTH COLUMN WEB STIFFNER USED IN COMPRESSION REGION.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	338.32	10.10
2	13.58	0.20	27	345.66	11.00
3	27.15	0.40	28	350.06	12.10
4	38.16	0.70	29	355.93	13.40
5	49.17	1.00	30	358.87	14.80
6	61.65	1.25	31	364.74	16.30
7	74.12	1.50	32	369.14	17.40
8	88.07	1.80	33	370.61	18.80
9	102.01	2.10	34	372.08	20.00
10	115.22	2.40	35	373.54	21.40
11	128.43	2.70	36	376.48	22.50
12	143.84	3.05	37	377.95	23.80
13	159.25	3.40	38	379.41	24.90
14	171.73	3.70	39	380.88	26.20
15	184.20	4.00	40	385.28	27.50
16	196.68	4.30	41	383.82	28.50
17	209.15	4.60	42	385.28	29.90
18	222.36	4.90	43	388.22	31.50
19	235.57	5.20	44	389.69	33.00
20	248.05	5.55	45	392.62	34.40
21	260.53	5.90	46	395.56	35.50
22	279.61	6.50	47	398.49	37.00
23	295.75	7.10	48	401.43	38.80
24	308.96	7.80	49	402.90	39.90
25	325.11	9.00			

19.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.O.Surtees & A.P.Mann (1970) ENGLAND
Test Id. : TEST C3

Column : 10 x 10 UC 60
Beam : 15 x 6 UB 40
Plate thickness : 3/4"

Fasteners: -- - -M25.4D
M31.8 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4450 pt = 11.4300 li = 25.4000 pc = 6.9850
cc = 0.6350 gt = 8.8900 gc = 8.8900
tp = 1.9050 nt = 2 X 2 nc = 2 X 1

Remark 1) 7" X 3" SHEAR PLATE WELDED TO COLUMN TO SUPPORT END PLATE.
2) HALF LENGTH COLUMN WEB STIFFNER USED IN COMPRESSION REGION.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	342.72	6.70
2	11.38	0.15	27	355.93	7.60
3	22.75	0.30	28	367.67	8.90
4	41.10	0.45	29	376.48	9.90
5	59.44	0.60	30	382.35	11.20
6	73.39	0.75	31	385.28	12.20
7	87.33	0.90	32	388.22	13.20
8	101.27	1.10	33	391.16	14.30
9	115.22	1.30	34	392.62	15.40
10	127.69	1.45	35	394.09	16.60
11	140.17	1.60	36	398.49	17.90
12	157.78	1.80	37	398.49	18.80
13	175.40	2.00	38	397.03	20.20
14	190.07	2.20	39	397.03	21.90
15	204.75	2.40	40	397.03	23.20
16	217.23	2.65	41	394.09	24.50
17	229.70	2.90	42	394.09	25.90
18	242.91	3.20	43	397.03	27.50
19	256.12	3.50	44	397.03	28.80
20	270.07	3.90	45	394.09	29.90
21	284.01	4.30	46	394.83	31.25
22	294.28	4.60	47	395.56	32.60
23	304.56	4.90	48	394.83	33.65
24	322.17	5.80	49	394.09	34.70
25	332.45	6.25	50	394.09	36.50
			51	392.62	38.40
			52	392.62	40.00

20.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.O.Surtees & A.P.Mann (1970) ENGLAND
Test Id. : TEST C4

Column : 10 x 10 UC 60
Beam : 15 x 6 UB 40
Plate thickness : 1"

Fasteners: -- - -M25.4D
M31.8 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4450 pt = 11.4300 li = 25.4000 pc = 6.9850
cc = 0.6350 gt = 8.8900 gc = 8.8900
tp = 2.5400 nt = 2 X 2 nc = 2 X 1

Remark 1) 7" X 3" SHEAR PLATE WELDED TO COLUMN TO SUPPORT END PLATE.
2) HALF LENGTH COLUMN WEB STIFFNER USED IN COMPRESSION REGION.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	372.82	11.30
2	14.28	0.40	27	378.68	13.10
3	28.57	0.80	28	382.34	14.35
4	46.15	1.25	29	386.01	15.60
5	63.72	1.70	30	388.14	16.75
6	76.91	2.05	31	390.27	17.90
7	90.09	2.40	32	392.54	19.10
8	106.21	2.80	33	394.80	20.30
9	122.32	3.20	34	396.26	21.40
10	139.17	3.65	35	397.73	22.50
11	156.01	4.10	36	401.39	24.45
12	169.20	4.45	37	405.05	26.40
13	182.38	4.80	38	405.78	27.65
14	198.50	5.20	39	406.52	28.90
15	214.61	5.60	40	408.71	30.05
16	229.99	5.95	41	410.91	31.20
17	245.37	6.30	42	413.11	32.55
18	261.49	6.70	43	415.31	33.90
19	277.60	7.10	44	418.23	35.35
20	291.52	7.40	45	421.16	36.80
21	305.44	7.70	46	424.09	38.40
22	318.62	8.15	47	427.02	40.00
23	331.80	8.60			
24	347.92	9.20			
25	361.10	10.00			

21.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.O.Surtees & A.P.Mann (1970) ENGLAND
Test Id. : TEST C5

Column : 10 x 10 UC 60
Beam : 15 x 6 UB 40
Plate thickness : 1"

Fasteners: -- - -M25.4D
M31.8 Oversize holes
Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.4450 pt = 11.4300 li = 25.4000 pc = 6.9850
cc = 0.6350 gt = 8.8900 gc = 8.8900
tp = 2.5400 nt = 2 X 2 nc = 2 X 1

Remark 1) 7" X 3" SHEAR PLATE WELDED TO COLUMN TO SUPPORT END PLATE.
2) HALF LENGTH COLUMN WEB STIFFNER USED IN COMPRESSION REGION.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	370.64	12.90
2	18.64	0.25	27	376.49	14.20
3	37.28	0.50	28	385.26	15.70
4	50.44	0.75	29	389.65	17.00
5	63.60	1.00	30	394.04	18.30
6	87.00	1.50	31	399.88	19.30
7	108.93	1.90	32	404.27	21.20
8	129.40	2.20	33	410.12	22.60
9	144.02	2.50	34	413.04	23.90
10	158.64	2.80	35	417.43	25.50
11	174.72	3.10	36	426.20	26.80
12	190.80	3.40	37	429.13	28.30
13	204.69	3.70	38	434.98	29.70
14	218.58	4.00	39	439.36	30.75
15	233.94	4.35	40	443.75	31.80
16	249.29	4.70	41	446.67	33.10
17	261.72	4.95	42	455.44	35.00
18	274.14	5.20	43	458.37	36.30
19	293.15	5.80	44	462.75	37.70
20	310.70	6.40	45	467.14	38.90
21	323.86	7.20	46	470.07	40.00
22	338.48	8.20			
23	348.71	9.10			
24	357.48	10.40			
25	364.79	11.50			

22.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.A.Packer & L.J.Morris (1977 ENGLAND
Test Id. : TEST J1

Column : 152 x 152 UC 37 Fasteners: -- - -M16
Beam : 254 x 102 UB 22 M20.6 Oversize holes
Plate thickness : 15 mm Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.0001 pt = 9.7000 li = 15.1000 pc = 5.0000
cc = 3.0000 gt = 8.5999 gc = 8.5999
tp = 1.5001 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY. TENSION SIDE HOLE IS 0.811" D.
2) HSFG BOLTS USED ON THE SIDE OF TENSION FLANGE. COMP.SIDE HLOE IS 0.689" D.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	95.30	70.00
2	4.84	0.50	27	95.88	75.00
3	9.42	1.00	28	96.18	80.00
4	13.79	1.50	29	96.47	85.00
5	17.94	2.00	30	96.47	90.00
6	21.50	2.50	31	96.47	95.20
7	25.00	3.00	32	93.24	100.90
8	31.25	3.50	33	89.41	104.90
9	37.94	4.00	34	85.59	107.30
10	41.76	5.00			
11	46.47	6.00			
12	51.77	8.00			
13	55.88	10.00			
14	59.70	12.40			
15	63.53	15.00			
16	69.41	20.00			
17	74.41	25.10			
18	77.65	29.90			
19	80.59	35.10			
20	83.24	39.80			
21	85.88	45.00			
22	87.94	50.10			
23	90.59	55.00			
24	92.36	60.00			
25	94.12	65.00			

23.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.A.Packer & L.J.Morris (1977 ENGLAND
Test Id. : TEST J2

Column : 152 x 152 UC 30 Fasteners: -- - -M16
Beam : 254 x 102 UB 22 M20.6 Oversize holes
Plate thickness : 15 mm Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.0001 pt = 9.7000 li = 15.1000 pc = 5.0000
cc = 3.0000 gt = 8.5999 gc = 8.5999
tp = 1.5001 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY. TENSION SIDE HOLE IS 0.811" D.
2) HSFG BOLTS USED ON THE SIDE OF TENSION FLANGE. COMP.SIDE HLOE IS 0.689" D.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	79.12	70.00
2	3.84	0.50	27	80.59	75.00
3	7.36	1.00	28	82.06	80.00
4	11.19	1.50	29	83.53	85.20
5	15.59	2.00	30	84.41	90.00
6	20.35	2.50	31	85.59	95.20
7	28.53	3.00	32	85.29	100.20
8	33.52	4.00	33	85.59	105.10
9	38.24	6.00	34	85.59	109.00
10	42.06	8.00	35	82.94	112.90
11	44.70	10.00	36	78.53	117.10
12	47.35	12.00			
13	50.00	14.00			
14	52.06	15.90			
15	54.41	18.10			
16	56.47	20.10			
17	61.17	25.00			
18	64.71	30.00			
19	67.35	35.00			
20	69.71	40.10			
21	71.47	45.10			
22	72.94	50.10			
23	74.41	55.10			
24	76.17	60.00			
25	77.65	65.00			

24.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.A.Packer & L.J.Morris (1977 ENGLAND
Test Id. : TEST J3

Column : 152 x 152 UC 23 Fasteners: -- - -M16
Beam : 254 x 102 UB 22 M20.6 Oversize holes
Plate thickness : 15 mm Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.0001 pt = 9.7000 li = 15.1000 pc = 5.0000
cc = 3.0000 gt = 8.5999 gc = 8.5999
tp = 1.5001 nt = 2 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY. TENSION SIDE HOLE IS 0.811 IN D.
2) HSFG BOLTS USED ON THE SIDE OF TENSION FLANGE. COMP.SIDE HLOE IS 0.689 IN D.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	66.77	55.00
2	3.96	0.50	27	67.65	60.00
3	7.36	1.00	28	68.82	65.00
4	12.94	2.10	29	69.41	70.10
5	16.95	3.00	30	70.59	74.90
6	21.18	4.00	31	71.17	80.20
7	25.00	5.10	32	72.06	84.90
8	27.94	6.00	33	72.94	90.20
9	30.29	7.00	34	73.53	95.10
10	32.35	8.00	35	74.41	100.10
11	34.71	9.00	36	75.00	105.10
12	36.47	10.00	37	75.88	110.00
13	40.00	12.00	38	76.77	115.10
14	42.94	14.00	39	77.36	120.10
15	45.29	16.00	40	77.65	125.10
16	47.35	18.00	41	77.36	128.90
17	49.71	20.00	42	76.77	130.60
18	51.77	22.50			
19	54.12	25.10			
20	56.47	27.50			
21	58.53	29.90			
22	62.05	35.00			
23	63.83	40.00			
24	65.00	45.00			
25	66.18	50.20			

25.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : P.Grundy et al. (1980) AUSTRARIA
Test Id. : T1

Column : 310 UC 240 Fasteners: -- - -M22.2D
Beam : 610 UB 113 M27.0 Oversize holes
Plate thickness : 1" Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 3.8100 pt = 9.5250 li = 51.2049 pc = 4.7625
cc = 6.8976 gt = 8.8900 gt2= 6.3500 gc = 15.2400
tp = 2.5400 nt = 4 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) HS BOLTS USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	829.79	3.20
2	36.45	0.10	27	850.62	3.40
3	72.91	0.20	28	871.45	3.60
4	107.63	0.30	29	888.81	3.80
5	142.35	0.40	30	906.17	4.00
6	177.07	0.50	31	909.64	4.20
7	211.79	0.60	32	913.11	4.40
8	246.51	0.70	33	927.00	4.55
9	281.22	0.80	34	940.89	4.70
10	315.94	0.90			
11	350.66	1.00			
12	388.85	1.10			
13	427.04	1.20			
14	454.82	1.30			
15	482.60	1.40			
16	517.32	1.55			
17	552.03	1.70			
18	586.75	1.85			
19	621.47	2.00			
20	656.19	2.15			
21	690.91	2.30			
22	725.63	2.50			
23	760.35	2.70			
24	783.49	2.87			
25	806.64	3.03			

26.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : P.Grundy et al. (1980) AUSTRARIA
Test Id. : T2

Column : 310 UC 240 Fasteners: -- - -M22.2D
Beam : 610 UB 113 M27.0 Oversize holes
Plate thickness : 1 1/4" Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 3.8100 pt = 9.5250 li = 51.2049 pc = 4.7625
cc = 6.8976 gt = 8.8900 gt2= 6.3500 gc = 15.2400
tp = 3.1750 nt = 4 X 2 nc = 2 X 1

Remark 1) END PLATE EXTENDED ON TENSION SIDE ONLY.
2) HS BOLTS USED.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	877.92	3.20
2	34.84	0.10	27	891.85	3.40
3	69.68	0.20	28	905.79	3.60
4	104.51	0.30	29	919.72	3.85
5	139.35	0.40	30	933.66	4.10
6	188.13	0.53	31	940.63	4.25
7	236.90	0.67	32	947.59	4.40
8	285.67	0.80	33	954.56	4.55
9	320.51	0.90	34	961.53	4.70
10	355.35	1.00	35	968.50	4.95
11	390.19	1.05	36	975.46	5.20
12	425.02	1.10	37	978.95	5.35
13	463.35	1.20	38	982.43	5.50
14	501.67	1.30	39	978.95	5.70
15	539.99	1.40	40	975.46	5.90
16	578.31	1.50			
17	609.67	1.60			
18	641.02	1.70			
19	672.37	1.80			
20	703.73	1.90			
21	735.08	2.10			
22	766.44	2.30			
23	797.79	2.55			
24	829.14	2.80			
25	853.53	3.00			

27.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1983) U.S.A
Test Id. : EP3

Column : --
Beam : W24x100
Plate thickness : 3/4"
Stiffener thickness : 1.5875cm

Fasteners: A325- -M22.2D
M23.8 Oversize holes
Material : A36
Fy = 266 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 10.4775	pt = 8.8900	li = 50.1650	pc = 8.8900
cc = 10.4775	pit= 6.6675	pi = 36.8300	pic= 6.6675
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 1.9050	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) 1)End plate was stiffened in the plane of beam web.
2) 2)Test was conducted for beam-to-beam connection.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	823.27	1.89
2	34.69	0.02	27	840.13	2.04
3	69.38	0.03	28	849.46	2.20
4	104.08	0.05	29	858.79	2.35
5	138.77	0.06	30	868.12	2.51
6	183.04	0.10	31	877.45	2.67
7	227.32	0.14	32	886.78	2.83
8	271.59	0.18	33	891.59	2.99
9	315.38	0.22	34	896.39	3.15
10	359.17	0.27	35	901.20	3.31
11	402.96	0.31	36	906.01	3.47
12	438.10	0.37			
13	473.24	0.42			
14	508.38	0.48			
15	543.53	0.53			
16	578.34	0.62			
17	613.16	0.70			
18	647.97	0.79			
19	682.79	0.87			
20	707.15	1.01			
21	731.50	1.14			
22	755.86	1.27			
23	772.71	1.43			
24	789.56	1.58			
25	806.42	1.73			

28.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1983) U.S.A
Test Id. : EP4

Column : --
Beam : W24x100
Plate thickness : 1"
Stiffener thickness : 1.5875cm

Fasteners: A325- -M22.2D
M23.8 Oversize holes
Material : A36
Fy = 277 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 10.4775	pt = 8.8900	li = 50.1650	pc = 8.8900
cc = 10.4775	pit= 6.6675	pi = 36.8300	pic= 6.6675
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 2.5400	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web.
2) Test was conducted for beam-to-beam connection.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	843.25	0.80
2	37.91	0.01	27	866.82	0.86
3	75.83	0.03	28	903.19	1.00
4	113.74	0.04	29	928.77	1.15
5	160.16	0.07	30	954.36	1.29
6	185.61	0.07	31	979.94	1.44
7	211.06	0.09	32	1005.53	1.58
8	240.26	0.10			
9	269.46	0.12			
10	306.88	0.13			
11	344.29	0.15			
12	379.47	0.16			
13	414.65	0.18			
14	446.86	0.20			
15	479.06	0.23			
16	512.79	0.27			
17	546.52	0.30			
18	590.01	0.36			
19	633.51	0.41			
20	665.76	0.46			
21	698.02	0.50			
22	726.55	0.56			
23	755.08	0.61			
24	787.38	0.67			
25	819.67	0.73			

29.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1983) U.S.A
Test Id. : EP5

Column : --
Beam : W27x114
Plate thickness : 1"
Stiffener thickness : 1.5875cm

Fasteners: A325- -M25.4D
M27.0 Oversize holes
Material : A36
Fy = 263 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.1125	pt = 9.9822	li = 56.8709	pc = 9.9822
cc = 11.1125	pit= 6.7734	pi = 43.3240	pic= 6.7734
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 2.5400	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) Test was conducted for beam-to-beam connection.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1130.27	0.85
2	43.91	0.01	27	1176.83	0.94
3	87.82	0.02			
4	131.73	0.03			
5	172.13	0.05			
6	212.52	0.06			
7	252.92	0.08			
8	297.05	0.10			
9	341.18	0.12			
10	387.55	0.14			
11	433.91	0.16			
12	483.25	0.18			
13	532.59	0.21			
14	579.62	0.25			
15	626.65	0.29			
16	678.90	0.34			
17	731.15	0.38			
18	787.92	0.42			
19	844.69	0.47			
20	881.49	0.50			
21	918.30	0.54			
22	955.10	0.58			
23	996.12	0.62			
24	1037.15	0.66			
25	1083.71	0.76			

30.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1983) U.S.A
Test Id. : EP6

Column : -- Fasteners: A325- -M25.4D
Beam : W27x114 M27.0 Oversize holes
Plate thickness : 1 1/4" Material : A36
Stiffener thickness : 1.5875cm Fy = 270 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.7475	pt = 12.5222	li = 54.3306	pc = 12.5222
cc = 11.7475	pit= 7.6200	pi = 39.0906	pic= 7.6200
gt = 16.5100	gi = 16.5100	gc = 16.5100	
tp = 3.1750	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) Test was conducted for beam-to-beam connection.

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	39.05	0.00
3	117.16	0.00
4	177.25	0.01
5	249.37	0.04
6	312.47	0.05
7	377.07	0.07
8	444.69	0.10
9	503.30	0.13
10	563.41	0.16
11	638.54	0.21
12	698.67	0.25
13	751.29	0.32
14	820.44	0.40
15	874.56	0.47
16	924.71	0.56
17	969.34	0.65
18	1008.96	0.74
19	1049.10	0.84
20	1073.20	0.93
21	1100.31	1.03
22	1130.43	1.13

31.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1983) U.S.A
Test Id. : EP7

Column : --
Beam : W24x162
Plate thickness : 1 1/2"
Stiffener thickness : 1.9050cm

Fasteners: A325- -M28.6D
M31.8 Oversize holes
Material : A36
Fy = 227 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.7475	pt = 11.3538	li = 49.0474	pc = 11.3538
cc = 11.7475	pit= 7.6200	pi = 33.8074	pic= 7.6200
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 3.8100	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) Test was conducted for beam-to-beam connection.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1264.60	1.15
2	44.84	0.01	27	1302.66	1.27
3	89.69	0.02	28	1333.61	1.39
4	134.53	0.03			
5	198.78	0.06			
6	263.03	0.09			
7	316.58	0.11			
8	370.12	0.13			
9	410.64	0.14			
10	451.16	0.16			
11	493.23	0.18			
12	535.31	0.20			
13	582.77	0.23			
14	630.23	0.26			
15	682.31	0.30			
16	734.38	0.34			
17	786.49	0.39			
18	838.65	0.46			
19	893.86	0.52			
20	949.07	0.59			
21	987.42	0.64			
22	1059.55	0.74			
23	1123.30	0.85			
24	1175.32	0.95			
25	1219.44	1.05			

32.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1983) U.S.A
Test Id. : EP7 With Shim

Column : --
Beam : W24x162
Plate thickness : 1 1/2"
Stiffener thickness : 1.9050cm

Fasteners: A325- -M28.6D
M31.8 Oversize holes
Material : A36
Fy = 227 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.7475	pt = 11.3538	li = 49.0474	pc = 11.3538
cc = 11.7475	pit= 7.6200	pi = 33.8074	pic= 7.6200
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 3.8100	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) Test was conducted for beam-to-beam connection.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1357.64	0.35
2	44.40	0.01	27	1388.49	0.44
3	86.40	0.03	28	1444.71	0.59
4	128.39	0.04	29	1481.13	0.75
5	209.45	0.05	30	1513.80	0.93
6	252.99	0.05	31	1537.80	1.12
7	296.53	0.05	32	1557.72	1.29
8	344.68	0.06	33	1577.42	1.49
9	392.82	0.07	34	1597.13	1.68
10	447.85	0.08	35	1618.57	1.89
11	502.88	0.10	36	1640.01	2.09
12	548.73	0.10	37	1658.65	2.29
13	594.57	0.10	38	1674.49	2.46
14	663.34	0.11			
15	729.82	0.12			
16	796.31	0.13			
17	863.55	0.14			
18	930.79	0.15			
19	998.83	0.17			
20	1066.87	0.19			
21	1108.92	0.20			
22	1150.97	0.21			
23	1219.78	0.23			
24	1268.75	0.26			
25	1320.85	0.31			

33.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1983) U.S.A
Test Id. : EP8

Column : --
Beam : W24x162
Plate thickness : 1 3/4"
Stiffener thickness : 1.9050cm

Fasteners: A325- -M28.6D
M31.8 Oversize holes
Material : A36
Fy = 307 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 12.3825	pt = 13.8938	li = 46.5074	pc = 13.8938
cc = 12.3825	pit= 8.5725	pi = 29.3624	pic= 8.5725
gt = 16.5100	gi = 16.5100	gc = 16.5100	
tp = 4.4450	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) Test was conducted for beam-to-beam connection.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1463.33	1.58
2	65.60	0.02			
3	131.19	0.04			
4	196.80	0.06			
5	262.41	0.08			
6	331.82	0.10			
7	401.22	0.12			
8	468.40	0.16			
9	535.57	0.19			
10	606.60	0.25			
11	677.63	0.30			
12	747.14	0.35			
13	816.64	0.40			
14	883.90	0.47			
15	951.16	0.54			
16	996.54	0.59			
17	1041.92	0.65			
18	1087.30	0.70			
19	1134.76	0.77			
20	1182.22	0.84			
21	1229.68	0.92			
22	1293.06	1.05			
23	1345.53	1.18			
24	1387.07	1.31			
25	1426.34	1.45			

34.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1983) U.S.A
Test Id. : EP8 With Shim

Column : --
Beam : W24x162
Plate thickness : 1 3/4"
Stiffener thickness : 1.9050cm

Fasteners: A325- -M28.6D
M31.8 Oversize holes
Material : A36
Fy = 307 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 12.3825	pt = 13.8938	li = 46.5074	pc = 13.8938
cc = 12.3825	pit= 8.5725	pi = 29.3624	pic= 8.5725
gt = 16.5100	gi = 16.5100	gc = 16.5100	
tp = 4.4450	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) Test was conducted for beam-to-beam connection.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1672.64	1.19
2	63.86	0.00	27	1693.38	1.33
3	127.73	0.00	28	1714.12	1.48
4	191.59	0.00	29	1734.86	1.62
5	281.27	0.01	30	1755.60	1.77
6	370.95	0.01	31	1768.57	1.91
7	439.97	0.03	32	1781.55	2.04
8	509.00	0.05	33	1794.52	2.18
9	578.03	0.07	34	1807.49	2.31
10	647.53	0.07	35	1820.46	2.45
11	717.04	0.08	36	1832.79	2.60
12	786.54	0.09	37	1845.11	2.75
13	872.43	0.10	38	1857.43	2.90
14	958.32	0.12	39	1869.76	3.06
15	1041.14	0.14			
16	1123.97	0.16			
17	1201.48	0.20			
18	1278.99	0.24			
19	1353.60	0.33			
20	1428.21	0.42			
21	1488.32	0.53			
22	1548.43	0.65			
23	1579.49	0.78			
24	1610.54	0.92			
25	1641.59	1.05			

35.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF4-U12x87

Column : W12x87 Fasteners: A325- -M22.2D
Beam : W24x100 M23.8 Oversize holes
Plate thickness : 1" Material : A36
Fy = 322 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 10.4775	pt = 8.8900	li = 50.1650	pc = 8.8900
cc = 10.4775	pit= 6.6675	pi = 36.8300	pic= 6.6675
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 2.5400	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00
2	85.81	0.12
3	162.56	0.20
4	233.31	0.31
5	304.09	0.43
6	367.32	0.54
7	420.10	0.74
8	470.02	1.13
9	504.94	1.57
10	535.34	1.99
11	562.79	2.52
12	593.23	2.99
13	620.78	3.63
14	646.89	4.36
15	668.39	4.95
16	685.37	5.55
17	706.88	6.15
18	724.02	6.95
19	745.65	7.71
20	765.72	8.41
21	779.75	9.06
22	790.79	9.74

36.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF4-U12x106

Column : W12x106 Fasteners: A325- -M22.2D
Beam : W24x100 M23.8 Oversize holes
Plate thickness : 1" Material : A36
Fy = 265 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 10.4775	pt = 8.8900	li = 50.1650	pc = 8.8900
cc = 10.4775	pit= 6.6675	pi = 36.8300	pic= 6.6675
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 2.5400	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1052.37	6.15
2	38.83	0.03	27	1079.14	6.77
3	77.66	0.06	28	1106.29	7.52
4	116.49	0.09	29	1120.06	7.95
5	162.50	0.14	30	1142.99	8.80
6	208.50	0.19			
7	254.50	0.24			
8	304.23	0.36			
9	353.97	0.47			
10	407.84	0.63			
11	461.71	0.80			
12	501.06	0.96			
13	540.41	1.13			
14	579.75	1.30			
15	629.88	1.56			
16	680.01	1.83			
17	727.58	2.15			
18	775.14	2.48			
19	817.89	2.86			
20	860.64	3.25			
21	891.08	3.60			
22	921.52	3.94			
23	951.57	4.34			
24	981.62	4.74			
25	1014.25	5.28			

37.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF4-U12x120

Column : W12x120 Fasteners: A325- -M22.2D
Beam : W24x100 M23.8 Oversize holes
Plate thickness : 1" Material : A36
Fy = 362 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 10.4775	pt = 8.8900	li = 50.1650	pc = 8.8900
cc = 10.4775	pit= 6.6675	pi = 36.8300	pic= 6.6675
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 2.5400	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	985.13	2.80
2	43.51	0.02	27	1001.97	3.00
3	87.02	0.05	28	1018.80	3.19
4	126.80	0.08	29	1031.67	3.41
5	166.57	0.12	30	1044.54	3.62
6	207.89	0.17	31	1057.41	3.84
7	249.21	0.23	32	1067.24	4.03
8	303.29	0.30	33	1077.07	4.23
9	357.37	0.37	34	1086.90	4.42
10	411.46	0.45	35	1093.19	4.59
11	465.55	0.52	36	1099.48	4.75
12	514.44	0.62	37	1105.76	4.92
13	563.33	0.72			
14	594.94	0.80			
15	626.54	0.88			
16	680.79	1.03			
17	709.42	1.12			
18	738.06	1.21			
19	792.33	1.40			
20	840.69	1.62			
21	861.14	1.75			
22	881.59	1.87			
23	911.25	2.11			
24	940.90	2.35			
25	963.02	2.58			

38.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF5-U10x68

Column : W10x68 Fasteners: A325- -M25.4D
Beam : W27x114 M27.0 Oversize holes
Plate thickness : 1" Material : A36
Fy = 280 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.1125	pt = 9.9822	li = 56.8709	pc = 9.9822
cc = 11.1125	pit= 6.7734	pi = 43.3240	pic= 6.7734
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 2.5400	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	699.10	3.04
2	38.88	0.02	27	711.02	3.22
3	77.76	0.04	28	723.68	3.43
4	115.12	0.09	29	736.33	3.63
5	152.51	0.12	30	748.24	3.86
6	192.87	0.17	31	760.15	4.09
7	228.74	0.24	32	769.82	4.30
8	267.60	0.31	33	779.49	4.52
9	293.02	0.35	34	790.89	4.76
10	318.43	0.40	35	802.30	5.00
11	345.33	0.46	36	813.70	5.25
12	372.23	0.53	37	827.08	5.54
13	393.90	0.57	38	840.47	5.83
14	415.57	0.62			
15	457.41	0.77			
16	496.24	0.96			
17	527.59	1.16			
18	555.96	1.37			
19	585.82	1.57			
20	608.19	1.80			
21	630.56	2.04			
22	646.21	2.26			
23	661.85	2.49			
24	674.52	2.68			
25	687.18	2.87			

39.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF5-U14x61

Column : W14x61 Fasteners: A325- -M25.4D
Beam : W27x114 M27.0 Oversize holes
Plate thickness : 1" Material : A36
Fy = 307 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.1125	pt = 9.9822	li = 56.8709	pc = 9.9822
cc = 11.1125	pit= 6.7734	pi = 43.3240	pic= 6.7734
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 2.5400	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	462.69	2.74
2	18.94	0.03	27	475.43	3.01
3	37.88	0.05	28	485.77	3.23
4	59.86	0.09	29	496.11	3.45
5	81.85	0.12	30	505.75	3.69
6	100.04	0.15	31	515.39	3.94
7	118.23	0.17	32	530.44	4.23
8	143.99	0.21	33	545.48	4.51
9	169.76	0.25	34	553.62	4.76
10	190.26	0.29	35	561.76	5.00
11	210.76	0.34	36	569.90	5.25
12	226.74	0.39	37	581.16	5.54
13	242.72	0.44	38	592.42	5.83
14	261.00	0.51	39	603.68	6.12
15	279.28	0.57			
16	294.56	0.64			
17	309.83	0.72			
18	334.37	0.87			
19	358.91	1.03			
20	383.69	1.28			
21	408.57	1.58			
22	417.39	1.79			
23	426.20	2.01			
24	438.08	2.24			
25	449.95	2.47			

40.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF5-U10x49

Column : W10x49 Fasteners: A325- -M25.4D
Beam : W27x114 M27.0 Oversize holes
Plate thickness : 1" Material : A36
Fy = 282 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.1125	pt = 9.9822	li = 56.8709	pc = 9.9822
cc = 11.1125	pit= 6.7734	pi = 43.3240	pic= 6.7734
gt = 13.9700	gi = 13.9700	gc = 13.9700	
tp = 2.5400	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	333.09	2.66
2	16.51	0.02	27	339.65	2.83
3	33.02	0.04	28	346.21	2.99
4	50.28	0.06	29	355.31	3.23
5	67.55	0.09	30	364.40	3.47
6	81.06	0.12	31	371.48	3.68
7	94.58	0.15	32	378.56	3.89
8	111.86	0.20	33	385.64	4.09
9	129.13	0.25	34	391.72	4.30
10	143.40	0.29	35	397.79	4.50
11	157.67	0.34	36	403.87	4.70
12	169.70	0.41	37	409.94	4.90
13	181.73	0.48			
14	199.78	0.60			
15	213.33	0.73			
16	226.89	0.87			
17	241.20	1.01			
18	255.50	1.14			
19	270.58	1.33			
20	285.65	1.51			
21	295.48	1.72			
22	305.30	1.92			
23	312.38	2.11			
24	319.45	2.31			
25	326.53	2.50			

41.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF6-U12x96

Column : W12x96 Fasteners: A325- -M25.4D
Beam : W27x114 M27.0 Oversize holes
Plate thickness : 1 1/4" Material : A36
Fy = 253 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.7475	pt = 12.5222	li = 54.3306	pc = 12.5222
cc = 11.7475	pit= 7.6200	pi = 39.0906	pic= 7.6200
gt = 16.5100	gi = 16.5100	gc = 16.5100	
tp = 3.1750	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	728.94	2.55
2	31.08	0.03	27	743.03	2.74
3	62.17	0.05	28	757.11	2.94
4	93.25	0.07	29	769.07	3.11
5	134.61	0.12	30	781.04	3.29
6	175.97	0.17	31	793.00	3.46
7	204.56	0.21	32	804.96	3.64
8	233.14	0.26	33	814.89	3.81
9	261.72	0.31	34	824.82	3.98
10	294.07	0.37	35	834.74	4.16
11	326.41	0.44	36	844.67	4.33
12	365.54	0.53			
13	404.66	0.62			
14	433.25	0.71			
15	461.84	0.79			
16	490.43	0.88			
17	519.03	1.00			
18	547.64	1.13			
19	576.25	1.25			
20	603.35	1.42			
21	630.46	1.59			
22	657.57	1.76			
23	676.67	1.96			
24	695.77	2.16			
25	714.86	2.35			

42.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF6-U14x158

Column : W14x158 Fasteners: A325- -M25.4D
Beam : W27x114 M27.0 Oversize holes
Plate thickness : 1 1/4" Material : A36
Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 11.7475	pt = 12.5222	li = 54.3306	pc = 12.5222
cc = 11.7475	pit= 7.6200	pi = 39.0906	pic= 7.6200
gt = 16.5100	gi = 16.5100	gc = 16.5100	
tp = 3.1750	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1252.16	6.36
2	53.38	0.03	27	1284.04	7.07
3	106.76	0.05	28	1310.60	7.92
4	156.00	0.09	29	1342.98	8.75
5	205.23	0.13			
6	254.47	0.17			
7	320.90	0.23			
8	387.34	0.30			
9	435.85	0.37			
10	484.37	0.44			
11	532.89	0.51			
12	593.30	0.66			
13	653.70	0.81			
14	701.46	0.97			
15	749.21	1.13			
16	793.58	1.33			
17	837.96	1.54			
18	881.55	1.83			
19	925.14	2.12			
20	963.51	2.41			
21	1030.46	2.98			
22	1084.09	3.57			
23	1132.81	4.21			
24	1176.49	4.86			
25	1216.34	5.60			

43.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : A.Mazroi (1984) U.S.A
Test Id. : CF8-U14x159

Column : W14x159 Fasteners: A325- -M28.6D
Beam : W24x162 M31.8 Oversize holes
Plate thickness : 1 3/4" Material : A36
Fy = 241 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.

ct = 12.3825	pt = 13.8938	li = 46.5074	pc = 13.8938
cc = 12.3825	pit= 8.5725	pi = 29.3624	pic= 8.5725
gt = 16.5100	gi = 16.5100	gc = 16.5100	
tp = 4.4450	nt = 2 X 3	ni = 2 X 2	nc = 2 X 3

Remark 1) End plate was stiffened in the plane of beam web by an end-plate-plate.
2) pic=poc and pit=pot

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	1421.62	5.23
2	54.86	0.04	27	1462.88	5.86
3	109.72	0.07	28	1501.24	6.48
4	164.58	0.11	29	1536.68	7.09
5	229.68	0.17	30	1573.07	7.75
6	294.78	0.24	31	1600.98	8.42
7	359.91	0.34	32	1620.43	9.08
8	425.04	0.44			
9	487.94	0.55			
10	550.83	0.66			
11	605.51	0.79			
12	660.19	0.92			
13	720.87	1.07			
14	781.56	1.23			
15	852.77	1.47			
16	923.99	1.71			
17	995.24	2.01			
18	1066.50	2.30			
19	1119.83	2.62			
20	1173.15	2.94			
21	1216.00	3.23			
22	1258.84	3.53			
23	1304.77	3.95			
24	1350.69	4.36			
25	1386.16	4.80			

44.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : B3

Column : 310UC96.8 Fasteners: G8.8- -M24
Beam : 460UB67.1 M27.0 Oversize holes
Plate thickness : 16 mm Material : G250
Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 1.5999 nt = 2 X 2 nc = 2 X 2

Remark 1) The beam stub, 3 deg. to horizontal was subjected to cantilever loading.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	206.23	16.29
2	9.15	0.23	27	208.03	17.53
3	18.30	0.46	28	209.83	18.78
4	27.45	0.70	29	211.63	20.02
5	36.60	0.93	30	215.03	21.78
6	47.02	1.24	31	218.44	23.53
7	57.43	1.56	32	221.84	25.28
8	67.85	1.87	33	225.24	27.03
9	75.87	2.10	34	228.64	28.79
10	83.90	2.32	35	231.31	30.23
11	91.92	2.62	36	233.97	31.67
12	99.95	2.92	37	236.64	33.11
13	109.24	3.33	38	239.30	34.55
14	118.53	3.75	39	241.97	35.99
15	129.80	4.52			
16	141.07	5.30			
17	152.34	6.08			
18	162.34	7.18			
19	172.35	8.27			
20	179.68	9.30			
21	187.01	10.33			
22	191.53	11.54			
23	196.05	12.74			
24	200.57	13.95			
25	203.40	15.12			

45.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : D1

Column : 460UB67.1 Fasteners: G8.8- -M20
Beam : 410UB59.7 M20.6 Oversize holes
Plate thickness : 16 mm Material : G250
Fy = 319 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.9999 pt = 11.2799 li = 23.1399 pc = 16.2799
cc = 5.0000 gt = 12.0000 gc = 12.0000
tp = 1.5999 nt = 2 X 2 nc = 2 X 2

Remark 1) The beam, 3 deg. to horizontal was subjected to cantilever loading.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	166.14	26.50
2	8.01	0.35	27	168.50	28.15
3	16.02	0.70	28	170.86	29.80
4	24.03	1.06	29	173.22	31.44
5	32.03	1.41	30	175.57	33.09
6	40.39	1.78	31	177.93	34.73
7	48.75	2.14	32	180.29	36.38
8	57.11	2.51	33	182.65	38.02
9	65.47	2.88			
10	73.94	3.67			
11	82.40	4.47			
12	90.87	5.26			
13	99.33	6.05			
14	107.67	7.46			
15	116.02	8.87			
16	122.00	10.40			
17	127.98	11.92			
18	133.96	13.45			
19	138.28	14.99			
20	142.59	16.52			
21	146.90	18.06			
22	151.21	19.59			
23	154.94	21.32			
24	158.68	23.05			
25	162.41	24.78			

46.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : D2

Column : 460UB67.1
Beam : 410UB59.7
Plate thickness : 16 mm

Fasteners: G8.8- -M20
M20.6 Oversize holes
Material : G250
Fy = 319 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 4.9999 pt = 11.2799 li = 23.1399 pc = 16.2799
cc = 5.0000 gt = 12.0000 gc = 12.0000
tp = 1.5999 nt = 2 X 2 nc = 2 X 2

Remark 1) 10 mm Doubler plates were welded to flange on both sides of column web.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	212.42	19.20
2	10.92	0.44	27	215.87	20.30
3	21.84	0.88	28	218.64	21.57
4	32.75	1.32	29	221.40	22.84
5	44.33	1.75	30	224.17	24.11
6	55.91	2.18	31	226.94	25.38
7	67.50	2.60	32	229.70	26.65
8	77.09	3.10	33	232.47	27.92
9	86.68	3.59	34	235.23	29.20
10	94.17	3.82			
11	101.65	4.06			
12	110.40	4.51			
13	119.14	4.96			
14	127.14	5.92			
15	135.13	6.88			
16	143.98	7.71			
17	152.84	8.54			
18	161.12	9.41			
19	169.41	10.28			
20	178.36	11.66			
21	187.31	13.04			
22	194.69	14.48			
23	202.08	15.91			
24	205.53	17.01			
25	208.98	18.11			

47.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : J.B.Davison et al. (1987) UNITED KINGDOM
Test Id. : JT/13B

Column : UC 152x152x23 Fasteners: G8.8- -M16
Beam : UB 254x102x22 --- Oversize holes
Plate thickness : 15 mm Material : 43A
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.0000 pt = 10.0000 li = 16.0000 pc = 4.1001
cc = 0.8999 gt = 7.5999 gc = 7.5999
tp = 1.5001 nt = 2 X 2 nc = 2 X 1

Remark 1) SLIP OCCURRED AT A RELATIVELY HIGH MOMENT
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	57.51	9.62
2	2.50	0.38	27	55.85	10.19
3	4.17	0.58			
4	5.83	0.58			
5	8.34	0.87			
6	10.84	1.35			
7	12.50	1.54			
8	16.67	1.73			
9	19.17	1.92			
10	20.84	2.12			
11	25.01	2.69			
12	26.67	2.88			
13	29.17	3.08			
14	31.26	3.17			
15	35.22	3.61			
16	39.18	4.04			
17	42.51	4.33			
18	45.85	4.62			
19	50.01	5.19			
20	51.68	5.58			
21	53.76	6.15			
22	55.85	6.73			
23	56.47	7.40			
24	57.10	8.08			
25	57.31	8.85			

48.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : D.B.Moore & P.A.C.Sims (1986) UNITED KINGDOM
Test Id. : J3

Column : UC 152x152x23 Fasteners: -- - -M16
Beam : UB 254x102x22 --- Oversize holes
Plate thickness : 15 mm Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.0000 pt = 10.0000 li = 13.4998 pc = 6.9002
cc = 1.0998 gt = 8.7000 gc = 8.7000
tp = 1.5001 nt = 2 X 2 nc = 2 X 1

Remark 1) FAIULRE OF COLUMN FLANGE AT 221.24 lb in
2) WEB FLANGE FRACTURE FOLLOWED BY BOLT FAILURE AT 677 lb in

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	76.69	67.50
2	5.00	0.38	27	78.69	72.00
3	10.00	0.75			
4	15.00	1.50			
5	20.01	1.88			
6	24.01	2.25			
7	26.92	3.75			
8	33.34	4.50			
9	36.68	7.50			
10	38.35	9.38			
11	40.02	12.75			
12	42.02	15.00			
13	44.02	18.75			
14	46.68	22.50			
15	49.35	26.25			
16	52.02	30.00			
17	54.68	33.75			
18	57.35	37.50			
19	59.35	41.25			
20	62.02	45.00			
21	64.68	48.75			
22	67.35	52.50			
23	70.68	56.25			
24	72.68	60.00			
25	74.68	63.75			

49.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : D.B.Moore & P.A.C.Sims (1986) UNITED KINGDOM
Test Id. : J4

Column : UC 152x152x23 Fasteners: -- - -M16
Beam : UB 254x102x22 --- Oversize holes
Plate thickness : 15 mm Material : G40.21
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on tension side only.
ct = 4.0000 pt = 10.0000 li = 13.4998 pc = 6.9002
cc = 1.0998 gt = 8.7000 gc = 8.7000
tp = 1.5001 nt = 2 X 2 nc = 2 X 1

Remark 1) TESTED WITH BACKING PLATES
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	75.96	31.88
2	5.00	0.30	27	77.24	33.75
3	10.00	0.60			
4	15.00	0.90			
5	20.01	1.35			
6	24.01	1.50			
7	30.01	1.88			
8	32.01	3.00			
9	34.34	3.75			
10	36.68	4.80			
11	38.35	5.62			
12	40.02	6.90			
13	41.35	7.50			
14	45.35	9.00			
15	46.68	9.75			
16	53.35	12.75			
17	56.68	15.00			
18	60.02	16.50			
19	63.35	18.75			
20	65.68	20.62			
21	68.02	22.50			
22	70.02	24.38			
23	72.02	26.25			
24	73.35	28.12			
25	74.68	30.00			

50.
Connection type : Extended end-plate connections
Mode : All bolted without column stiffener

Tested by : Y.L.Yee (1984) AUSTRALIA
Test Id. : B2

Column : 310UC96.8 Fasteners: G8.8- -M24
Beam : 460UB67.1 M27.0 Oversize holes
Plate thickness : 20 mm Material : G250
Fy = 260 MPa
Fu = -- MPa

Major parameters (cm)

End plate extended on both sides.
ct = 6.0000 pt = 13.2700 li = 24.8600 pc = 19.2700
cc = 6.0000 gt = 13.0000 gc = 13.0000
tp = 2.0000 nt = 2 X 2 nc = 2 X 2

Remark 1) The beam stub, 3 deg. to horizontal was subjected to cantilever loading.
2) End-plate yield stress (Fy) is mentioned.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	216.70	20.49
2	11.16	0.28	27	219.77	21.88
3	22.32	0.55	28	222.85	23.28
4	33.48	0.83	29	225.92	24.67
5	45.48	1.21	30	229.00	26.07
6	57.49	1.60	31	232.07	27.38
7	69.49	1.99	32	235.14	28.69
8	79.25	2.32	33	238.21	30.00
9	89.00	2.65	34	241.29	31.30
10	98.75	2.98	35	244.36	32.61
11	110.58	3.65			
12	122.41	4.31			
13	134.23	4.97			
14	142.54	5.68			
15	150.86	6.38			
16	159.31	7.28			
17	167.77	8.18			
18	175.26	9.39			
19	182.74	10.60			
20	188.54	11.74			
21	194.33	12.88			
22	199.15	14.43			
23	203.98	15.98			
24	208.80	17.54			
25	213.62	19.09			

II.16 Detalle ensayos unión placa rígida todo apernado con atiesador de columna

1.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 2

Column : W8x28 Fasteners: A325- -M19.1D
Beam : W10x21 M20.6 Oversize holes
Plate thickness : 1/2" Material : A36
Stiffener thickness : 0.9525cm Fy = 313 MPa
Fu = 484 MPa

Major parameters (cm)

ct = 1.2700 pt = 6.3500 li = 12.7000 pc = 6.3500
cc = 1.2700 gt = 8.8900 gc = 8.8900
tp = 1.2700 nt = 2 X 1 nc = 2 X 1

Remark 1) 3 X 7 1/8 X 3/8 COLUMN WEB STIFFENERS USED, FY = 50.5 KSI, FU = 72.5 KS
2) FY = 41.3, FU = 66.9 KSI FOR BEAM, FY = 51.1, FU = 77.3 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	61.53	21.44
2	2.71	0.20	27	62.53	23.52
3	5.31	0.50	28	63.52	25.60
4	7.97	0.75	29	64.22	27.82
5	10.62	1.00	30	64.92	30.04
6	13.28	1.30	31	65.63	32.26
7	15.94	1.60	32	66.33	34.48
8	18.59	1.90	33	67.03	36.70
9	21.25	2.20	34	67.59	38.98
10	23.91	2.50	35	68.16	41.27
11	26.56	2.80	36	68.72	43.55
12	29.22	3.25	37	69.29	45.83
13	31.87	3.70	38	69.85	48.12
14	34.53	4.25	39	70.42	50.40
15	37.19	4.80			
16	39.84	5.50			
17	42.50	6.20			
18	45.16	7.25			
19	47.81	8.30			
20	50.24	9.70			
21	52.67	11.10			
22	55.61	13.15			
23	58.55	15.20			
24	59.54	17.28			
25	60.54	19.36			

2.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 5

Column : W8x28 Fasteners: A325- -M19.1D
Beam : W10x21 M20.6 Oversize holes
Plate thickness : 1/2" Material : A36
Stiffener thickness : 0.6350cm Fy = 313 MPa
Fu = 484 MPa

Major parameters (cm)

ct = 1.2700 pt = 6.3500 li = 12.7000 pc = 6.3500
cc = 1.2700 gt = 8.8900 gc = 8.8900
tp = 1.2700 nt = 2 X 1 nc = 2 X 1

Remark 1) 3 X 7 1/8 X 1/4 COLUMN WEB STIFFENERS USED, FY = 49.6 KSI, FU = 71.9 KSI.
2) FY = 41.3, FU = 66.9 KSI FOR BEAM, FY = 51.1, FU = 77.3 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	63.41	31.80
2	2.66	0.25	27	64.46	36.60
3	5.31	0.50	28	65.50	41.40
4	7.97	0.75	29	66.55	46.20
5	10.62	1.00	30	67.59	51.00
6	13.28	1.25	31	68.33	55.64
7	15.94	1.50	32	69.07	60.27
8	18.59	1.75	33	69.81	64.91
9	21.25	2.00	34	70.55	69.55
10	23.91	2.35	35	71.29	74.18
11	26.56	2.70	36	72.03	78.82
12	29.22	3.15	37	72.77	83.45
13	31.87	3.60	38	73.51	88.09
14	34.53	4.20	39	74.25	92.73
15	37.19	4.80	40	74.99	97.36
16	39.84	5.60	41	75.73	102.00
17	42.50	6.40			
18	45.16	7.70			
19	47.81	9.00			
20	50.47	10.95			
21	53.12	12.90			
22	55.78	16.10			
23	58.44	19.30			
24	60.09	23.47			
25	61.75	27.63			

3.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 6

Column : W8x28
Beam : W10x21
Plate thickness : 3/8"
Stiffener thickness : 0.6350cm

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 313 MPa
Fu = 472 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 12.7000	pc = 6.3500
cc = 1.2700	gt = 8.8900	gc = 8.8900	
tp = 0.9525	nt = 2 X 1	nc = 2 X 1	

Remark 1) 3 X 7 1/8 X 1/4 COLUMN WEB STIFFENERS USED, FY = 49.6 KSI, FU = 71.9 KSI.
2) FY = 41.3, FU = 66.9 KSI FOR BEAM, FY = 51.1, FU = 77.3 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	55.61	40.50
2	2.66	0.15	27	56.24	43.72
3	5.31	0.30	28	56.88	46.94
4	7.97	0.50	29	57.51	50.16
5	10.62	0.70	30	58.14	53.38
6	13.28	0.90	31	58.78	56.60
7	15.94	1.10	32	59.16	59.96
8	18.59	1.55	33	59.54	63.32
9	21.25	2.00	34	59.93	66.68
10	23.91	2.55	35	60.31	70.04
11	26.56	3.10	36	60.70	73.40
12	29.22	3.90			
13	31.87	4.70			
14	34.53	6.05			
15	37.19	7.40			
16	39.84	9.65			
17	42.50	11.90			
18	45.16	15.35			
19	47.81	18.80			
20	49.13	22.07			
21	50.45	25.33			
22	51.77	28.60			
23	52.73	31.57			
24	53.69	34.55			
25	54.65	37.52			

4.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 7

Column : W8x28 Fasteners: A325- -M19.1D
Beam : W10x21 M20.6 Oversize holes
Plate thickness : 1/4" Material : A36
Stiffener thickness : 0.6350cm Fy = 320 MPa
Fu = 491 MPa

Major parameters (cm)

ct = 1.2700 pt = 6.3500 li = 12.7000 pc = 6.3500
cc = 1.2700 gt = 8.8900 gc = 8.8900
tp = 0.6350 nt = 2 X 1 nc = 2 X 1

Remark 1) 3 X 7 1/8 X 1/4 COLUMN WEB STIFFENERS USED, FY = 49.6 KSI, FU = 71.9 KSI.
2) FY = 41.3, FU = 66.9 KSI FOR BEAM, FY = 51.1, FU = 77.3 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	29.16	25.80
2	1.33	0.23	27	29.84	28.00
3	2.66	0.45	28	30.52	30.20
4	3.98	0.68	29	31.20	32.40
5	5.31	0.90	30	31.87	34.60
6	6.64	1.18	31	32.42	36.74
7	7.97	1.45	32	32.96	38.88
8	9.30	1.73	33	33.50	41.02
9	10.62	2.00	34	34.04	43.16
10	11.95	2.40	35	34.59	45.30
11	13.28	2.80	36	34.81	47.03
12	14.61	3.20	37	35.04	48.77
13	15.94	3.60	38	35.27	50.50
14	17.27	4.60			
15	18.59	5.60			
16	19.92	6.60			
17	21.25	7.60			
18	22.61	9.65			
19	23.96	11.70			
20	24.83	13.60			
21	25.70	15.50			
22	26.56	17.40			
23	27.21	19.50			
24	27.86	21.60			
25	28.51	23.70			

5.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 8

Column : W8x28
Beam : W10x21
Plate thickness : 1/4"
Stiffener thickness : 0.9525cm

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 320 MPa
Fu = 491 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 12.7000	pc = 6.3500
cc = 1.2700	gt = 8.8900	gc = 8.8900	
tp = 0.6350	nt = 2 X 1	nc = 2 X 1	

Remark 1) 3 X 7 1/8 X 3/8 COLUMN WEB STIFFENERS USED, FY = 50.5 KSI, FU = 72.5 KSI.
2) FY = 41.3, FU = 66.9 KSI FOR BEAM, FY = 51.1, FU = 77.3 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	29.16	26.10
2	1.33	0.12	27	29.84	28.30
3	2.66	0.25	28	30.52	30.50
4	3.98	0.38	29	31.20	32.70
5	5.31	0.50	30	31.87	34.90
6	6.64	0.78	31	32.30	36.80
7	7.97	1.05	32	32.73	38.70
8	9.30	1.32	33	33.16	40.60
9	10.62	1.60	34	33.59	42.50
10	11.95	1.98	35	34.02	44.40
11	13.28	2.35			
12	14.61	2.73			
13	15.94	3.10			
14	17.27	4.10			
15	18.59	5.10			
16	19.92	6.10			
17	21.25	7.10			
18	22.61	9.15			
19	23.96	11.20			
20	24.83	13.27			
21	25.70	15.33			
22	26.56	17.40			
23	27.21	19.57			
24	27.86	21.75			
25	28.51	23.93			

6.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 10

Column : W8x28 Fasteners: A325- -M19.1D
Beam : W10x21 M20.6 Oversize holes
Plate thickness : 3/4" Material : A36
Stiffener thickness : 0.9525cm Fy = 220 MPa
Fu = 403 MPa

Major parameters (cm)

ct = 1.2700 pt = 6.3500 li = 12.7000 pc = 6.3500
cc = 1.2700 gt = 8.8900 gc = 8.8900
tp = 1.9050 nt = 2 X 1 nc = 2 X 1

Remark 1) 3 X 7 1/8 X 3/8 COLUMN WEB STIFFENERS USED, FY = 40.5 KSI, FU = 60.3 KSI.
2) FY = 42.8, FU = 48.2 KSI FOR BEAM, FY = 45.9, FU = 74.9 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	65.95	12.25
2	2.66	0.05	27	68.50	14.60
3	5.31	0.10	28	70.19	16.80
4	7.97	0.25	29	71.89	19.00
5	10.62	0.40	30	73.58	21.20
6	13.28	0.55	31	74.43	23.28
7	15.94	0.70	32	75.28	25.37
8	18.59	0.85	33	76.13	27.45
9	21.25	1.00	34	76.97	29.53
10	23.91	1.15	35	77.82	31.62
11	26.56	1.30	36	78.67	33.70
12	29.22	1.50	37	79.43	35.79
13	31.87	1.70	38	80.19	37.87
14	34.53	2.00	39	80.95	39.96
15	37.19	2.30	40	81.70	42.04
16	39.84	2.60	41	82.46	44.13
17	42.50	2.90	42	83.22	46.21
18	45.16	3.35	43	83.98	48.30
19	47.81	3.80			
20	50.47	4.50			
21	53.12	5.20			
22	55.78	6.20			
23	58.44	7.20			
24	60.92	8.55			
25	63.41	9.90			

7.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 14

Column : W8x40
Beam : W12x27
Plate thickness : 3/8"
Stiffener thickness : 0.6350cm

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 433 MPa
Fu = 752 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 17.7800	pc = 6.3500
cc = 1.2700	gt = 10.1600	gc = 10.1600	
tp = 0.9525	nt = 2 X 1	nc = 2 X 1	

Remark 1) 4 X 7 X 1/4 COLUMN WEB STIFFENERS USED, FY = 52.5 KSI, FU = 75.3 KSI.
2) FY = 58.0, FU = 78.8 KSI FOR BEAM, FY = 42.0, FU = 71.6 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	69.99	29.98
2	2.66	0.10	27	71.27	32.25
3	5.31	0.20	28	72.54	34.52
4	8.85	0.87	29	73.81	36.80
5	12.40	1.53	30	75.14	39.27
6	15.94	2.20	31	76.46	41.75
7	19.48	2.80	32	77.79	44.23
8	23.02	3.40	33	79.12	46.70
9	26.56	4.00	34	79.65	48.80
10	30.10	4.67	35	80.18	50.90
11	33.65	5.33	36	80.70	53.00
12	37.19	6.00			
13	40.73	6.90			
14	44.27	7.80			
15	47.81	8.70			
16	50.47	9.90			
17	53.12	11.10			
18	55.78	12.85			
19	58.44	14.60			
20	60.81	16.85			
21	63.18	19.10			
22	64.54	21.50			
23	65.90	23.90			
24	67.31	25.80			
25	68.72	27.70			

8.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 15

Column : W8x40 Fasteners: A325- -M19.1D
Beam : W12x27 M20.6 Oversize holes
Plate thickness : 1/2" Material : A36
Stiffener thickness : 0.6350cm Fy = 292 MPa
Fu = 490 MPa

Major parameters (cm)

ct = 1.2700 pt = 6.3500 li = 17.7800 pc = 6.3500
cc = 1.2700 gt = 10.1600 gc = 10.1600
tp = 1.2700 nt = 2 X 1 nc = 2 X 1

Remark 1) 4 X 7 X 1/4 COLUMN WEB STIFFENERS USED, FY = 52.5 KSI, FU = 75.3 KSI.
2) FY = 58.0, FU = 78.8 KSI FOR BEAM, FY = 42.0, FU = 71.6 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	79.46	10.80
2	3.54	0.13	27	81.23	11.73
3	7.08	0.27	28	83.00	12.67
4	10.62	0.40	29	84.77	13.60
5	14.17	0.60	30	86.04	14.57
6	17.71	0.80	31	87.32	15.55
7	21.25	1.00	32	88.59	16.52
8	24.79	1.13	33	89.86	17.50
9	28.33	1.27	34	90.99	18.45
10	31.87	1.40	35	92.12	19.40
11	35.42	1.77	36	93.00	20.60
12	38.96	2.13	37	93.87	21.80
13	42.50	2.50	38	94.75	23.00
14	46.04	2.93	39	95.62	24.20
15	49.58	3.37			
16	53.12	3.80			
17	55.78	4.20			
18	58.44	4.60			
19	61.09	5.05			
20	63.75	5.50			
21	66.41	6.15			
22	69.06	6.80			
23	71.72	7.70			
24	74.37	8.60			
25	76.92	9.70			

9.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 16

Column : W8x40
Beam : W12x27
Plate thickness : 5/8"
Stiffener thickness : 0.6350cm

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 282 MPa
Fu = 504 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 17.7800	pc = 6.3500
cc = 1.2700	gt = 10.1600	gc = 10.1600	
tp = 1.5875	nt = 2 X 1	nc = 2 X 1	

Remark 1) 4 X 7 X 1/4 COLUMN WEB STIFFENERS USED, FY = 52.5 KSI, FU = 75.3 KSI.
2) FY = 58.0, FU = 78.8 KSI FOR BEAM, FY = 42.0, FU = 71.6 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	102.29	15.70
2	5.31	0.15	27	103.87	17.10
3	10.62	0.30	28	105.46	18.50
4	15.94	0.45	29	106.41	19.72
5	21.25	0.60	30	107.36	20.94
6	26.56	0.75	31	108.31	22.16
7	31.87	0.90	32	109.25	23.38
8	37.19	1.05	33	110.20	24.60
9	42.50	1.20	34	110.91	25.85
10	47.81	1.55	35	111.62	27.10
11	53.12	1.90	36	112.32	28.35
12	58.44	2.30	37	113.03	29.60
13	63.75	2.80			
14	69.06	3.40			
15	74.37	4.10			
16	79.35	5.10			
17	82.17	5.80			
18	85.00	6.50			
19	87.37	7.35			
20	89.75	8.20			
21	92.35	9.45			
22	94.95	10.70			
23	96.87	11.90			
24	98.79	13.10			
25	100.71	14.30			

10.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 20

Column : W8x24
Beam : W12x27
Plate thickness : 3/8"
Stiffener thickness : 0.6350cm

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 433 MPa
Fu = 490 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 17.7800	pc = 6.3500
cc = 1.2700	gt = 10.1600	gc = 10.1600	
tp = 0.9525	nt = 2 X 1	nc = 2 X 1	

Remark 1) 3 X 7 1/8 X 1/4 COLUMN WEB STIFFENERS USED, FY = 41.4 KSI, FU = 57.0 KSI.
2) FY = 58.0, FU = 78.8 KSI FOR BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	64.26	41.85
2	3.54	0.37	27	65.02	44.58
3	7.08	0.73	28	65.78	47.30
4	10.62	1.10	29	66.52	50.25
5	14.17	1.43	30	67.25	53.20
6	17.71	1.77	31	67.99	56.15
7	21.25	2.10	32	68.72	59.10
8	24.79	2.63	33	69.55	62.57
9	28.33	3.17	34	70.38	66.03
10	31.87	3.70	35	71.21	69.50
11	35.42	4.80			
12	38.96	5.90			
13	42.50	7.00			
14	45.16	8.60			
15	47.81	10.20			
16	50.47	12.85			
17	53.12	15.50			
18	54.63	18.40			
19	56.14	21.30			
20	57.65	24.20			
21	58.92	27.25			
22	60.19	30.30			
23	61.46	33.35			
24	62.73	36.40			
25	63.49	39.12			

11.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 21

Column : W8x24
Beam : W12x27
Plate thickness : 1/2"
Stiffener thickness : 0.6350cm

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 292 MPa
Fu = 490 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 17.7800	pc = 6.3500
cc = 1.2700	gt = 10.1600	gc = 10.1600	
tp = 1.2700	nt = 2 X 1	nc = 2 X 1	

Remark 1) 3 X 7 1/8 X 1/4 COLUMN WEB STIFFENERS USED, FY = 41.4 KSI, FU = 57.0 KSI.
2) FY = 58.0, FU = 78.8 KSI FOR BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	77.27	30.40
2	3.54	0.33	27	78.90	32.80
3	7.08	0.67	28	79.91	35.03
4	10.62	1.00	29	80.93	37.27
5	14.17	1.37	30	81.95	39.50
6	17.71	1.73	31	83.42	42.60
7	21.25	2.10	32	84.32	44.55
8	24.79	2.63	33	85.22	46.50
9	28.33	3.17	34	86.39	49.60
10	31.87	3.70	35	87.56	52.70
11	35.42	4.37	36	88.73	55.80
12	38.96	5.03	37	89.38	58.35
13	42.50	5.70	38	90.03	60.90
14	46.04	6.83	39	90.68	63.45
15	49.58	7.97	40	91.33	66.00
16	53.12	9.10			
17	55.55	10.30			
18	57.98	11.50			
19	60.92	13.25			
20	63.86	15.00			
21	66.40	17.50			
22	68.95	20.00			
23	71.49	22.80			
24	74.03	25.60			
25	75.65	28.00			

12.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 22

Column : W8x24
Beam : W12x27
Plate thickness : 5/8"
Stiffener thickness : 0.6350cm

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 294 MPa
Fu = 491 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 17.7800	pc = 6.3500
cc = 1.2700	gt = 10.1600	gc = 10.1600	
tp = 1.5875	nt = 2 X 1	nc = 2 X 1	

Remark 1) 3 X 7 1/8 X 1/4 COLUMN WEB STIFFENERS USED, FY = 41.4 KSI, FU = 57.0 KSI.
2) FY = 58.0, FU = 78.8 KSI FOR BEAM.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	73.56	20.68
2	3.54	0.17	27	74.89	22.66
3	7.08	0.33	28	76.23	24.64
4	10.62	0.50	29	77.56	26.62
5	14.17	0.63	30	78.90	28.60
6	17.71	0.77	31	80.03	30.50
7	21.25	0.90	32	81.16	32.40
8	24.79	1.13	33	82.29	34.30
9	28.33	1.37	34	83.42	36.20
10	31.87	1.60	35	84.09	37.97
11	35.42	2.00	36	84.77	39.73
12	38.96	2.40	37	85.45	41.50
13	42.50	2.80			
14	46.04	3.63			
15	49.58	4.47			
16	53.12	5.30			
17	55.44	6.25			
18	57.76	7.20			
19	60.75	8.65			
20	63.75	10.10			
21	66.01	11.80			
22	68.27	13.50			
23	69.59	15.23			
24	70.91	16.97			
25	72.23	18.70			

13.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 24

Column : W8x48
Beam : W12x27
Plate thickness : 5/8"
Stiffener thickness : 0.6350cm

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 294 MPa
Fu = 491 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 17.7800	pc = 6.3500
cc = 1.2700	gt = 10.1600	gc = 10.1600	
tp = 1.5875	nt = 2 X 1	nc = 2 X 1	

Remark 1) 4 X 6 3/4 X 1/4 COLUMN WEB STIFFENERS USED, FY = 41.4 KSI, FU = 57.0 KSI.
2) FY = 58.0, FU = 78.8 KSI FOR BEAM, FY = 38.4, FU = 65.7 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	103.46	12.17
2	5.31	0.15	27	104.89	13.10
3	10.62	0.30	28	106.25	13.85
4	15.94	0.40	29	107.60	14.60
5	21.25	0.50	30	108.02	15.30
6	26.56	0.65	31	108.43	16.00
7	31.87	0.80	32	108.85	16.70
8	37.19	1.00	33	109.70	17.45
9	42.50	1.20	34	110.54	18.20
10	47.81	1.45	35	109.24	19.05
11	53.12	1.70	36	107.94	19.90
12	58.44	2.05			
13	63.75	2.40			
14	69.06	2.90			
15	74.37	3.40			
16	79.40	4.30			
17	84.43	5.20			
18	87.15	5.80			
19	89.86	6.40			
20	92.35	7.25			
21	94.83	8.10			
22	96.75	8.83			
23	98.68	9.57			
24	100.60	10.30			
25	102.03	11.23			

14.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.Phillips & J.A.Packer (1981 CANADA
Test Id. : BM1

Column : W 200 x 100
Beam : W 250 x 33
Plate thickness : 3/8"
Stiffener thickness : 0.6096cm

Fasteners: A325- -M22.2D
--- Oversize holes
Material : G40.21
Fy = 284 MPa
Fu = -- MPa

Major parameters (cm)

ct =	1.0843	pt =	4.4158	li =	17.0002	pc =	4.4158
cc =	1.0843	pit=	6.0000	pi =	0.0000	pic=	11.0002
gt =	8.0000	gi =	8.0000	gc =	8.0000		
tp =	0.9525	nt =	2 X 1	ni =	2 X 1	nc =	2 X 1

Remark 1) SLIGHT INCREASE IN BOLT FORCE IN TOP BOLT ROW BEFORE SEPARATION
2) BOLT PRELOADED TO APROXIMATLY 39 kip

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	82.92	5.51
2	4.74	0.06	27	85.88	6.38
3	8.29	0.17	28	88.84	7.25
4	11.85	0.29	29	91.45	8.70
5	14.81	0.43	30	94.76	10.15
6	17.77	0.58	31	97.13	11.60
7	20.73	0.65	32	100.68	13.05
8	23.69	0.72	33	101.87	14.49
9	26.65	0.87	34	103.05	15.95
10	29.61	1.01	35	104.24	17.39
11	32.57	1.09	36	105.03	18.84
12	35.54	1.16	37	105.82	20.29
13	38.50	1.38	38	106.61	21.74
14	41.46	1.59	39	107.79	23.19
15	44.42	1.81	40	108.98	24.64
16	47.38	2.03	41	109.45	26.09
17	50.34	2.10	42	110.16	27.54
18	53.30	2.17	43	111.19	28.99
19	56.27	2.39	44	112.21	30.44
20	59.23	2.61	45	113.24	31.89
21	63.17	2.95	46	113.71	33.34
22	67.12	3.29	47	114.42	34.79
23	71.07	3.62	48	114.90	36.24
24	74.63	3.99	49	115.14	37.69
25	78.18	4.35	50	115.61	39.14
			51	116.08	40.59

15.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.Phillips & J.A.Packer (1981 CANADA
Test Id. : BM2

Column : W 200 x 100
Beam : W 250 x 33
Plate thickness : 5/8"
Stiffener thickness : 0.6096cm

Fasteners: A325- -M22.2D
--- Oversize holes
Material : G40.21
Fy = 300 MPa
Fu = -- MPa

Major parameters (cm)

ct =	1.0843	pt =	4.4158	li =	17.0002	pc =	4.4158
cc =	1.0843	pit=	6.0000	pi =	0.0000	pic=	11.0002
gt =	8.0000	gi =	8.0000	gc =	8.0000		
tp =	1.5875	nt =	2 X 1	ni =	2 X 1	nc =	2 X 1

Remark 1) SLIGHT INCREASE IN BOLT FORCE IN TOP BOLT ROW BEFORE SEPRATION
2) BOLT PRELOADED UPTO APROXIMATELY 39 kip

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	118.36	14.49
2	5.92	0.07	27	120.82	15.95
3	11.85	0.14	28	123.19	17.39
4	17.77	0.43	29	124.38	18.84
5	23.69	0.58	30	125.56	20.29
6	29.61	0.72	31	126.74	21.74
7	35.54	0.78	32	127.93	23.19
8	41.46	0.87	33	128.40	24.64
9	47.38	1.01	34	129.35	26.09
10	52.12	1.09	35	130.30	27.54
11	56.86	1.16	36	131.48	28.99
12	61.60	1.26	37	132.67	30.44
13	66.33	1.35	38	133.85	31.89
14	71.07	1.45	39	135.04	33.34
15	76.99	2.03	40	135.51	34.79
16	83.51	2.32	41	136.22	36.24
17	90.02	2.61	42	137.40	37.69
18	95.35	3.33			
19	100.68	4.06			
20	106.61	5.80			
21	108.98	7.25			
22	111.35	8.70			
23	112.53	10.15			
24	114.90	11.60			
25	117.27	13.05			

16.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.Phillips & J.A.Packer (1981 CANADA
Test Id. : BM3

Column : W 200 x 100
Beam : W 250 x 33
Plate thickness : 3/4"
Stiffener thickness : 0.6096cm

Fasteners: A325- -M22.2D
--- Oversize holes
Material : G40.21
Fy = 284 MPa
Fu = -- MPa

Major parameters (cm)

ct =	1.0843	pt =	4.4158	li =	17.0002	pc =	4.4158
cc =	1.0843	pit=	6.0000	pi =	0.0000	pic=	11.0002
gt =	8.0000	gi =	8.0000	gc =	8.0000		
tp =	1.9050	nt =	2 X 1	ni =	2 X 1	nc =	2 X 1

Remark 1) (A) BOLTS WERE PRELOADED (B) FAILURE OCCURED DUE TO BOLT FRACTURE
2) (A) CLEAR SEPARATION OCCURED (B) END PLATE COLLAPSED

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	125.32	15.95
2	5.92	0.07	27	126.98	17.39
3	11.85	0.14	28	128.05	18.84
4	17.77	0.22	29	129.11	20.29
5	23.69	0.29	30	130.30	21.74
6	29.61	0.43	31	132.19	23.19
7	35.54	0.58	32	133.02	24.64
8	41.46	0.72	33	133.85	26.09
9	47.38	0.87	34	134.80	27.54
10	53.30	1.01	35	135.75	28.99
11	59.23	1.16	36	136.58	30.44
12	65.15	1.30	37	137.40	31.89
13	71.07	1.45	38	139.77	33.34
14	76.99	1.84	39	140.96	34.79
15	82.92	2.22	40	141.55	36.24
16	88.84	2.61	41	142.14	37.69
17	94.76	3.19			
18	100.68	4.35			
19	106.61	5.80			
20	111.35	7.25			
21	113.71	8.70			
22	116.08	10.15			
23	118.45	11.60			
24	120.82	13.05			
25	124.38	14.49			

17.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.Phillips & J.A.Packer (1981 CANADA
Test Id. : BM4

Column : W 200 x 100
Beam : W 250 x 33
Plate thickness : 7/8"
Stiffener thickness : 0.6096cm

Fasteners: A325- -M22.2D
--- Oversize holes
Material : G40.21
Fy = 284 MPa
Fu = -- MPa

Major parameters (cm)

ct = 1.0843	pt = 4.4158	li = 17.0002	pc = 4.4158
cc = 1.0843	pit= 6.0000	pi = 0.0000	pic= 11.0002
gt = 8.0000	gi = 8.0000	gc = 8.0000	
tp = 2.2225	nt = 2 X 1	ni = 2 X 1	nc = 2 X 1

Remark 1) (A) BOLTS WERE PRELOADED (B) FAILURE DUE TO BOLT FRACTURE
2) (A) CLEAR SEPARATION OCCURED (B) END PLATE COLLAPSED

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	127.93	13.05
2	5.92	0.07	27	130.30	14.49
3	11.85	0.14	28	132.07	15.94
4	17.77	0.22	29	133.85	17.39
5	23.69	0.29	30	135.63	18.84
6	29.61	0.36	31	137.40	20.29
7	35.54	0.43	32	137.88	21.74
8	41.46	0.51	33	138.83	23.19
9	47.38	0.58	34	139.77	24.64
10	53.30	0.72	35	140.72	26.09
11	59.23	0.87	36	142.03	27.54
12	65.15	1.01	37	143.33	28.99
13	71.07	1.16	38	144.51	30.44
14	76.99	1.30	39	144.99	31.89
15	82.92	1.45	40	145.70	33.34
16	88.05	1.93			
17	93.18	2.42			
18	98.32	2.90			
19	102.46	3.62			
20	106.61	4.35			
21	112.53	5.80			
22	118.45	7.25			
23	120.82	8.70			
24	123.19	10.15			
25	125.56	11.60			

18.
Connection type : Flush end-plate connections
Mode : All bolted with column stiffener

Tested by : J.Phillips & J.A.Packer (1981 CANADA
Test Id. : BM5

Column : W 200 x 100
Beam : W 250 x 33
Plate thickness : 1"
Stiffener thickness : 0.6096cm

Fasteners: A325- -M22.2D
--- Oversize holes
Material : G40.21
Fy = 284 MPa
Fu = -- MPa

Major parameters (cm)

ct =	1.0843	pt =	4.4158	li =	17.0002	pc =	4.4158
cc =	1.0843	pit=	6.0000	pi =	0.0000	pic=	11.0002
gt =	8.0000	gi =	8.0000	gc =	8.0000		
tp =	2.5400	nt =	2 X 1	ni =	2 X 1	nc =	2 X 1

Remark 1) (A) BOLTS WERE PRELOADED (B) FAILURE DUE BOLT FRACTURE
2) (A) CLEAR SEPARATION OCCURED (B) END PLATE YIELDED

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	128.52	7.97
2	5.92	0.05	27	130.30	8.70
3	11.85	0.10	28	131.48	9.42
4	17.77	0.14	29	132.67	10.15
5	23.69	0.18	30	133.85	10.87
6	29.61	0.24	31	135.04	11.60
7	35.54	0.29	32	135.63	12.32
8	41.46	0.38	33	136.22	13.05
9	47.38	0.46	34	137.56	14.02
10	53.30	0.60	35	138.91	14.98
11	59.23	0.73	36	140.25	15.95
12	65.15	0.80	37	141.43	16.67
13	71.07	0.87	38	142.62	17.39
14	76.99	1.01	39	144.75	18.12
15	82.92	1.16	40	146.88	18.84
16	88.84	1.45	41	148.07	19.57
17	94.76	1.84	42	149.25	20.29
18	100.68	2.22	43	149.61	21.02
19	106.61	2.61	44	149.96	21.74
20	113.71	3.48	45	150.20	22.47
21	118.45	4.35	46	150.44	23.19
22	120.82	5.07	47	151.62	24.35
23	123.19	5.80			
24	124.97	6.52			
25	126.74	7.25			

II.17 Detalle ensayos unión placa rígida todo apernado sin atiesador de columna

1.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 1

Column : W8x28
Beam : W10x21
Plate thickness : 1/2"

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 313 MPa
Fu = 484 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 12.7000	pc = 6.3500
cc = 1.2700	gt = 8.8900	gc = 8.8900	
tp = 1.2700	nt = 2 X 1	nc = 2 X 1	

Remark 1) ACTUAL STRENGTH FY = 41.3 KSI, FU = 66.9 KSI FOR BEAM.
2) ACTUAL STRENGTH FY = 51.1 KSI, FU = 77.3 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	56.18	29.10
2	2.71	0.30	27	56.80	31.55
3	5.31	0.60	28	57.42	34.00
4	7.97	0.85	29	58.04	36.45
5	10.62	1.10	30	58.66	38.90
6	13.28	1.40	31	59.21	41.58
7	15.94	1.70	32	59.76	44.27
8	18.59	2.05	33	60.30	46.95
9	21.25	2.40	34	60.85	49.63
10	23.91	2.95	35	61.39	52.32
11	26.56	3.50	36	61.94	55.00
12	29.22	4.30			
13	31.87	5.10			
14	34.53	6.05			
15	37.19	7.00			
16	39.84	8.35			
17	42.50	9.70			
18	45.16	11.65			
19	47.81	13.60			
20	49.43	15.77			
21	51.05	17.93			
22	52.67	20.10			
23	53.55	22.35			
24	54.42	24.60			
25	55.30	26.85			

2.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 3

Column : W8x28 Fasteners: A325- -M19.1D
Beam : W10x21 M20.6 Oversize holes
Plate thickness : 3/8" Material : A36
Fy = 313 MPa
Fu = 472 MPa

Major parameters (cm)

ct = 1.2700 pt = 6.3500 li = 12.7000 pc = 6.3500
cc = 1.2700 gt = 8.8900 gc = 8.8900
tp = 0.9525 nt = 2 X 1 nc = 2 X 1

Remark 1) ACTUAL STRENGTH FY = 41.3 KSI, FU = 66.9 KSI FOR BEAM.
2) ACTUAL STRENGTH FY = 51.1 KSI, FU = 77.3 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	51.39	35.13
2	2.66	0.25	27	52.11	37.50
3	5.31	0.50	28	52.58	40.00
4	7.97	0.85	29	53.05	42.50
5	10.62	1.20	30	53.52	45.00
6	13.28	1.60	31	53.99	47.50
7	15.94	2.00	32	54.46	50.00
8	18.59	2.50	33	54.93	52.50
9	21.25	3.00			
10	23.91	3.70			
11	26.56	4.40			
12	29.22	5.35			
13	31.87	6.30			
14	34.53	7.80			
15	37.19	9.30			
16	39.84	11.75			
17	42.50	14.20			
18	43.83	16.48			
19	45.16	18.75			
20	46.48	21.02			
21	47.81	23.30			
22	48.53	25.67			
23	49.24	28.03			
24	49.96	30.40			
25	50.68	32.77			

3.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 4

Column : W8x28
Beam : W10x21
Plate thickness : 1/4"

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 320 MPa
Fu = 491 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 12.7000	pc = 6.3500
cc = 1.2700	gt = 8.8900	gc = 8.8900	
tp = 0.6350	nt = 2 X 1	nc = 2 X 1	

Remark 1) ACTUAL STRENGTH FY = 41.3 KSI, FU = 66.9 KSI FOR BEAM.
2) ACTUAL STRENGTH FY = 51.1 KSI, FU = 77.3 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	26.56	22.60
2	1.33	0.25	27	26.97	24.30
3	2.66	0.50	28	27.38	26.00
4	3.98	0.75	29	27.79	27.70
5	5.31	1.00	30	28.20	29.40
6	6.64	1.27	31	28.61	31.10
7	7.97	1.55	32	29.02	32.80
8	9.30	1.82	33	29.43	34.50
9	10.62	2.10	34	29.84	36.20
10	11.95	2.55			
11	13.28	3.00			
12	14.61	3.45			
13	15.94	3.90			
14	17.27	5.25			
15	18.59	6.60			
16	19.92	7.95			
17	21.25	9.30			
18	21.93	10.78			
19	22.61	12.25			
20	23.28	13.72			
21	23.96	15.20			
22	24.48	16.68			
23	25.00	18.16			
24	25.52	19.64			
25	26.04	21.12			

4.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 9

Column : W8x28
Beam : W10x21
Plate thickness : 3/4"

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 220 MPa
Fu = 403 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 12.7000	pc = 6.3500
cc = 1.2700	gt = 8.8900	gc = 8.8900	
tp = 1.9050	nt = 2 X 1	nc = 2 X 1	

Remark 1) ACTUAL STRENGTH FY = 42.8 KSI, FU = 48.2 KSI FOR BEAM.
2) ACTUAL STRENGTH FY = 45.9 KSI, FU = 74.9 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	60.17	26.23
2	2.66	0.15	27	60.87	28.80
3	5.31	0.30	28	61.56	31.37
4	7.97	0.40	29	62.26	33.93
5	10.62	0.50	30	62.96	36.50
6	13.28	0.70	31	63.57	39.33
7	15.94	0.90	32	64.17	42.15
8	18.59	1.10	33	64.78	44.98
9	21.25	1.30	34	65.39	47.80
10	23.91	1.55	35	66.00	50.62
11	26.56	1.80	36	66.60	53.45
12	29.22	2.10	37	67.21	56.27
13	31.87	2.40	38	67.82	59.10
14	34.53	2.95			
15	37.19	3.50			
16	39.84	4.35			
17	42.50	5.20			
18	44.82	6.40			
19	47.13	7.60			
20	49.90	10.00			
21	52.67	12.40			
22	54.71	15.30			
23	56.74	18.20			
24	58.78	21.10			
25	59.47	23.67			

5.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 11

Column : W8x40 Fasteners: A325- -M19.1D
Beam : W12x27 M20.6 Oversize holes
Plate thickness : 3/8" Material : A36
Fy = 433 MPa
Fu = 752 MPa

Major parameters (cm)

ct = 1.2700 pt = 6.3500 li = 17.7800 pc = 6.3500
cc = 1.2700 gt = 10.1600 gc = 10.1600
tp = 0.9525 nt = 2 X 1 nc = 2 X 1

Remark 1) ACTUAL STRENGTH FY = 58.0 KSI, FU = 78.8 KSI FOR BEAM.
2) ACTUAL STRENGTH FY = 42.0 KSI, FU = 71.6 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	60.73	25.40
2	2.66	0.20	27	62.17	27.90
3	5.31	0.40	28	63.12	30.29
4	7.97	0.60	29	64.07	32.67
5	10.62	0.80	30	65.02	35.06
6	13.28	1.05	31	65.98	37.44
7	15.94	1.30	32	66.93	39.83
8	18.59	1.65	33	67.88	42.21
9	21.25	2.00	34	68.84	44.60
10	23.91	2.35	35	69.68	46.80
11	26.56	2.70	36	70.53	49.00
12	29.22	3.10	37	71.38	51.20
13	31.87	3.50	38	72.23	53.40
14	34.53	4.00			
15	37.19	4.50			
16	39.84	5.30			
17	42.50	6.10			
18	44.87	7.35			
19	47.25	8.60			
20	50.07	10.70			
21	52.90	12.80			
22	54.56	15.33			
23	56.21	17.87			
24	57.87	20.40			
25	59.30	22.90			

6.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 12

Column : W8x40
Beam : W12x27
Plate thickness : 1/2"

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 292 MPa
Fu = 490 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 17.7800	pc = 6.3500
cc = 1.2700	gt = 10.1600	gc = 10.1600	
tp = 1.2700	nt = 2 X 1	nc = 2 X 1	

Remark 1) ACTUAL STRENGTH FY = 58.0 KSI, FU = 78.8 KSI FOR BEAM.
2) ACTUAL STRENGTH FY = 42.0 KSI, FU = 71.6 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	77.46	20.10
2	3.54	0.17	27	79.12	22.30
3	7.08	0.33	28	80.82	24.90
4	10.62	0.50	29	82.51	27.50
5	14.17	0.70	30	84.21	30.10
6	17.71	0.90	31	84.87	32.52
7	21.25	1.10	32	85.53	34.93
8	24.79	1.30	33	86.19	37.35
9	28.33	1.50	34	86.84	39.77
10	31.87	1.70	35	87.50	42.18
11	35.42	1.97	36	88.16	44.60
12	38.96	2.23	37	89.18	47.13
13	42.50	2.50	38	90.20	49.67
14	46.04	3.00	39	91.22	52.20
15	49.58	3.50			
16	53.12	4.00			
17	55.78	4.80			
18	58.44	5.60			
19	61.15	6.85			
20	63.86	8.10			
21	66.46	9.60			
22	69.06	11.10			
23	71.60	13.40			
24	74.15	15.70			
25	75.81	17.90			

7.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 13

Column : W8x40 Fasteners: A325- -M19.1D
Beam : W12x27 M20.6 Oversize holes
Plate thickness : 5/8" Material : A36
Fy = 282 MPa
Fu = 504 MPa

Major parameters (cm)

ct = 1.2700 pt = 6.3500 li = 17.7800 pc = 6.3500
cc = 1.2700 gt = 10.1600 gc = 10.1600
tp = 1.5875 nt = 2 X 1 nc = 2 X 1

Remark 1) ACTUAL STRENGTH FY = 58.0 KSI, FU = 78.8 KSI FOR BEAM.
2) ACTUAL STRENGTH FY = 42.0 KSI, FU = 71.6 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	84.66	17.80
2	3.54	0.27	27	86.20	19.13
3	7.08	0.53	28	87.75	20.47
4	10.62	0.80	29	89.29	21.80
5	14.17	1.13	30	90.59	23.60
6	17.71	1.47	31	91.89	25.40
7	21.25	1.80	32	93.19	27.20
8	24.79	2.13	33	94.49	29.00
9	28.33	2.47	34	95.62	30.88
10	31.87	2.80	35	96.75	32.76
11	35.42	3.23	36	97.88	34.64
12	38.96	3.67	37	99.01	36.52
13	42.50	4.10	38	100.14	38.40
14	46.04	4.63			
15	49.58	5.17			
16	53.12	5.70			
17	56.67	6.47			
18	60.21	7.23			
19	63.75	8.00			
20	66.41	8.80			
21	69.06	9.60			
22	74.03	11.40			
23	76.86	12.70			
24	79.69	14.00			
25	82.17	15.90			

8.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 17

Column : W8x24
Beam : W12x27
Plate thickness : 3/8"

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 433 MPa
Fu = 752 MPa

Major parameters (cm)

ct = 1.2700 pt = 6.3500 li = 17.7800 pc = 6.3500
cc = 1.2700 gt = 10.1600 gc = 10.1600
tp = 0.9525 nt = 2 X 1 nc = 2 X 1

Remark 1) ACTUAL STRENGTH FY = 58.0 KSI, FU = 78.8 KSI FOR BEAM.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	58.07	34.08
2	2.66	0.20	27	59.06	37.15
3	5.31	0.40	28	60.05	40.23
4	7.97	0.60	29	61.04	43.30
5	10.62	0.80	30	61.69	46.90
6	13.28	1.10	31	62.35	50.50
7	15.94	1.40	32	63.00	54.10
8	18.59	1.70	33	63.66	57.70
9	21.25	2.00	34	64.31	61.30
10	23.91	2.48	35	64.57	64.62
11	26.56	2.95	36	64.82	67.95
12	29.22	3.42	37	65.08	71.28
13	31.87	3.90	38	65.33	74.60
14	34.53	5.03			
15	37.19	6.15			
16	39.84	7.28			
17	42.50	8.40			
18	45.16	10.60			
19	47.81	12.80			
20	50.19	16.20			
21	52.56	19.60			
22	53.69	22.45			
23	54.82	25.30			
24	55.95	28.15			
25	57.08	31.00			

9.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 18

Column : W8x24
Beam : W12x27
Plate thickness : 1/2"

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 292 MPa
Fu = 490 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 17.7800	pc = 6.3500
cc = 1.2700	gt = 10.1600	gc = 10.1600	
tp = 1.2700	nt = 2 X 1	nc = 2 X 1	

Remark 1) ACTUAL STRENGTH FY = 58.0 KSI, FU = 78.8 KSI FOR BEAM.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	73.58	47.60
2	3.54	0.43	27	74.13	51.52
3	7.08	0.87	28	74.67	55.44
4	10.62	1.30	29	75.21	59.36
5	14.17	1.80	30	75.75	63.28
6	17.71	2.30	31	76.30	67.20
7	21.25	2.80	32	75.93	70.20
8	24.79	3.43	33	75.56	73.20
9	28.33	4.07	34	75.19	76.20
10	31.87	4.70	35	74.83	79.20
11	35.42	5.80			
12	38.96	6.90			
13	42.50	8.00			
14	45.85	9.77			
15	49.21	11.53			
16	52.56	13.30			
17	55.44	15.70			
18	58.32	18.10			
19	61.04	21.95			
20	63.75	25.80			
21	65.33	29.27			
22	66.91	32.73			
23	68.50	36.20			
24	70.19	40.00			
25	71.89	43.80			

10.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 19

Column : W8x24
Beam : W12x27
Plate thickness : 5/8"

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 282 MPa
Fu = 504 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 17.7800	pc = 6.3500
cc = 1.2700	gt = 10.1600	gc = 10.1600	
tp = 1.5875	nt = 2 X 1	nc = 2 X 1	

Remark 1) ACTUAL STRENGTH FY = 58.0 KSI, FU = 78.8 KSI FOR BEAM.
2)

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	63.52	21.20
2	2.66	0.20	27	64.20	23.14
3	5.31	0.40	28	64.88	25.08
4	7.97	0.65	29	65.56	27.02
5	10.62	0.90	30	66.24	28.96
6	13.28	1.15	31	66.91	30.90
7	15.94	1.40	32	67.57	33.10
8	18.59	1.70	33	68.23	35.30
9	21.25	2.00	34	68.89	37.50
10	23.91	2.35	35	69.55	39.70
11	26.56	2.70	36	70.21	41.90
12	29.22	3.15	37	70.87	44.10
13	31.87	3.60			
14	34.53	4.15			
15	37.19	4.70			
16	39.84	5.40			
17	42.50	6.10			
18	44.99	7.10			
19	47.47	8.10			
20	50.30	9.50			
21	53.12	10.90			
22	55.78	12.80			
23	58.44	14.70			
24	60.13	16.87			
25	61.83	19.03			

11.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.R.Ostrander (1970) CANADA
Test Id. : TEST 23

Column : W8x48
Beam : W12x27
Plate thickness : 5/8"

Fasteners: A325- -M19.1D
M20.6 Oversize holes
Material : A36
Fy = 282 MPa
Fu = 504 MPa

Major parameters (cm)

ct = 1.2700	pt = 6.3500	li = 17.7800	pc = 6.3500
cc = 1.2700	gt = 10.1600	gc = 10.1600	
tp = 1.5875	nt = 2 X 1	nc = 2 X 1	

Remark 1) ACTUAL STRENGTH FY = 58.0 KSI, FU = 78.8 KSI FOR BEAM.
2) ACTUAL STRENGTH FY = 38.4 KSI, FU = 65.7 KSI FOR COLUMN.

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	78.05	8.15
2	3.54	0.17	27	81.49	9.30
3	7.08	0.33	28	83.59	10.28
4	10.62	0.50	29	85.68	11.25
5	14.17	0.67	30	87.77	12.22
6	17.71	0.83	31	89.86	13.20
7	21.25	1.00	32	91.13	14.18
8	24.79	1.27	33	92.40	15.15
9	28.33	1.53	34	93.67	16.12
10	31.87	1.80	35	94.95	17.10
11	35.42	2.07	36	95.94	18.22
12	38.96	2.33	37	96.94	19.33
13	42.50	2.60	38	97.94	20.45
14	45.16	2.80	39	98.94	21.57
15	47.81	3.00	40	99.94	22.68
16	50.47	3.25	41	100.94	23.80
17	53.12	3.50			
18	55.78	3.80			
19	58.44	4.10			
20	61.09	4.45			
21	63.75	4.80			
22	66.29	5.25			
23	68.84	5.70			
24	71.72	6.35			
25	74.60	7.00			

12.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.B.Davison et al (1987) UNITED KINGDOM
Test Id. : JT/11

Column : UC 152x152x23 Fasteners: -- - -M16
Beam : UB 254x102x22 --- Oversize holes
Plate thickness : 12 mm Material : 43A
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

ct =	0.5001	pt =	5.0000	li =	15.0000	pc =	5.4000
cc =	0.5999	pit=	5.0000	pi =	0.0000	pic=	10.0000
gt =	7.5999	gi =	7.5999	gc =	7.5999		
tp =	1.1999	nt =	2 X 1	ni =	2 X 1	nc =	2 X 1

Remark 1) SUDDENLY FAILED AT 0,01 RADIAN AND 407 KIP-IN
2) (A) PREMATURE WELD FAILURE (B) MINOR AXIS CONNECTION

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	42.93	6.25
2	2.08	0.20	27	43.76	6.73
3	4.17	0.33	28	44.18	7.21
4	6.25	0.52	29	44.59	7.69
5	8.34	0.71	30	44.80	8.17
6	10.42	0.81	31	45.01	8.65
7	12.50	1.00	32	45.43	9.13
8	14.59	1.10	33	45.84	9.62
9	16.67	1.19	34	46.26	10.10
10	18.75	1.33	35	46.68	10.58
11	20.84	1.48			
12	22.92	1.50			
13	25.01	1.72			
14	27.09	1.80			
15	29.17	1.92			
16	31.26	2.16			
17	33.34	2.40			
18	35.43	2.88			
19	36.47	3.17			
20	37.51	3.46			
21	38.76	3.85			
22	39.80	4.33			
23	40.84	4.81			
24	41.47	5.29			
25	42.09	5.77			

13.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.B.Davison et al (1987) UNITED KINGDOM
Test Id. : JT/11B

Column : UC 152x152x23 Fasteners: -- - -M16
Beam : UB 254x102x22 --- Oversize holes
Plate thickness : 12 mm Material : 43A
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

ct = 0.5001	pt = 5.0000	li = 15.0000	pc = 5.4000
cc = 0.5999	pit= 5.0000	pi = 0.0000	pic= 10.0000
gt = 7.5999	gi = 7.5999	gc = 7.5999	
tp = 1.1999	nt = 2 X 1	ni = 2 X 1	nc = 2 X 1

Remark 1) THE BOLT STRIPPING WAS THE CAUSE OF FAILURE
2) MINOR AXIS CONNECTION

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	43.76	3.85
2	2.08	0.05	27	44.73	4.49
3	4.17	0.10	28	45.71	5.13
4	6.25	0.14	29	46.68	5.77
5	8.34	0.19	30	47.30	6.25
6	10.42	0.24	31	47.93	6.73
7	12.50	0.29	32	48.62	7.21
8	14.59	0.34	33	49.32	7.69
9	16.67	0.38	34	50.01	8.17
10	18.75	0.43	35	50.18	8.65
11	20.84	0.48	36	50.35	9.13
12	22.92	0.53	37	50.51	9.62
13	25.01	0.58	38	50.51	10.10
14	27.09	0.62	39	50.51	10.58
15	29.17	0.67	40	50.07	11.07
16	31.26	0.72	41	49.62	11.56
17	33.34	0.79	42	49.18	12.05
18	35.01	0.96	43	48.07	12.52
19	36.26	1.25	44	46.96	12.99
20	37.51	1.54	45	45.84	13.46
21	38.76	1.73			
22	40.01	1.92			
23	41.68	2.40			
24	42.37	2.88			
25	43.07	3.37			

14.
Connection type : Flush end-plate connections
Mode : All bolted without column stiffener

Tested by : J.B.Davison et al (1987) UNITED KINGDOM
Test Id. : JT/12

Column : UC 152x152x23 Fasteners: -- - -M16
Beam : UB 254x102x22 --- Oversize holes
Plate thickness : 12 mm Material : 43A
Fy = -- MPa
Fu = -- MPa

Major parameters (cm)

ct = 0.5001	pt = 5.0000	li = 15.0000	pc = 5.4000
cc = 0.5999	pit= 5.0000	pi = 0.0000	pic= 10.0000
gt = 7.5999	gi = 7.5999	gc = 7.5999	
tp = 1.1999	nt = 2 X 1	ni = 2 X 1	nc = 2 X 1

Remark 1) THE BOLT STRIPPING WAS THE FAILURE
2) MINOR AXIS CONNECTION

No	Moment (kN-m)	Rotation (radians) X 1/1000	No	Moment (kN-m)	Rotation (radians) X 1/1000
1	0.00	0.00	26	20.84	11.54
2	1.04	0.13	27	21.26	12.50
3	2.08	0.26	28	21.67	13.46
4	3.20	0.38	29	21.92	14.42
5	4.31	0.51	30	22.51	15.38
6	5.42	0.64	31	22.76	16.35
7	6.39	0.77	32	22.76	17.31
8	7.36	0.90	33	22.92	18.27
9	8.34	1.03	34	23.34	19.23
10	9.38	1.15	35	23.76	20.19
11	10.42	1.28	36	24.17	21.15
12	11.46	1.41	37	24.51	22.11
13	12.50	1.54	38	24.76	22.88
14	13.50	1.92	39	25.01	23.65
15	14.46	2.40			
16	15.42	2.88			
17	16.05	3.37			
18	16.67	3.85			
19	17.92	4.81			
20	18.76	5.77			
21	19.17	6.73			
22	19.59	7.69			
23	20.01	8.65			
24	20.17	9.62			
25	20.51	10.58			