UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

FACULTAD DE INGENIERÍA

Análisis y Diseño Estructural de una Nave Industrial

INFORME DE ACTIVIDADES PROFESIONALES

Que para obtener el título de

Ingeniero Civil

P R E S E N T A

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Ciudad Universitaria, Cd. Mx., 2024

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Introducción

Los edificios prefabricados de acero son construcciones fabricadas a base de elementos elaborados previamente en una planta de manufactura y ensamblados posteriormente en un sitio específico.

Debido a que la sociedad actual requiere edificios con un período de construcción menor, sin afectar la durabilidad o confiabilidad de estos, las estructuras prefabricadas de acero han ganado popularidad vertiginosamente durante los últimos años.

Entre las ventajas de una estructura de acero prefabricada respecto a una edificación convencional de concreto se encuentran: rapidez en el montaje, reciclabilidad, menor peso, mayor control de calidad durante la fabricación y que, por las características inherentes al acero, se requieren elementos estructurales de menor sección, por lo que se aumenta el espacio libre.

El presente documento ofrece una metodología para el análisis y diseño de una nave industrial localizada en una zona de baja sismicidad en Minnesota (EE. UU.).

En el primer capítulo se muestran todos los antecedentes relacionados con el proceso de análisis y diseño, incluyendo las normativas y códigos, las combinaciones de cargas y los requerimientos mínimos de cargas ambientales.

Por su parte, el capítulo segundo incluye los datos generales del proyecto, así como su localización geográfica, su geometría, la distribución de los elementos estructurales y una descripción muy específica de los sistemas de resistencia.

El tercer capítulo consiste en el diseño estructural de la estructura, desde la verificación de cargas hasta el diseño de los marcos, largueros y contraventeos. Asimismo, los planos estructurales obtenidos a partir de los resultados del diseño pueden consultarse en el capítulo cuatro.

Para finalizar, en el capítulo cinco, se presentan las conclusiones generales del proyecto, donde se aborda lo descrito a lo largo de todo el informe en el contexto de la experiencia profesional.

1. Antecedentes

1.1. Código de Construcción Internacional

Un código de construcción se define como el conjunto de normas que especifican el nivel mínimo aceptable de seguridad de una construcción. El Código Internacional de Construcción, o IBC por sus siglas en inglés, es un código modelo desarrollado por la organización global líder en códigos modelo, estándares y soluciones de seguridad estructural en edificaciones llamada Consejo Internacional de Códigos (ICC).

El IBC establece los estándares mínimos requeridos para proteger la vida y las propiedades de la población en general de todos los riesgos relacionados con la ocupación de edificios, estructuras o locales. En resumen, el propósito final del IBC es proteger la salud pública, la seguridad y el bienestar en lo que se refiere a la construcción de edificios.

Antes de la creación del IBC, diferentes códigos de construcción eran usados a lo largo de Estados Unidos, por lo que el desarrollo del código internacional consolidó esos códigos de construcción existentes en un código uniforme para ser usado dentro de los Estados Unidos y en el resto del mundo para la construcción de edificios.

1.1.1. Historia de los códigos de construcción en Estados Unidos

Históricamente, los primeros códigos de construcción se remontan al año 1800 a.C. cuando el emperador de Babilonia, Hammurabi, instauró lo que hoy en día se conoce como el Código de Hammurabi. Este reglamento era muy estricto y declaraba que si un constructor construía una casa para una persona de manera inadecuada, y esa casa se derrumbaba y mataba al dueño, entonces el constructor sería condenado a la pena de muerte.

En Estados Unidos, los primeros códigos de construcción se crearon en el año 1700 d.C., impulsados por George Washington y Thomas Jefferson con la intención de establecer regulaciones de construcción mínimas que garantizaran la salud y la seguridad de los ciudadanos americanos.

A principios de 1900, las compañías de seguros presionaron constantemente para continuar el desarrollo de los códigos de construcción con el objetivo final de reducir los pagos por pérdida de propiedad causados por estándares de construcción ineficientes y estructuras mal construidas. Durante este periodo, los oficiales encargados de hacer cumplir los códigos locales crearon la mayoría de los códigos de construcción con asistencia de la industria de la construcción.

En 1915 se fundó la Administración de Códigos y Funcionarios de Construcción, o BOCA por sus siglas en inglés. Esta organización creó lo que hoy se conoce como el Código Nacional de Construcción (NBC). En 1927 se instituyó la Conferencia Internacional de Oficiales de Construcción, o ICBO por sus siglas en inglés, creadores del Código Uniforme de Construcción

(UBC). En 1940 se instauró el Congreso Internacional de Código de Construcción del Sur, o SBCCI por sus siglas en inglés, y el Código Estándar de Edificaciones (SBC) se produjo en consecuencia.

A lo largo del tiempo, los códigos NBC, UBC y SBC recibieron constantes modificaciones y actualizaciones y en general, la información plasmada en ellos era muy similar entre sí, incluso tenían secciones duplicadas. Con el objetivo de evitar la información repetida y consolidar el conocimiento, BOCA, ICBO y SBCCI crearon el Consejo Internacional de Códigos (ICC). El propósito de la ICC fue crear un código sin limitaciones regionales y en 1994 empezó la creación de los primeros borradores que se convertirían en el Código Internacional de Construcción. Posteriormente, en 1997, se publicó la primera edición del IBC.

Las versiones actualizadas del IBC se publican cíclicamente, con un periodo de tres años entre una y otra, por lo que hoy en día existen nueve versiones: IBC 97, IBC 00, IBC 03, IBC 06, IBC 09, IBC 12, IBC 15, IBC 18 e IBC 21.

Cabe recalcar que, en Estados Unidos, cada gobierno local es responsable de elegir qué versión del IBC será la base de su código local de construcción, siendo opcional la utilización del código más reciente. Como resultado de lo descrito anteriormente, existen estados que todavía utilizan el IBC 09 en pleno 2024.

1.1.2. Combinaciones de carga

La sección 1605 del IBC enlista un conjunto de combinaciones de cargas para utilizarse con el método LRFD (1605.2) y dos conjuntos de combinaciones de carga para usar con el método de diseño ASD (1605.3). Ambos métodos arrojan resultados estructuralmente satisfactorios, pero para efectos de este trabajo el método seleccionado es el ASD.

A continuación, en la tabla No. 1.1, se enlistan las combinaciones de cargas requeridas para llevar a cabo el método de diseño ASD. Primero se presentan el conjunto de combinaciones de cargas estándar, seguido de las combinaciones de cargas sísmicas que utilizan factores de sobrerresistencia y al final las combinaciones de cargas adicionales requeridas cuando cargas vivas de entrepiso o cargas auxiliares de grúas están presentes.

Tabla No. 1.1 Combinaciones de carga

ASD	#	Combinación de Carga
Cargas Básicas (Muerta, Viva, Viento, Nieve y Sismo)	1	1.0 D + 1.0Lr
	2	1.0 D + 1.0Lr (NON-UNIFORM)
	3	1.0 D + 0.6W
	4	0.6 D + 0.6W
	5	1.0 D + 0.45 W + 0.75 Lr
	6	1.0 D + 1.0S
	7	1.0 D + 1.0S*
	8	1.0 D + 0.45 W + 0.75 S
	9	1.0 D + 0.7Eh+ 0.7Ev
	10	1.0 D + 0.525Eh+ 0.525Ev+ 0.15 S
	11	0.6 D + 0.7Eh-0.7Ev
	12	1.0 D + 0.7Emh+ 0.7Ev
	13	1.0 D + 0.525 Emh+ 0.525 Ev+ 0.15 S
	14	0.6 D + 0.7Emh-0.7Ev
Cargas Vivas de Entrepiso (Lf)	15	1.0 D + 1.0Lf
	16	1.0 D + 0.75 Lf+ 0.75 Lr
	17	1.0 D + 0.75 Lf+ 0.45 W
	18	1.0 D + 0.75 Lf+ 0.45 W + 0.75 Lr
	19	1.0 D + 0.75 Lf+ 0.75 S
	20	1.0 D + 0.75 Lf+ 0.45 W + 0.75 S
	21	1.0 D + 0.75 Lf+ 0.525 Eh+ 0.525 Ev
	22	1.0 D + 0.75 Lf+ 0.525 Eh+ 0.525 Ev+ 0.15 S
	23	1.0 D + 0.75 Lf+ 0.525 Emh+ 0.525 Ev
	24	1.0 D + 0.75 Lf+ 0.525 Emh+ 0.525 Ev+ 0.15 S
Cargas Vivas de Grua (Lc)	25	1.0 D + 1.0Lc
	26	1.0 D + 0.75 Lc+ 0.225 W
	27	1.0 D + 0.75 Lc+ 0.5625 S
	28	1.0 D + 0.75 Lc+ 0.225 W + 0.5625 S
	29	1.0 D +0.75 Lc+ 0.525 Eh+ 0.525 Ev
	30	1.0 D + 0.75 Lc+ 0.525 Eh+ 0.525 Ev+ 0.1125 S
	31	1.0 D + 0.75 Lc+ 0.525 Emh+ 0.525 Ev
	32	1.0 D + 0.75 Lc+ 0.525 Emh+ 0.525 Ev+ 0.1125 S
Cargas Vivas de Entrepiso y de Gruas (Lf and Lc)	33	1.0 D + 0.75 Lc+ 0.75 Lf
	34	1.0 D + 0.75 Lc+ 0.75 Lf+ 0.225 W
	35	1.0 D + 0.75 Lc+ 0.75 Lf+ 0.5625 S
	36	1.0 D + 0.75 Lc+ 0.75 Lf+ 0.225 W + 0.5625 S
	37	1.0 D + 0.75 Lc+ 0.75 Lf+ 0.525 Ev+ 0.525 Eh
	38	1.0 D + 0.75 Lc+ 0.75 Lf+ 0.525 Ev+ 0.525 Eh+ 0.1125 S
	39	1.0 D + 0.75 Lc+ 0.75 Lf+ 0.525 Ev+ 0.525 Emh
	40	1.0 D + 0.75 Lc+ 0.75 Lf+ 0.525 Ev+ 0.525 Emh+ 0.1125 S

Notación

- D = Cargas muertas, incluyendo todos los tipos de cargas muertas: D, Cg, Cu, Ce. Por ejemplo, el peso del panel, de los elementos estructurales primarios y secundarios, etc.
- Cg, Cu, Ce = Cargas colaterales como el peso muerto de plafones, tuberías contraincendios, equipos instalados en el techo, ductos y equipo de aire acondicionado.
- Dc = Carga muerta del sistema de una grúa: sistema de trabes, sistema de rieles, viga de puente, cabezales, gancho, carro, polipasto, etc.
- Df = Carga muerta de un sistema de entrepiso.
- Lc = Carga viva de una grúa.
- Lf = Carga viva de entrepiso.
- Lr = Carga viva de techo.
- Wm = Carga mínima de viento de acuerdo con el ASCE (16 lb/ft^2).
- S = Carga uniformemente distribuida de techo.
- SD = Carga de deriva de nieve.
- Sp = Carga parcial de nieve.
- Sr = Carga de lluvia sobre nieve.
- Ss = Carga de nieve deslizante.
- Su = Carga desequilibrada de nieve.
- R = Carga de lluvia acumulada.
- W = Carga de viento, basada en los coeficientes requeridos por el código y la velocidad máxima de viento.
- Eh = Carga horizontal de sismo. Esta carga tiene en cuenta tanto el cortante basal (V, E) como los efectos de las fuerzas de los componentes del muro (Fp).
- Emh = Carga horizontal máxima de sismo, incluyendo el factor de sobrerresistencia Ω_o.
- Ed = Carga horizontal de sismo utilizado para el desplazamiento lateral, incluye el factor de amplificación de deflexión (Cd) y el periodo del marco.
- Ev = Carga vertical de sismo.

Adicionalmente, es importante menciona que las combinaciones de cargas enlistas previamente en este informe aplican tanto el sistema estructural primario como al sistema estructural secundario del edificio.

1.1.2.1. Nieve en combinaciones de carga

El IBC define dos tipos de cargas de nieve:

a) Cargas nominales de nieve: Son los valores representativos para el periodo de retorno de 50 años.
b) La carga de nieve en “un punto arbitrario en el tiempo” que corresponde un evento de nieve extremo y raro.

El primer tipo de carga de nieve a menudo se llama "carga de nieve complementaria", ya que está destinado a combinarse y evaluarse en conjunto con otras cargas transitorias y no transitorias. El otro tipo de carga de nieve representa una carga extrema cuya ocurrencia no es probable que coincida con el valor máximo de cualquier otra carga transitoria; por lo tanto, esta carga se considera actuando sola, en combinación con cargas muertas únicamente.

1.1.2.2. Cargas internas de viento en combinaciones de carga

Las siguientes reglas se aplican para el uso de cargas de viento de presión o succión interna:

1) Cuando el viento es la carga principal y la única transitoria (aplicada además de las cargas muertas) tanto los casos de la succión interna como la presión interna deben de ser considerados.
2) Cuando el viento es la carga complementaria, solo se considerarán los casos de succión interna.
3) Cuando el viento es la carga principal y se combina con otras cargas transitorias:
    a. Si esas otras cargas se aplican a la superficie de techo (como S o Lr) solo se deben considerar los casos de succión interna.
    b. Si esas otras cargas no se aplican a la superficie de techo, tanto como presión como succión interna deben de ser consideradas.

1.1.3. Combinaciones de carga de servicio

La sección 1604.3 del IBC requiere que todos los elementos y sistemas estructurales tengan una rigidez adecuada para limitar la deflexión de miembros de techo o pared (en relación con sus soportes).

Los estados límite de servicio de las estructuras deben someterse a las cargas de servicio. Estas cargas no se deben factorizar, por lo tanto, las combinaciones de servicio son idénticas para los métodos de diseño ASD y LRFD como se muestra en la tabla 1.2.

Tabla 1.2 Combinaciones de servicio

ASD	#	Combinación de Carga
Cargas de Servicio	1	1.0 Lr
	2	1.0 Lf
	3	1.0 D + 1.0 Lf
	4	1.0 Lc
	5	1.0 Lp
	6	1.0 S
	7	0.42 W
	8	0.5 Fp
	9	1.0 Eh – 1.0 Ev
Desplazamiento Lateral	10	1.0 D + 1.0 Ed + 1.0 Ev
	11	1.0 D + 1.0 Ed – 1.0 Ev

1.2. ASCE 7-16 Cargas mínimas de diseño para edificaciones

La norma ASCE 7-16 establece cargas mínimas, niveles de riesgo, criterios asociados y expectativas de rendimiento para edificaciones, otras estructuras y sus componentes no estructurales que estén sujetos a los requisitos del código de construcción correspondiente.

Tanto las cargas, como las combinaciones de carga y el criterio asociado proporcionado en esta norma deben de usarse con las resistencias de diseño o los límites de relación de esfuerzo permisibles contenidos en las especificaciones de diseño para materiales estructurales. La utilización conjunta de ambos resulta en los niveles de rendimiento esperados plasmados en la norma.

1.2.1. Definiciones básicas

- Diseño de relación de esfuerzos aceptable o ASD por sus siglas en inglés: Método de diseño que proporciona elementos estructurales de tal manera que los esfuerzos calculados elásticamente producidos en dicho elemento por cargas nominales no excedan los esfuerzos admisibles del mismo.
- Edificaciones: Estructuras que usualmente se encuentran cerradas por muros y techos.
- Resistencia de diseño: El producto de la resistencia nominal por el factor de resistencia.
- Carga factorizada: El producto de una carga nominal y un factor de carga.
- Factor de Importancia: Un factor que toma en cuenta el grado de riesgo a la vida humana, la salud y bienestar asociados al daño a la propiedad o a la pérdida de funcionalidad de esta.
- Estado límite: Condición más allá de la cual una estructura o elemento se vuelve no apto para el servicio y se considera que deja de ser útil para la función prevista (estado límite de servicio) o que no es seguro (estado límite de falla).
- Efectos de carga: Fuerzas y deformaciones producidas en un elemento estructural debido a la aplicación de una carga.
- Factor de Carga: Un factor que tiene en cuenta las variaciones entre la carga real y la carga nominal, las incertidumbres en el análisis y de que ocurra más de una carga extrema simultáneamente.
- Cargas: Fuerzas u otras acciones resultantes del peso de todos los materiales de la edificación, usuarios y sus posesiones, efectos ambientales, movimientos diferenciales y restricciones en el cambio dimensional. Las cargas permanentes son cargas en las que las variaciones en el tiempo son raras o de pequeña magnitud. Todas las demás cargas se consideran cargas variables.
- Cargas nominales: La magnitud de las cargas especificadas en la norma para muerta, viva, nieve, lluvia y sismo.
- Resistencia nominal: La capacidad de una estructura o elemento de resistir los efectos de cargas determinada por cálculos basados en resistencias y dimensiones de materiales específicos y fórmulas derivadas de principios aceptados de mecánica estructural o pruebas

de campo o pruebas de laboratorio de modelos a escala, que permiten modelar efectos y diferencias, entre las condiciones de laboratorio y de campo.

- Ocupación: El propósito para el cual se usa o se pretende usar un edificio o cualquier otra estructura.
- Efecto P-Delta: El efecto de segundo orden en el cortante y el momento en un marco desplazado lateralmente inducido por cargas axiales.
- Factor de resistencia: Factor que toma en cuenta las variaciones entre la resistencia real y la resistencia nominal.
- Categoría de riesgo: Una clasificación de edificios y otras estructuras para determinar las cargas de nieve, hielo, sismos e inundaciones con base en el riesgo asociado con un desempeño inaceptable.
- Diseño de Resistencia: Método para proporcionar elementos estructurales de tal manera que las fuerzas calculadas producidas en el mismo por las cargas factorizadas no excedan la resistencia de diseño.

1.2.2. Cargas de nieve

1.2.2.1. Carga de nieve a nivel de suelo (p_g)

Es el peso de la nieve acumulada al nivel de suelo de un sitio específico que se usa para obtener las cargas de nieve en el techo de la estructura. Generalmente tiene se considera un periodo de retorno de 50 años.

1.2.2.2. Carga de nieve sin pendiente a nivel de techo (p_f)

Es la carga de nieve uniforme para edificios sin pendiente, se determina a partir de la siguiente ecuación:

$$p_f = 0.7\,\mathrm{Ce}\,\mathrm{Ct}\,\mathrm{I}\,p_g \qquad \text{Eq. 7.3-1 del ASCE}$$

donde:

Factor de exposición de nieve (Ce): Se obtiene de la tabla 7.3-1 del ASCE con base en la categoría del terreno (B, C o D) y el grado de exposición del techo (Totalmente expuesto, parcialmente expuesto o protegido).

Factor térmico (Ct): Se obtiene de la tabla 7.3-2 del ASCE pudiendo ser:

- Estructuras con una temperatura por encima del punto de calefacción = 1.1
- Estructuras sin calefacción o al aire libre = 1.2
- Edificios congeladores = 1.3
- Cualquier otra condición = 1.0

Factor de importancia (I): Se obtiene de la tabla 1.5.2 del ASCE y se basa en la categoría de ocupación del edificio.

1.2.2.3. Carga de nieve con pendiente a nivel de techo (p_s)

Carga de nieve uniforme en proyección horizontal de un techo inclinada. Se obtiene de la siguiente ecuación:

$$p_s = Cs\ p_f \qquad \text{Eq. 7.4-1 del ASCE}$$

Donde

P_f = carga de nieve sin pendiente a nivel de techo obtenido a partir de la Eq. 7.3-1
Cs = una vez dado el factor térmico, el factor de pendiente de techo es determinado por la figura No. 1.1 mostrada a continuación.

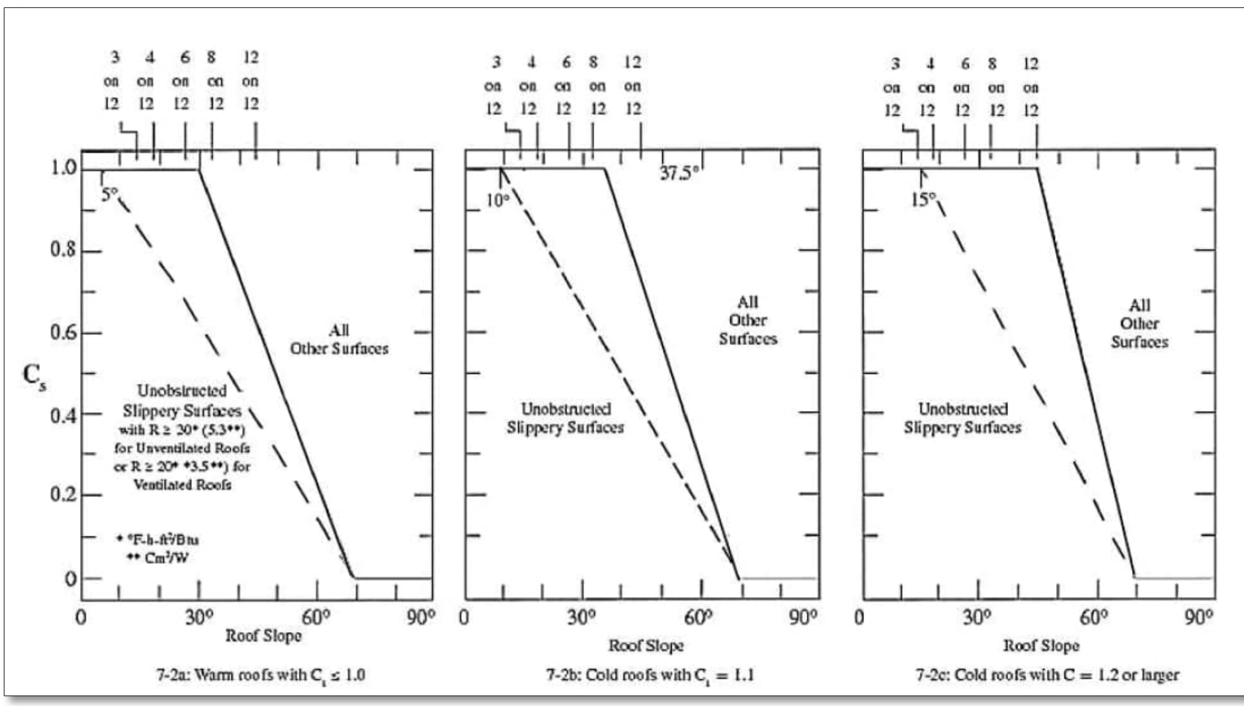


Figura No. 1.1 Coeficiente de pendiente de cubierta (7.4-1 del ASCE)

1.2.2.4. Carga desequilibrada de nieve (p_u)

En edificios a dos aguas, simétricos o asimétricos, con una pendiente superior a 2.38° e inferior a 30.2° s una porción de la nieve acumulada de la ladera de barlovento es transportada por la acción del viento y depositada detrás de la línea de cresta en la ladera de sotavento. Ver figura No. 1.2 para referencia.

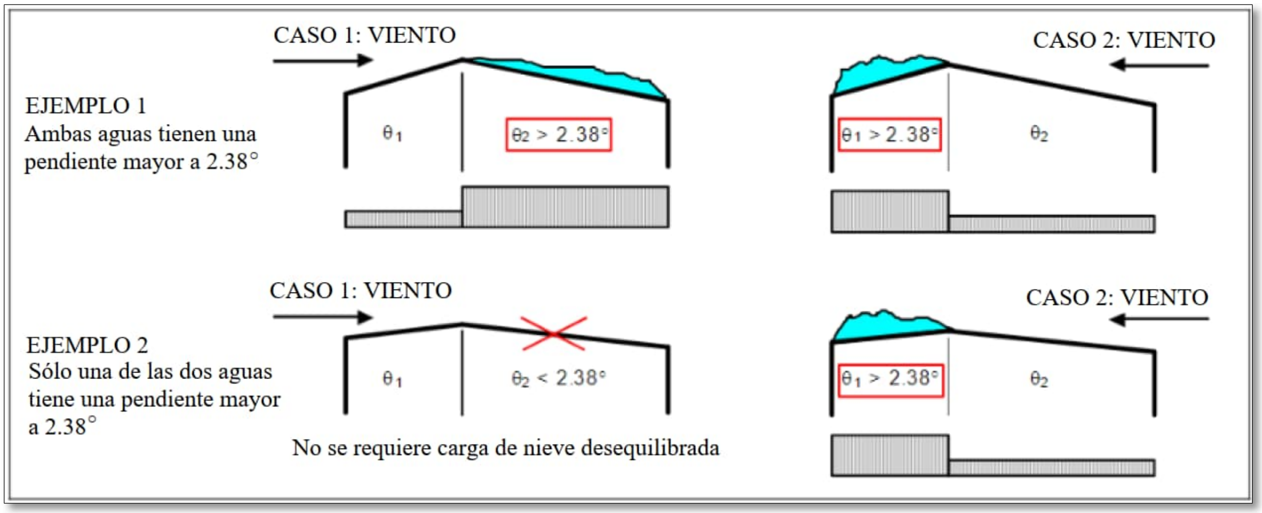


Figura No. 1.2 Carga desequilibrada de nieve (Elaboración propia)

En caso de que el edificio en cuestión satisfaga la geometría descrita en el párrafo anterior la carga desequilibrada de nieve debe de calcularse de acuerdo con la siguiente ecuación:

$$p_u = 0.3p_f \qquad \text{Eq. 7.6-1 del ASCE}$$

1.2.2.5. Deriva de nieve (SD)

Es la acumulación de nieve provocada por la acción del viento que genera una sobrecarga local en una estructura y que usualmente ocurre en las localizaciones donde existe una diferencia de alturas, como un parapeto.

La deriva de nieve debe de aplicarse de acuerdo con la figura No. 1.3, mostrada a continuación, y en conjunción con la carga de nieve a nivel de techo.

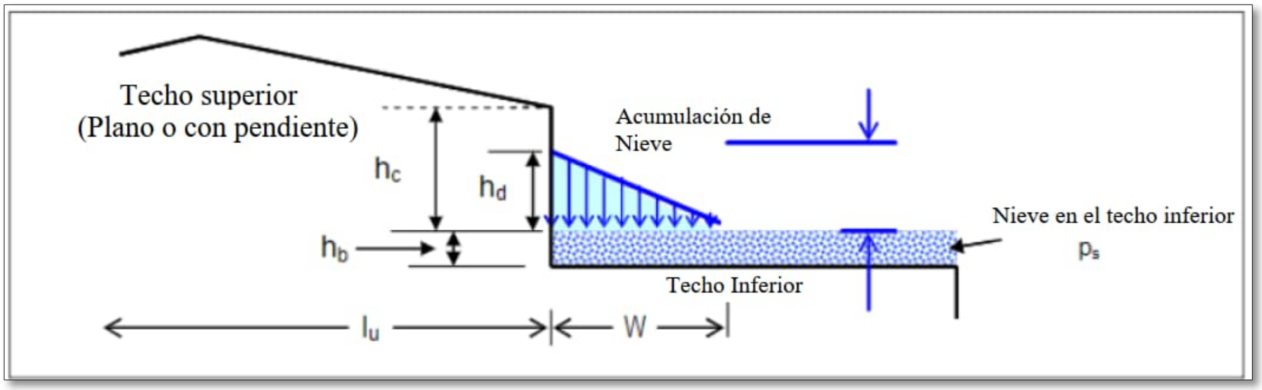


Figura No. 1.3 Deriva de nieve (Elaboración propia)

1.2.2.6. Deslizamiento de nieve (SS)

El deslizamiento de nieve de un techo superior a uno inferior debe de aplicarse en concordancia con la sección 7.9 del ASCE, como se muestra en la figura 1.4, considerando para ello la pendiente y la rugosidad del techo superior.

Es importante mencionar que el deslizamiento de nieve solo se aplica en los siguientes casos:

- Techos superiores resbaladizos con pendientes superiores a ¼ en 12.
- Techos superiores no resbaladizos con pendientes superiores a 2 en 12.

La magnitud de la nieve que se desliza desde el techo superior se obtiene a través de la siguiente ecuación:

$$p_u = 0.4 p_f W \qquad \text{Eq. 7.9-1 del ASCE}$$

Donde
W = Distancia horizontal desde el alero a la cresta del edificio

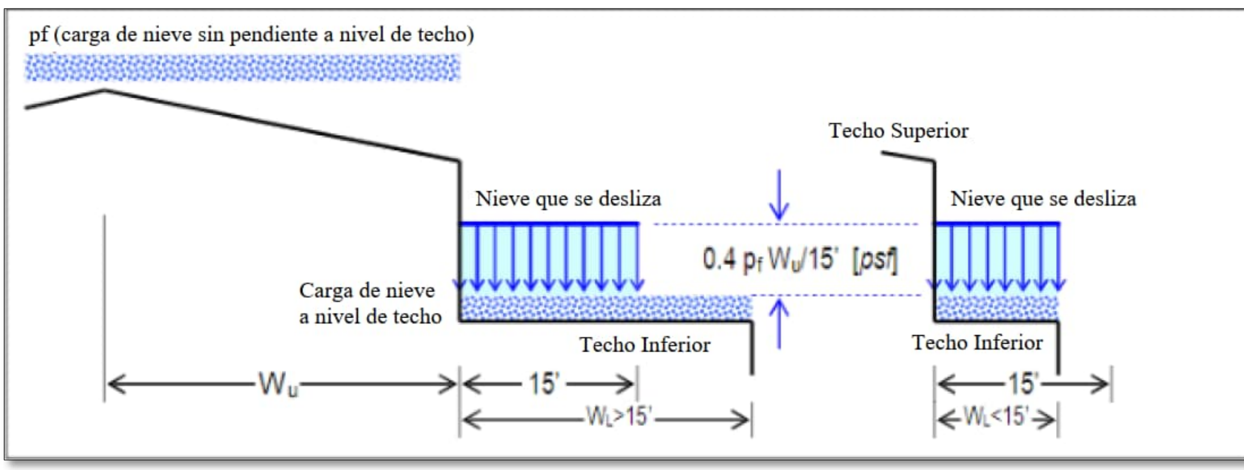


Figura No. 1.4 Deslizamiento de nieve (Elaboración propia)

1.2.3. Cargas de viento

En una edificación, tanto el sistema principal de resistencia a la fuerza de viento (MWFRS por sus siglas en inglés) como el sistema secundario de resistencia a la fuerza de viento (C&C por sus siglas en inglés) deben estar diseñados y construidos para soportar las cargas de viento en el sitio de trabajo donde vaya a erigirse la estructura en cuestión. La actual normativa provee los requerimientos mínimos de las solicitaciones de viento en los capítulos comprendido del 26 al 31 del ASCE.

1.2.3.1. Velocidad básica de viento (V)

La velocidad básica de viento, V, utilizada en la determinación de las cargas de viento de diseño de edificios y otras estructuras se determina a partir de cuatro mapas independientes (mostrados en las figuras de la 1.5 a la 1.8), contenidos en la norma ASCE.

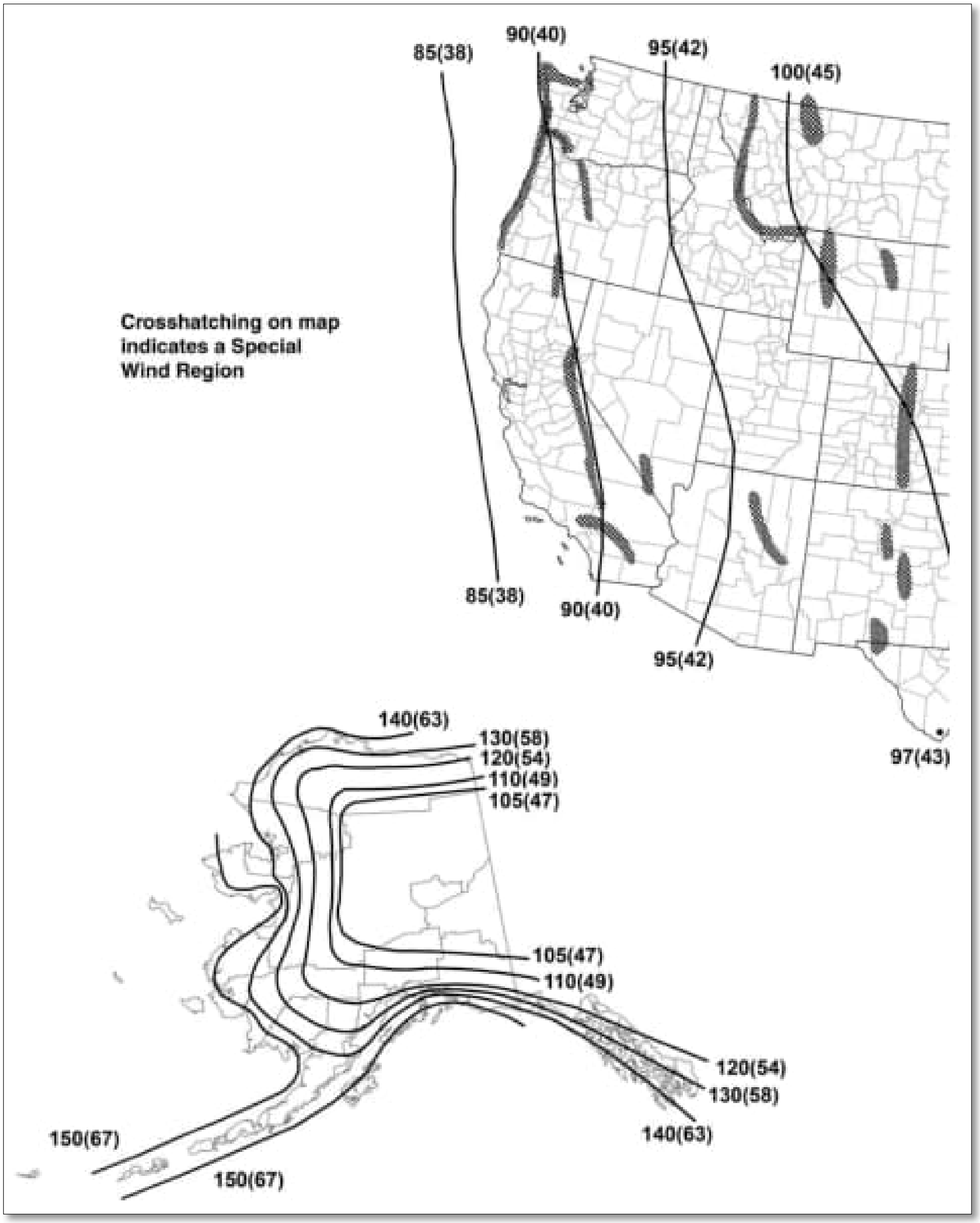


Figura No. 1.5a Velocidad Básica de Viento para Estructuras de Categoría de Riesgo I (26.5-1A ASCE)

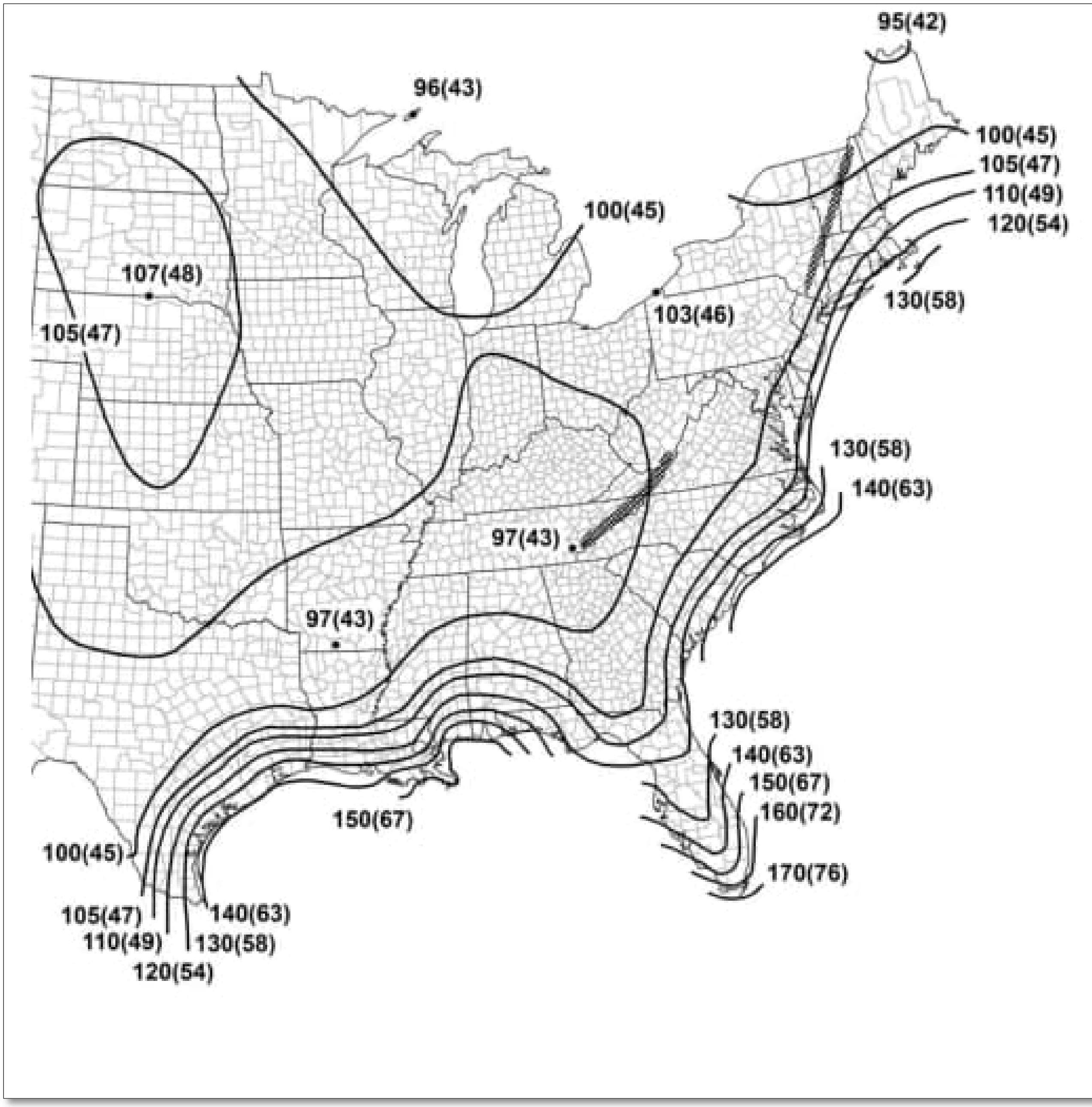


Figura No. 1.5b Velocidad Básica de Viento para Estructuras de Categoría de Riesgo I (26.5-1A ASCE)

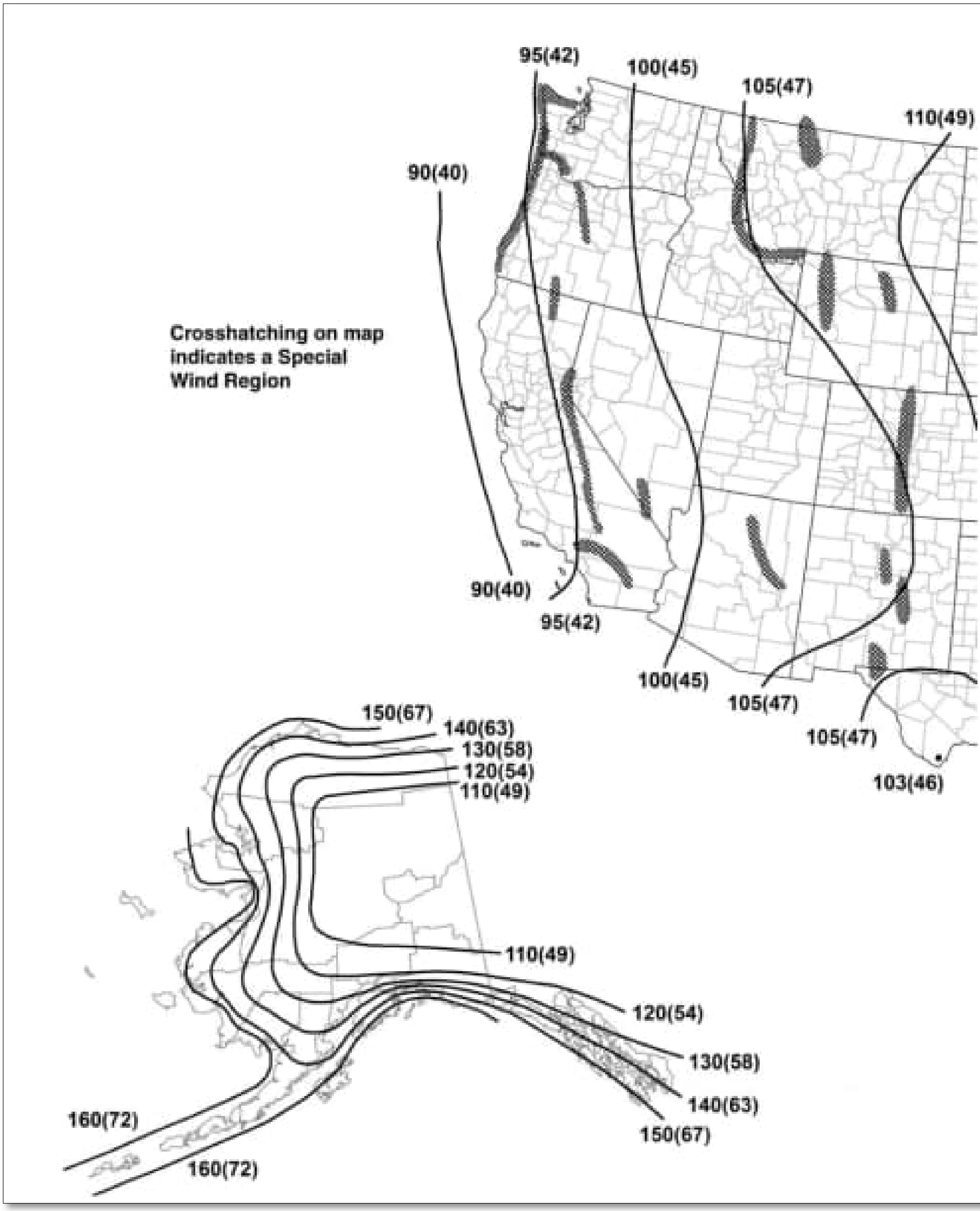


Figura No. 1.6a Velocidad Básica de Viento para Estructuras de Categoría de Riesgo II (26.5-1B ASCE)

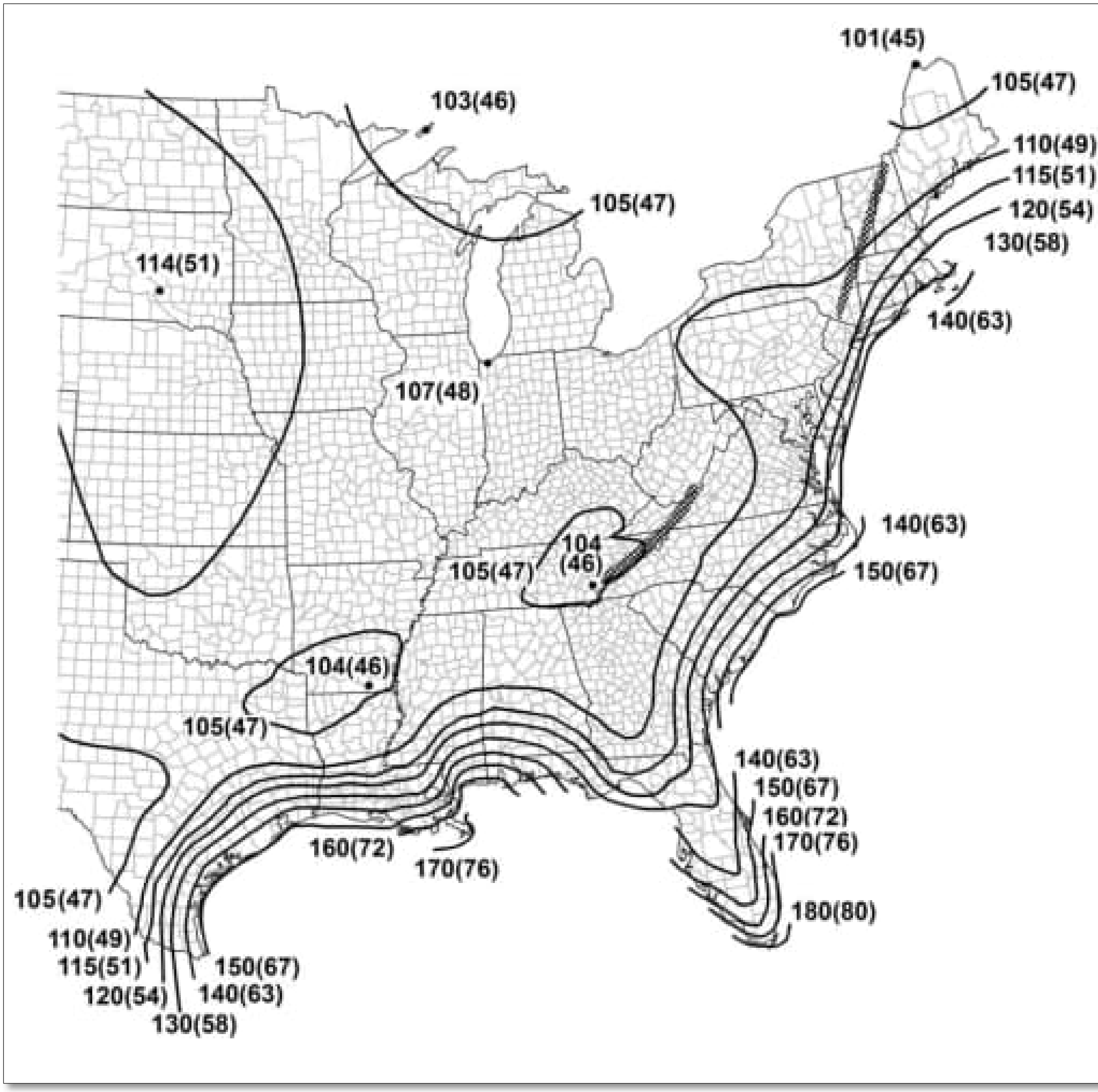


Figura No. 1.6b Velocidad Básica de Viento para Estructuras de Categoría de Riesgo II
(26.5-1B ASCE)

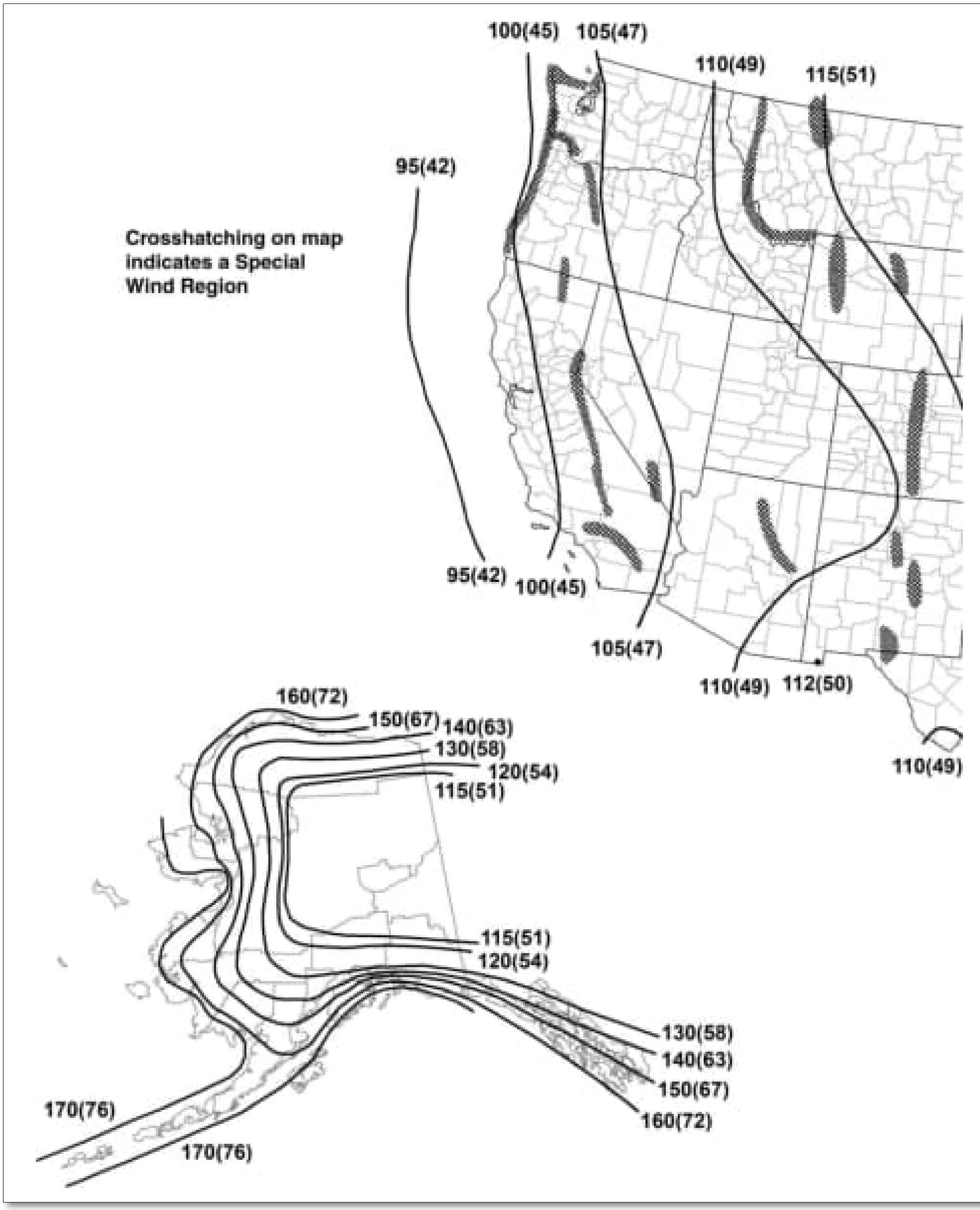


Figura No. 1.7a Velocidad Básica de Viento para Estructuras de Categoría de Riesgo III (26.5-1C ASCE)

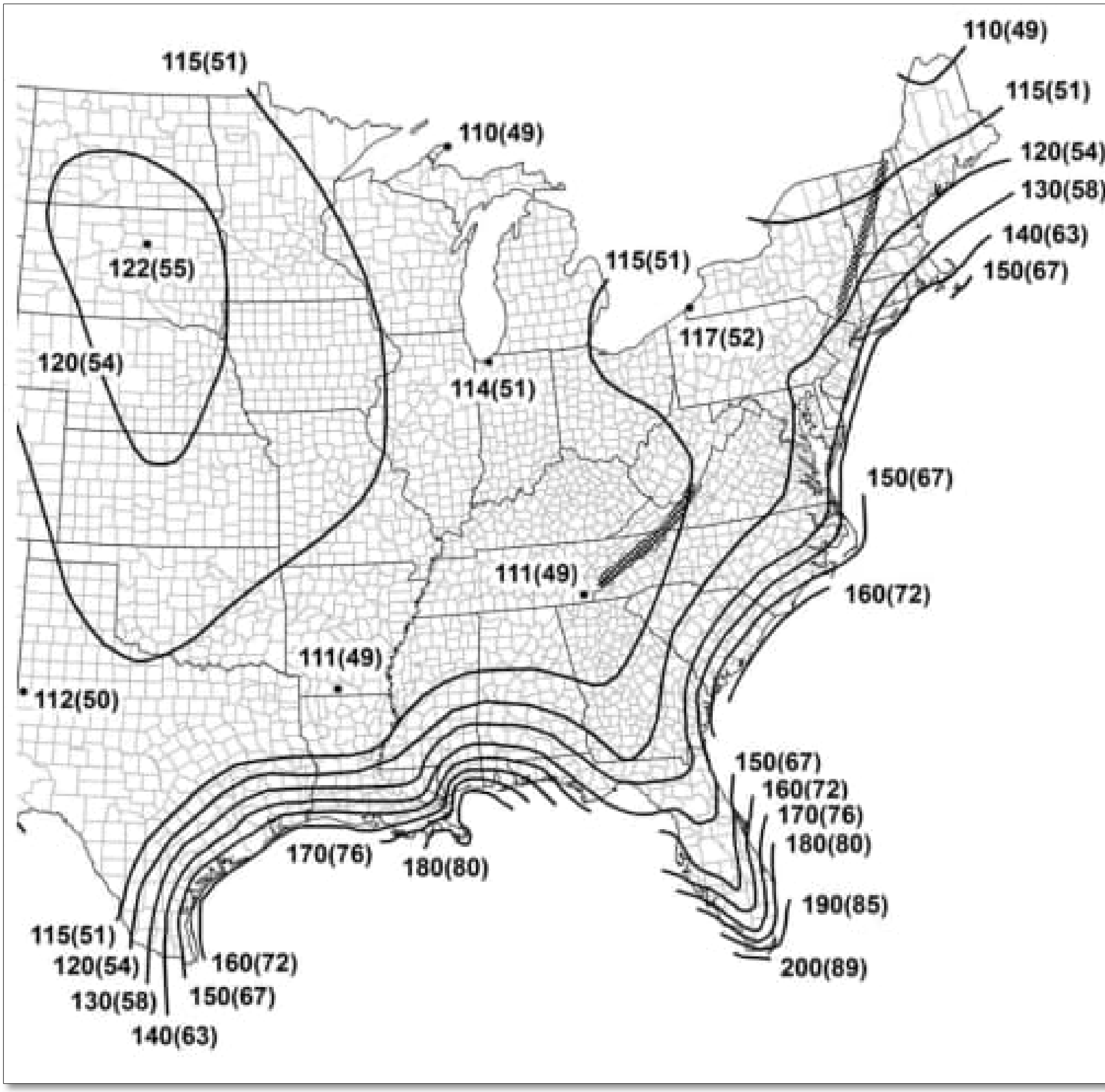


Figura No. 1.7b Velocidad Básica de Viento para Estructuras de Categoría de Riesgo III (26.5-1C ASCE)

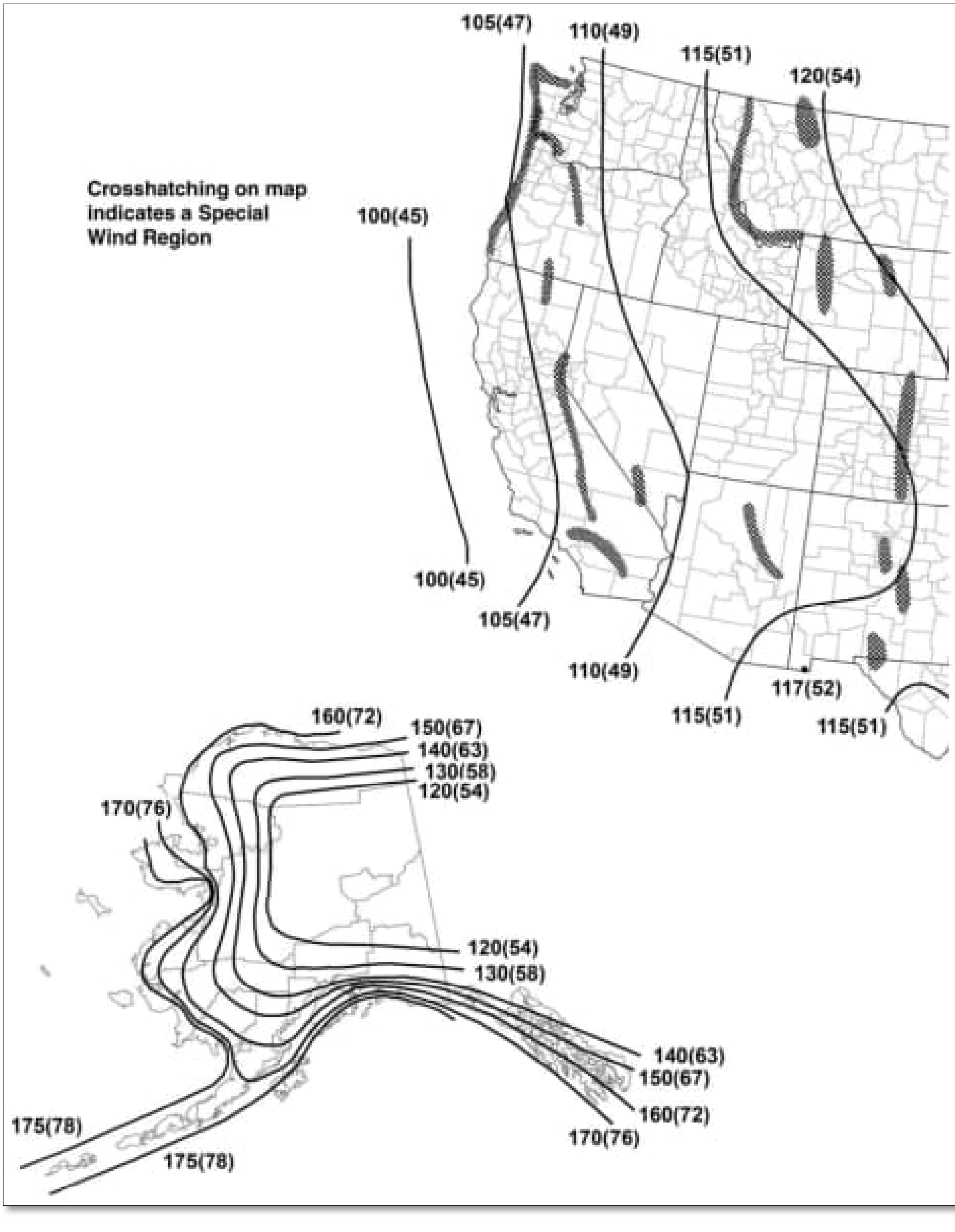


Figura No. 1.8a Velocidad Básica de Viento para Estructuras de Categoría de Riesgo IV (26.5-1C ASCE)

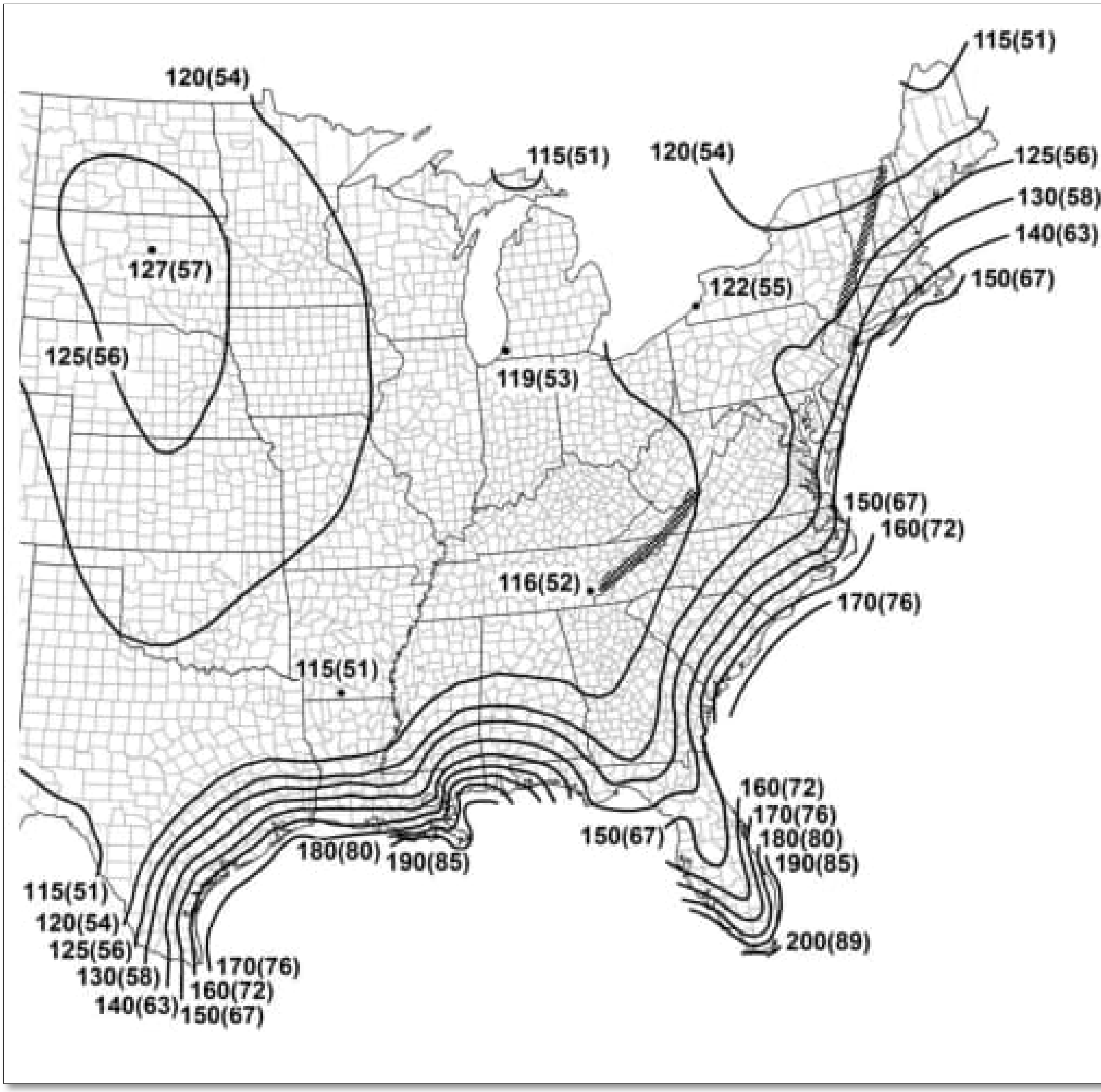


Figura No. 1.8b Velocidad Básica de Viento para Estructuras de Categoría de Riesgo IV
(26.5-1C ASCE)

1.2.3.2. Presión básica de viento (q_z)

La presión básica de viento, q_z, evaluada a la altura z sobre el suelo se debe calcular con base a la siguiente ecuación:

$$q_z = 0.00256\, K_z K_{zt} K_d K_e V^2 \qquad \text{Eq. 26.10-1 del ASCE}$$

Donde:
K_z = Coeficiente de exposición de viento, obtenido de la sección 26.10.1. del ASCE.
K_{zt} = Factor topográfico de viento, obtenido de la sección 26.8.2. del ASCE.
K_d = Factor de direccionalidad de viento, obtenido de la sección 26.6. del ASCE.
K_e = Factor de elevación de suelo, obtenido de la sección 26.9. del ASCE.
V = Velocidad básica de viento, obtenido de la sección 26.5. del ASCE.

1.2.3.3. Clasificación de cerramiento

Con la finalidad de determinar los coeficientes de presión interna de un edificio, este debe de ser clasificado en una de las siguientes cuatro categorías en función de sus aberturas: cerrado, parcialmente abierto, parcialmente cerrado, abierto libre y abierto obstruido. Con la finalidad de identificar correctamente la clasificación de cerramiento de un edificio en particular, se propone el siguiente diagrama de flujo (figura 1.9):

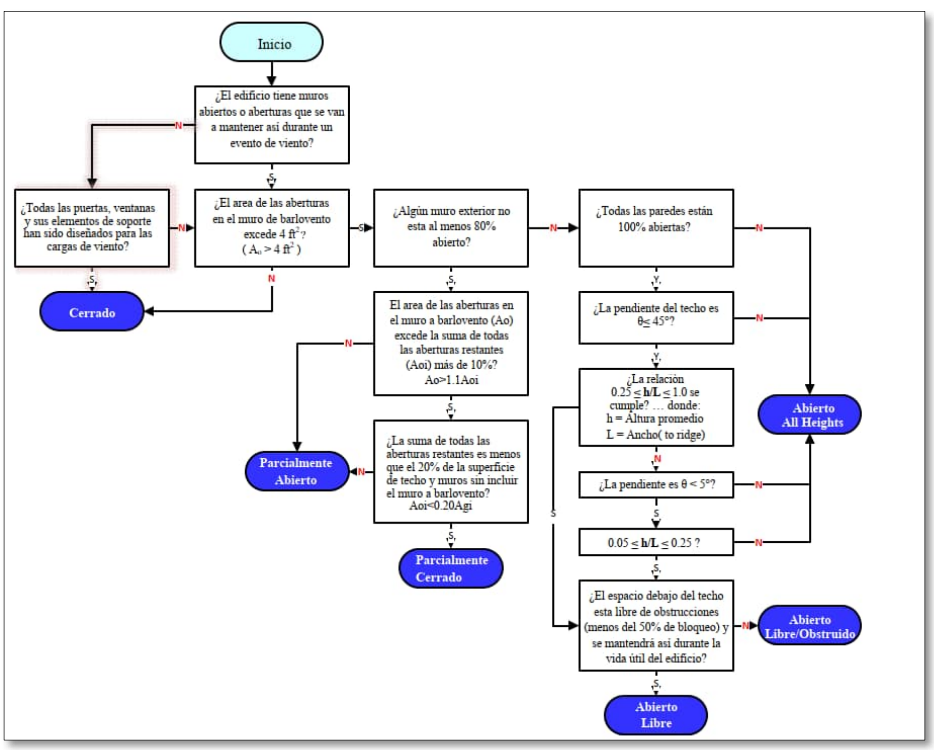


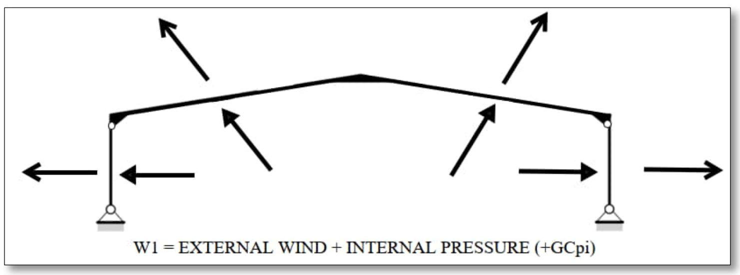
Figura 1.9. Diagrama de flujo para determinar la clasificación de cerramiento de un edificio. (Elaboración propia)

1.2.3.3.1. Coeficiente de presión interna

La tabla No. 1.3 (26.13-1 del ASCE 7-16) muestra los coeficientes de presión interna basados en la clasificación de cerramiento de la estructura en cuestión. Por su parte, en la figura se ilustran los diferentes escenarios de carga para una edificación determinada en función a si dentro de la misma existe presión o succión.

Tabla No. 1.3 Coeficientes de presión interna

Cerramiento	Presión Interna	Coeficiente de presión interna (GCpi)
Cerrado	Moderada	+0.18 -0.18
Parcialmente cerrado	Alta	+0.55 -0.55
Parcialmente abierto	Moderada	+0.18 -0.18
Abierto	Despreciable	0.00



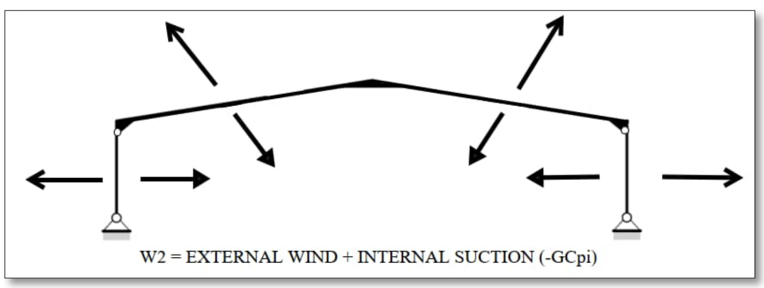


Figura No. 1.10 Coeficiente de presión interna en diferentes escenarios de carga (Elaboración propia)

1.2.3.4. Carga mínima de viento

Las cargas mínimas de vientos son cargas independientes del método de diseño por viento seleccionado, los coeficientes de presión o cualquier otro factor. Las cargas mínimas de viento deben de ser aplicadas en el sentido longitudinal y en el sentido transversal de la estructura como un caso de carga independiente y su magnitud mínima debe de ser de 16 psf.

2. Datos generales del proyecto

Durante los últimos 7 años en los que me he desempeñado como diseñador estructural en BlueScope Buildings NA he participado en el proceso de ingeniería de más de 200 naves industriales que en su mayoría fueron procesadas y fabricadas para clientes localizados en Estados Unidos, salvo algunas excepciones.

Intervenir activamente en el diseño de esas estructuras han permitido mi desarrollo gradual y progresivo como ingeniero, estoy completamente seguro de que todos y cada uno de esos proyectos contribuyeron en mayor o menor medida a mi formación profesional.

Adicionalmente me gustaría recalcar la dificultad tácita de participar en proyectos cuya localización final es diferente a mi país de origen ya que formar parte de un equipo de ingenieros internacional es al mismo tiempo un proceso enriquecedor y un reto. Más allá de la barrera de lenguaje intrínseca, la exposición a códigos de construcción internacionales complementó mi formación y me obligó a empujar mis límites. Afortunadamente en el camino me he encontrado con excelentes profesionistas que me han tendido una mano cada vez que he necesitado ayuda y que, con su ejemplo, me han enseñado a hacer lo mismo con compañeros de profesión con menor experiencia.

Hacer un análisis detallado de mi participación en todos esos proyectos es inviable; así que para efectos de este trabajo solo se considerará una nave industrial localizada en Minnesota, misma que diseñé en mayo del 2021 y que se erigió posteriormente.

Finalmente es importante mencionar que por razones obvias relacionadas con la protección de la información y la privacidad tanto el nombre del cliente como el del proyecto y la dirección exacta no se mencionarán durante el desarrollo del informe.

2.1. Localización del proyecto

La ubicación geográfica del proyecto de expansión es la siguiente:

País: Estados Unidos
Estado: Minnesota
Condado: Traverse
Ciudad: Browns Valley
CP: 56219
Coordenadas: 45.5952262, -96.83350399999999

En las figuras 2.1 y 2.2 se muestran tanto un mapa Minnesota así como una imagen satelital del edificio existente y el proyecto de expansión.

Figura No. 2.1 Localización geográfica del proyecto.

Figura No. 2.2 Imagen satelital del sitio de construcción.

Browns Valley es una pequeña ciudad localizada al norte de los Estados Unidos en el estado de Minnesota, casi en su frontera con Dakota del Sur. La ciudad recibe su nombre debido a Joseph R. Brown quién colonizó por primera vez estas tierras en 1867.

Geográficamente la ciudad descansa en un antiguo sendero glaciar, en el centro de la brecha de Traverse, anteriormente el canal de un antiguo río, pero hoy en día un valle. A pesar de la baja elevación sobre el nivel del mar y la topografía plana de su suelo, la ciudad marca el punto más al sur de la llamada Divisoria Laurentina (división continental entre las cuencas hidrográficas del océano ártico y el atlántico)

2.2. Descripción general del proyecto

El proyecto en cuestión es parte de una extensión de un edificio existente. Ambos edificios se consideraron completamente independientes entre sí ya que la única conexión entre ellos se llevó a cabo con elementos no estructurales como paneles y juntas flexibles.

Ninguna de las edificaciones mostradas en la figura 6 exceden la altura de alero de la nave industrial por lo que dichas estructuras no imponen cargas suplementarias ni condicionan los efectos ambientales como la nieve o el viento. Adicionalmente, es digno de mención que la poca interacción entre las estructuras existentes en el sitio d construcción con la nueva nave industrial se tomaron en cuenta para la selección de la categoría de exposición al viento y la condición de exposición de la superficie de techo en concordancia con la norma ASCE 7-16.

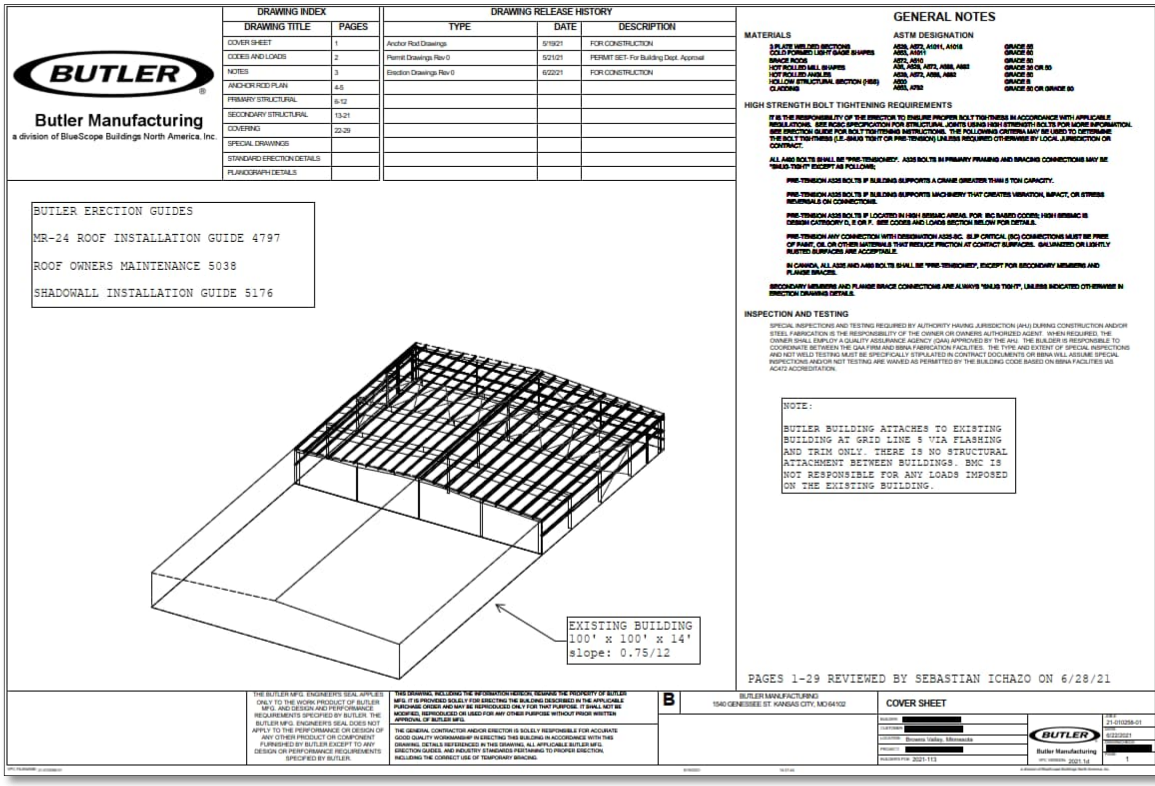
2.2.1. Dimensiones y Geometría

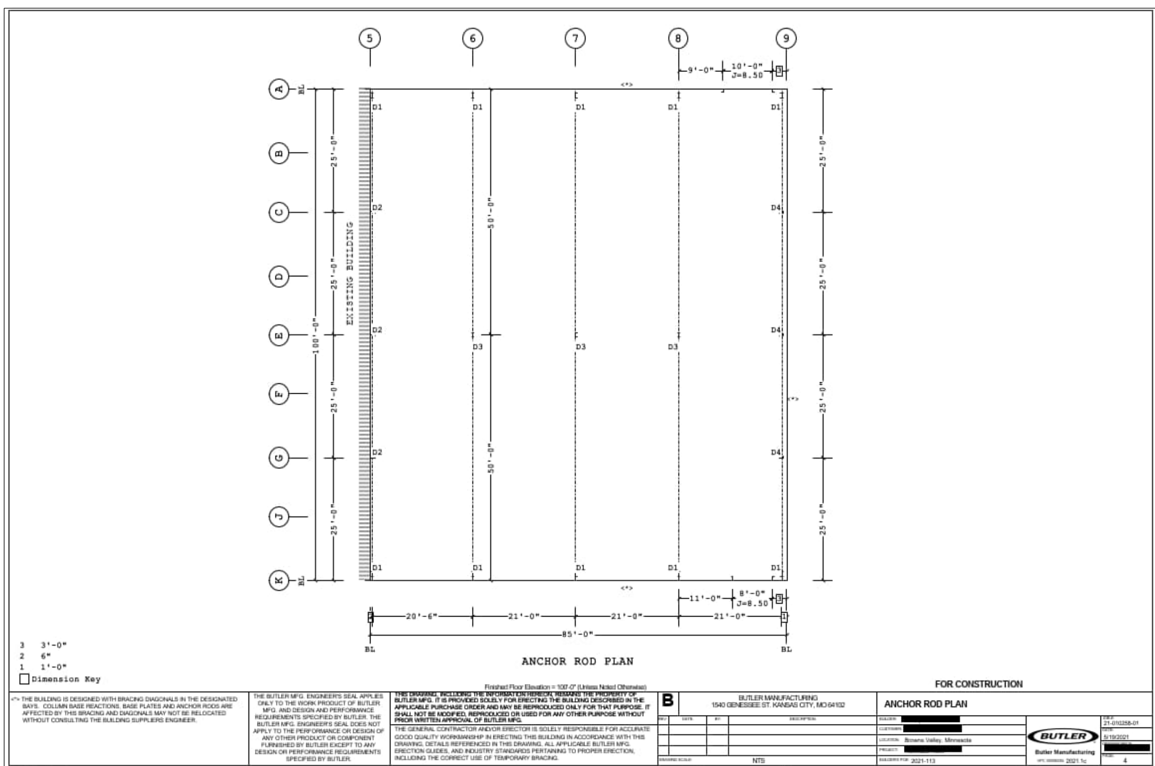
2.2.1.1. Edificio existente

El edificio existente tiene actualmente un uso comercial, es una nave industrial a dos aguas con un ancho de 100 pies y un largo de igual magnitud, la cumbrera se encuentra exactamente a la mitad del ancho del edificio. La altura del alero del edificio es de 14 pies, la pendiente del techo de 0.7500 en 12 y la altura de la cumbrera es de 17 pies y 1.5 pulgadas. Se desconoce tanto el año de construcción como la estructuración general de dicho edificio

2.2.1.2. Proyecto de expansión

La solicitud del cliente respecto al proyecto de expansión incluyó igualar la geometría del edificio existente en su sección transversal, es decir, mantener la condición del techo a dos aguas, la altura del alero en 14 pies, la altura de la cumbrera en 17 pies y 1.5 pulgadas, el ancho de 100 pies y localizar la cumbrera a 50 pies respecto al alero. La única discrepancia fue el largo ya que la longitud final del edificio de expansión fue de 85 pies. Ver figuras 2.3a. 2.3b y 2.3c para referencia de las características geométricas de la estructura.


BUTLER
Butler Manufacturing
a division of BlueScope Buildings North America, Inc.
DRAWING INDEX
DRAWING RELEASE HISTORY
GENERAL NOTES
BUTLER ERECTION GUIDES
MR-24 ROOF INSTALLATION GUIDE 4797
ROOF OWNERS MAINTENANCE 5038
SHADOWALL INSTALLATION GUIDE 5176
NOTE:
BUTLER BUILDING ATTACHES TO EXISTING BUILDING AT GRID LINE 5 VIA FLASHING AND TRIM ONLY. THERE IS NO STRUCTURAL ATTACHMENT BETWEEN BUILDINGS. BMC IS NOT RESPONSIBLE FOR ANY LOADS IMPOSED ON THE EXISTING BUILDING.
EXISTING BUILDING
100' x 100' x 14'
slope: 0.75/12
PAGES 1-29 REVIEWED BY SEBASTIAN ICHAZO ON 6/28/21
COVER SHEET


EXISTING BUILDING
ANCHOR ROD PLAN
FOR CONSTRUCTION
Dimension Key
NTS

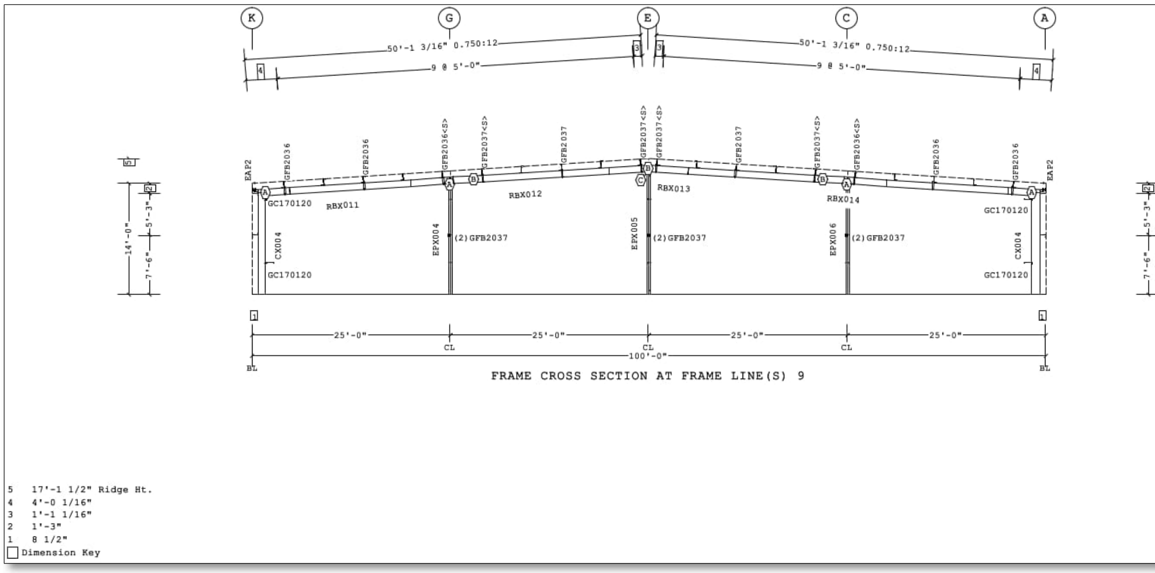


Figura No. 2.3a, 2.3b y 2.3c Características geométricas del proyecto de expansión

2.2.2 Sistema primario de resistencia

Todas las cargas, laterales y verticales, son resistidas en última instancia por los cimientos del edificio. Para llegar a la cimentación, debe de existir una trayectoria que permita a la carga moverse desde su punto de origen a la cimentación y de ahí disiparse. Estas trayectorias requieren estar completas y ser diseñadas adecuadamente para garantizar la resistencia y la rigidez del sistema de construcción.

En general todos los edificios tienen dos grupos de elementos principales que garantizan una ruta adecuada para la transferencia de cargas:

- Los elementos verticales como los marcos rígidos de baja ductilidad o los marcos con contraventeos concéntricos de ductilidad normal que resisten y transfieren las cargas del techo a la cimentación.
- El segundo grupo de elementos en la ruta de transferencia de cargas es esencialmente el sistema de distribución de cargas horizontales, que usualmente se le conoce como diafragma.

En el proyecto de expansión la trayectoria de las cargas se garantizó transversalmente con cuatro marcos de acero rígidos de ductilidad reducida localizados en los ejes 5, 6, 7 y 8 más un marco semirrígido en el eje 9 con un espaciamiento de bahía aproximado de 21 pies entre sí. Por su parte, en el sentido longitudinal se requirió el uso de contraventeos (redondos roscados en cruz de diferentes diametros), entre los ejes 7 y 8, instalados verticalmente de columna a columna y en el sistema de techo, entre viga y viga, para garantizar el correcto funcionamiento del sistema de distribución de cargas horizontales.

2.2.2.1 Sistema lateral de resistencia

2.2.2.1.1. Sistema longitudinal de resistencia

Este sistema de resistencia transfiere cargas horizontales desde la parte superior de la estructura (techo) a la cimentación, en su dirección longitudinal. También proporciona estabilidad general en contra de la inestabilidad producida por los efectos de las cargas gravitacionales. Los sistemas de longitudinales de resistencia para estructuras metálicas más utilizados son los muros de cortante, los marcos resistentes a momento orientados en el sentido longitudinal del edificio, columnas empotradas y, el que se seleccionó para este edificio, marcos arriostrados concéntricamente con redondos/ángulos.

En el edificio, las cargas en la dirección longitudinal se aplican de manera similar a las cargas en el sentido transversal excepto que, en lugar de aplicarse directamente a los marcos, se aplican a los puntales en el techo (componente estructural diseñado para resistir compresión) que a su vez forma parte del sistema horizontal de distribución de fuerzas, o diagrama de techo.

Cada vez que las cargas longitudinales son transmitidas al diafragma de techo, ya sea en la parte superior de los postes en los muros cabeceros (efectos de viento) o a través de las líneas de puntales (efectos sísmicos), la carga sigue la trayectoria por el sistema de contravientos del techo en el mismo plano del techo hasta el alero, donde se acumulan las fuerzas. Desde aquí el puntal del alero actúa como colector para transmitir las fuerzas acumuladas por el diafragma de techo a los contravientos de los muros, y finalmente, a la cimentación

La figura 2.4 ilustra la trayectoria de la carga de viento aplicada a un muro cabecero donde los postes del marco están alineados con los puntales de techo:

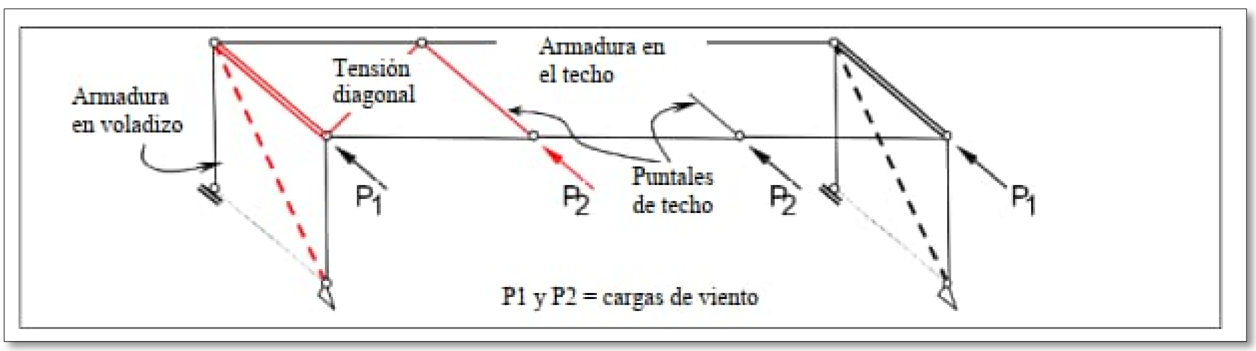


Figura No. 2.4 Trayectoria de las cargas de viento aplicadas en un muro cabecero
(Elaboración propia)

Como se mencionó anteriormente, la estabilidad lateral en el sentido longitudinal de este edificio es proporcionada por los marcos contraventeados concéntricamente con redondos roscados en cruz que resisten las fuerzas laterales mediante una armadura conformada por los contraventeos y las columnas (Ver figura 2.5), lo que significa que los efectos primarios en los elementos que conforman la armadura son tensión y compresión axial.

La selección del sistema de estabilidad lateral para este edificio se basó en las siguientes razones:

- La simplicidad en el diseño y el proceso de montaje/construcción.
- Se puede tolerar una excentricidad menor en el área de conexión sin afectar el comportamiento general del marco.
- La rigidez proporcionada por los marcos arriostrados concéntricamente es significativamente mayor a otras alternativas.

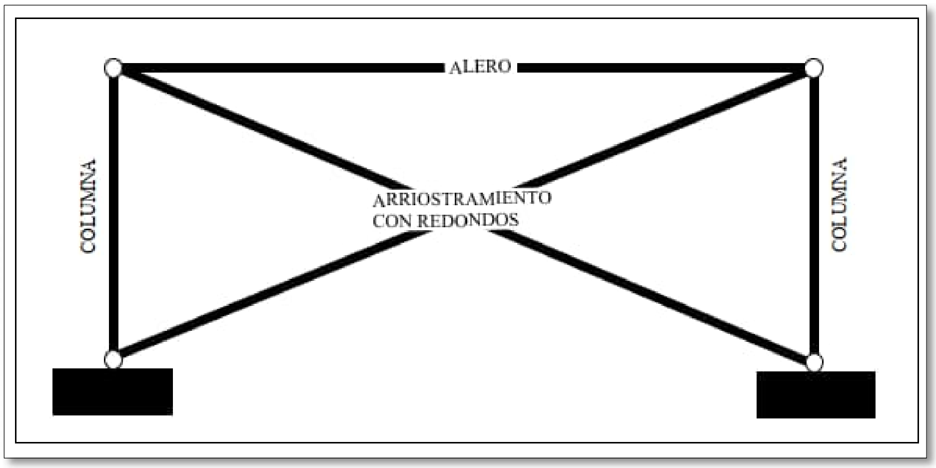


Figura No. 2.5 Esquema de un marco contraventeado concéntricamente. Elaboración propia

2.2.2.1.2. Sistema transversal y vertical de resistencia

Usualmente una estructura de carácter industrial está compuesta por marcos rígidos, semirrígidos o libremente apoyados que a su vez se componen de columnas, vigas y conexiones entre dichos elementos y cuya en un edificio usualmente se basa una combinación de factores como el proyecto arquitectónico, la eficiencia económica y la integridad estructural.

De manera muy general se puede resumir que el objetivo final de los marcos de acero en una estructura es soportar las cargas, tanto verticales como laterales, para proveer así un patrón de transferencia de cargas adecuado y transmitirlas a la cimentación donde posteriormente se disiparán.

Además, es preciso mencionar que la combinación entre vigas y columnas de diferente configuraciones o materiales es aceptable, pero que para efectos de este trabajo solo se considerarán marcos con elementos estructurales de alma llena ya que fueron los utilizados para el diseño y fabricación del proyecto de expansión en cuestión.

Marco de acero cabecero en el eje 5

Buscando la relación costo-beneficio más eficiente se decidió utilizar en el eje 5 un marco cabecero rígido de baja ductilidad con tres columnas interiores ya que en la pared común no se necesitaba tener un claro libre determinado debajo del mismo (Ver figura 2.6).

Para el análisis del marco se asume que la viga es un elemento continuo de alero a alero con columnas exteriores unidas mediante conexiones totalmente restringidas a momento. Las conexiones entre la viga y las columnas interiores se consideraron como articuladas al igual que todas las conexiones en la base de las columnas, tanto interiores como exteriores.

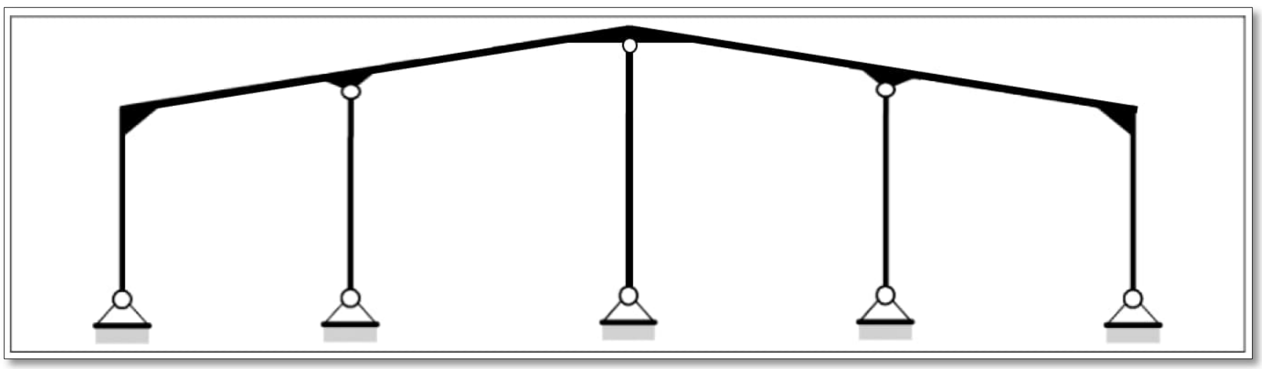


Figura No. 2.6 Esquema del marco cabecero en el eje 5
(Elaboración propia)

Marcos de acero interiores en los ejes 6, 7 y 8

En los marcos interiores se buscó maximizar el espacio libre dentro del edificio así que en los ejes 6, 7 y 8 se consideraron marcos rígidos de baja ductilidad y de claro libre. Para el análisis de estos marcos se asume que la viga es un elemento continuo que se extiende de alero a alero con columnas exteriores unidas mediante conexiones restringidas a momento. Por otra parte, la base de las columnas exteriores se consideró como articulada (Ver figura 2.7)

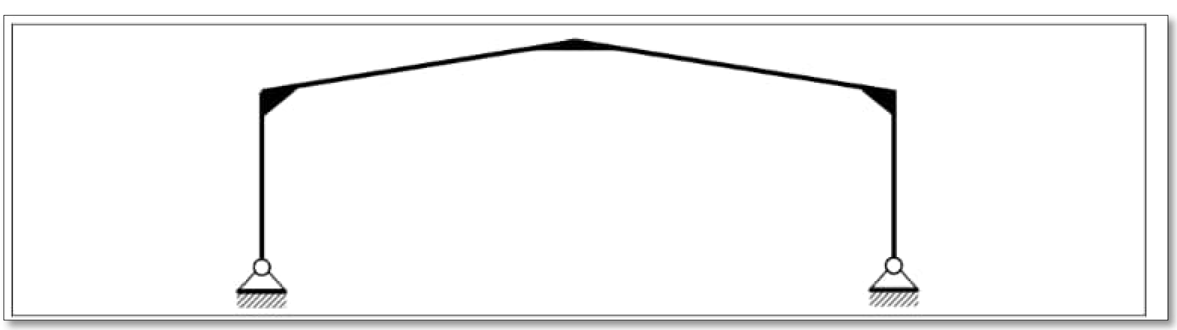


Figura No. 2.7 Esquema de los marcos interiores en los ejes 6, 7 y 8
(Elaboración propia)

Marco de acero cabecero en el eje 9

A pesar de que las condiciones en el eje 9 eran similares a las presentes en el eje 5 (con la excepción del edificio existente), por solicitud explicita del cliente se decidió utilizar un marco semirrígido sin estabilidad lateral en esta localización.

Para el análisis del marco se supone que la viga es un elemento continuo de alero a alero con columnas exteriores e interiores articuladas en la base y en la parte superior. La estabilidad lateral de este marco es proporcionada por un sistema lateral adicional, que en este caso es un sistema de contraventeo con redondos (Ver figura 2.8)

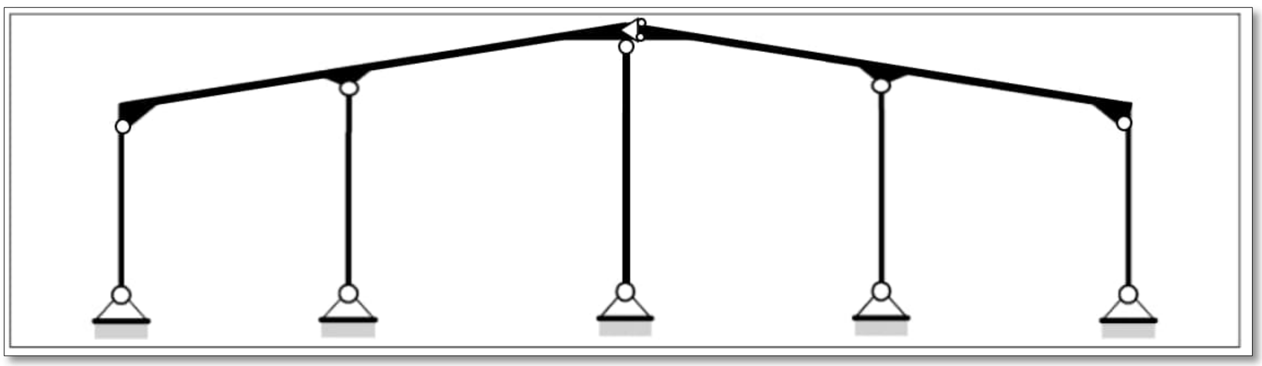


Figura No. 2.8 Esquema del marco cabecero en el eje 9
(Elaboración propia)

2.2.2.2.Sistema de distribución de cargas horizontales - Diafragma

La definición más común de un diafragma se refiere al techo, piso u otro sistema de arriostramiento que transfiere las fuerzas horizontales a los elementos de resistencia verticales. Las partes esenciales del sistema de distribución son los elementos que limitan el área donde ocurre la distribución de las fuerzas conocidos como cuerdas y colectores como se muestra en la figura 2.9.

Las cuerdas son los límites del diafragma perpendiculares a la carga aplicada. Debido a que un diafragma tiene un comportamiento similar a una armadura, las cuerdas resisten tanto tensión como compresión y la carga máxima se encuentra cercana al centro del diafragma.

Los colectores son los elementos del diafragma paralelos a la dirección de la fuerza aplicada y transfieren dicha carga a los elementos verticales del sistema principal de resistencia.

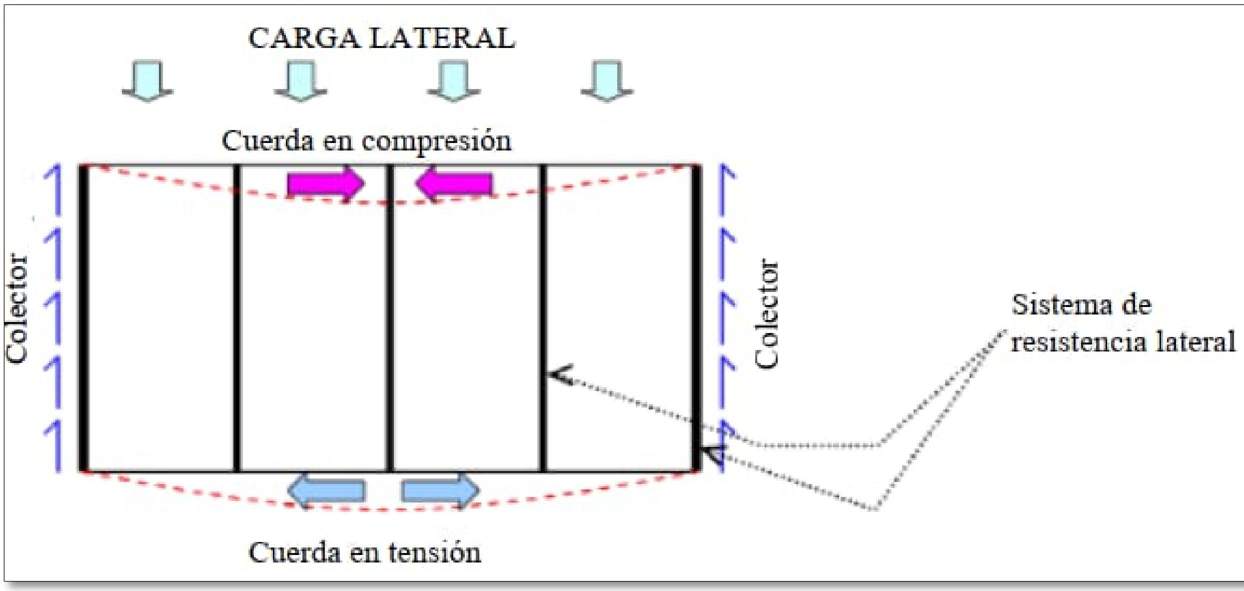


Figura No. 2.9 Esquema del funcionamiento de un diafragma
(Elaboración propia)

Para el proyecto de expansión se eligió un diafragma de cubierta basado en el uso de contraventeos (redondos roscados en cruz) entre las vigas de los marcos localizados en los ejes 7 y 8 debido principalmente a la versatilidad, la facilidad de montaje y el bajo costo de este sistema.

2.2.3. Sistema secundario de resistencia

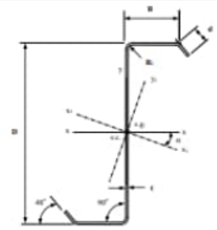
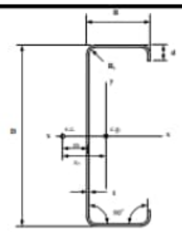
2.2.3.1 Largueros de acero

Los largueros de acero, en ocasiones también llamados correas o polines, son vigas que abarcan el claro existente entre dos marcos y cuya función es transmitir las cargas aplicadas a la cubierta, incluido el peso de la cubierta, al sistema de resistencia principal.

Usualmente, y dependiendo de las características del panel de recubrimiento utilizado en un edificio determinado, los largueros se colocan con separaciones equidistantes de hasta 5 pies entre sí.

En la industria de la construcción de naves industriales los perfiles más comunes para utilizarse como largueros son perfiles de lámina doblada en frío en forma C o en Z, siendo estos últimos más eficientes debido a sus características geométricas. Para este proyecto en particular, el cliente tenía la opción de utilizar cualquiera de las secciones mostradas en la tabla 2.1, decantándose al final por una sección de tipo Z con un peralte de 8.5 pulgadas.

Tabla No.2.1 Largueros de acero

FORMA	PERALTE	ESPESOR DISPONIBLE						
		0.060"	**0.068"**	**0.073"**	**0.079"**	**0.088"**	**0.098"**	**0.113"**
	**7"**	x		x			x	x
	8½"	x	x	x	x	x	x	x
	10"	x	x	x	x	x	x	x
	11½"		x	x		x		x
	**7"**	x		x			x	x
	8½"	x	x	x	x	x	x	x
	10"	x	x	x	x	x	x	x
	11½"		x	x		x		x

En el proyecto de expansión se utilizaron largueros traslapados en los apoyos para brindar continuidad a los elementos a través de dichos soportes como se ilustra en la figura 2.10.

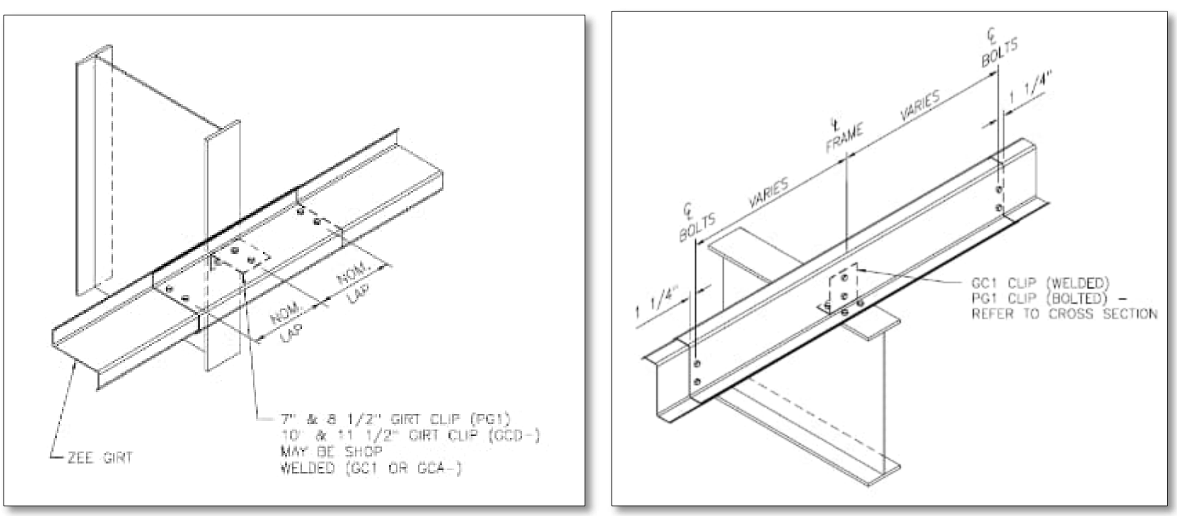


Figura No. 2.10 Largueros continuos de acero

Las condiciones de traslape en los apoyos localizados en cada marco proporcionan una doble sección en la región donde el momento es máximo, lo que a su vez proporciona una rigidez adicional que resultan en una reducción de los momentos a la mitad del claro y en un aumento del momento en los apoyos.

En los muros cabeceros los largueros deben de extenderse más allá de su apoyo en el marco por lo que se analizaron en su extremo como elementos en voladizo. La longitud del elemento en voladizo es la distancia entre el apoyo en el marco cabecero y la línea de construcción, en este caso en particular dicha distancia es de un pie.

Tanto los largueros utilizados en muro como los utilizados en techo fueron diseñados para los efectos de succión de viento, presión de viento y cargas gravitacionales de acuerdo con la Especificación Norteamericana para el Diseño de Elementos Estructurales de Acero Doblado en Frío publicada por el Instituto Estadounidense del Hierro y del Acero comúnmente conocida como el Estándar del AISI.

La tabla No. 2.2 contiene un resumen de las disposiciones de diseño del AISI utilizadas para determinar la resistencia de los largueros en el proyecto:

Tabla No. 2.2 Estados límite

Estado Límite / Consideración de Diseño	Código de Referencia	Sección
Propiedades de las secciones:	AISI	B5
Resistencia a flexión:		
• Fluencia	AISI	F3.1
• Pandeo lateral-torsional	AISI	F2.1.1, F2.1.3, F3
• Factor R (Paneles atornillados)	AISI	I6.2.1
• Factor R (Paneles standing seam)	AISI	I6.2.2
Cortante		
• Resistencia al cortante	AISI	G2, G3.1, G2.3
• Combinación de flexion y cortante	AISI	H2
Aplastamiento del alma		
• Aplastamiento del alma	AISI	G5
• Combinación de flexión y aplastamiento del alma.	AISI	H3
Pandeo		
• Por flexión	AISI	F4, F4.1
• Por compresión	AISI	E4, E4.1

A continuación, se presentan las condiciones generales de los largueros asumidas durante el proceso de diseño:

1. Los largueros de condición continua están conectados en la sección traslapada de manera que se garantiza la completa continuidad entre los elementos individuales.
2. Para establecer los diagramas de elementos mecánicos (cortante y momento) de una viga continua se asume un elemento prismático continuo en el que los valores de Ix dentro de las zonas traslapadas es la suma de los Ix de los elementos individuales.

3. Para la determinación de la porción traslapada de la viga continua se considera la distancia entre la línea central de la conexión en el marco y las líneas de los tornillos utilizadas para el traslape.
4. La resistencia a la flexión, al cortante y al aplastamiento del alma de los largueros en la zona traslapada es igual a la suma de las resistencias de las secciones individuales.

De modo complementario, la especificación AISI indica algunos requerimientos adicionales de acuerdo con el tipo de panel de recubrimiento utilizado en techo y muro. Más adelante se describirá con mayor grado de profundidad las características de las láminas de panel seleccionadas para el proyecto en cuestión, sin embargo, a esta altura es suficiente mencionar que el panel de muro son paneles atornillados que cumplen con los requerimientos del estándar AISI sección I6.2.1 debido a que han sido verificados experimentalmente. Es preciso señalar que este tipo de panel proveen de total soporte al patín superior de los largueros en toda su longitud.

Por su parte las láminas de panel para el techo son del tipo standing sean por lo que los largueros requieren un arriostramiento adicional en ambos patines. Este arriostramiento se lleva a cabo mediante la utilización de una sección canal C de 5 pulgadas de peralte y 0.0600 pulgadas de espesor. Este canal tiene pestañas en ambos extremos que se extienden a través de unas ranuras previamente perforadas en el alma de los largueros para facilitar su conexión a todo lo largo de la superficie de techo y provee de arriostramiento lateral a los patines superior e inferior del larguero (Ver figura 2.11).

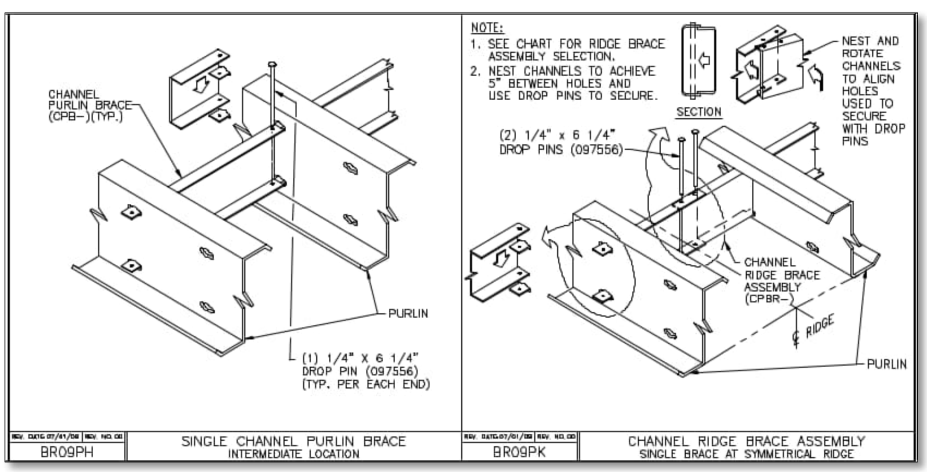


Figura No. 2.11 Arriostramientos laterales en los largueros de techo

2.2.3.1.1. Anclaje de los largueros de cubierta

Si un larguero de sección Z es colocado con su alma alineada verticalmente sin restricción lateral o torsional y se encuentra sujeto a cargas verticales entre sus apoyos, inevitablemente el larguero tenderá a trasladarse, lateral y torsionalmente (Ver figura 2.12). Las fuerzas causantes de dichas traslaciones son el resultado de varios efectos, como los siguientes:

- Los largueros Z tienen una sección transversal simétrica. Su centro de cortante está localizado en la intersección de sus ejes neutros. Además, sus ejes principales son oblicuos al plano del alma del larguero. Cuando un larguero se carga en el plano del alma y no tiene restricción lateral o torsional, este se desplazará tanto vertical como lateralmente.

  Si se proporciona suficiente fuerza de restricción, se puede evitar la deflexión lateral y se puede hacer que el larguero se desvíe únicamente en sentido vertical. La cantidad de fuerza de restricción (W_R) requerida se puede calcular en función de varios factores que incluyen la carga aplicada y la geometría del elemento.

  Otra opción sería proporcionar una fuerza de restricción de torsión mediante un arriostramiento torsional que retendría la orientación del larguero sin restringir el movimiento lateral. Ambas alternativas son eficientes, pero durante el diseño del proyecto de expansión se consideró la primera opción para prevenir la deflexión lateral de los largueros

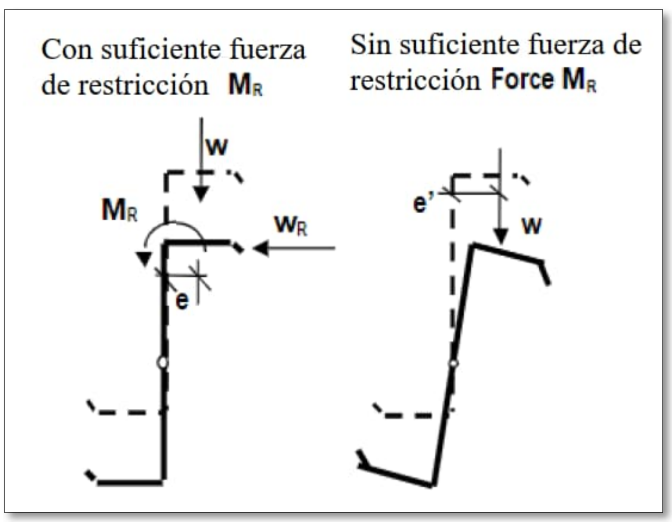


Figura No. 2.12 Efectos de la fuerza de restricción en los largueros

- La carga aplicada (W) no actúa en el mismo plano del alma sino a cierta distancia (e). Adicionalmente, es posible que la fuerza de restricción (W_R) típicamente no se aplique en el centro de cortante de la sección, sino en el patín superior. La excentricidad antes mencionada provoca un momento torsional (w*e) en el sentido de las agujas del reloj en la sección y la excentricidad de la fuerza de restricción provoca un momento en el sentido contrario al de las agujas del reloj (W_R * d/2). Si estos son iguales en magnitud, existirá el equilibrio de fuerzas, de lo contrario se requerirá algún tipo de fuerza de restricción adicional. La conexión entre los paneles de la cubierta y los largueros provee de cierta parte de resistencia a la torsión.

En los apoyos, el patín inferior no se puede trasladar libremente. Por lo tanto, si se proporciona una restricción lateral y/o torsional insuficiente, el elemento rotará y se trasladará entre los puntos de restricción. Dado que la carga (w) debe moverse con el miembro de apoyo, esta excentricidad da como resultado un momento de torsión aún mayor (Ver figura 2.13). Cuando este momento de torsión excede la capacidad de la fuerza de restricción de torsión, los largueros se voltean. Dado que el miembro tiene muy poca resistencia o rigidez en el eje menor, el pandeo local y la fluencia ocurren de inmediato y el elemento falla.

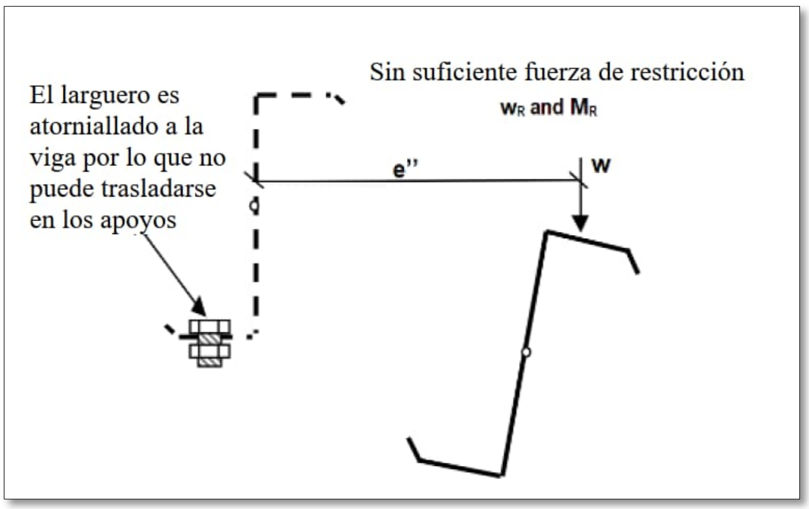


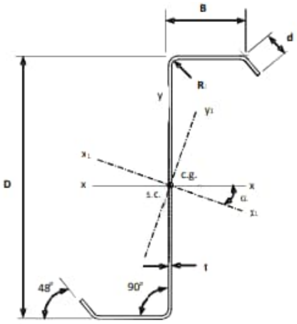
Figura No. 2.13 Momento torsional adicional

En este proyecto de expansión, las fuerzas de restricción, o de anclaje, se obtuvieron de las ecuaciones desarrolladas empíricamente a partir de pruebas realizadas en la Universidad Tecnológica de en un aparato de prueba en varias inclinaciones de techo. Los resultados de las experimentaciones fueron plasmados en la especificación AISI.

Después de cuidadosa consideración, el elemento seleccionado en este edificio para proveer de suficiente fuerza de anclaje a los largueros fue una línea de arriostramientos laterales en cada bahía (ver figura 2.13).

2.2.3.1.2. Propiedades de los largueros

A continuación, en la figura 2.13a y 2.13b, se presentan las propiedades de la sección correspondientes a los largueros de 8.5 pulgadas de peralte utilizados en el proyecto de expansión.



8 ½" Zee Section

D = 8 ½"
B = 2 ½"
R_i =0.3125"
F_y = 60 ksi
F_u = 70 ksi

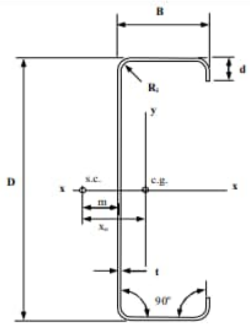
j = 0.0"
m = 0.0"
x_o = 0.0"

Dimensions					Full Properties						
					Axis x-x			Axis y-y			α_1 deg.
Thick in.	Blank in.	Area in^2	Lip, d in.	Weight plf	I_x in^4	S_x in^3	r_x in.	I_y in^4	S_y in^3	r_y in.	
0.060	14.500	0.870	0.766	2.99	9.30	2.19	3.266	1.24	0.42	1.195	-15.76
0.068	14.500	0.986	0.782	3.38	10.52	2.48	3.263	1.42	0.47	1.198	-15.83
0.073	14.750	1.077	0.916	3.69	11.52	2.71	3.267	1.69	0.55	1.253	-16.60
0.079	14.750	1.165	0.928	3.99	12.45	2.93	3.264	1.84	0.60	1.255	-16.65
0.088	14.750	1.298	0.945	4.44	13.84	3.26	3.260	2.06	0.67	1.259	-16.72
0.098	14.750	1.446	0.964	4.94	15.37	3.62	3.256	2.31	0.75	1.263	-16.81
0.113	14.750	1.667	0.993	5.70	17.67	4.16	3.250	2.69	0.87	1.269	-16.93

						Distortional Buckling					
	Full Properties					Critical Stress				Critical Unbraced Length	
Thick in.	J in^4	C_w in^6	r_o in.	I_{yc} in^4	I_{xy} in^4	$F_{db(0.0)}$ ksi	$F_{db(0.0-12")}$ ksi	$F_{db(2.4)}$ ksi	$F_{da(0.0)}$ ksi	$L_{crd-bend}$ in.	$L_{crd-axial}$ in.
0.060	0.00105	15.749	3.478	0.622	2.470	35.13	53.23	180.14	13.29	21.00	18.75
0.068	0.00152	17.931	3.476	0.709	2.806	41.15	59.00	154.57	15.74	21.00	18.75
0.073	0.00192	21.538	3.499	0.847	3.214	47.91	74.01	155.67	18.78	21.00	21.00
0.079	0.00243	23.382	3.497	0.920	3.484	52.78	78.55	144.56	20.83	21.00	21.00
0.088	0.00336	26.172	3.495	1.031	3.889	60.71	85.34	133.81	24.09	21.00	21.00
0.098	0.00464	29.299	3.492	1.156	4.342	69.79	93.02	127.60	27.92	18.75	18.75
0.113	0.00712	34.050	3.489	1.347	5.024	84.23	105.16	125.69	34.00	18.75	18.75

	Effective Properties Evaluated at f = 60 ksi							Deflection Properties at f = 36 ksi		Minor Principal Axis Properties	
	Axis x-x			Axis y-y							
Thick in.	I_{ex} in^4	S_{ex} in^3	M_{nxo} k-in.	I_{ey} in^4	S_{ey} in^3	M_{nyo} k-in.	$A_{e\,col}$ in^2	I_{dx} in^4	I_{dy} in^4	I_2 in^4	r_2 in.
0.060	8.26	1.803	108.18	1.00	0.322	19.29	0.447	9.07	1.24	0.547	0.792
0.068	9.66	2.164	129.84	1.21	0.396	23.75	0.538	10.48	1.42	0.623	0.794
0.073	10.92	2.486	149.16	1.67	0.543	32.59	0.639	11.52	1.69	0.735	0.825
0.079	12.07	2.786	167.16	1.84	0.597	35.81	0.741	12.45	1.84	0.798	0.827
0.088	13.77	3.251	195.08	2.06	0.668	40.07	0.902	13.84	2.06	0.894	0.829
0.098	15.37	3.618	217.05	2.31	0.747	44.81	1.055	15.37	2.31	1.001	0.831
0.113	17.67	4.157	249.40	2.69	0.867	51.99	1.273	17.67	2.69	1.164	0.834

Figura 2.13a Propiedades de una sección Z de 8 1/2 pulgadas



8 ½" Cee Section

D = 8½"
B = 2 $^5/_8$"
R_i =0.3125"
F_y = 60 ksi
F_u = 70 ksi

α_1 = 0.0 degrees
I_{xy} = 0.0 in^4

Dimensions					Full Properties							
					Axis x-x			Axis y-y				m in.
Thick in.	Blank in.	Area in^2	Lip, d in.	Weight plf	I_x in^4	S_x in^3	r_x in.	I_y in^4	S_{yw} in^3	S_{yl} in^3	r_y in.	
0.060	14.500	0.870	0.808	2.99	9.22	2.17	3.251	0.77	1.09	0.40	0.940	1.123
0.068	14.500	0.986	0.830	3.38	10.43	2.45	3.247	0.88	1.23	0.46	0.941	1.126
0.073	14.750	1.077	0.969	3.69	11.38	2.68	3.246	1.00	1.34	0.53	0.964	1.177
0.079	14.750	1.165	0.985	3.99	12.29	2.89	3.243	1.09	1.45	0.58	0.964	1.179
0.088	14.750	1.298	1.010	4.44	13.66	3.21	3.238	1.21	1.60	0.65	0.963	1.182
0.098	14.750	1.446	1.037	4.94	15.16	3.57	3.232	1.35	1.76	0.72	0.963	1.186
0.113	14.750	1.667	1.078	5.70	17.40	4.09	3.223	1.55	2.00	0.84	0.963	1.192

	Full Cross-Section						Distortional Buckling					
							Critical Stress				Critical Unbraced Length	
Thick in.	J in^4	C_w in^6	j in.	r_o in.	x_o in.	I_{yc} in^4	$F_{db(0.0)}$ ksi	$F_{db(0.0\text{-}12")}$ ksi	$F_{db(2.4)}$ ksi	$F_{da(0.0)}$ ksi	$L_{crd\text{-}bend}$ in.	$L_{crd\text{-}axial}$ in.
0.060	0.00105	11.023	4.544	3.832	1.798	0.386	50.59	77.24	263.35	17.88	26.25	26.25
0.068	0.00152	12.548	4.530	3.831	1.803	0.438	59.67	91.70	225.90	21.02	23.44	23.44
0.073	0.00192	14.992	4.454	3.876	1.887	0.502	71.21	113.29	230.15	25.52	26.25	26.26
0.079	0.00243	16.276	4.444	3.875	1.890	0.543	78.72	126.19	213.29	28.20	26.25	26.26
0.088	0.00336	18.215	4.427	3.874	1.896	0.605	90.65	144.34	196.53	32.41	23.44	26.25
0.098	0.00465	20.389	4.409	3.872	1.902	0.674	82.69	162.95	186.23	40.57	30.00	33.75
0.113	0.00713	23.689	4.382	3.869	1.910	0.777	125.70	188.84	181.39	44.99	23.44	23.44

	Effective Properties Evaluated at f = 60 ksi									Deflection Properties at f = 36 ksi	
	Axis x-x			Axis y-y					Axial		
Thick in.	I_{ex} in^4	S_{ex} in^3	M_{nxo} k-in.	I_{ey} in^4	S_{eyw} in^3	M_{nywo} k-in.	S_{eyw} in^3	M_{nywo} k-in.	$A_{e\,col}$ in^2	I_{dx} in^4	I_{dy} in^4
0.060	8.28	1.820	109.19	0.57	0.402	24.10	0.361	21.66	0.455	9.01	0.64
0.068	9.71	2.190	131.42	0.68	0.457	27.42	0.418	25.08	0.551	10.36	0.74
0.073	10.95	2.514	150.82	0.78	0.534	32.02	0.491	29.48	0.659	11.38	0.86
0.079	12.08	2.808	168.46	0.87	0.579	34.75	0.539	32.33	0.762	12.29	0.95
0.088	13.66	3.213	192.80	1.01	0.647	38.84	0.610	36.62	0.917	13.66	1.10
0.098	15.16	3.567	214.04	1.17	0.724	43.44	0.691	41.46	1.056	15.16	1.26
0.113	17.40	4.094	245.65	1.41	0.839	50.37	0.814	48.81	1.275	17.40	1.51

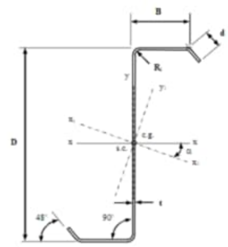
Figura 2.13b Propiedades de una sección C de 8 1/2 pulgadas

2.2.3.1.3. Tablas de resistencia de los largueros

A continuación, se presentan las tablas No 2.3, 2.4, 2.5 y 2.6 correspondientes a las resistencias de los largueros de 8.5 pulgadas de peralte utilizados en el proyecto de expansión para las condiciones de flexión, cortante y pandeo local en el alma por aplastamiento.

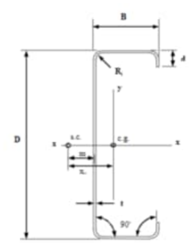
Tablas No. 2.3 y 2.4 Máxima resistencia a la flexión de una sección Z/C

Máxima resistencia a la flexión
de una sección Z, en kips



			USA and Mexico		Canada
Section	Design Thickness (in.)	Nominal Strength M_n (kip-in.)	Allowable Strength (ASD) M_n / Ω_b (kip-in.)	Design Strength (LRFD) $\phi_b M_n$ (kip-in.)	Factored Resistance (LSD) $\phi_b M_n$ (kip-in.)
8.5" Z	0.060	108.20	64.79	97.38	97.38
	0.068	129.82	77.73	116.83	116.83
	0.073	149.15	89.31	134.24	134.24
	0.079	167.14	100.09	150.43	150.43
	0.088	195.08	116.81	175.57	175.57
	0.098	217.05	129.97	195.35	195.35
	0.113	249.40	149.34	224.46	224.46
8.5"	0.079	167.14	100.09	150.43	150.43
	0.088	195.08	116.81	175.57	175.57
	0.098	217.05	129.97	195.35	195.35
	0.113	249.40	149.34	224.46	224.46

Máxima resistencia a la flexión
de una sección C, en kips



			USA and Mexico		Canada
Section	Design Thickness (in.)	Nominal Strength M_n (kip-in.)	Allowable Strength (ASD) M_n / Ω_b (kip-in.)	Design Strength (LRFD) $\phi_b M_n$ (kip-in.)	Factored Resistance (LSD) $\phi_b M_n$ (kip-in.)
8.5" C	0.060	109.20	65.39	98.28	98.28
	0.068	131.40	78.68	118.26	118.26
	0.073	150.84	90.32	135.76	135.76
	0.079	168.48	100.89	151.63	151.63
	0.088	192.78	115.44	173.50	173.50
	0.098	214.02	128.16	192.62	192.62
	0.113	245.64	147.09	221.08	221.08
8.5"	0.079	168.48	100.89	151.63	151.63
	0.088	192.78	115.44	173.50	173.50
	0.098	214.02	128.16	192.62	192.62
	0.113	245.64	147.09	221.08	221.08

Tablas No. 2.5 y 2.6 Máxima resistencia al cortante y al pandeo local del alma por aplastamiento de una sección Z/C

Máxima resistencia al cortante de una sección C y Z, en kips

			USA and Mexico		Canada
Section	Design Thickness (in.)	Nominal Strength V_n (kip)	Allowable Strength (ASD) V_n / Ω_v (kip)	Design Strength (LRFD) $\phi_v V_n$ (kip)	Factored Resistance (LSD) $\phi_v V_n$ (kip)
8.5" Z or C	0.060	3.97	2.48	3.77	3.17
	0.068	5.78	3.62	5.5	4.63
	0.073	7.17	4.48	6.81	5.73
	0.079	9.10	5.69	8.64	7.28
	0.088	12.60	7.88	11.97	10.08
	0.098	17.45	10.91	16.58	13.96
	0.113	23.55	14.72	22.38	18.84

Máxima resistencia al pandeo local en el alma por aplastamiento de una sección C y Z, en kips

End - One Flange Loading			USA and Mexico		Canada
Section	Design Thickness (in.)	Nominal Strength P_n (kip)	Allowable Strength (ASD) P_n / Ω_w (kip)	Design Strength (LRFD) $\phi_w P_n$ (kip)	Factored Resistance (LSD) $\phi_w P_n$ (kip)
8.5" Z or C	0.060	1.91	1.09	1.62	1.43
	0.068	2.44	1.40	2.08	1.83
	0.073	2.81	1.61	2.39	2.11
	0.079	3.28	1.88	2.79	2.46
	0.088	4.05	2.31	3.44	3.04
	0.098	4.98	2.85	4.23	3.73
	0.113	6.54	3.74	5.56	4.90

Notas de las tablas

- La resistencia a la flexión para las secciones C y Z se obtuvieron de acuerdo con la norma AISI S100 sección F3.1 donde $\Omega = 1.67$
- La resistencia al cortante para las secciones C y Z se obtuvieron de acuerdo con la norma AISI S100 sección G2 donde $\Omega = 1.60$
- La resistencia al pandeo local en el alma por aplastamiento para las secciones C y Z se obtuvieron de acuerdo con la norma AISI S100 sección G5 donde $\Omega = 1.65$

2.2.3.2 Paneles metálicos de recubrimiento

Los paneles metálicos en muros y cubierta fueron diseñados de acuerdo con la Especificación Norteamericana para el Diseño de Elementos Estructurales de Acero Doblado en Frío. Los estados límite y otras consideraciones tomadas durante el proceso de diseño se resumen a continuación, en la tabla No 2.7:

Tabla No. 2.7 Estados límites de falla

Estado Límite / Consideración de Diseño	Código de Referencia	Sección
Propiedades de la sección	AISI	Sección B5
Resistencia a la flexión	AISI	Sección F1, F3.1, F2.4.1, I6.2.1, I6.2.2
Pandeo Local	AISI	Sección G5
Resistencia al cortante	AISI	Sección G, G2, G3
Resistencia a la flexion y al cortante	AISI	Sección H2

2.2.3.2.1. Paneles metálicos de recubrimiento en cubierta

Dentro de todas las opciones de paneles metálicos disponibles para la cubierta, el cliente se decidió por un sistema “standing seam” llamado MR-24. El sistema de cubierta MR-24 se diferencia considerablemente de otros sistemas debido al método utilizado para sujetar los paneles de techo entre sí y a la estructura.

El sistema de cubierta MR-24 se compone de paneles laminados de nervadura trapezoidal con 24 pulgadas de ancho, un calibre de 22, fabricados de una aleación de aluminio-zinc y recubiertos de acrílico o pintura acrílica. La figura 2.14 presenta la sección transversal de un panel de cubierta MR-24.

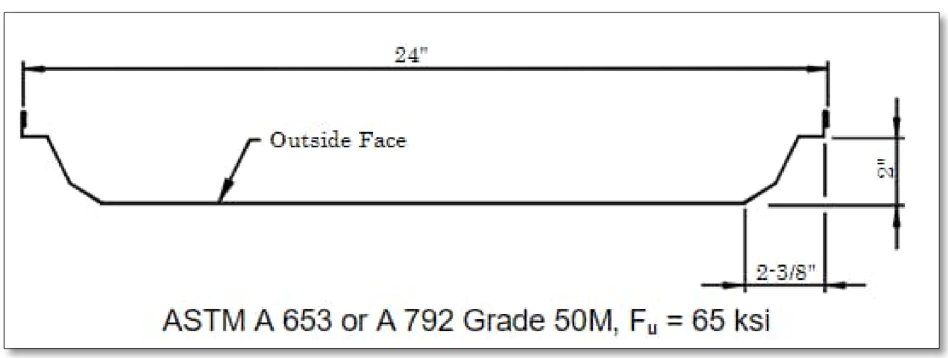


Figura No. 2.14 Sección transversal del panel de cubierta

Las láminas de panel se unen entre sí mediante una costura creada mecánicamente con una máquina especial y un sellador; Por otra parte, los paneles se unen a la estructura con clips ocultos.

Estos clips tienen una pestaña deslizante de acero inoxidable que permiten los movimientos de la cubierta debido a expansión o compresión térmica (Ver figura 2.15).

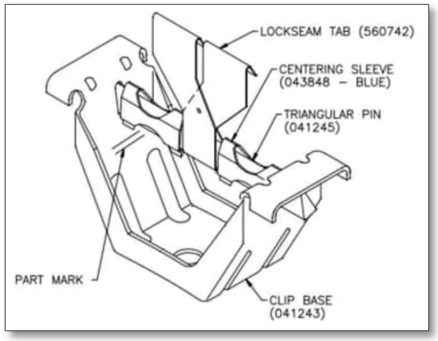


Figura No. 2.15 Clip de sujeción de la cubierta a los largueros

En las tablas No. 2.8 y 2.9 se presentan las propiedades de la sección de una lámina de panel de cubierta MR-24 y de la resistencia a la flexión de esta, respectivamente.

Tabla No. 2.8 Propiedades de la sección del panel de cubierta

Panel Material	Design Thickness (in)	Panel Weight (psf)	F_y (ksi)	F_u (ksi)	Compression on Outside		Compression on Inside	
					S_{xe}+ (in^3)	I_{xe}+ (in^4)	S_{xe}- (in^3)	I_{xe}- (in^4)
24 Ga	0.023	1.17	50	65	0.090	0.200	0.068	0.094

Tabla No. 2.9 Resistencia a la flexión del panel de cubierta

Nominal Gage	Outside of Panel in Compression, S_{xe} (+)				Inside of Panel in Compression, S_{xe} (-)			
	Nominal Strength M_n	Allowable Strength (ASD)	Design Strength (LRFD)	Design Resistance (LSD)	Nominal Strength M_n	Allowable Strength (ASD)	Design Strength (LRFD)	Design Resistance (LSD)
24 Ga	4.48	2.68	4.03	4.03	3.39	1.70	2.72	2.55

Notas:

- Ω = 1.67
- Resistencia máxima = Mn / 1.67
- Resistencia nominal a la flexión = Mn

2.2.3.2.2. Paneles metálicos de recubrimiento en muro

Respecto a los paneles metálicos de recubrimiento en muro, el sistema seleccionado por el cliente fue el panel tipo shadowall. Este sistema de recubrimiento presenta paneles corrugados en forma V entre sus ondulaciones, fabricados de una aleación de aluminio-zinc y recubiertos de acrílico o pintura acrílica. En las tablas No. 2.10, 2.11, 2.12 y 2.13 se muestran las propiedades de la sección de una lámina de panel de muro shadowall, así como su resistencia a la flexión, cortante y pandeo local de la misma (Ver figura 2.16).

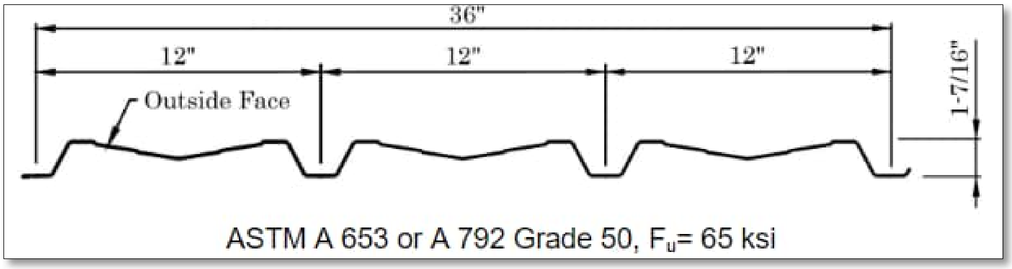


Figura No. 2.16 Sección transversal del panel de muro

Tabla No. 2.10 Propiedades de la sección del panel de muro

Panel Material	Design Thickness (in)	Weight (psf)	E (ksi)	F_y (ksi)	F_u (ksi)	Compression on Outside		Compression on Inside	
						Sx (in³)	I (in⁴)	Sx (in³)	I (in⁴)
26 Ga.	0.0180	0.92	29500	50	65	0.059	0.051	0.044	0.042

Tabla No. 2.11 Resistencia a la flexión del panel de muro

Nominal Gage	Outside of Panel in Compression, Sxe (+)				Inside of Panel in Compression, Sxe (-)			
	Nominal Strength	Allowable Strength (ASD)	Design Strength (LRFD)	Design Resistance (LSD)	Nominal Strength	Allowable Strength (ASD)	Design Strength (LRFD)	Design Resistance (LSD)
26 Ga.	2.95	1.77	2.66	2.66	2.21	1.11	1.77	1.66

Notas:

- Ω = 1.67
- Resistencia máxima = Mn / 1.67
- Resistencia nominal a la flexión = Mn = SxeFy, kip-in

Tabla No. 2.12 Resistencia al cortante del panel de muro

Panel Nominal Gage	Nominal Strength V_n	Allowable Strength (ASD)	Design Strength (LRFD)	Design Resistance (LSD)
26 Ga.	0.513	0.320	0.487	0.410

Notas:

- Ω = 1.60
- Resistencia máxima = Vn / 1.60
- Resistencia nominal al cortante = Vn, kips per-ft

Tabla No. 2.13 Resistencia al pandeo local del panel de muro

Panel Nominal Gage	End – One Flange Loading				Interior – One Flange Loading			
	Nominal Strength P_n	Allowable Strength (ASD)	Design Strength (LRFD)	Design Resistance (LSD)	Nominal Strength P_n	Allowable Strength (ASD)	Design Strength (LRFD)	Design Resistance (LSD)
26 Ga.	0.288	0.170	0.260	0.231	0.454	0.259	0.386	0.340

Notas:

- Ω = 1.70
- Resistencia máxima = Pn / 1.67
- Resistencia nominal al pandeo local del alma por aplastamiento = Pn kips per-ft

2.3 Especificación de los materiales

A continuación, en la tabla No. 2.14, se presenta un resumen de las características de los materiales utilizadas para el diseño y la fabricación del proyecto de expansión:

Tabla No. 2.14 Especificación de los materiales utilizados en el proyecto de expansión

Materiales	ASTM estándar	Grado del acero
Elementos de 3 placas soldadas (Marcos)	A529, A572, A1011, A1018	Grado 55
Elementos de calibre ligero rolados en frío (Largueros)	A653, A1011	Grado 60
Redondos roscados (Contraventeos)	A572, A510	Grado 50
Paneles de recubrimiento	A653, A792	Grado 50
Ángulos rolados en caliente (Arriostramientos de patín)	A529, A572, A588, A992	Grado 50

3. Análisis y diseño estructural

3.1. Códigos, especificaciones y cargas

A partir de marzo del 2020, el código de construcción vigente en el sitio de la construcción (Browns Valley) es el Código de Construcción de Minnesota del 2020, que a está basado íntegramente en el Código de Construcción Internacional del 2018.

Las únicas diferencias entre el IBC18 t el 2020 MNBC son las siguientes:

- Sección 1303.1700 del 2020 MNBC – Carga de nieve a nivel del suelo
  La carga de nieve a nivel del suelo, Pg, que se utilizará para determinar las cargas de nieve de diseño para edificios y otras estructuras será de 60 libras por pie cuadrado en los siguientes condados: Aitkin, Becker, Beltrami, Carlton, Cass, Clearwater, Cook, Crow Wing, Hubbard, Itasca, Kanabec, Kittson, Koochiching, Lake, Lake of the Woods, Mahnomen, Marshall, Mille Lacs, Morrison, Norman, Otter Tail, Pennington, Pine, Polk,

Red Lake, Roseau, St. Louis, Todd y Wadena . La carga de nieve del suelo, Pg, que se utilizará para determinar las cargas de nieve de diseño para edificios y otras estructuras será de 50 libras por pie cuadrado en todos los demás condados.

- Sección 1305.011 subtema 4 del 2020 MNBC – Cargas sísmicas
  La evaluación de cargas sísmicas no es obligatoria para el estado de Minnesota.

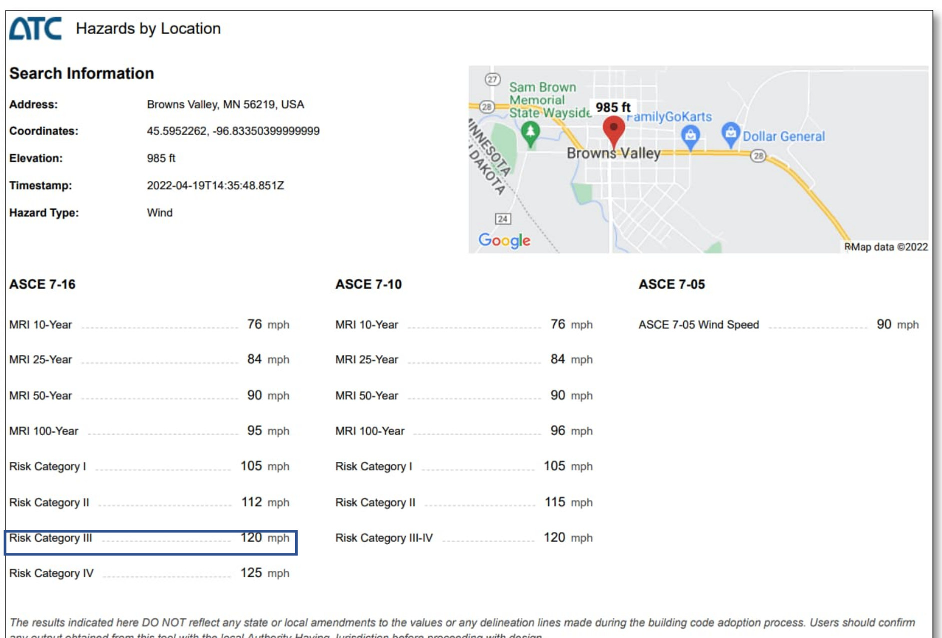
Por otra parte, tanto pare el diseño estructural los elementos de 3-placas soldados (marcos) como para el de los elementos de acero ligero rolados en frío (largueros y paneles) se utilizaron la Especificación para Edificios de Acero Estructural 2016 del Instituto Americano de la Construcción en Acero (AISC16) y la Especificación Norteamericana para el Diseño de Elementos Estructurales Rolados en Frío del Instituto Americano del Hierro y del Acero (AISI16), respectivamente.

Asimismo, el método de diseño seleccionado para el proyecto de expansión fue el de Diseño por Resistencia Permisible, o ASD por sus siglas en inglés (Allowable Stress Design).

A pesar de que proveer las cargas finales para el diseño de la estructura es la responsabilidad del cliente, se realizó una verificación de estas utilizando para ello los datos proporcionados por el Consejo de Tecnología Aplicada (ATC por sus siglas en inglés).

El ATC es una asociación creada sin fines de lucro en 1973 por la asociación de ingenieros estructurales de California y cuya misión es proveer y promover recursos y aplicaciones ingenieriles para mitigar los efectos de los peligros de la naturaleza.

Los resultados obtenidos directamente del sitio del ATC se presentan en las figuras 3.1, 3.2 y 3.3:


ATC Hazards by Location

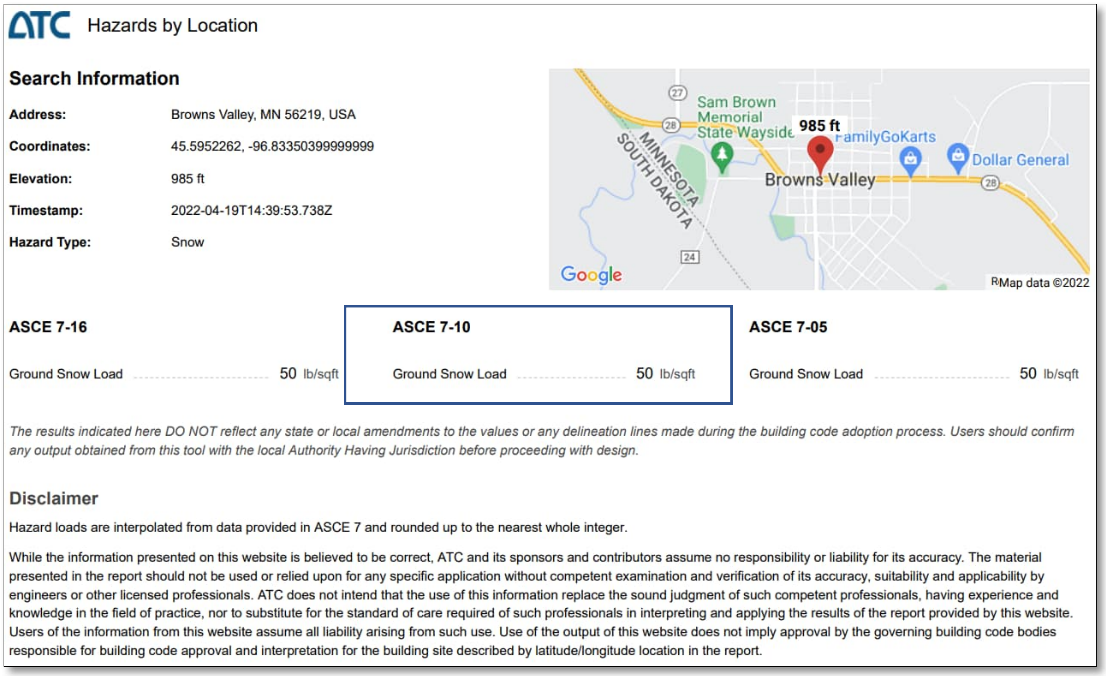
Search Information

Address:	Browns Valley, MN 56219, USA
Coordinates:	45.5952262, -96.83350399999999
Elevation:	985 ft
Timestamp:	2022-04-19T14:35:48.851Z
Hazard Type:	Wind

ASCE 7-16		**ASCE 7-10**		**ASCE 7-05**	
MRI 10-Year	76 mph	MRI 10-Year	76 mph	ASCE 7-05 Wind Speed	90 mph
MRI 25-Year	84 mph	MRI 25-Year	84 mph		
MRI 50-Year	90 mph	MRI 50-Year	90 mph		
MRI 100-Year	95 mph	MRI 100-Year	96 mph		
Risk Category I	105 mph	Risk Category I	105 mph		
Risk Category II	112 mph	Risk Category II	115 mph		
Risk Category III	120 mph	Risk Category III-IV	120 mph		
Risk Category IV	125 mph				

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Figura No. 3.1 Velocidad de viento obtenida del sitio del ATC para Browns Ville, Minnesota



ATC Hazards by Location

Search Information

Address:	Browns Valley, MN 56219, USA
Coordinates:	45.5952262, -96.83350399999999
Elevation:	985 ft
Timestamp:	2022-04-19T14:39:53.738Z
Hazard Type:	Snow

ASCE 7-16		ASCE 7-10		ASCE 7-05	
Ground Snow Load	50 lb/sqft	Ground Snow Load	50 lb/sqft	Ground Snow Load	50 lb/sqft

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are interpolated from data provided in ASCE 7 and rounded up to the nearest whole integer.

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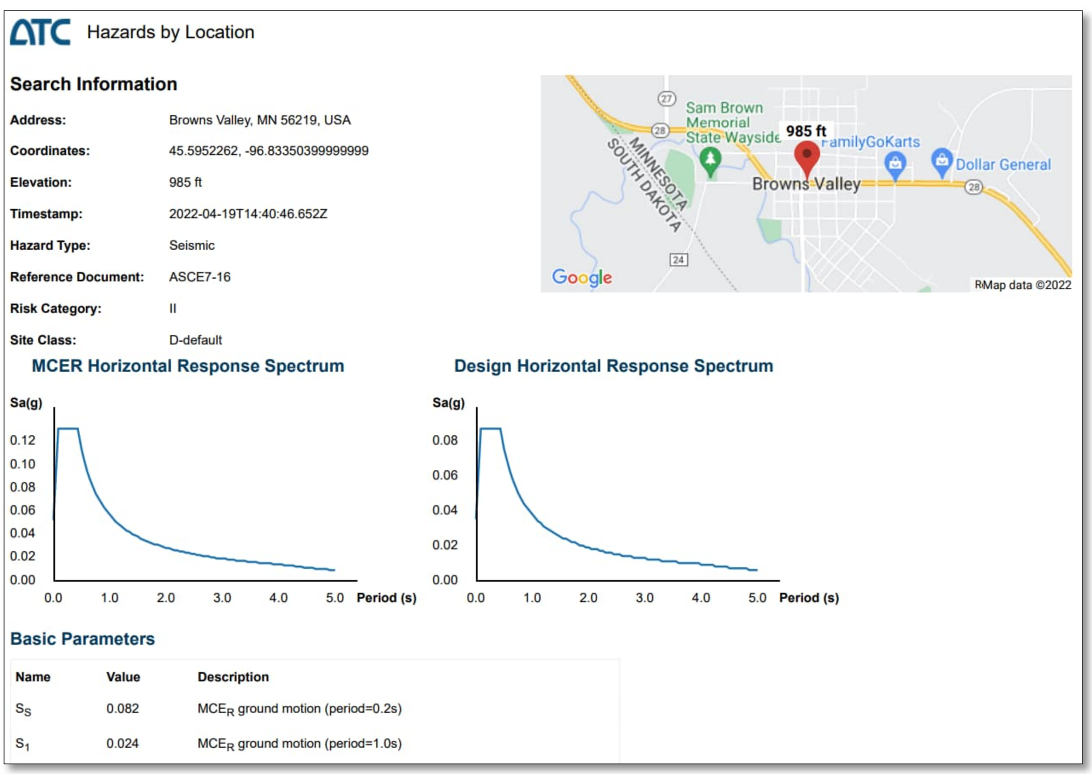
Figura No. 3.2 Carga mínima de nieve a nivel de suelo obtenida del sitio del ATC para Browns Ville, Minnesota



ATC Hazards by Location

Search Information

Address:	Browns Valley, MN 56219, USA
Coordinates:	45.5952262, -96.83350399999999
Elevation:	985 ft
Timestamp:	2022-04-19T14:40:46.652Z
Hazard Type:	Seismic
Reference Document:	ASCE7-16
Risk Category:	II
Site Class:	D-default

Basic Parameters

Name	Value	Description
S_S	0.082	MCE_R ground motion (period=0.2s)
S_1	0.024	MCE_R ground motion (period=1.0s)

Figura No. 3.3 Factores mínimos de sismo obtenidos del sitio del ATC para Browns Ville, Minnesota

Una vez comprobado que las cargas proporcionadas por el cliente cumplen con los requisitos mínimos publicados por el ATC, el resumen de las cargas utilizadas para el diseño del edificio se presentan en la figura 3.4.

City: Browns Valley **County:** Traverse **State:** Minnesota **Country:** United States
Building Code: 2020 Minnesota State Building Code Structural: 16AISC - ASD Rainfall: I: 5.00 inches per hour
Building Risk/Occupancy Category: II (Standard Occupancy Structure) Cold Form: 16AISI - ASD f'c: 3000.00 psi Concrete

Dead and Collateral Loads
Collateral Gravity:5.00 psf
Collateral Uplift: 0.00 psf
Frame Weight (assumed for seismic):0.00 psf - USR

Side	Type	Mag	Units	Shape	Applied to	Description
A	D	2.331	psf	Entire	Frm	Covering Weight - 24 MR-24 + Secondary Weight 1.13 : Roof: A
A	D	1.200	psf	Entire	Pur	Covering Weight - 24 MR-24 : Roof: A
B	D	2.331	psf	Entire	Frm	Covering Weight - 24 MR-24 + Secondary Weight 1.13 : Roof: B
B	D	1.200	psf	Entire	Pur	Covering Weight - 24 MR-24 : Roof: B

Roof Live Load
Roof Live Load: 20.00 psf Reducible

Wind Load
Wind Speed: Vult: 112.00 (Vasd: 86.75) mph
Wind Enclosure: Enclosed
Height Used: 15/0/0 (Type: Eave)
Base Elevation: 0/0/0
Site Elevation: 983.0 ft
Primary Zone Strip Width: 2a: 11/2/6
Velocity Pressure: qz: 32.11 psf
Topographic Factor: Kzt: 1.0000
Directionality Factor: Kd: 0.8500
Ground Elevation Factor: Ke: 0.9650
Primaries
Primaries Wind Exposure: C - Kz: 0.849
Basic Wind Pressure: q: 22.36 psf

Gust Factor: G: 1.0000
Least Horiz. Dimension: 100/0/0

NOT Windborne Debris Region
Parts / Portions Zone Strip Width:
Walls, a: 5/7/3
Roof(s), 0.6h: 8/4/13
qz= 0.00256 * (1.00) * (112.00)^2 * (1.00)
The 'Envelope Procedure' is Used
Parts and Portions
Parts Wind Exposure Factor: 0.849
Basic Wind Pressure:22.36 psf

Snow Load
Ground Snow Load: pg: 50.00 psf
Flat Roof Snow: pf: 35.00 psf
Design Snow (Sloped): ps: 35.00 psf
Specified Minimum Roof Snow: 20.00 psf (Code)
Snow Accumulation Factor: 1.000
Snow Importance: Is: 1.000
Ground / Roof Conversion: 0.70

Rain Surcharge: 0.00
Exposure Factor: 2 Partially Exposed Ce: 1.00
Thermal Factor: Heated - Ct: 1.00
Unobstructed, Slippery
Slope Reduction: Cs: 1.00
Slope Used: 3.576 deg. (0.750:12)

Seismic Load
N/A

Figura No. 3.4 Cargas de diseño

3.2. Modelado de la estructura

El edificio fue modelado en un software de diseño, ingeniería y estimaciones patentado por BlueScope Buildings que ha liderado la industria desde su creación en 1990 y que ha recibido constantes actualizaciones y mejoras que garantizan su completa compatibilidad con otros programas de modelado BIM.

A grandes rasgos, el proceso para la correcta creación del modelo estructural fue el siguiente:

a) Se crearon las dos geometrías principales, una representando el edificio existente y otra para el proyecto de expansión.

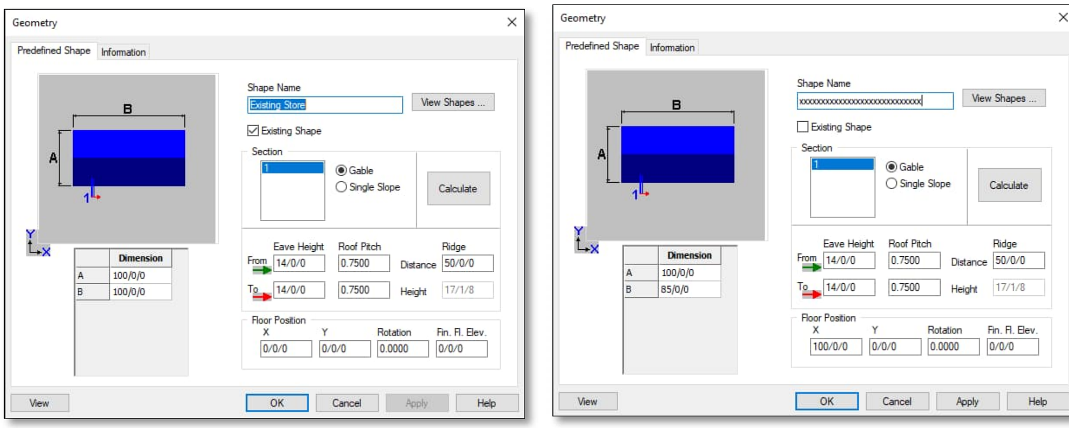
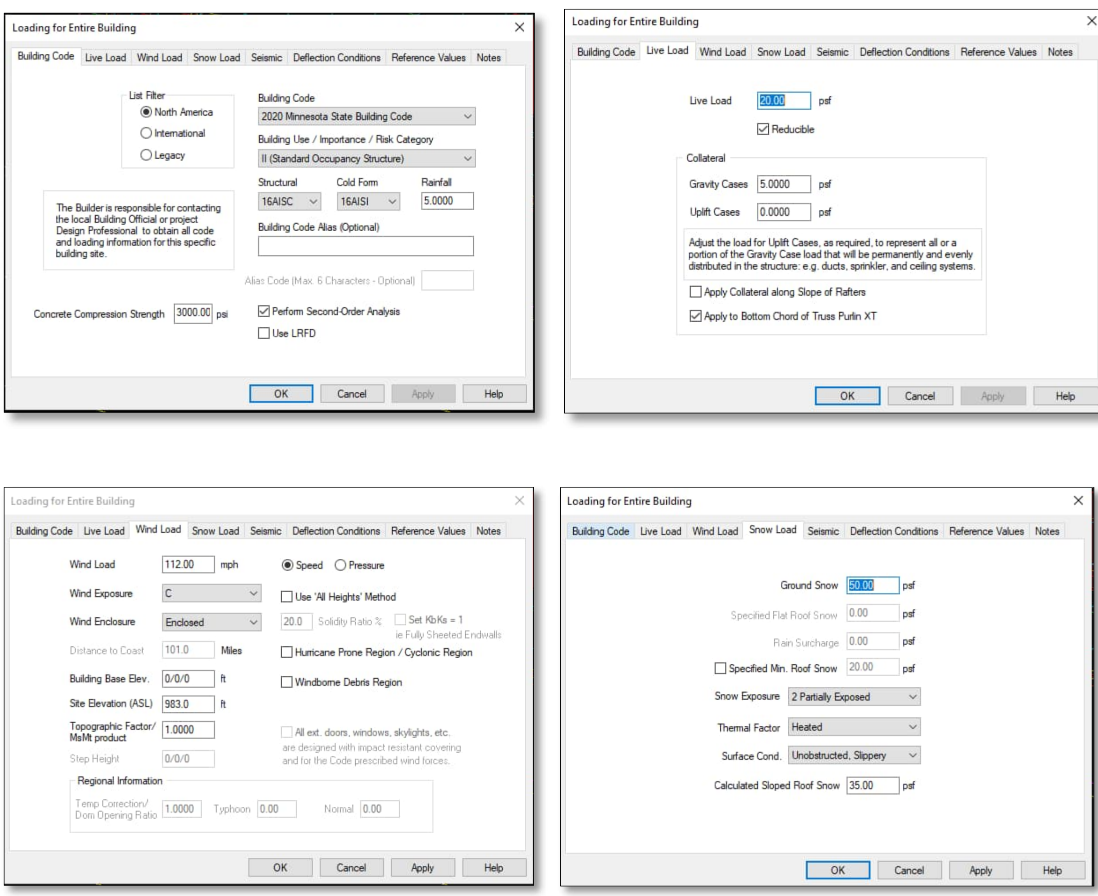
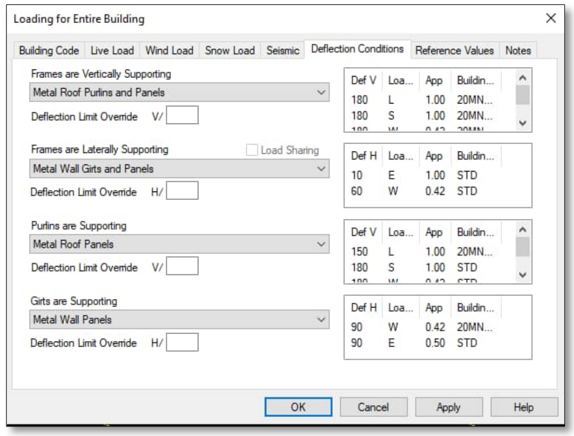


Figura No. 3.5 Ingreso de las características geométricas del proyecto de expansión en el software estructural

b) Se ingresó la información correspondiente al código seleccionado, a las cargas proporcionadas por el cliente y el criterio de deflexión.





Figuras No. 3.6, No. 3.7, No 3.8, No. 3.9 y 3.10 Ingreso de las cargas de diseño del proyecto de expansión en el software estructural

c) Se configuraron los tres tipos de marcos utilizados en el proyecto: marco cabecero rígido de baja ductilidad con tres columnas interiores para el muro cabecero en el eje 5, marco cabecero rígido de baja ductilidad con una columna interior para los ejes del 6 al 7 y un marco cabecero semirrígido sin estabilidad lateral contraventeado concéntricamente con redondos roscados en cruz en el eje 9.

d) Se localizaron los marcos de acero y los redondos roscados en cruz en las ubicaciones correspondientes de acuerdo con el proyecto estructural y se agruparon los marcos 7 y 8 para simplificar el diseño.

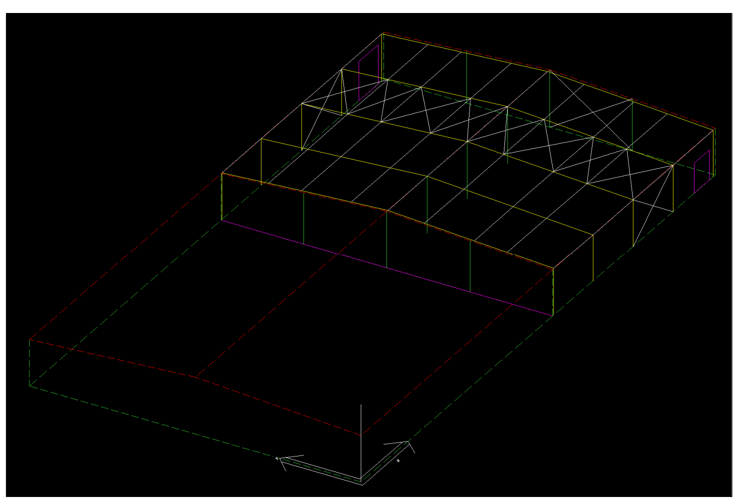


Figura No. 3.11 Ingreso de los marcos y las bahías contraventeadas del proyecto de expansión en el software estructural

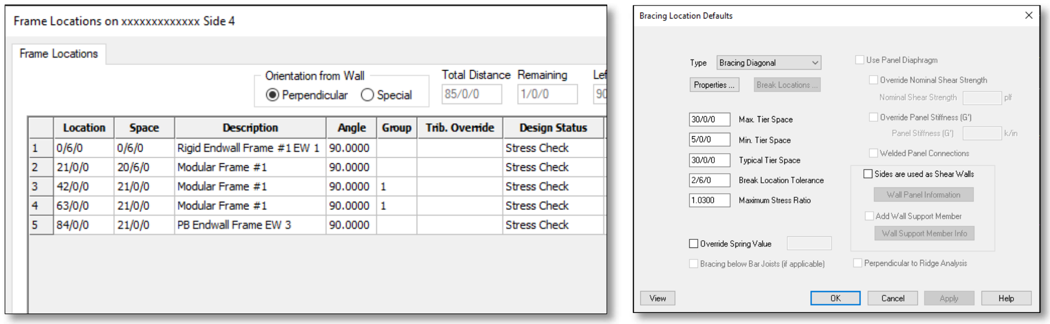


Figura No. 3.12 Ingreso de los marcos y las bahías contraventeadas del proyecto de expansión en el software estructural

e) Se seleccionó la forma y el peralte de los largueros para muros/cubiertas, así como el tipo de panel correspondiente.

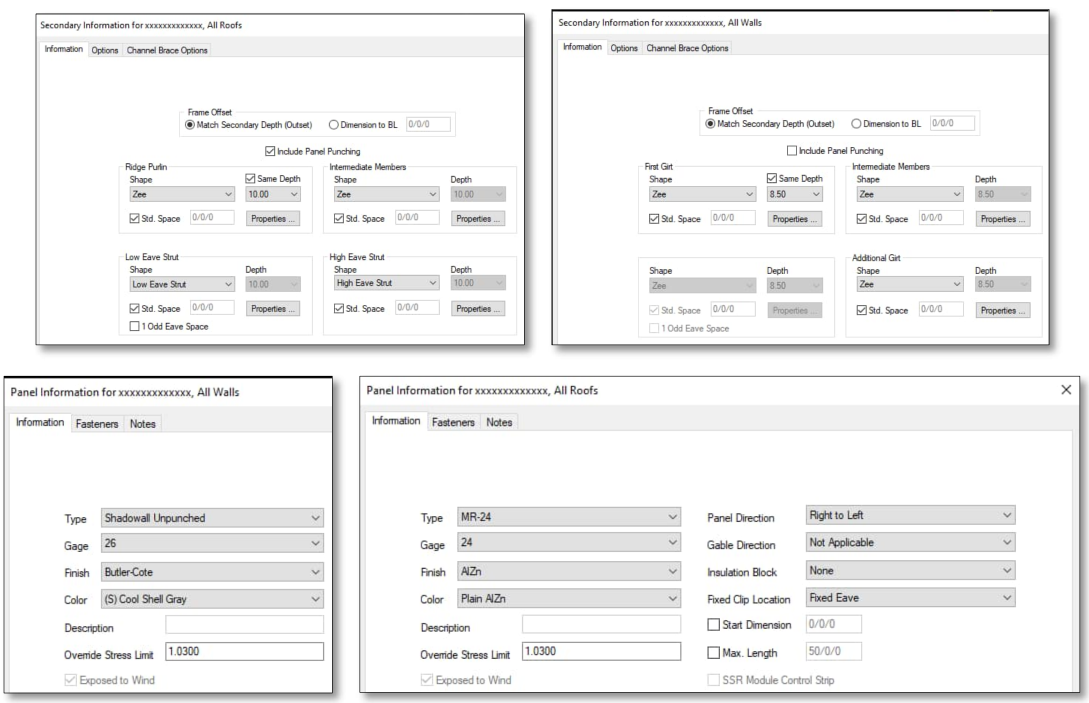


Figura No. 3.13 Selección de los largueros de cubierta y muros del proyecto de expansión en el software estructural

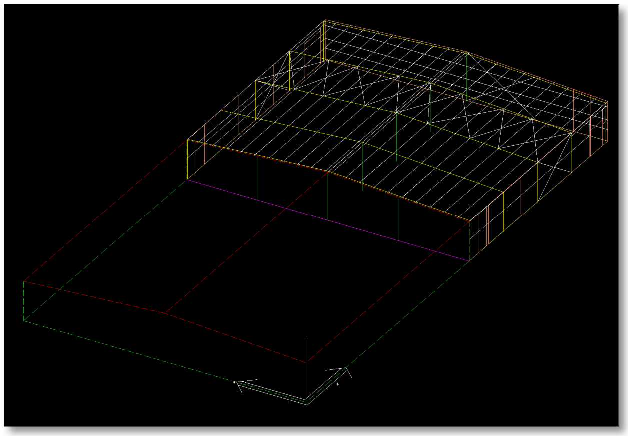


Figura No. 3.14 Selección de los largueros de cubierta y muros del proyecto de expansión en el software estructural

f) Una vez ingresados todos los parámetros correspondientes se procede a ejecutar el programa para diseñar la estructura

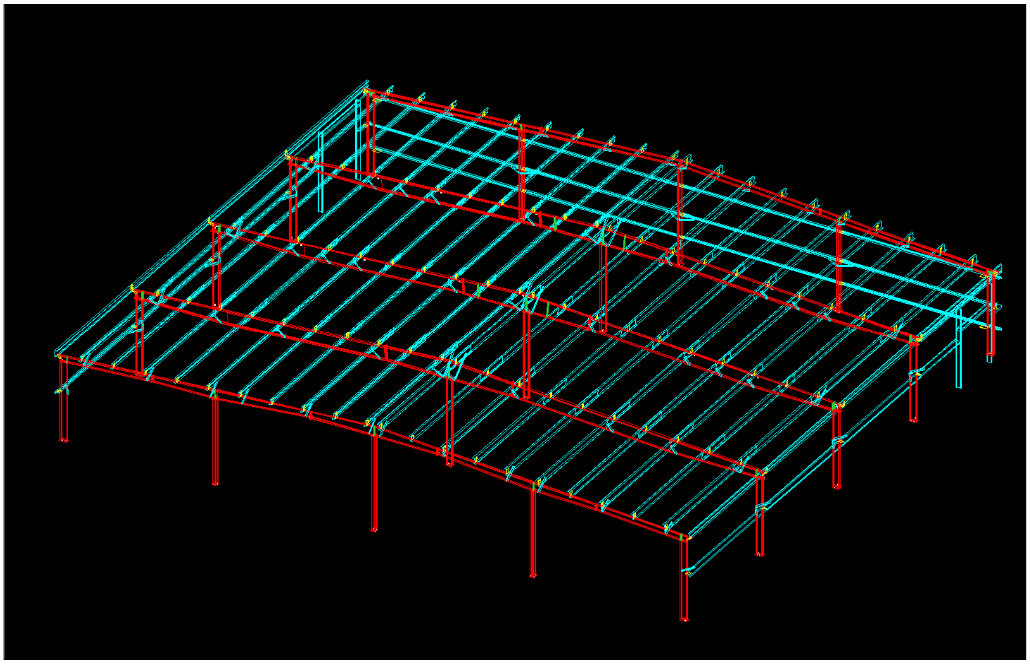


Figura No. 3.15 Ejecución del programa de diseño estructural

3.3. Diseño del sistema primario de resistencia

3.3.1. Marco cabecero en el eje 5

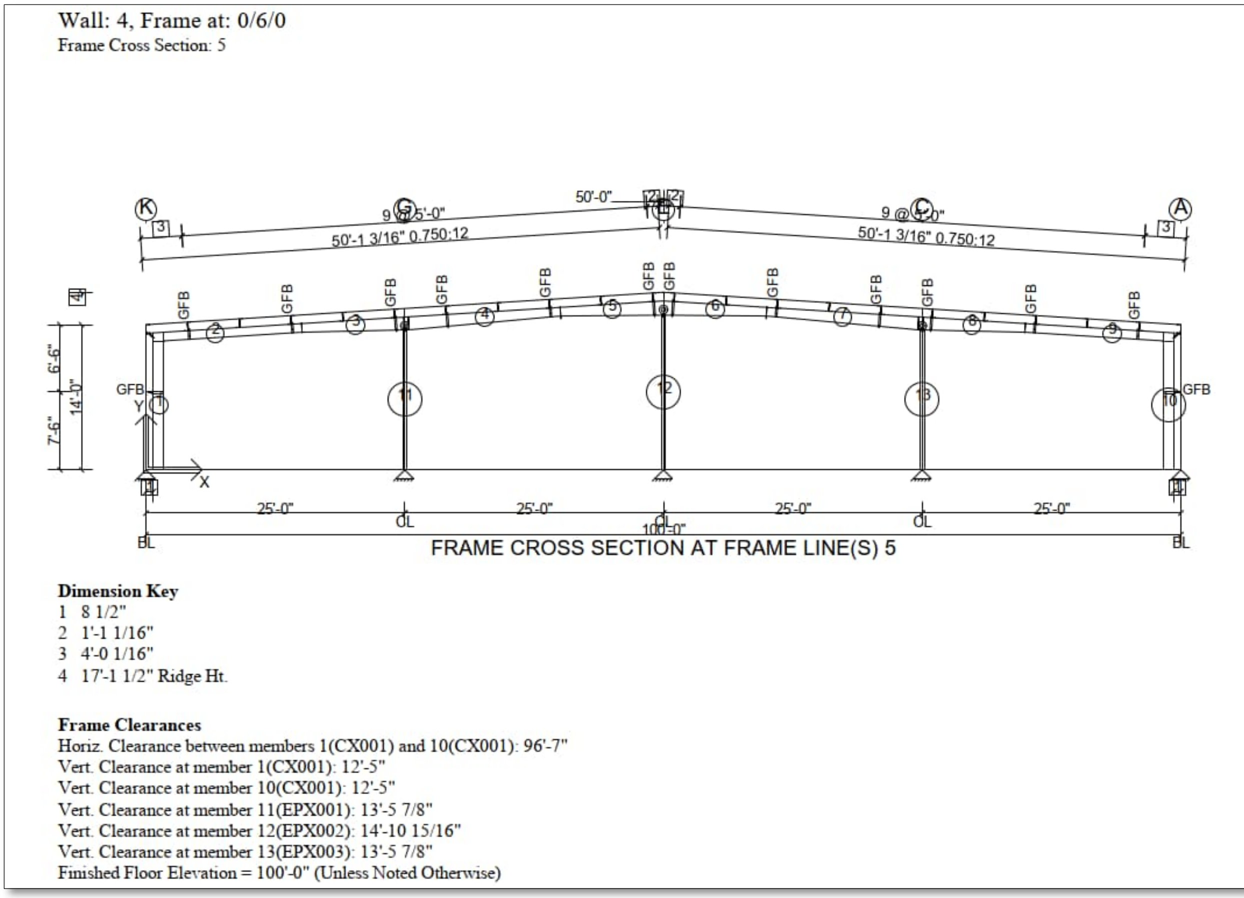


Figura No. 3.16 Marco cabecero en el eje 5

A continuación, se muestran las combinaciones de carga (tabla No. 3.1), las características geométricas de los elementos estructurales a lo largo del marco (tabla No. 3.2), las reacciones en la base de las columnas (tabla No. 3.3 sin factorizar y tabla No. 3.4 factorizadas), el diseño de las placas base (tabla No. 3.5, 3.6 y 3.7), el diseño de las conexiones entre elementos estructurales (tabla No. 3.8, 3.9 y 3.10), el diseño de dichos elementos estructurales del marco cabecero en el eje 5 (tabla No. 3.11 y 3.12) así como sus deflexiones (tabla No. 3.13 y 3.14).

Tabla No. 3.1 Combinaciones de Carga

No.	Factor	Application	Description
1	1.000	1.0 D + 1.0 CG + 1.0 L>	D + CG + L>
2	1.000	1.0 D + 1.0 CG + 1.0 <L	D + CG + <L
3	1.000	1.0 D + 1.0 CG + 1.0 ASL^	D + CG + ASL^
4	1.000	1.0 D + 1.0 CG + 1.0 ^ASL	D + CG + ^ASL
5	1.000	1.0 D + 1.0 CG + 1.0 PL2	D + CG + PL2(Spans 1 and 2)

6	1.000	1.0 D + 1.0 CG + 1.0 PL2	D + CG + PL2(Spans 2 and 3)
7	1.000	1.0 D + 1.0 CG + 1.0 PL2	D + CG + PL2(Spans 3 and 4)
8	1.000	1.0 D + 1.0 CG + 1.0 S>	D + CG + S>
9	1.000	1.0 D + 1.0 CG + 1.0 <S	D + CG + <S
10	1.000	1.0 D + 1.0 CG + 1.0 US1*	D + CG + US1*
11	1.000	1.0 D + 1.0 CG + 1.0 *US1	D + CG + *US1
12	1.000	1.0 D + 1.0 CG + 0.6 W1>	D + CG + W1>
13	1.000	1.0 D + 1.0 CG + 0.6 <W1	D + CG + <W1
14	1.000	1.0 D + 1.0 CG + 0.6 W2>	D + CG + W2>
15	1.000	1.0 D + 1.0 CG + 0.6 <W2	D + CG + <W2
16	1.000	1.0 D + 1.0 CG + 0.6 WPL	D + CG + WPL
17	1.000	1.0 D + 1.0 CG + 0.6 WPR	D + CG + WPR
18	1.000	0.6 MW	MW - Wall: 1
19	1.000	0.6 MW	MW - Wall: 2
20	1.000	0.6 MW	MW - Wall: 3
21	1.000	0.6 MW	MW - Wall: 4
22	1.000	0.6 D + 0.6 CU + 0.6 W1>	D + CU + W1>
23	1.000	0.6 D + 0.6 CU + 0.6 <W1	D + CU + <W1
24	1.000	0.6 D + 0.6 CU + 0.6 W2>	D + CU + W2>
25	1.000	0.6 D + 0.6 CU + 0.6 <W2	D + CU + <W2
26	1.000	0.6 D + 0.6 CU + 0.6 WPL	D + CU + WPL
27	1.000	0.6 D + 0.6 CU + 0.6 WPR	D + CU + WPR
28	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 W1>	D + CG + L + W1>
29	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 <W1	D + CG + L + <W1
30	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 W2>	D + CG + L + W2>
31	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 <W2	D + CG + L + <W2
32	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL	D + CG + L + WPL
33	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR	D + CG + L + WPR
34	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1>	D + CG + S + W1>
35	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W1	D + CG + S + <W1
36	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W2>	D + CG + S + W2>
37	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2	D + CG + S + <W2
38	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL	D + CG + S + WPL
39	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR	D + CG + S + WPR

Tabla No. 3.2 Características geométricas de los elementos estructurales en el marco

Mem. No.	Flg Width (in.)	Flg Thk (in.)	Web Thk (in.)	Depth1 (in.)	Depth2 (in.)	Length (ft)	Weight (p)	Flg Fy (ksi)	Web Fy (ksi)	Splice Jt.1	Codes Jt.2	Shape
1	5.00	0.1875	0.1345	12.00	12.00	13.19	163.9	55.00	55.00	BP	KN	3P
2	5.00	0.1345	0.1345	10.00	10.00	14.35	145.6	55.00	55.00	KN	SP	3P
3	5.00	0.1875	0.1345	10.00	15.00	10.33	129.9	55.00	55.00	SP	SS	3P
4	5.00	0.1875	0.1345	15.00	10.00	14.70	183.6	55.00	55.00	SS	SP	3P
5	5.00	0.1875	0.1345	10.00	16.44	10.01	130.5	55.00	55.00	SP	SS	3P
6	5.00	0.1875	0.1345	16.44	10.00	10.00	130.4	55.00	55.00	SS	SP	3P
7	5.00	0.1875	0.1345	10.00	15.00	14.71	183.7	55.00	55.00	SP	SS	3P
8	5.00	0.1875	0.1345	15.00	10.00	10.32	129.9	55.00	55.00	SS	SP	3P
9	5.00	0.1345	0.1345	10.00	10.00	14.35	145.7	55.00	55.00	SP	KN	3P
10	5.00	0.1875	0.1345	12.00	12.00	13.19	163.9	55.00	55.00	BP	KN	3P
11	5.00	0.1875	0.1345	10.00	10.00	13.49	161.2	55.00	55.00	BP	CP	3P
12	5.00	0.1345	0.1345	10.00	10.00	14.92	150.5	55.00	55.00	BP	CP	3P
13	5.00	0.1875	0.1345	10.00	10.00	13.49	161.2	55.00	55.00	BP	CP	3P

Tabla No. 3.3 Reacciones sin factorizar en la base de las columnas

Type		Exterior Column		Interior Column		Interior Column		Interior Column		Exterior Column	
X-Loc		0/0/0		25/0/0		50/0/0		75/0/0		100/0/0	
Grid1 - Grid2		5-K		5-G		5-E		5-C		5-A	
Base Plate W x L (in.)		8 X 13		8 X 11		8 X 11		8 X 11		8 X 13	
Base Plate Thickness (in.)		0.375		0.375		0.375		0.375		0.375	
Anchor Rod Qty/Diam. (in.)		4 - 0.750		4 - 0.750		4 - 0.750		4 - 0.750		4 - 0.750	
Column Base Elev.		100'-0"		100'-0"		100'-0"		100'-0"		100'-0"	
Load Type	Desc.	Hx	Vy	Hx	Vy	Hx	Vy	Hx	Vy	Hx	Vy
D	Frm	0.08	0.55	-	1.11	-	1.04	-	1.11	-0.08	0.55
CG	Frm	0.13	0.63	-	1.41	-	1.28	-	1.41	-0.13	0.63
L>	Frm	0.34	1.71	-	3.82	-	3.47	-	3.82	-0.34	1.71
<L	Frm	0.34	1.71	-	3.82	-	3.47	-	3.82	-0.34	1.71
ASL^	Frm	0.17	-0.07	-	1.90	-	1.73	-	1.92	-0.17	1.78
^ASL	Frm	0.17	1.78	-	1.91	-	1.73	-	1.90	-0.17	-0.07
S>	Frm	0.88	4.44	-	9.89	-	8.99	-	9.89	-0.88	4.44
<S	Frm	0.88	4.44	-	9.89	-	8.99	-	9.89	-0.88	4.44
US1*	Frm	0.54	1.71	-	1.88	-	8.13	-	13.78	-0.54	3.93
*US1	Frm	0.54	3.93	-	13.78	-	8.13	-	1.88	-0.54	1.71
W1>	Frm	-1.26	-2.76	-	-5.23	-	-4.04	-	-3.75	-0.82	-1.29
<W1	Frm	0.82	-1.29	-	-3.75	-	-4.04	-	-5.23	1.26	-2.76
W2>	Frm	-1.58	-1.68	-	-2.98	-	-2.04	-	-1.51	-0.51	-0.21
<W2	Frm	0.51	-0.21	-	-1.51	-	-2.04	-	-2.98	1.58	-1.68
WPL	Frm	0.39	-1.86	-	-3.10	-	-3.95	-	-5.79	-0.63	-2.38
WPR	Frm	0.63	-2.38	-	-5.79	-	-3.95	-	-3.10	-0.39	-1.86
MW - Wall: 1	Frm	-	-	-	-	-	-	-	-	-	-
MW - Wall: 2	Frm	0.82	0.67	-	-0.79	-	-0.08	-	0.73	1.86	-0.53
MW - Wall: 3	Frm	-	-	-	-	-	-	-	-	-	-
MW - Wall: 4	Frm	-1.86	-0.53	-	0.73	-	-0.08	-	-0.79	-0.82	0.67
CU	Frm	-	-	-	-	-	-	-	-	-	-
L	Frm	0.34	1.71	-	3.82	-	3.47	-	3.82	-0.34	1.71
S	Frm	0.88	4.44	-	9.89	-	8.99	-	9.89	-0.88	4.44

Tabla No. 3.4 Reacciones máximas factorizadas en la base de las columnas

X-Loc	Grid	Hrz left (-Hx) (k)	Load Case	Hrz Right (Hx) (k)	Load Case	Hrz In (-Hz) (k)	Load Case	Hrz Out (Hz) (k)	Load Case	Uplift (-Vy) (k)	Load Case	Vrt Down (Vy) (k)	Load Case	Mom cw (-Mzz) (in-k)	Load Case	Mom ccw (Mzz) (in-k)	Load Case
0/0/0	5-K	1.11	21	1.24	35	-	-	-	-	1.33	22	5.62	8	-	-	-	-
25/0/0	5-G	-	-	-	-	-	-	-	-	2.81	27	16.31	11	-	-	-	-
50/0/0	5-E	-	-	-	-	-	-	-	-	1.80	23	11.31	8	-	-	-	-
75/0/0	5-C	-	-	-	-	-	-	-	-	2.81	26	16.31	10	-	-	-	-
100/0/0	5-A	1.24	34	1.11	19	-	-	-	-	1.33	23	5.62	8	-	-	-	-

Tabla No. 3.5 Placas base

X-Loc	Grid	Mem. No.	Thickness (in.)	Width (in.)	Length (in.)	Stiff.	Num. Of Rods	Rod Diam. (in.)	Pitch (in.)	Gage (in.)	Hole Type	Welds to Flange	Welds to Web
0/0/0	5-K	1	0.375	8	13	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
25/0/0	5-G	11	0.375	8	11	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
50/0/0	5-E	12	0.375	8	11	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
75/0/0	5-C	13	0.375	8	11	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
100/0/0	5-A	10	0.375	8	13	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875

Tabla No. 3.6 Cargas en la placa base

	Maximum Shear Case			Maximum Tension Case			Maximum Comp Case			Maximum Bracing/WA Case			
X-Loc	Shear (k)	Axial (k)	Load Case	Shear (k)	Tension (k)	Load Case	Shear (k)	Comp (k)	Load Case	Shear (k)	Axial (k)	Frame Shear (k)	Load Case
0/0/0	1.36	4.05	35	0.69	-1.31	22	1.17	5.69	9	-	-	-	0
25/0/0	0.14	16.53	11	0.01	-2.80	27	0.14	16.53	11	-	-	-	0
50/0/0	0.08	10.44	11	0.01	-1.80	22	0.02	11.30	9	-	-	-	0
75/0/0	0.14	16.53	10	0.01	-2.80	26	0.14	16.53	10	-	-	-	0
100/0/0	1.36	4.05	34	0.69	-1.31	23	1.17	5.69	8	-	-	-	0

Tabla No 3.7. Relaciones de esfuerzos en las placas base

X-Loc	Rod Shear	Load Case	Rod Tension	Load Case	Rod V + T	Load Case	Rod Bending	Load Case	Conc. Bearing	Load Case	Plate Tension	Load Case	Plate Comp	Load Case	Flange Weld	Load Case	Web Weld	Load Case
0/0/0	0.073	35	0.034	22	-	0	-	0	0.050	9	0.050	22	0.092	9	0.072	9	0.059	9
25/0/0	0.008	11	0.073	27	-	0	-	0	0.170	11	0.098	27	0.314	11	0.227	11	0.163	11
50/0/0	0.005	11	0.047	22	-	0	-	0	0.116	9	0.064	22	0.215	9	0.133	9	0.133	9
75/0/0	0.008	10	0.073	26	-	0	-	0	0.170	10	0.098	26	0.314	10	0.227	10	0.163	10
100/0/0	0.073	34	0.034	23	-	0	-	0	0.049	8	0.050	23	0.092	8	0.072	8	0.059	8

Tabla No. 3.8 Conexiones atornilladas intermedias en el marco

			End-Plate Dimensions			Bolt			Outside Flange			Inside Flange		
Mem. No.	Jt. No.	Type	Thick. (in.)	Width (in.)	Length (in.)	Diam. (in.)	Spec/Joint	Gages In/Out (in.)	Configuration ID	Configuration Desc.	Pitches 1st/2nd (in.)	Configuration ID	Configuration Desc.	Pitches 1st/2nd (in.)
1	2	KN(Top)	0.375	6.00	13.00	0.750	A325N/ST	3.00	11	Flush	2.50/2.50	11	Flush	2.50/2.50
2	1	KN(Top)	0.375	6.00	13.00	0.750	A325N/ST	3.00	11	Flush	2.50	11	Flush	2.50
2	2	SP	0.375	6.00	11.00	0.750	A325N/ST	3.00	11	Flush	2.50	11	Flush	2.50
3	1	SP	0.375	6.00	11.02	0.750	A325N/ST	3.00	11	Flush	2.50	11	Flush	2.50
4	2	SP	0.375	6.00	13.39	0.750	A325N/ST	3.00	11	Flush	6.66	31	Extended	3.25
5	1	SP	0.375	6.00	13.40	0.750	A325N/ST	3.00	11	Flush	6.66	31	Extended	3.25
6	2	SP	0.375	6.00	13.40	0.750	A325N/ST	3.00	11	Flush	6.66	31	Extended	3.25
7	1	SP	0.375	6.00	13.39	0.750	A325N/ST	3.00	11	Flush	6.66	31	Extended	3.25
8	2	SP	0.375	6.00	11.02	0.750	A325N/ST	3.00	11	Flush	2.50	11	Flush	2.50
9	1	SP	0.375	6.00	11.00	0.750	A325N/ST	3.00	11	Flush	2.50	11	Flush	2.50
9	2	KN(Top)	0.375	6.00	13.00	0.750	A325N/ST	3.00	11	Flush	2.50	11	Flush	2.50
10	2	KN(Top)	0.375	6.00	13.00	0.750	A325N/ST	3.00	11	Flush	2.50/2.50	11	Flush	2.50/2.50
11	2	CP	0.375	6.00	11.00	0.500	A325/-	3.00	11	Flush	3.00	11	Flush	3.00
12	2	CP	0.375	6.00	11.00	0.500	A325/-	3.00	11	Flush	3.00	11	Flush	3.00
13	2	CP	0.375	6.00	11.00	0.500	A325/-	3.00	11	Flush	3.00	11	Flush	3.00

Tabla No. 3.9 Conexiones a momento

Outside Flange		Required Strength					Strength Ratios *							
Mem. No.	Jt. No.	Ld Cs	Axial (k)	Shear (k)	Moment (in-k)	Design Proc.	Bolt Tension	Bolt Shear	Plate Bending	Shear Yielding	Shear Rupture	Bearing Tearing	Flange Weld	Web Weld
1	2	37	-4.6	1.1	180.4	AISC DG-16/Thin plate	0.465	0.023	0.750	0.000	0.000	0.030	0.719	0.516
2	1	37	-4.6	1.1	180.4	AISC DG-16/Thin plate	0.465	0.023	0.750	0.000	0.000	0.030	0.719	0.516
2	2	27	0.9	0.4	22.1	AISC DG-16/Thin plate	0.101	0.009	0.163	0.000	0.000	0.012	0.516	0.516
3	1	27	0.9	0.4	22.1	AISC DG-16/Thin plate	0.101	0.009	0.163	0.000	0.000	0.012	0.516	0.516
4	2	4	-0.4	0.1	40.4	AISC DG-16/Thin plate	0.146	0.002	0.234	0.000	0.000	0.003	0.719	0.516
5	1	4	-0.4	0.1	40.4	AISC DG-16/Thin plate	0.146	0.002	0.234	0.000	0.000	0.003	0.719	0.516
6	2	3	-0.4	0.1	40.4	AISC DG-16/Thin plate	0.146	0.002	0.234	0.000	0.000	0.003	0.719	0.516
7	1	3	-0.4	0.1	40.4	AISC DG-16/Thin plate	0.146	0.002	0.234	0.000	0.000	0.003	0.719	0.516
8	2	26	1.0	0.4	22.1	AISC DG-16/Thin plate	0.101	0.009	0.163	0.000	0.000	0.011	0.719	0.516
9	1	26	1.0	0.4	22.1	AISC DG-16/Thin plate	0.101	0.009	0.163	0.000	0.000	0.011	0.719	0.516
9	2	36	-4.6	1.1	180.4	AISC DG-16/Thin plate	0.464	0.023	0.752	0.000	0.000	0.030	0.516	0.516
10	2	36	-4.6	1.1	180.4	AISC DG-16/Thin plate	0.464	0.023	0.752	0.000	0.000	0.030	0.516	0.516

Inside Flange		Required Strength					Strength Ratios *							
Mem. No.	Jt. No.	Ld Cs	Axial (k)	Shear (k)	Moment (in-k)	Design Proc.	Bolt Tension	Bolt Shear	Plate Bending	Shear Yielding	Shear Rupture	Bearing Tearing	Flange Weld	Web Weld
1	2	22	1.3	0.3	72.6	AISC DG-16/Thin plate	0.243	0.006	0.392	0.000	0.000	0.008	0.719	0.516
2	1	22	1.3	0.3	72.6	AISC DG-16/Thin plate	0.243	0.006	0.392	0.000	0.000	0.008	0.719	0.516
2	2	8	-0.9	1.7	103.3	AISC DG-16/Thin plate	0.372	0.034	0.601	0.000	0.000	0.044	0.516	0.516
3	1	8	-0.9	1.7	103.3	AISC DG-16/Thin plate	0.372	0.034	0.601	0.000	0.000	0.044	0.516	0.516
4	2	11	-0.7	0.9	188.6	AISC DG-16/Thin plate	0.290	0.012	0.636	0.202	0.299	0.009	0.719	0.516
5	1	11	-0.7	0.9	188.6	AISC DG-16/Thin plate	0.290	0.012	0.636	0.202	0.299	0.009	0.719	0.516
6	2	10	-0.7	0.9	188.5	AISC DG-16/Thin plate	0.290	0.012	0.635	0.202	0.299	0.009	0.719	0.516
7	1	10	-0.7	0.9	188.5	AISC DG-16/Thin plate	0.290	0.012	0.635	0.202	0.299	0.009	0.719	0.516
8	2	9	-0.9	1.7	103.2	AISC DG-16/Thin plate	0.372	0.034	0.599	0.000	0.000	0.043	0.719	0.516
9	1	9	-0.9	1.7	103.2	AISC DG-16/Thin plate	0.372	0.034	0.599	0.000	0.000	0.043	0.719	0.516
9	2	23	1.3	0.3	72.6	AISC DG-16/Thin plate	0.243	0.006	0.394	0.000	0.000	0.008	0.516	0.516
10	2	23	1.3	0.3	72.6	AISC DG-16/Thin plate	0.243	0.006	0.394	0.000	0.000	0.008	0.516	0.516

Tabla No. 3.10 Conexiones articuladas

		Maximum Shear Case			Maximum Tension Case			Strength Ratios							
Mem. No.	Jt. No.	Ld Cs	Axial (k)	Shear (k)	Ld Cs	Axial (k)	Shear (k)	Bolt Tension	Bolt Shear	Bolt V + T	Plate Bending	Flange Yielding	Flange Bearing	Flange Weld	Web Weld
11	2	11	-16.5	0.4	27	2.8	0.1	0.088	0.017	0.000	0.090	0.045	0.009	0.241	0.014
12	2	0	0.0	0.0	22	1.8	0.0	0.057	0.000	0.000	0.058	0.041	0.000	0.164	0.000
13	2	10	-16.5	0.4	26	2.8	0.1	0.088	0.017	0.000	0.090	0.045	0.009	0.241	0.014

Tabla No. 3.11 Diseño de los elementos estructurales en el marco (Caso de carga máximo)

			Controlling Cases		Required Strength				Available Strength				Strength Ratios	
Mem. No.	Loc. ft	Depth in.	Axial + Flexure	Shear	Axial Pr k	Shear Vr k	Mom-x Mrx in-k	Mom-y Mry in-k	Axial Pc k	Shear Vc k	Mom-x Mcx in-k	Mom-y Mcy in-k	Axial + Flexure	Shear
1	12.44	12.00	37		-4.6		-180.4	0.0	64.1		407.7	55.4	0.48	
1	0.00	12.00		35		-1.4				21.6				0.06
2	0.47	10.00	37		-1.3		-166.8	0.0	42.1		183.6	39.0	0.92	
2	0.47	10.00		9		4.7				21.5				0.22
3	9.95	15.00	11		-0.2		-499.0	0.0	61.6		510.6	52.6	0.98	
3	9.95	15.00		11		-7.8				21.4				0.36
4	0.00	15.00	11		-1.4		-499.0	0.0	61.6		510.6	52.6	0.99	
4	0.00	15.00		11		8.5				21.4				0.40
5	0.00	10.00	11		-0.7		188.6	0.0	37.9		330.4	57.4	0.58	
5	9.97	16.44		11		-7.1				21.4				0.33
6	9.96	10.00	10		-0.7		188.5	0.0	37.9		330.4	57.4	0.58	
6	0.00	16.44		10		7.1				21.4				0.33
7	15.09	15.00	10		-1.4		-499.1	0.0	61.6		510.6	52.6	0.99	
7	15.09	15.00		10		-8.5				21.4				0.40
8	0.00	15.00	10		-0.2		-499.0	0.0	61.6		510.6	52.6	0.98	
8	0.00	15.00		10		7.8				21.4				0.36
9	13.40	10.00	36		-1.3		-166.8	0.0	42.1		183.6	39.0	0.92	
9	13.40	10.00		8		-4.7				21.5				0.22
10	12.44	12.00	36		-4.6		-180.4	0.0	64.1		407.7	55.4	0.48	
10	0.00	12.00		34		1.4				21.6				0.06
11	11.24	10.00	11		-16.5		0.0	0.0	22.5		144.6	57.4	0.74	
11	11.24	10.00		1		0.0				21.7				0.00
12	12.43	10.00	9		-11.3		0.0	0.0	13.2		84.3	39.0	0.86	
12	12.43	10.00		1		0.0				21.5				0.00
13	11.24	10.00	10		-16.5		0.0	0.0	22.5		144.6	57.4	0.74	
13	11.24	10.00		1		0.0				21.7				0.00

Tabla No. 3.12 Parámetros utilizados para el diseño por carga axial y flexión de los elementos

Mem. No.	Loc. ft	Lx in.	Ly/Lt in.	Lb in.	Ag in.2	Afn in.2	Ixx in.4	Iyy in.4	Sx in.3	Sy in.3	Zx in.3	Zy in.3	J in.4	Cw in.6	Cb	Rpg	Rpc	Aeff/ Ag
1	12.44	149.24	59.2	59.2	3.44	0.94	83.02	3.91	13.84	1.56	15.62	2.40	0.03	136.35	1.17	1.00	1.13	0.72
2	0.47	280.23	10.3	10.3	2.65	0.67	43.06	2.80	8.61	1.12	9.82	1.73	0.02	68.23	1.00	1.00	1.14	0.71
3	9.95	280.23	60.0	60.0	3.84	0.94	137.92	3.91	18.39	1.56	21.08	2.41	0.03	214.43	1.28	1.00	1.07	0.65
4	0.00	300.60	60.0	60.0	3.84	0.94	137.92	3.91	18.39	1.56	21.08	2.41	0.03	214.43	1.28	1.00	1.07	0.65
5	0.00	300.60	120.0	60.0	3.17	0.94	55.13	3.91	11.03	1.56	12.31	2.39	0.03	94.08	1.77	1.00	1.12	0.93
6	9.96	300.60	120.0	60.0	3.17	0.94	55.13	3.91	11.03	1.56	12.31	2.39	0.03	94.08	1.77	1.00	1.12	0.93
7	15.09	300.60	60.0	60.0	3.84	0.94	137.92	3.91	18.39	1.56	21.08	2.41	0.03	214.43	1.28	1.00	1.07	0.65
8	0.00	280.23	60.0	60.0	3.84	0.94	137.92	3.91	18.39	1.56	21.08	2.41	0.03	214.43	1.28	1.00	1.07	0.65
9	13.40	280.23	28.8	28.8	2.65	0.67	43.06	2.80	8.61	1.12	9.82	1.73	0.02	68.23	1.32	1.00	1.14	0.71
10	12.44	149.24	59.2	59.2	3.44	0.94	83.02	3.91	13.84	1.56	15.62	2.40	0.03	136.35	1.17	1.00	1.13	0.72
11	11.24	169.23	161.9	161.9	3.17	0.94	55.13	3.91	11.03	1.56	12.31	2.39	0.03	94.08	1.00	1.00	1.12	1.00
12	12.43	187.23	179.0	179.0	2.65	0.67	43.06	2.80	8.61	1.12	9.82	1.73	0.02	68.23	1.00	1.00	1.14	1.00
13	11.24	169.23	161.9	161.9	3.17	0.94	55.13	3.91	11.03	1.56	12.31	2.39	0.03	94.08	1.00	1.00	1.12	1.00

Tabla No. 3.14 Combinaciones de deflexión

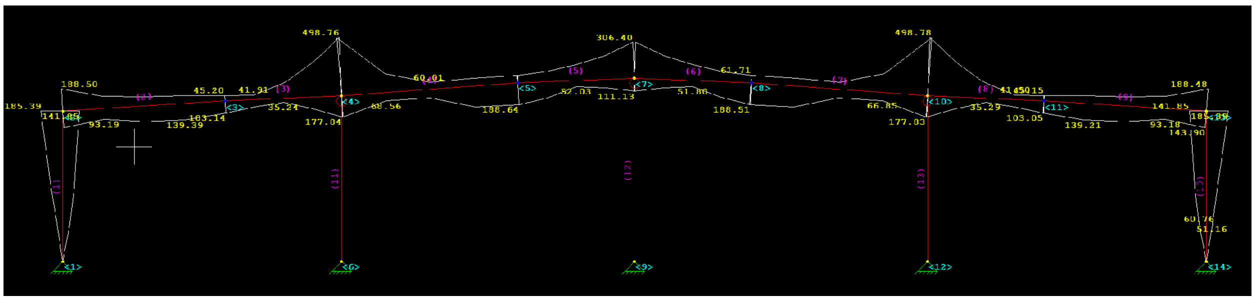
No.	Origin	Factor	Def H	Def V	Application	Description
1	System	1.000	0	180	1.0 L	L
2	System	1.000	0	180	1.0 S	S
3	System	1.000	60	180	0.42 W1>	W1>
4	System	1.000	60	180	0.42 <W1	<W1
5	System	1.000	60	180	0.42 W2>	W2>
6	System	1.000	60	180	0.42 <W2	<W2
7	System	1.000	60	180	0.42 WPL	WPL
8	System	1.000	60	180	0.42 WPR	WPR

Tabla No. 3.15 Deflexiones máximas en el marco

Description	Ratio	Deflection (in.)	Member	Joint	Load Case	Load Case Description
Max. Horizontal Deflection	(H/392)	0.392	1	2	5	W2>
Max. Vertical Deflection for Span 1	(L/714)	-0.400	3	1	2	S
Max. Vertical Deflection for Span 2	(L/1577)	-0.190	5	1	2	S
Max. Vertical Deflection for Span 3	(L/1578)	-0.190	7	1	2	S
Max. Vertical Deflection for Span 4	(L/714)	-0.400	9	1	2	S

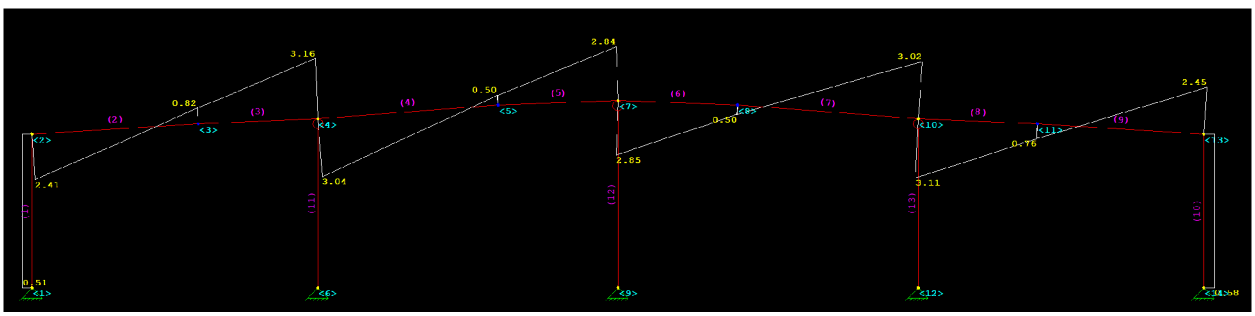
Figura No. 3.17 Diagramas envolventes de los elementos mecánicos del marco

Momento



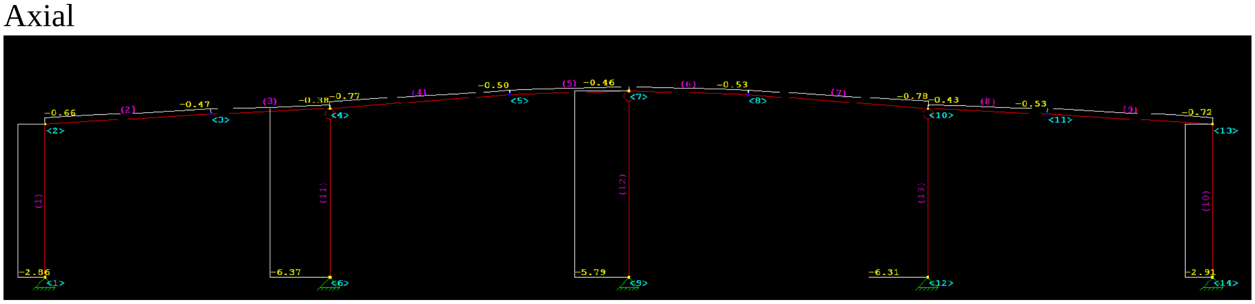
Valores mostrados en kip-in

Cortante



Valores mostrados en kips

Axial



Valores mostrados en kips

3.3.2. Marco interior en el eje 6

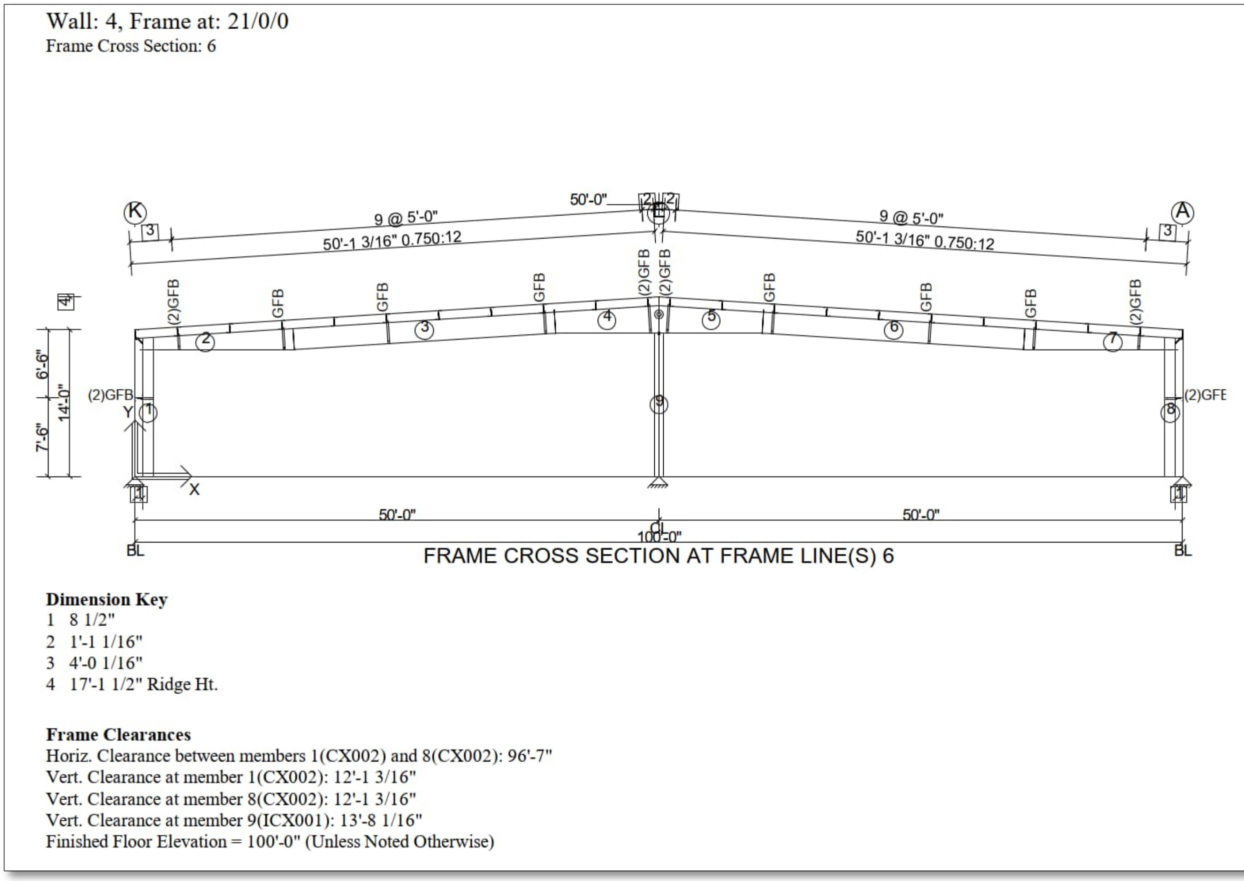


Figura No. 3.17 Marco interior en el eje 6

A continuación, se muestran las combinaciones de carga (tabla No. 3.16), las características geométricas de los elementos estructurales a lo largo del marco (tabla No. 3.17), las reacciones en la base de las columnas (tabla No. 3.18 sin factorizar y tabla No. 3.19 factorizadas), el diseño de las placas base (tabla No. 3.20, 3.21 y 3.22), el diseño de las conexiones entre elementos estructurales (tabla No. 3.23, 3.24 y 3.25), el diseño de dichos elementos estructurales del marco en el eje 6 (tabla No. 3.26 y 3.27) así como sus deflexiones (tabla No. 3.28 y 3.29).

Tabla No. 3.16 Combinaciones de Carga

No.	Factor	Application	Description
1	1.000	1.0 D + 1.0 CG + 1.0 L>	D + CG + L>
2	1.000	1.0 D + 1.0 CG + 1.0 <L	D + CG + <L
3	1.000	1.0 D + 1.0 CG + 1.0 ASL^	D + CG + ASL^
4	1.000	1.0 D + 1.0 CG + 1.0 ^ASL	D + CG + ^ASL
5	1.000	1.0 D + 1.0 CG + 1.0 S>	D + CG + S>
6	1.000	1.0 D + 1.0 CG + 1.0 <S	D + CG + <S
7	1.000	1.0 D + 1.0 CG + 1.0 US1*	D + CG + US1*
8	1.000	1.0 D + 1.0 CG + 1.0 *US1	D + CG + *US1

9	1.000	1.0 D + 1.0 CG + 0.6 W1>	D + CG + W1>
10	1.000	1.0 D + 1.0 CG + 0.6 <W1	D + CG + <W1
11	1.000	1.0 D + 1.0 CG + 0.6 W2>	D + CG + W2>
12	1.000	1.0 D + 1.0 CG + 0.6 <W2	D + CG + <W2
13	1.000	1.0 D + 1.0 CG + 0.6 WPL	D + CG + WPL
14	1.000	1.0 D + 1.0 CG + 0.6 WPR	D + CG + WPR
15	1.000	0.6 MW	MW - Wall: 1
16	1.000	0.6 MW	MW - Wall: 2
17	1.000	0.6 MW	MW - Wall: 3
18	1.000	0.6 MW	MW - Wall: 4
19	1.000	0.6 D + 0.6 CU + 0.6 W1>	D + CU + W1>
20	1.000	0.6 D + 0.6 CU + 0.6 <W1	D + CU + <W1
21	1.000	0.6 D + 0.6 CU + 0.6 W2>	D + CU + W2>
22	1.000	0.6 D + 0.6 CU + 0.6 <W2	D + CU + <W2
23	1.000	0.6 D + 0.6 CU + 0.6 WPL	D + CU + WPL
24	1.000	0.6 D + 0.6 CU + 0.6 WPR	D + CU + WPR
25	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 W1>	D + CG + L + W1>
26	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 <W1	D + CG + L + <W1
27	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 W2>	D + CG + L + W2>
28	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 <W2	D + CG + L + <W2
29	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL	D + CG + L + WPL
30	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR	D + CG + L + WPR
31	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1>	D + CG + S + W1>
32	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W1	D + CG + S + <W1
33	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W2>	D + CG + S + W2>
34	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2	D + CG + S + <W2
35	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL	D + CG + S + WPL
36	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR	D + CG + S + WPR

Tabla No. 3.17 Características geométricas de los elementos estructurales en el marco

Mem. No.	Flg Width (in.)	Flg Thk (in.)	Web Thk (in.)	Depth1 (in.)	Depth2 (in.)	Length (ft)	Weight (p)	Flg Fy (ksi)	Web Fy (ksi)	Splice Jt.1	Codes Jt.2	Shape
1	5.00	0.3750	0.1345	12.00	12.00	13.20	239.5	55.00	55.00	BP	KN	3P
2	6.00	0.3750	0.1644	13.91	24.00	14.39	383.0	55.00	55.00	KN	SS	3P
3	6.00	0.5000	0.1644	24.00	24.00	25.00	853.9	55.00	55.00	SS	SP	3P
4	6.00	0.5000	0.1644	24.00	31.38	10.00	372.8	55.00	55.00	SP	SS	3P
5	6.00	0.5000	0.1644	31.38	24.00	10.00	372.8	55.00	55.00	SS	SP	3P
6	6.00	0.5000	0.1644	24.00	24.00	25.00	853.9	55.00	55.00	SP	SS	3P
7	6.00	0.3750	0.1644	24.00	13.91	14.39	383.1	55.00	55.00	SS	KN	3P
8	5.00	0.3750	0.1345	12.00	12.00	13.20	239.5	55.00	55.00	BP	KN	3P
9	6.00	0.3750	0.1345	10.00	10.00	13.67	284.7	55.00	55.00	BP	CP	3P

Tabla No. 3.18 Reacciones sin factorizar en la base de las columnas

Type		Exterior Column		Interior Column		Exterior Column			
X-Loc		0/0/0		50/0/0		100/0/0			
Grid1 - Grid2		6-K		6-E		6-A			
Base Plate W x L (in.)		8 X 13		8 X 11		8 X 13			
Base Plate Thickness (in.)		0.375		0.375		0.375			
Anchor Rod Qty/Diam. (in.)		4 - 0.750		4 - 0.750		4 - 0.750			
Column Base Elev.		100'-0"		100'-0"		100'-0"			
Load Type	Desc.	Hx	Vy	Hx	Vy	Hx	Vy		
D	Frm	0.35	1.81	-	5.10	-0.35	1.81	-	-
CG	Frm	0.46	2.15	-	6.08	-0.46	2.15	-	-
L>	Frm	1.09	5.16	-	14.58	-1.09	5.16	-	-
<L	Frm	1.09	5.16	-	14.58	-1.09	5.16	-	-
ASL^	Frm	0.55	-0.61	-	7.29	-0.55	5.77	-	-
^ASL	Frm	0.55	5.77	-	7.29	-0.55	-0.61	-	-
S>	Frm	3.19	15.05	-	42.53	-3.19	15.05	-	-
<S	Frm	3.19	15.05	-	42.53	-3.19	15.05	-	-
US1*	Frm	2.39	2.63	-	35.47	-2.39	18.69	-	-
*US1	Frm	2.39	18.69	-	35.47	-2.39	2.63	-	-
W1>	Frm	-3.14	-9.01	-	-19.24	-0.88	-4.71	-	-
<W1	Frm	0.88	-4.71	-	-19.24	3.14	-9.01	-	-
W2>	Frm	-3.32	-5.43	-	-9.69	-0.70	-1.13	-	-
<W2	Frm	0.70	-1.13	-	-9.69	3.32	-5.43	-	-
WPL	Frm	-0.09	-5.20	-	-18.89	-0.38	-8.86	-	-
WPR	Frm	0.38	-8.86	-	-18.89	0.09	-5.20	-	-
MW - Wall: 1	Frm	-	-	-	-	-	-	-	-
MW - Wall: 2	Frm	1.68	0.54	-	-0.27	3.49	-0.26	-	-
MW - Wall: 3	Frm	-	-	-	-	-	-	-	-
MW - Wall: 4	Frm	-3.49	-0.26	-	-0.27	-1.68	0.54	-	-
CU	Frm	-	-	-	-	-	-	-	-
L	Frm	1.09	5.16	-	14.58	-1.09	5.16	-	-
S	Frm	3.19	15.05	-	42.53	-3.19	15.05	-	-

Tabla No. 3.19 Reacciones máximas sin factorizar en la base de las columnas

X-Loc	Grid	Hrz left (-Hx) (k)	Load Case	Hrz Right (Hx) (k)	Load Case	Hrz In (-Hz) (k)	Load Case	Hrz Out (Hz) (k)	Load Case	Uplift (-Vy) (k)	Load Case	Vrt Down (Vy) (k)	Load Case	Mom cw (-Mzz) (in-k)	Load Case	Mom ccw (Mzz) (in-k)	Load Case
0/0/0	6-K	2.09	18	4.00	5	-	-	-	-	4.32	19	22.64	8	-	-	-	-
50/0/0	6-E	-	-	-	-	-	-	-	-	8.48	20	53.71	5	-	-	-	-
100/0/0	6-A	4.00	5	2.09	16	-	-	-	-	4.32	20	22.64	7	-	-	-	-

Tabla No. 3.20 Placas base

X-Loc	Grid	Mem. No.	Thickness (in.)	Width (in.)	Length (in.)	Stiff.	Num. Of Rods	Rod Diam. (in.)	Pitch (in.)	Gage (in.)	Hole Type	Welds to Flange	Welds to Web
0/0/0	6-K	1	0.375	8	13	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
50/0/0	6-E	9	0.375	8	11	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
100/0/0	6-A	8	0.375	8	13	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875

Tabla No. 3.21 Cargas en la placa base

	Maximum Shear Case			Maximum Tension Case			Maximum Comp Case			Maximum Bracing/WA Case			
X-Loc	Shear (k)	Axial (k)	Load Case	Shear (k)	Tension (k)	Load Case	Shear (k)	Comp (k)	Load Case	Shear (k)	Axial (k)	Frame Shear (k)	Load Case
0/0/0	4.08	19.01	6	1.67	-4.32	19	2.65	22.25	8	-	-	-	0
50/0/0	1.17	46.77	8	0.02	-8.48	19	0.03	53.76	6	-	-	-	0
100/0/0	4.08	19.01	5	1.67	-4.32	20	2.66	22.25	7	-	-	-	0

Tabla No. 3.22 Relaciones de esfuerzos en las placas base

X-Loc	Rod Shear	Load Case	Rod Tension	Load Case	Rod V + T	Load Case	Rod Bending	Load Case	Conc. Bearing	Load Case	Plate Tension	Load Case	Plate Comp	Load Case	Flange Weld	Load Case	Web Weld	Load Case
0/0/0	0.221	6	0.112	19	-	0	-	0	0.194	8	0.162	19	0.358	8	0.369	8	0.156	6
50/0/0	0.063	8	0.221	19	-	0	-	0	0.553	6	0.267	19	0.693	6	0.816	6	0.293	6
100/0/0	0.221	5	0.112	20	-	0	-	0	0.194	7	0.162	20	0.358	7	0.369	7	0.156	5

Tabla No. 3.23 Conexiones atornilladas intermedias en el marco

			End-Plate Dimensions			Bolt			Outside Flange			Inside Flange		
Mem. No.	Jt. No.	Type	Thick. (in.)	Width (in.)	Length (in.)	Diam. (in.)	Spec/Joint	Gages In/Out (in.)	Configuration ID	Configuration Desc.	Pitches 1st/2nd (in.)	Configuration ID	Configuration Desc.	Pitches 1st/2nd (in.)
1	2	KN(Top)	0.500	6.00	15.38	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	8.06
2	1	KN(Top)	0.500	6.00	15.38	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	8.06
3	2	SP	0.500	6.00	27.25	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	20.00
4	1	SP	0.500	6.00	27.28	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	20.00
5	2	SP	0.500	6.00	27.28	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	20.00
6	1	SP	0.500	6.00	27.25	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	20.00
7	2	KN(Top)	0.500	6.00	15.38	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	8.06
8	2	KN(Top)	0.500	6.00	15.38	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	8.06
9	2	CP	0.375	8.00	11.00	0.500	A325/-	3.00	11	Flush	3.00	11	Flush	3.00

Tabla No. 3.24 Conexiones a momento

Outside Flange		Required Strength					Strength Ratios *							
Mem. No.	Jt. No.	Ld Cs	Axial (k)	Shear (k)	Moment (in-k)	Design Proc.	Bolt Tension	Bolt Shear	Plate Bending	Shear Yielding	Shear Rupture	Bearing Tearing	Flange Weld	Web Weld
1	2	7	-6.7	4.2	607.5	AISC DG-16/Thin plate	0.690	0.057	0.916	0.364	0.538	0.032	0.853	0.631
2	1	7	-6.7	4.2	607.5	AISC DG-16/Thin plate	0.690	0.057	0.916	0.364	0.538	0.032	0.959	0.631
3	2	7	-3.4	9.7	1486.0	AISC DG-16/Thin plate	0.912	0.131	0.958	0.485	0.718	0.076	0.959	0.631
4	1	7	-3.4	9.7	1486.0	AISC DG-16/Thin plate	0.912	0.131	0.958	0.485	0.718	0.076	0.959	0.631
5	2	8	-3.8	9.5	1485.8	AISC DG-16/Thin plate	0.908	0.129	0.954	0.485	0.718	0.075	0.959	0.631
6	1	8	-3.8	9.5	1485.8	AISC DG-16/Thin plate	0.908	0.129	0.954	0.485	0.718	0.075	0.959	0.631
7	2	8	-6.7	4.2	607.5	AISC DG-16/Thin plate	0.690	0.057	0.916	0.364	0.538	0.032	0.959	0.631
8	2	8	-6.7	4.2	607.5	AISC DG-16/Thin plate	0.690	0.057	0.916	0.364	0.538	0.032	0.853	0.631

Inside Flange		Required Strength					Strength Ratios *							
Mem. No.	Jt. No.	Ld Cs	Axial (k)	Shear (k)	Moment (in-k)	Design Proc.	Bolt Tension	Bolt Shear	Plate Bending	Shear Yielding	Shear Rupture	Bearing Tearing	Flange Weld	Web Weld
1	2	19	4.3	0.9	187.3	AISC DG-16/Thin plate	0.611	0.019	0.600	0.000	0.000	0.014	0.959	0.631
2	1	19	4.3	0.9	187.3	AISC DG-16/Thin plate	0.611	0.019	0.600	0.000	0.000	0.014	0.959	0.631
3	2	8	-1.2	21.0	364.8	AISC DG-16/Thin plate	0.565	0.428	0.402	0.000	0.000	0.328	0.959	0.631
4	1	8	-1.2	21.0	364.8	AISC DG-16/Thin plate	0.565	0.428	0.402	0.000	0.000	0.328	0.959	0.631
5	2	7	-1.5	21.0	365.3	AISC DG-16/Thin plate	0.560	0.428	0.398	0.000	0.000	0.327	0.959	0.631
6	1	7	-1.5	21.0	365.3	AISC DG-16/Thin plate	0.560	0.428	0.398	0.000	0.000	0.327	0.959	0.631
7	2	20	4.3	0.9	187.3	AISC DG-16/Thin plate	0.611	0.019	0.601	0.000	0.000	0.014	0.959	0.631
8	2	20	4.3	0.9	187.3	AISC DG-16/Thin plate	0.611	0.019	0.601	0.000	0.000	0.014	0.959	0.631

Tabla No. 3.25 Conexiones articuladas

		Maximum Shear Case			Maximum Tension Case			Strength Ratios							
Mem. No.	Jt. No.	Ld Cs	Axial (k)	Shear (k)	Ld Cs	Axial (k)	Shear (k)	Bolt Tension	Bolt Shear	Bolt V + T	Plate Bending	Flange Yielding	Flange Bearing	Flange Weld	Web Weld
9	2	7	-46.8	0.0	19	8.5	0.0	0.267	0.000	0.000	0.205	0.057	0.000	0.709	0.000

Tabla No. 3.26 Diseño de los elementos estructurales en el marco (Caso de carga máximo)

			Controlling Cases		Required Strength				Available Strength				Strength Ratios	
Mem. No.	Loc. ft	Depth in.	Axial + Flexure	Shear	Axial Pr k	Shear Vr k	Mom-x Mrx in-k	Mom-y Mry in-k	Axial Pc k	Shear Vc k	Mom-x Mcx in-k	Mom-y Mcy in-k	Axial + Flexure	Shear
1	12.11	12.00	6		-19.0		-596.1	0.0	126.9		859.7	156.4	0.77	
1	10.09	12.00		7		-4.2				22.3				0.19
2	13.93	24.00	8		-2.7		2145.3	0.0	98.4		2122.0	227.9	1.02	
2	0.46	13.91		8		20.5				33.0				0.62
3	6.46	24.00	8		-2.8		2543.7	0.0	132.4		2663.3	302.1	0.97	
3	25.00	24.00		8		-21.0				32.6				0.65
4	9.92	31.38	6		-3.0		-3345.5	0.0	203.0		3614.8	303.8	0.93	
4	9.92	31.38		8		-33.1				32.3				1.03
5	0.00	31.38	6		-2.9		-3345.5	0.0	203.0		3614.8	303.8	0.93	
5	0.00	31.38		7		33.1				32.3				1.03
6	18.54	24.00	7		-2.8		2539.7	0.0	132.4		2660.4	302.1	0.97	
6	0.00	24.00		7		21.0				32.6				0.65
7	0.00	24.00	7		-2.7		2145.1	0.0	98.4		2119.7	227.9	1.03	
7	13.46	13.91		7		-20.5				33.0				0.62
8	12.11	12.00	5		-19.0		-594.2	0.0	126.9		859.7	156.4	0.77	
8	10.09	12.00		8		4.2				22.3				0.19
9	11.39	10.00	6		-53.8		0.0	0.0	72.9		535.5	224.1	0.74	
9	11.39	10.00		7		-0.0				22.6				0.00

Tabla No. 3.27 Parámetros utilizados para el diseño por carga axial y flexión de los elementos

Mem. No.	Loc. ft	Lx in.	Ly/Lt in.	Lb in.	Ag in.2	Afn in.2	Ixx in.4	Iyy in.4	Sx in.3	Sy in.3	Zx in.3	Zy in.3	J in.4	Cw in.6	Cb	Rpg	Rpc	Aeff/ Ag
1	12.11	145.33	55.3	55.3	5.26	1.88	142.70	7.81	23.78	3.13	26.05	4.74	0.19	264.02	1.17	1.00	1.10	0.86
2	13.93	580.65	120.0	60.0	8.32	2.25	800.14	13.51	66.68	4.50	75.37	6.91	0.25	1884.93	1.04	0.99	1.00	0.73
3	6.46	580.65	120.0	60.0	9.78	3.00	995.19	18.01	82.93	6.00	92.24	9.16	0.53	2486.30	1.04	0.99	1.00	0.77
4	9.92	580.65	23.0	23.0	10.99	3.00	1814.38	18.01	115.65	6.00	130.56	9.21	0.55	4293.25	1.02	0.95	1.00	0.66
5	0.00	580.65	23.0	23.0	10.99	3.00	1814.38	18.01	115.65	6.00	130.56	9.21	0.55	4293.25	1.02	0.95	1.00	0.66
6	18.54	580.65	120.0	60.0	9.78	3.00	995.19	18.01	82.93	6.00	92.24	9.16	0.53	2486.30	1.04	0.99	1.00	0.77
7	0.00	580.65	120.0	60.0	8.32	2.25	800.14	13.51	66.68	4.50	75.37	6.91	0.25	1884.93	1.04	0.99	1.00	0.73
8	12.11	145.33	55.3	55.3	5.26	1.88	142.70	7.81	23.78	3.13	26.05	4.74	0.19	264.02	1.17	1.00	1.10	0.86
9	11.39	179.73	164.0	164.0	5.74	2.25	113.14	13.50	22.63	4.50	24.53	6.79	0.22	312.71	1.00	1.00	1.08	0.97

Tabla No. 3.28 Combinaciones de deflexión

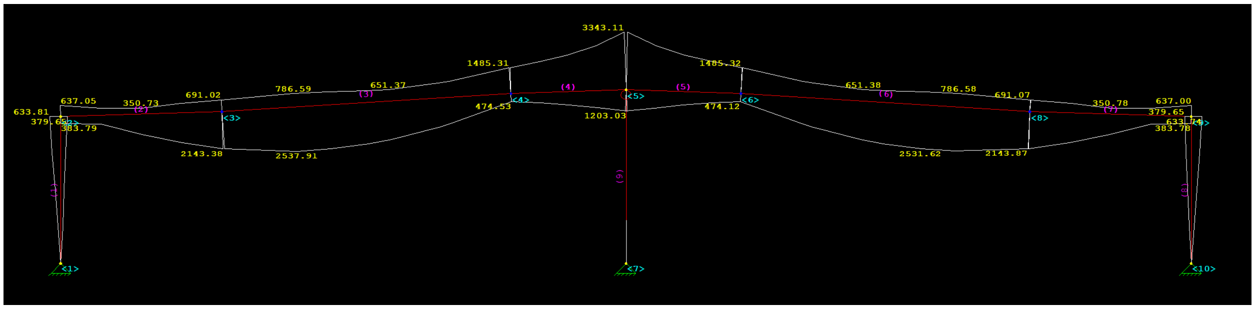
No.	Origin	Factor	Def H	Def V	Application	Description
1	System	1.000	0	180	1.0 L	L
2	System	1.000	0	180	1.0 S	S
3	System	1.000	60	180	0.42 W1>	W1>
4	System	1.000	60	180	0.42 <W1	<W1
5	System	1.000	60	180	0.42 W2>	W2>
6	System	1.000	60	180	0.42 <W2	<W2
7	System	1.000	60	180	0.42 WPL	WPL
8	System	1.000	60	180	0.42 WPR	WPR

Tabla 3.29 Deflexiones máximas en el marco

Description	Ratio	Deflection (in.)	Member	Joint	Load Case	Load Case Description
Max. Horizontal Deflection	(H/706)	0.215	8	2	7	WPL
Max. Vertical Deflection for Span 1	(L/596)	-0.982	3	1	2	S
Max. Vertical Deflection for Span 2	(L/596)	-0.982	7	1	2	S

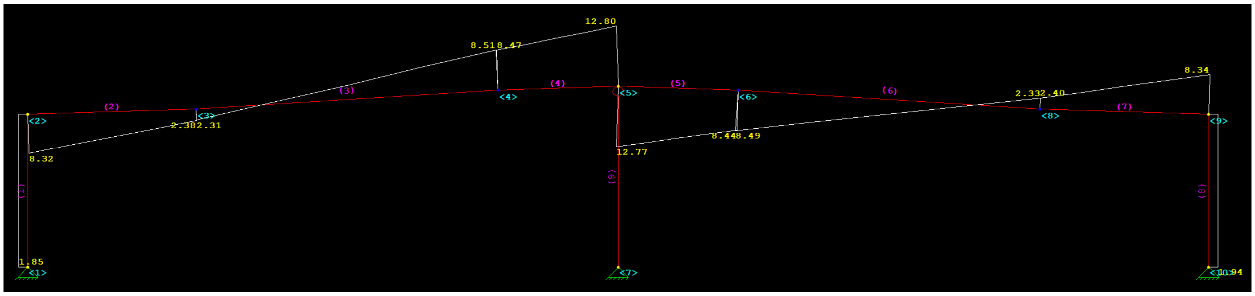
Figura No. 3.18 Diagramas envolventes de los elementos mecánicos del marco

Momento



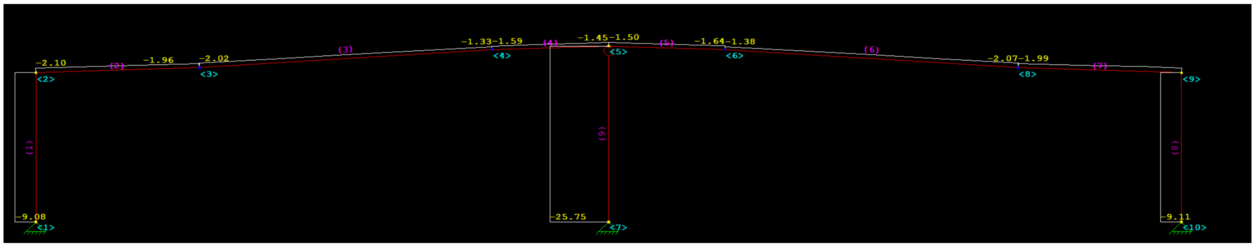
Valores mostrados en kip-in

Cortante



Valores mostrados en kips

Axial



Valores mostrados en kips

3.3.3. Marcos interiores en los ejes 7 y 8

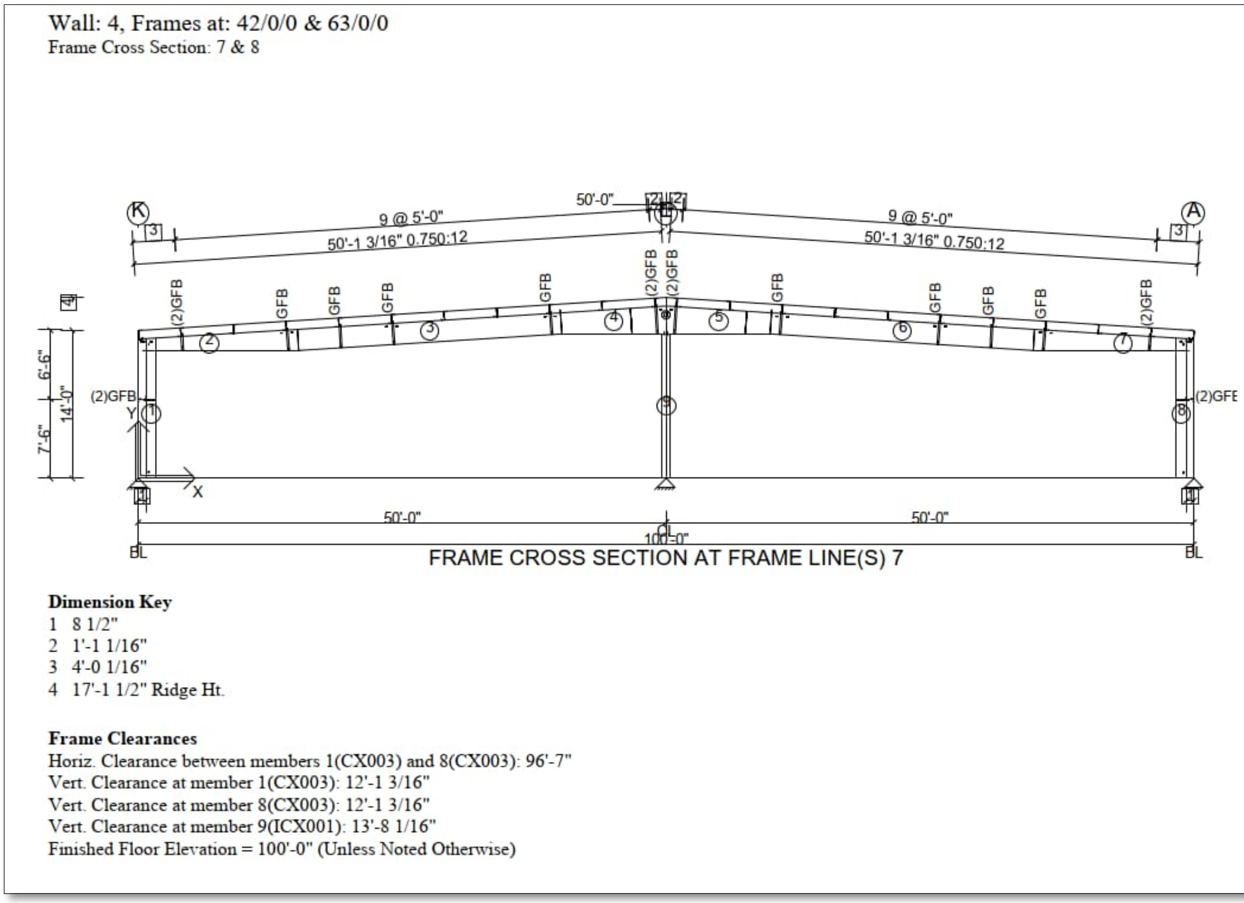


Figura No. 3.19 Marcos interiores en los ejes 7 y 8

A continuación, se muestran las combinaciones de carga (tabla No. 3.30), las características geométricas de los elementos estructurales a lo largo del marco (tabla No. 3.31), las reacciones en la base de las columnas (tabla No. 3.32 sin factorizar y tabla No. 3.33 factorizadas), el diseño de las placas base (tabla No. 3.34, 3.35 y 3.36), el diseño de las conexiones entre elementos estructurales (tabla No. 3.37, 3.38 y 3.39), el diseño de dichos elementos estructurales de los marcos interiores en los ejes 7 y 8 (tabla No. 3.40 y 3.41) así como sus deflexiones (tabla No. 3.42 y 3.43).

Tabla No. 3.30 Combinaciones de Carga

No.	Factor	Application	Description
1	1.000	1.0 D + 1.0 CG + 1.0 L>	D + CG + L>
2	1.000	1.0 D + 1.0 CG + 1.0 <L	D + CG + <L
3	1.000	1.0 D + 1.0 CG + 1.0 ASL^	D + CG + ASL^
4	1.000	1.0 D + 1.0 CG + 1.0 ^ASL	D + CG + ^ASL
5	1.000	1.0 D + 1.0 CG + 1.0 S>	D + CG + S>
6	1.000	1.0 D + 1.0 CG + 1.0 <S	D + CG + <S
7	1.000	1.0 D + 1.0 CG + 1.0 US1*	D + CG + US1*
8	1.000	1.0 D + 1.0 CG + 1.0 *US1	D + CG + *US1

9	1.000	1.0 D + 1.0 CG + 0.6 W1>	D + CG + W1>
10	1.000	1.0 D + 1.0 CG + 0.6 <W1	D + CG + <W1
11	1.000	1.0 D + 1.0 CG + 0.6 W2>	D + CG + W2>
12	1.000	1.0 D + 1.0 CG + 0.6 <W2	D + CG + <W2
13	1.000	1.0 D + 1.0 CG + 0.6 WPL	D + CG + WPL
14	1.000	1.0 D + 1.0 CG + 0.6 WPR	D + CG + WPR
15	1.000	0.6 MW	MW - Wall: 1
16	1.000	0.6 MW	MW - Wall: 2
17	1.000	0.6 MW	MW - Wall: 3
18	1.000	0.6 MW	MW - Wall: 4
19	1.000	0.6 D + 0.6 CU + 0.6 W1>	D + CU + W1>
20	1.000	0.6 D + 0.6 CU + 0.6 <W1	D + CU + <W1
21	1.000	0.6 D + 0.6 CU + 0.6 W2>	D + CU + W2>
22	1.000	0.6 D + 0.6 CU + 0.6 <W2	D + CU + <W2
23	1.000	0.6 D + 0.6 CU + 0.6 WPL	D + CU + WPL
24	1.000	0.6 D + 0.6 CU + 0.6 WPR	D + CU + WPR
25	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 W1>	D + CG + L + W1>
26	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 <W1	D + CG + L + <W1
27	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 W2>	D + CG + L + W2>
28	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 <W2	D + CG + L + <W2
29	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL	D + CG + L + WPL
30	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR	D + CG + L + WPR
31	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1>	D + CG + S + W1>
32	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W1	D + CG + S + <W1
33	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W2>	D + CG + S + W2>
34	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2	D + CG + S + <W2
35	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL	D + CG + S + WPL
36	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR	D + CG + S + WPR
37	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 WB1>	D + CG + WPR + WB1>
38	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 WB1>	D + CU + WPR + WB1>
39	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 WB1>	D + CG + L + WPR + WB1>
40	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 WB1>	D + CG + S + WPR + WB1>
41	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 <WB1	D + CG + WPR + <WB1
42	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 <WB1	D + CU + WPR + <WB1
43	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 <WB1	D + CG + L + WPR + <WB1
44	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 <WB1	D + CG + S + WPR + <WB1
45	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 WB2>	D + CG + WPR + WB2>
46	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 WB2>	D + CU + WPR + WB2>
47	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 WB2>	D + CG + L + WPR + WB2>
48	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 WB2>	D + CG + S + WPR + WB2>
49	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 <WB2	D + CG + WPR + <WB2
50	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 <WB2	D + CU + WPR + <WB2
51	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 <WB2	D + CG + L + WPR + <WB2
52	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 <WB2	D + CG + S + WPR + <WB2
53	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 WB3>	D + CG + WPL + WB3>
54	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 WB3>	D + CU + WPL + WB3>
55	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 WB3>	D + CG + L + WPL + WB3>
56	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 WB3>	D + CG + S + WPL + WB3>
57	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 <WB3	D + CG + WPL + <WB3
58	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 <WB3	D + CU + WPL + <WB3
59	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 <WB3	D + CG + L + WPL + <WB3
60	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 <WB3	D + CG + S + WPL + <WB3
61	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 WB4>	D + CG + WPL + WB4>
62	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 WB4>	D + CU + WPL + WB4>
63	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 WB4>	D + CG + L + WPL + WB4>
64	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 WB4>	D + CG + S + WPL + WB4>
65	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 <WB4	D + CG + WPL + <WB4
66	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 <WB4	D + CU + WPL + <WB4
67	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 <WB4	D + CG + L + WPL + <WB4
68	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 <WB4	D + CG + S + WPL + <WB4
69	1.000	0.6 MWB	MWB - Wall: 1
70	1.000	0.6 MWB	MWB - Wall: 2
71	1.000	0.6 MWB	MWB - Wall: 3
72	1.000	0.6 MWB	MWB - Wall: 4
73	1.000	1.0 D + 1.0 CG + 1.0 L>	D + CG + L> (Set 1)

74	1.000	1.0 D + 1.0 CG + 1.0 <L	D + CG + <L (Set 1)
75	1.000	1.0 D + 1.0 CG + 1.0 ASL^	D + CG + ASL^ (Set 1)
76	1.000	1.0 D + 1.0 CG + 1.0 ^ASL	D + CG + ^ASL (Set 1)
77	1.000	1.0 D + 1.0 CG + 1.0 S>	D + CG + S> (Set 1)
78	1.000	1.0 D + 1.0 CG + 1.0 <S	D + CG + <S (Set 1)
79	1.000	1.0 D + 1.0 CG + 1.0 US1*	D + CG + US1* (Set 1)
80	1.000	1.0 D + 1.0 CG + 1.0 *US1	D + CG + *US1 (Set 1)
81	1.000	1.0 D + 1.0 CG + 0.6 W1>	D + CG + W1> (Set 1)
82	1.000	1.0 D + 1.0 CG + 0.6 <W1	D + CG + <W1 (Set 1)
83	1.000	1.0 D + 1.0 CG + 0.6 W2>	D + CG + W2> (Set 1)
84	1.000	1.0 D + 1.0 CG + 0.6 <W2	D + CG + <W2 (Set 1)
85	1.000	1.0 D + 1.0 CG + 0.6 WPL	D + CG + WPL (Set 1)
86	1.000	1.0 D + 1.0 CG + 0.6 WPR	D + CG + WPR (Set 1)
87	1.000	0.6 MW	MW - Wall: 1 (Set 1)
88	1.000	0.6 MW	MW - Wall: 2 (Set 1)
89	1.000	0.6 MW	MW - Wall: 3 (Set 1)
90	1.000	0.6 MW	MW - Wall: 4 (Set 1)
91	1.000	0.6 D + 0.6 CU + 0.6 W1>	D + CU + W1> (Set 1)
92	1.000	0.6 D + 0.6 CU + 0.6 <W1	D + CU + <W1 (Set 1)
93	1.000	0.6 D + 0.6 CU + 0.6 W2>	D + CU + W2> (Set 1)
94	1.000	0.6 D + 0.6 CU + 0.6 <W2	D + CU + <W2 (Set 1)
95	1.000	0.6 D + 0.6 CU + 0.6 WPL	D + CU + WPL (Set 1)
96	1.000	0.6 D + 0.6 CU + 0.6 WPR	D + CU + WPR (Set 1)
97	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 W1>	D + CG + L + W1> (Set 1)
98	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 <W1	D + CG + L + <W1 (Set 1)
99	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 W2>	D + CG + L + W2> (Set 1)
100	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 <W2	D + CG + L + <W2 (Set 1)
101	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL	D + CG + L + WPL (Set 1)
102	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR	D + CG + L + WPR (Set 1)
103	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1>	D + CG + S + W1> (Set 1)
104	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W1	D + CG + S + <W1 (Set 1)
105	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W2>	D + CG + S + W2> (Set 1)
106	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2	D + CG + S + <W2 (Set 1)
107	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL	D + CG + S + WPL (Set 1)
108	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR	D + CG + S + WPR (Set 1)
109	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 WB1>	D + CG + WPR + WB1> (Set 1)
110	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 WB1>	D + CU + WPR + WB1> (Set 1)
111	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 WB1>	D + CG + L + WPR + WB1> (Set 1)
112	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 WB1>	D + CG + S + WPR + WB1> (Set 1)
113	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 <WB1	D + CG + WPR + <WB1 (Set 1)
114	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 <WB1	D + CU + WPR + <WB1 (Set 1)
115	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 <WB1	D + CG + L + WPR + <WB1 (Set 1)
116	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 <WB1	D + CG + S + WPR + <WB1 (Set 1)
117	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 WB2>	D + CG + WPR + WB2> (Set 1)
118	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 WB2>	D + CU + WPR + WB2> (Set 1)
119	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 WB2>	D + CG + L + WPR + WB2> (Set 1)
120	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 WB2>	D + CG + S + WPR + WB2> (Set 1)
121	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 <WB2	D + CG + WPR + <WB2 (Set 1)
122	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 <WB2	D + CU + WPR + <WB2 (Set 1)
123	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 <WB2	D + CG + L + WPR + <WB2 (Set 1)
124	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 <WB2	D + CG + S + WPR + <WB2 (Set 1)
125	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 WB3>	D + CG + WPL + WB3> (Set 1)
126	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 WB3>	D + CU + WPL + WB3> (Set 1)
127	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 WB3>	D + CG + L + WPL + WB3> (Set 1)
128	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 WB3>	D + CG + S + WPL + WB3> (Set 1)
129	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 <WB3	D + CG + WPL + <WB3 (Set 1)
130	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 <WB3	D + CU + WPL + <WB3 (Set 1)
131	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 <WB3	D + CG + L + WPL + <WB3 (Set 1)
132	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 <WB3	D + CG + S + WPL + <WB3 (Set 1)
133	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 WB4>	D + CG + WPL + WB4> (Set 1)
134	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 WB4>	D + CU + WPL + WB4> (Set 1)
135	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 WB4>	D + CG + L + WPL + WB4> (Set 1)
136	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 WB4>	D + CG + S + WPL + WB4> (Set 1)
137	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 <WB4	D + CG + WPL + <WB4 (Set 1)
138	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 <WB4	D + CU + WPL + <WB4 (Set 1)

139	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 <WB4	D + CG + L + WPL + <WB4 (Set 1)
140	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 <WB4	D + CG + S + WPL + <WB4 (Set 1)
141	1.000	0.6 MWB	MWB - Wall: 1 (Set 1)
142	1.000	0.6 MWB	MWB - Wall: 2 (Set 1)
143	1.000	0.6 MWB	MWB - Wall: 3 (Set 1)
144	1.000	0.6 MWB	MWB - Wall: 4 (Set 1)

Tabla No. 3.31 Características geométricas de los elementos estructurales en el marco

Mem. No.	Flg Width (in.)	Flg Thk (in.)	Web Thk (in.)	Depth1 (in.)	Depth2 (in.)	Length (ft)	Weight (p)	Flg Fy (ksi)	Web Fy (ksi)	Splice Jt.1	Codes Jt.2	Shape
1	5.00	0.3750	0.1345	12.00	12.00	13.21	239.5	55.00	55.00	BP	KN	3P
2	6.00	0.3750	0.1644	13.91	24.00	14.39	383.0	55.00	55.00	KN	SS	3P
3	6.00	0.5000	0.1644	24.00	24.00	25.00	853.9	55.00	55.00	SS	SP	3P
4	6.00	0.5000	0.1644	24.00	31.38	10.00	372.8	55.00	55.00	SP	SS	3P
5	6.00	0.5000	0.1644	31.38	24.00	10.00	372.8	55.00	55.00	SS	SP	3P
6	6.00	0.5000	0.1644	24.00	24.00	25.00	853.9	55.00	55.00	SP	SS	3P
7	6.00	0.3750	0.1644	24.00	13.91	14.39	383.1	55.00	55.00	SS	KN	3P
8	5.00	0.3750	0.1345	12.00	12.00	13.21	239.5	55.00	55.00	BP	KN	3P
9	6.00	0.3750	0.1345	10.00	10.00	13.67	284.7	55.00	55.00	BP	CP	3P

Tabla No. 3.32 Reacciones sin factorizar en la base de las columnas

Type		Exterior Column			Interior Column		Exterior Column				
X-Loc		0/0/0			50/0/0		100/0/0				
Grid1 - Grid2		7-K			7-E		7-A				
Base Plate W x L (in.)		8 X 13			8 X 11		8 X 13				
Base Plate Thickness (in.)		0.375			0.375		0.375				
Anchor Rod Qty/Diam. (in.)		4 - 0.750			4 - 0.750		4 - 0.750				
Column Base Elev.		100'-0"			100'-0"		100'-0"				
Load Type	Desc.	Hx	Hz	Vy	Hx	Vy	Hx	Hz	Vy		
D	Frm	0.35	-	1.82	-	5.14	-0.35	-	1.82	-	-
CG	Frm	0.46	-	2.18	-	6.15	-0.46	-	2.18	-	-
L>	Frm	1.11	-	5.22	-	14.76	-1.11	-	5.22	-	-
<L	Frm	1.11	-	5.22	-	14.76	-1.11	-	5.22	-	-
ASL^	Frm	0.55	-	-0.62	-	7.38	-0.55	-	5.84	-	-
^ASL	Frm	0.55	-	5.84	-	7.38	-0.55	-	-0.62	-	-
S>	Frm	3.23	-	15.23	-	43.04	-3.23	-	15.23	-	-
<S	Frm	3.23	-	15.23	-	43.04	-3.23	-	15.23	-	-
US1*	Frm	2.42	-	2.66	-	35.90	-2.42	-	18.91	-	-
*US1	Frm	2.42	-	18.91	-	35.90	-2.42	-	2.66	-	-
W1>	Frm	-3.18	-	-9.11	-	-19.47	-0.89	-	-4.76	-	-
<W1	Frm	0.89	-	-4.76	-	-19.47	3.18	-	-9.11	-	-
W2>	Frm	-3.36	-	-5.49	-	-9.81	-0.71	-	-1.14	-	-
<W2	Frm	0.71	-	-1.14	-	-9.81	3.36	-	-5.49	-	-
WPL	Frm	-0.09	-	-5.27	-	-19.11	-0.38	-	-8.97	-	-
WPR	Frm	0.38	-	-8.97	-	-19.11	0.09	-	-5.27	-	-
MW - Wall: 1	Frm	-	-	-	-	-	-	-	-	-	-
MW - Wall: 2	Frm	1.70	-	0.54	-	-0.28	3.53	-	-0.27	-	-
MW - Wall: 3	Frm	-	-	-	-	-	-	-	-	-	-
MW - Wall: 4	Frm	-3.53	-	-0.27	-	-0.28	-1.70	-	0.54	-	-
CU	Frm	-	-	-	-	-	-	-	-	-	-
L	Frm	1.11	-	5.22	-	14.76	-1.11	-	5.22	-	-
S	Frm	3.23	-	15.23	-	43.04	-3.23	-	15.23	-	-
WB1>	Brc	0.36	-10.51	-7.25	-	-0.10	-0.36	-10.11	-7.07	-	-
<WB1	Brc	-0.11	-	5.95	-	-0.08	0.11	-	5.62	-	-
WB2>	Brc	0.25	-7.38	-5.17	-	-0.07	-0.25	-6.98	-4.97	-	-
<WB2	Brc	-0.15	-	8.15	-	-0.12	0.15	-	7.82	-	-
WB3>	Brc	0.37	-10.11	-7.08	-	-0.10	-0.37	-10.51	-7.42	-	-
<WB3	Brc	-0.11	-	5.72	-	-0.09	0.11	-	6.02	-	-
WB4>	Brc	0.26	-6.98	-4.96	-	-0.07	-0.26	-7.38	-5.27	-	-
<WB4	Brc	-0.15	-	7.89	-	-0.12	0.15	-	8.19	-	-
MWB - Wall: 1	Brc	0.21	-6.22	-4.10	-	-0.06	-0.21	-6.23	-4.14	-	-
MWB - Wall: 2	Brc	-	-	-	-	-	-	-	-	-	-
MWB - Wall: 3	Brc	-0.16	-	8.36	-	-0.12	0.16	-	8.36	-	-
MWB - Wall: 4	Brc	-	-	-	-	-	-	-	-	-	-

Tabla No. 3.33 Reacciones máximas sin factorizar en la base de las columnas

X-Loc	Grid	Hrz left (-Hx) (k)	Load Case	Hrz Right (Hx) (k)	Load Case	Hrz In (-Hz) (k)	Load Case	Hrz Out (Hz) (k)	Load Case	Uplift (-Vy) (k)	Load Case	Vrt Down (Vy) (k)	Load Case	Mom cw (-Mzz) (in-k)	Load Case	Mom ccw (Mzz) (in-k)	Load Case
0/0/0	8-K	2.12	18	4.04	5	-	-	7.47	71	9.40	50	22.93	8	-	-	-	-
50/0/0	8-E	-	-	-	-	-	-	-	-	9.13	20	54.33	5	-	-	-	-
100/0/0	8-A	4.04	5	2.12	16	-	-	7.47	71	9.40	66	22.93	7	-	-	-	-

Tabla No. 3.34Placas base

X-Loc	Grid	Mem. No.	Thickness (in.)	Width (in.)	Length (in.)	Stiff.	Num. Of Rods	Rod Diam. (in.)	Pitch (in.)	Gage (in.)	Hole Type	Welds to Flange	Welds to Web
0/0/0	8-K	1	0.375	8	13	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
50/0/0	8-E	9	0.375	8	11	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
100/0/0	8-A	8	0.375	8	13	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875

Tabla No. 3.35 Cargas en la placa base

	Maximum Shear Case			Maximum Tension Case			Maximum Comp Case			Maximum Bracing/WA Case			
X-Loc	Shear (k)	Axial (k)	Load Case	Shear (k)	Tension (k)	Load Case	Shear (k)	Comp (k)	Load Case	Shear (k)	Axial (k)	Frame Shear (k)	Load Case
0/0/0	4.13	19.25	78	0.64	-9.41	122	2.68	22.53	80	6.91	-9.41	0.64	122
50/0/0	1.20	47.31	80	0.02	-9.13	91	0.03	54.38	78	-	-	-	0
100/0/0	4.12	19.26	77	0.66	-9.41	138	2.68	22.53	79	6.91	-9.41	0.66	138

Tabla No. 3.36 Relaciones de esfuerzos en las placas base

X-Loc	Rod Shear	Load Case	Rod Tension	Load Case	Rod V + T	Load Case	Rod Bending	Load Case	Conc. Bearing	Load Case	Plate Tension	Load Case	Plate Comp	Load Case	Flange Weld	Load Case	Web Weld	Load Case
0/0/0	0.301	122	0.245	122	0.245	122	-	0	0.196	80	0.354	122	0.363	80	0.373	80	0.195	122
50/0/0	0.065	80	0.237	91	-	0	-	0	0.559	78	0.287	91	0.712	78	0.825	78	0.296	78
100/0/0	0.302	138	0.245	138	0.245	138	-	0	0.196	79	0.354	138	0.363	79	0.373	79	0.195	138

Tabla No. 3.37 Conexiones atornilladas intermedias en el marco

			End-Plate Dimensions			Bolt			Outside Flange			Inside Flange		
Mem.	Jt.	Type	Thick.	Width	Length	Diam.	Spec/Joint	Gages In/Out	Configuration		Pitches 1st/2nd	Configuration		Pitches 1st/2nd
No.	No.		(in.)	(in.)	(in.)	(in.)		(in.)	ID	Desc.	(in.)	ID	Desc.	(in.)
1	2	KN(Top)	0.500	6.00	15.38	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	8.06
2	1	KN(Top)	0.500	6.00	15.38	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	8.06
3	2	SP	0.500	6.00	27.25	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	20.00
4	1	SP	0.500	6.00	27.28	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	20.00
5	2	SP	0.500	6.00	27.28	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	20.00
6	1	SP	0.500	6.00	27.25	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	20.00
7	2	KN(Top)	0.500	6.00	15.38	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	8.06
8	2	KN(Top)	0.500	6.00	15.38	0.750	A325N/ST	3.00	31	Extended	3.50	11	Flush	8.06
9	2	CP	0.375	8.00	11.00	0.500	A325/-	3.00	11	Flush	3.00	11	Flush	3.00

Tabla No. 3.38 Conexiones a momento

Outside Flange		Required Strength					Strength Ratios *							
Mem. No.	Jt. No.	Ld Cs	Axial (k)	Shear (k)	Moment (in-k)	Design Proc.	Bolt Tension	Bolt Shear	Plate Bending	Shear Yielding	Shear Rupture	Bearing Tearing	Flange Weld	Web Weld
1	2	7	-6.8	4.2	616.6	AISC DG-16/Thin plate	0.700	0.057	0.930	0.365	0.540	0.033	0.866	0.631
2	1	7	-6.8	4.2	616.6	AISC DG-16/Thin plate	0.700	0.057	0.930	0.365	0.540	0.033	0.962	0.631
3	2	79	-3.4	9.8	1504.3	AISC DG-16/Thin plate	0.923	0.133	0.970	0.485	0.718	0.077	0.959	0.631
4	1	79	-3.4	9.8	1504.3	AISC DG-16/Thin plate	0.923	0.133	0.970	0.485	0.718	0.077	0.959	0.631
5	2	80	-3.8	9.6	1504.2	AISC DG-16/Thin plate	0.920	0.130	0.966	0.485	0.718	0.076	0.959	0.631
6	1	80	-3.8	9.6	1504.2	AISC DG-16/Thin plate	0.920	0.130	0.966	0.485	0.718	0.076	0.959	0.631
7	2	80	-6.8	4.2	616.6	AISC DG-16/Thin plate	0.700	0.057	0.930	0.365	0.540	0.033	0.961	0.631
8	2	80	-6.8	4.2	616.6	AISC DG-16/Thin plate	0.700	0.057	0.930	0.365	0.540	0.033	0.865	0.631

Inside Flange		Required Strength					Strength Ratios *							
Mem. No.	Jt. No.	Ld Cs	Axial (k)	Shear (k)	Moment (in-k)	Design Proc.	Bolt Tension	Bolt Shear	Plate Bending	Shear Yielding	Shear Rupture	Bearing Tearing	Flange Weld	Web Weld
1	2	91	4.7	1.0	200.2	AISC DG-16/Thin plate	0.654	0.020	0.643	0.000	0.000	0.015	0.959	0.631
2	1	91	4.7	1.0	200.2	AISC DG-16/Thin plate	0.654	0.020	0.643	0.000	0.000	0.015	0.959	0.631
3	2	80	-1.2	21.3	369.8	AISC DG-16/Thin plate	0.578	0.433	0.408	0.000	0.000	0.331	0.959	0.631
4	1	80	-1.2	21.3	369.8	AISC DG-16/Thin plate	0.578	0.433	0.408	0.000	0.000	0.331	0.959	0.631
5	2	7	-1.6	21.3	370.4	AISC DG-16/Thin plate	0.572	0.433	0.404	0.000	0.000	0.331	0.959	0.631
6	1	7	-1.6	21.3	370.4	AISC DG-16/Thin plate	0.572	0.433	0.404	0.000	0.000	0.331	0.959	0.631
7	2	92	4.7	1.0	200.2	AISC DG-16/Thin plate	0.654	0.020	0.643	0.000	0.000	0.015	0.959	0.631
8	2	92	4.7	1.0	200.2	AISC DG-16/Thin plate	0.654	0.020	0.643	0.000	0.000	0.015	0.959	0.631

Tabla No. 3.39 Conexiones articuladas

		Maximum Shear Case			Maximum Tension Case			Strength Ratios							
Mem. No.	Jt. No.	Ld Cs	Axial (k)	Shear (k)	Ld Cs	Axial (k)	Shear (k)	Bolt Tension	Bolt Shear	Bolt V + T	Plate Bending	Flange Yielding	Flange Bearing	Flange Weld	Web Weld
9	2	7	-47.3	0.0	91	9.1	0.0	0.287	0.000	0.000	0.221	0.061	0.000	0.717	0.000

Tabla No. 3.40 Diseño de los elementos estructurales en el marco (Caso de carga máximo)

			Controlling Cases		Required Strength				Available Strength				Strength Ratios	
Mem. No.	Loc. ft	Depth in.	Axial + Flexure	Shear	Axial Pr k	Shear Vr k	Mom-x Mrx in-k	Mom-y Mry in-k	Axial Pc k	Shear Vc k	Mom-x Mcx in-k	Mom-y Mcy in-k	Axial + Flexure	Shear
1	12.11	12.00	78		-19.3		-603.1	0.0	126.9		859.7	156.4	0.78	
1	10.09	12.00		7		-4.2				22.3				0.19
2	13.93	24.00	80		-2.7		2172.6	0.0	144.4		2159.4	227.9	1.02	
2	0.46	13.91		8		20.8				33.0				0.63
3	6.46	24.00	80		-2.8		2575.4	0.0	184.3		2575.4	302.1	1.01	
3	25.00	24.00		80		-21.3				32.6				0.65
4	9.92	31.38	78		-3.1		-3384.5	0.0	203.0		3614.8	303.8	0.94	
4	9.45	31.02		80		-32.9				32.3				1.02
5	0.00	31.38	78		-2.9		-3384.4	0.0	203.0		3614.8	303.8	0.94	
5	0.48	31.02		7		32.9				32.3				1.02
6	18.54	24.00	79		-2.8		2571.2	0.0	184.3		2574.6	302.1	1.01	
6	0.00	24.00		79		21.3				32.6				0.65
7	0.00	24.00	79		-2.7		2172.3	0.0	144.4		2157.8	227.9	1.02	
7	13.46	13.91		79		-20.8				33.0				0.63
8	12.11	12.00	77		-19.3		-601.1	0.0	126.9		859.7	156.4	0.78	
8	10.09	12.00		80		4.2				22.3				0.19
9	11.39	10.00	78		-54.4		0.0	0.0	72.9		535.5	224.1	0.75	
9	11.39	10.00		7		-0.0				22.6				0.00

Tabla No. 3.41Parámetros utilizados para el diseño por carga axial y flexión de los elementos

Mem. No.	Loc. ft	Lx in.	Ly/Lt in.	Lb in.	Ag in.2	Afn in.2	Ixx in.4	Iyy in.4	Sx in.3	Sy in.3	Zx in.3	Zy in.3	J in.4	Cw in.6	Cb	Rpg	Rpc	Aeff/ Ag
1	12.11	145.33	55.3	55.3	5.26	1.88	142.70	7.81	23.78	3.13	26.05	4.74	0.19	264.02	1.17	1.00	1.10	0.86
2	13.93	580.65	60.0	60.0	8.32	2.25	800.14	13.51	66.68	4.50	75.37	6.91	0.25	1884.93	1.06	0.99	1.00	0.70
3	6.46	580.65	60.0	60.0	9.78	3.00	995.19	18.01	82.93	6.00	92.24	9.16	0.53	2486.30	1.01	1.00	1.00	0.75
4	9.92	580.65	23.0	23.0	10.99	3.00	1814.38	18.01	115.65	6.00	130.56	9.21	0.55	4293.25	1.02	0.95	1.00	0.66
5	0.00	580.65	23.0	23.0	10.99	3.00	1814.38	18.01	115.65	6.00	130.56	9.21	0.55	4293.25	1.02	0.95	1.00	0.66
6	18.54	580.65	60.0	60.0	9.78	3.00	995.19	18.01	82.93	6.00	92.24	9.16	0.53	2486.30	1.01	1.00	1.00	0.75
7	0.00	580.65	60.0	60.0	8.32	2.25	800.14	13.51	66.68	4.50	75.37	6.91	0.25	1884.93	1.06	0.99	1.00	0.70
8	12.11	145.33	55.3	55.3	5.26	1.88	142.70	7.81	23.78	3.13	26.05	4.74	0.19	264.02	1.17	1.00	1.10	0.86
9	11.39	179.73	164.0	164.0	5.74	2.25	113.14	13.50	22.63	4.50	24.53	6.79	0.22	312.71	1.00	1.00	1.08	0.97

Tabla No. 3.42 Combinaciones de deflexión

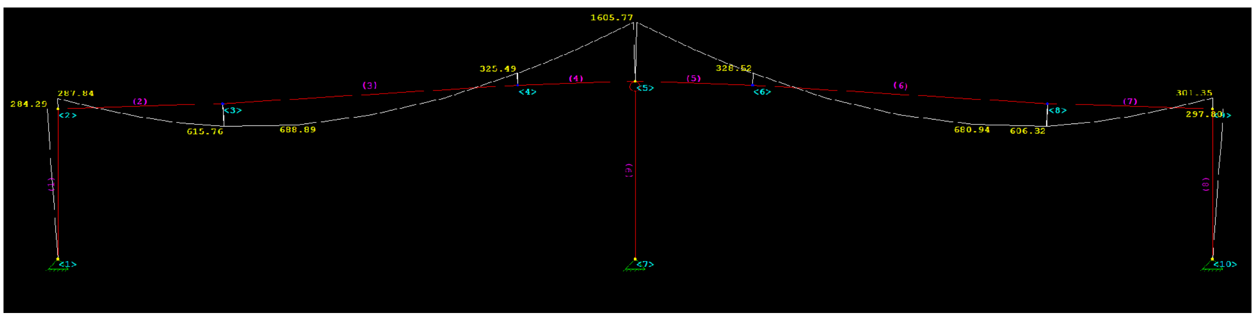
No.	Origin	Factor	Def H	Def V	Application	Description
1	System	1.000	0	180	1.0 L	L
2	System	1.000	0	180	1.0 S	S
3	System	1.000	60	180	0.42 W1>	W1>
4	System	1.000	60	180	0.42 <W1	<W1
5	System	1.000	60	180	0.42 W2>	W2>
6	System	1.000	60	180	0.42 <W2	<W2
7	System	1.000	60	180	0.42 WPL	WPL
8	System	1.000	60	180	0.42 WPR	WPR
9	System	1.000	0	180	1.0 L	L (Set 1)
10	System	1.000	0	180	1.0 S	S (Set 1)
11	System	1.000	60	180	0.42 W1>	W1> (Set 1)
12	System	1.000	60	180	0.42 <W1	<W1 (Set 1)
13	System	1.000	60	180	0.42 W2>	W2> (Set 1)
14	System	1.000	60	180	0.42 <W2	<W2 (Set 1)
15	System	1.000	60	180	0.42 WPL	WPL (Set 1)
16	System	1.000	60	180	0.42 WPR	WPR (Set 1)

Tabla No. 3.43 Deflexiones máximas en el marco

Description	Ratio	Deflection (in.)	Member	Joint	Load Case	Load Case Description
Max. Horizontal Deflection	(H/647)	0.235	8	2	15	WPL (Set 1)
Max. Vertical Deflection for Span 1	(L/589)	-0.993	3	1	10	S (Set 1)
Max. Vertical Deflection for Span 2	(L/589)	-0.994	7	1	10	S (Set 1)

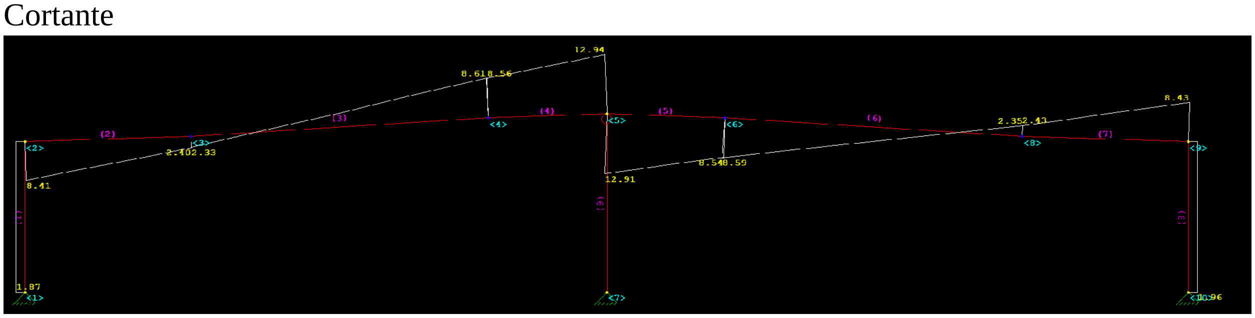
Figura No. 3.20 Diagramas envolventes de los elementos mecánicos del marco

Momento



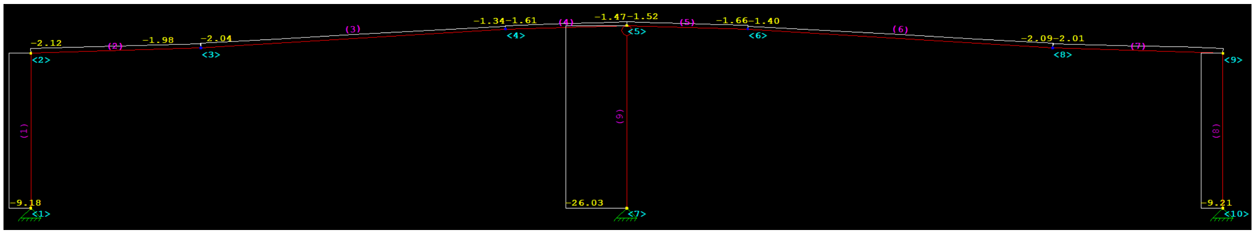
Valores mostrados en kip-in

Cortante



Valores mostrados en kips

Axial



Valores mostrados en kips

3.3.4. Marco cabecero en el eje 9

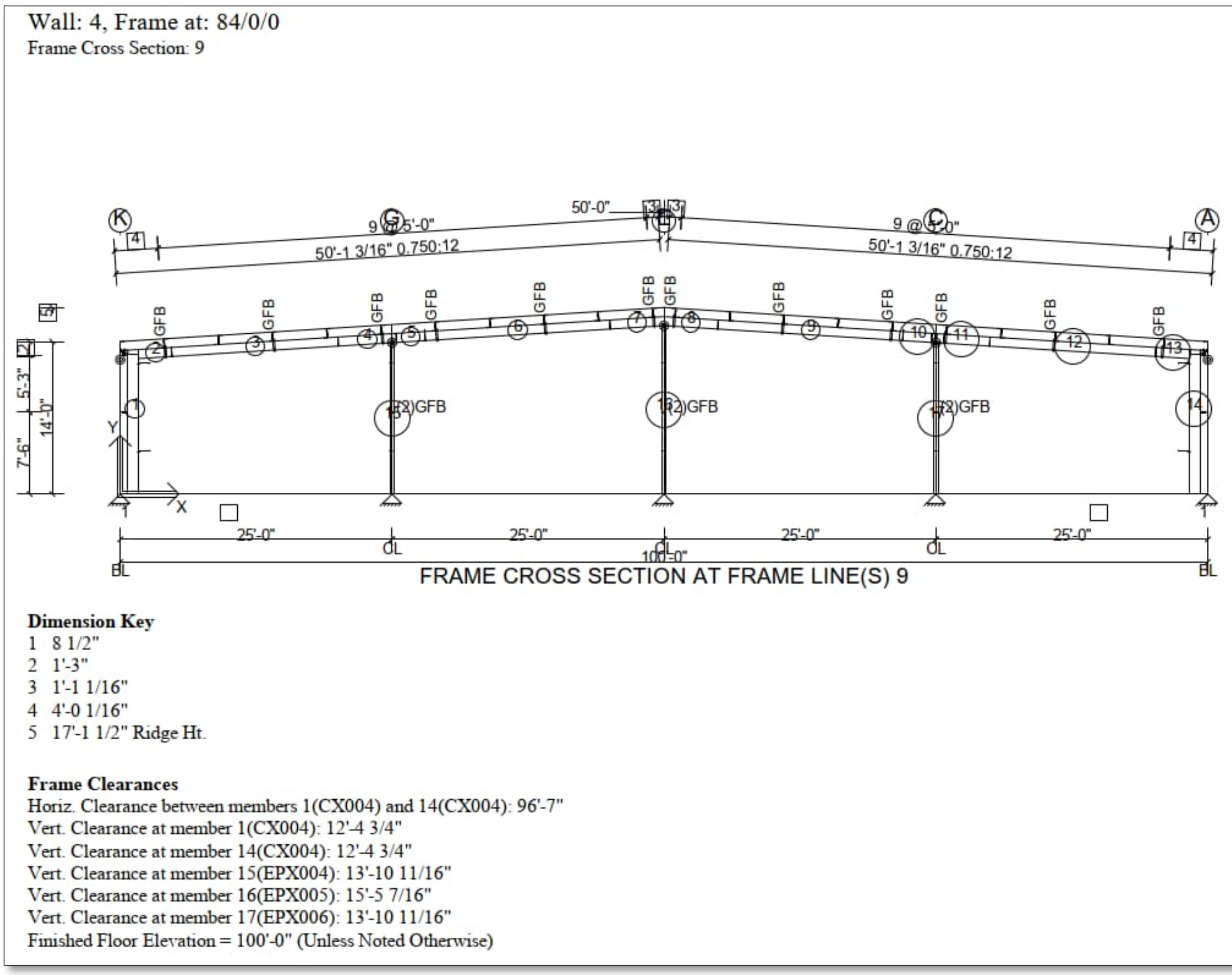


Figura No. 3.16 Marco cabecero en el eje 9

A continuación, se muestran las combinaciones de carga (tabla No. 3.44), las características geométricas de los elementos estructurales a lo largo del marco (tabla No. 3.45), las reacciones en la base de las columnas (tabla No. 3.46 sin factorizar y tabla No. 3.47 factorizadas), el diseño de las placas base (tabla No. 3.48, 3.49 y 3.50), el diseño de las conexiones entre elementos estructurales (tabla No. 3.51, 3.52 y 3.53), el diseño de dichos elementos estructurales del marco en el eje 9 (tabla No. 3.54 y 3.55) así como sus deflexiones (tabla No. 3.56).

Tabla No. 3.44 Combinaciones de Carga

No.	Factor	Application
1	1.000	1.0 D + 1.0 CG + 1.0 L>
2	1.000	1.0 D + 1.0 CG + 1.0 <L
3	1.000	1.0 D + 1.0 CG + 1.0 ASL^
4	1.000	1.0 D + 1.0 CG + 1.0 ^ASL
5	1.000	1.0 D + 1.0 CG + 1.0 PL2
6	1.000	1.0 D + 1.0 CG + 1.0 PL2
7	1.000	1.0 D + 1.0 CG + 1.0 PL2
8	1.000	1.0 D + 1.0 CG + 1.0 S>
9	1.000	1.0 D + 1.0 CG + 1.0 <S
10	1.000	1.0 D + 1.0 CG + 1.0 US1*
11	1.000	1.0 D + 1.0 CG + 1.0 *US1
12	1.000	1.0 D + 1.0 CG + 0.6 W1>
13	1.000	1.0 D + 1.0 CG + 0.6 <W1
14	1.000	1.0 D + 1.0 CG + 0.6 W2>
15	1.000	1.0 D + 1.0 CG + 0.6 <W2
16	1.000	1.0 D + 1.0 CG + 0.6 WPL
17	1.000	1.0 D + 1.0 CG + 0.6 WPR
18	1.000	0.6 MW
19	1.000	0.6 MW
20	1.000	0.6 MW
21	1.000	0.6 MW
22	1.000	0.6 D + 0.6 CU + 0.6 W1>
23	1.000	0.6 D + 0.6 CU + 0.6 <W1
24	1.000	0.6 D + 0.6 CU + 0.6 W2>
25	1.000	0.6 D + 0.6 CU + 0.6 <W2
26	1.000	0.6 D + 0.6 CU + 0.6 WPL
27	1.000	0.6 D + 0.6 CU + 0.6 WPR
28	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 W1>
29	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 <W1
30	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 W2>
31	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 <W2
32	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL
33	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR
34	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1>
35	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W1
36	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W2>
37	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2
38	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL
39	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR
40	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 WB1>
41	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 WB1>
42	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 WB1>
43	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 WB1>
44	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 <WB1
45	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 <WB1
46	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 <WB1
47	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 <WB1
48	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 WB2>
49	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 WB2>

50	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 WB2>
51	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 WB2>
52	1.000	1.0 D + 1.0 CG + 0.6 WPR + 0.6 <WB2
53	1.000	0.6 D + 0.6 CU + 0.6 WPR + 0.6 <WB2
54	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPR + 0.45 <WB2
55	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPR + 0.45 <WB2
56	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 WB3>
57	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 WB3>
58	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 WB3>
59	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 WB3>
60	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 <WB3
61	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 <WB3
62	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 <WB3
63	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 <WB3
64	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 WB4>
65	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 WB4>
66	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 WB4>
67	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 WB4>
68	1.000	1.0 D + 1.0 CG + 0.6 WPL + 0.6 <WB4
69	1.000	0.6 D + 0.6 CU + 0.6 WPL + 0.6 <WB4
70	1.000	1.0 D + 1.0 CG + 0.75 L + 0.45 WPL + 0.45 <WB4
71	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 WPL + 0.45 <WB4
72	1.000	0.6 MWB
73	1.000	0.6 MWB
74	1.000	0.6 MWB
75	1.000	0.6 MWB

Tabla No. 3.45 Características geométricas de los elementos estructurales en el marco

Mem. No.	Flg Width (in.)	Flg Thk (in.)	Web Thk (in.)	Depth1 (in.)	Depth2 (in.)	Length (ft)	Weight (p)	Flg Fy (ksi)	Web Fy (ksi)	Splice Jt.1	Codes Jt.2	Shape
1	5.00	0.3750	0.1345	12.00	12.00	13.21	259.3	55.00	55.00	BP	KN	3P
2	5.00	0.3750	0.1345	10.00	10.00	4.00	57.9	55.00	55.00	KN	SS	3P
3	5.00	0.3750	0.1345	10.00	10.00	15.34	260.6	55.00	55.00	SS	SS	3P
4	5.00	0.3750	0.1345	10.00	10.00	5.37	91.2	55.00	55.00	SS	SS	3P
5	5.00	0.3750	0.1345	10.00	10.00	2.64	52.4	55.00	55.00	SS	SP	3P
6	5.00	0.1875	0.1345	10.00	10.00	17.04	191.5	55.00	55.00	SP	SS	3P
7	5.00	0.1875	0.1345	10.00	10.00	5.01	61.3	55.00	55.00	SS	SP	3P
8	5.00	0.1875	0.1345	10.00	10.00	5.00	61.1	55.00	55.00	SP	SS	3P
9	5.00	0.1875	0.1345	10.00	10.00	17.04	191.6	55.00	55.00	SS	SP	3P
10	5.00	0.3750	0.1345	10.00	10.00	2.65	52.6	55.00	55.00	SP	SS	3P
11	5.00	0.3750	0.1345	10.00	10.00	5.35	90.9	55.00	55.00	SS	SS	3P
12	5.00	0.3750	0.1345	10.00	10.00	15.34	260.6	55.00	55.00	SS	SS	3P
13	5.00	0.3750	0.1345	10.00	10.00	4.02	58.2	55.00	55.00	SS	KN	3P
14	5.00	0.3750	0.1345	12.00	12.00	13.21	259.3	55.00	55.00	BP	KN	3P
15	5.00	0.1345	0.1345	10.00	10.00	13.89	141.3	55.00	55.00	BP	CP	3P
16	5.00	0.1345	0.1345	10.00	10.00	15.46	155.4	55.00	55.00	BP	CP	3P
17	5.00	0.1345	0.1345	10.00	10.00	13.89	141.3	55.00	55.00	BP	CP	3P

Tabla No. 3.46 Reacciones sin factorizar en la base de las columnas

Type		Exterior Column			Interior Column			Interior Column			Interior Column			Exterior Column		
X-Loc		0/0/0			25/0/0			50/0/0			75/0/0			100/0/0		
Grid1 - Grid2		9-K			9-G			9-E			9-C			9-A		
Base Plate W x L (in.)		8 X 13			8 X 11			8 X 11			8 X 11			8 X 13		
Base Plate Thickness (in.)		0.375			0.375			0.375			0.375			0.375		
Anchor Rod Qty/Diam. (in.)		4 - 0.750			4 - 0.750			4 - 0.750			4 - 0.750			4 - 0.750		
Column Base Elev.		100'-0"			100'-0"			100'-0"			100'-0"			100'-0"		
Load Type	Desc.	Hx	Hz	Vy	Hx	Hz	Vy	Hx	Hz	Vy	Hx	Hz	Vy	Hx	Hz	Vy
D	Frm	-	-	0.69	-	-	1.30	-	-	1.01	-	-	1.30	-	-	0.69
CG	Frm	-	-	0.66	-	-	1.60	-	-	1.36	-	-	1.60	-	-	0.65
L>	Frm	-	-	2.22	-	-	5.93	-	-	5.01	-	-	5.93	-	-	2.22
<L	Frm	-	-	2.22	-	-	5.93	-	-	5.01	-	-	5.93	-	-	2.22
ASL^	Frm	-	-	-0.41	-	-	3.26	-	-	2.51	-	-	2.67	-	-	2.63
^ASL	Frm	-	-	2.63	-	-	2.67	-	-	2.51	-	-	3.26	-	-	-0.41
S>	Frm	-	-	4.20	-	-	11.22	-	-	9.49	-	-	11.22	-	-	4.20
<S	Frm	-	-	4.20	-	-	11.22	-	-	9.49	-	-	11.22	-	-	4.20
US1*	Frm	-	-	1.43	-	-	2.58	-	-	8.46	-	-	15.19	-	-	3.89
*US1	Frm	-	-	3.89	-	-	15.19	-	-	8.46	-	-	2.58	-	-	1.43
W1>	Frm	-0.63	-	-3.01	-	3.68	-8.53	-	4.05	-5.49	-	3.68	-4.64	-0.95	-	-1.90
<W1	Frm	0.95	-	-1.90	-	-3.32	-4.64	-	-3.65	-5.49	-	-3.32	-8.53	0.63	-	-3.01
W2>	Frm	-1.22	-	-2.01	-	-	-5.94	-	-	-3.41	-	-	-2.05	-0.36	-	-0.90
<W2	Frm	0.36	-	-0.90	-	-	-2.05	-	-	-3.41	-	-	-5.94	1.22	-	-2.01
WPL	Frm	1.10	-1.55	-1.91	-	-	-4.64	-	-	-5.35	-	-	-8.54	-1.06	-1.55	-3.13
WPR	Frm	1.06	1.55	-3.13	-	-	-8.54	-	-	-5.35	-	-	-4.64	-1.10	1.55	-1.91
MW - Wall: 1	Frm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW - Wall: 2	Frm	-	-	-	-	-	-	-	-	-0.11	-	-	-	1.18	-	0.10
MW - Wall: 3	Frm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW - Wall: 4	Frm	-1.18	-	0.10	-	-	-	-	-	-0.11	-	-	-	-	-	-
CU	Frm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
L	Frm	-	-	2.22	-	-	5.93	-	-	5.01	-	-	5.93	-	-	2.22
S	Frm	-	-	4.20	-	-	11.22	-	-	9.49	-	-	11.22	-	-	4.20
WB1>	Brc	-	-	-	1.66	-	-1.18	-	-	1.18	-	-	-	-	-	-
<WB1	Brc	-	-	-	-	-	1.07	-1.66	-	-1.07	-	-	-	-	-	-
WB2>	Brc	-	-	-	1.66	-	-1.19	-	-	1.19	-	-	-	-	-	-
<WB2	Brc	-	-	-	-	-	1.08	-1.66	-	-1.08	-	-	-	-	-	-
WB3>	Brc	-	-	-	1.66	-	-1.21	-	-	1.20	-	-	-	-	-	-
<WB3	Brc	-	-	-	-	-	1.09	-1.66	-	-1.09	-	-	-	-	-	-
WB4>	Brc	-	-	-	1.66	-	-1.21	-	-	1.20	-	-	-	-	-	-
<WB4	Brc	-	-	-	-	-	1.09	-1.66	-	-1.09	-	-	-	-	-	-
MWB - Wall: 1	Brc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MWB - Wall: 2	Brc	-	-	-	-	-	0.94	-1.52	-	-0.94	-	-	-	-	-	-
MWB - Wall: 3	Brc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MWB - Wall: 4	Brc	-	-	-	1.52	-	-1.03	-	-	1.03	-	-	-	-	-	-

Tabla No. 3.47 Reacciones máximas sin factorizar en la base de las columnas

X-Loc	Grid	Hrz left (-Hx) (k)	Load Case	Hrz Right (Hx) (k)	Load Case	Hrz In (-Hz) (k)	Load Case	Hrz Out (Hz) (k)	Load Case	Uplift (-Vy) (k)	Load Case	Vrt Down (Vy) (k)	Load Case	Mom cw (-Mzz) (in-k)	Load Case	Mom ccw (Mzz) (in-k)	Load Case
0/0/0	9-K	0.73	14	0.66	16	0.93	16	0.93	17	1.47	27	5.55	8	-	-	-	-
25/0/0	9-G	-	-	0.99	40	1.99	13	2.21	12	5.06	49	18.09	11	-	-	-	-
50/0/0	17/1/8	1.30	13	1.54	12	-	-	-	-	-	-	-	-	-	-	-	-
50/0/0	9-E	0.99	52	-	-	2.19	13	2.43	12	3.26	69	11.85	8	-	-	-	-
75/0/0	9-C	-	-	-	-	1.99	13	2.21	12	4.35	26	18.09	10	-	-	-	-
100/0/0	9-A	0.66	17	0.73	15	0.93	16	0.93	17	1.47	26	5.54	8	-	-	-	-

Tabla No. 3.48 Placas base

X-Loc	Grid	Mem. No.	Thickness (in.)	Width (in.)	Length (in.)	Stiff.	Num. Of Rods	Rod Diam. (in.)	Pitch (in.)	Gage (in.)	Hole Type	Welds to Flange	Welds to Web
0/0/0	9-K	1	0.375	8	13	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
25/0/0	9-G	15	0.375	8	11	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
50/0/0	9-E	16	0.375	8	11	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
75/0/0	9-C	17	0.375	8	11	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875
100/0/0	9-A	14	0.375	8	13	No	4	0.750	5.0	5.0	Std	OS-0.1875	OS-0.1875

Tabla No. 3.49 Cargas en la placa base

X-Loc	Maximum Shear Case Shear (k)	Axial (k)	Load Case	Maximum Tension Case Shear (k)	Tension (k)	Load Case	Maximum Comp Case Shear (k)	Comp (k)	Load Case	Maximum Bracing/WA Case Shear (k)	Axial (k)	Frame Shear (k)	Load Case
0/0/0	4.13	19.25	78	0.64	-9.41	122	2.68	22.53	80	6.91	-9.41	0.64	122
50/0/0	1.20	47.31	80	0.02	-9.13	91	0.03	54.38	78	-	-	-	0
100/0/0	4.12	19.26	77	0.66	-9.41	138	2.68	22.53	79	6.91	-9.41	0.66	138

Tabla No. 3.50 Relaciones de esfuerzos en las placas base

X-Loc	Rod Shear	Load Case	Rod Tension	Load Case	Rod V + T	Load Case	Rod Bending	Load Case	Conc. Bearing	Load Case	Plate Tension	Load Case	Plate Comp	Load Case	Flange Weld	Load Case	Web Weld	Load Case
0/0/0	0.051	49	0.038	49	-	0	-	0	0.048	8	0.055	49	0.089	8	0.092	8	0.034	49
25/0/0	0.120	22	0.132	49	-	0	-	0	0.186	11	0.180	49	0.344	11	0.213	11	0.213	11
50/0/0	0.132	22	0.085	69	-	0	-	0	0.122	9	0.116	69	0.225	9	0.140	9	0.140	9
75/0/0	0.120	22	0.113	61	-	0	-	0	0.186	10	0.154	61	0.344	10	0.213	10	0.213	10
100/0/0	0.051	57	0.038	57	-	0	-	0	0.048	9	0.055	57	0.089	9	0.092	9	0.034	57

Tabla No. 3.51 Conexiones atornilladas intermedias en el marco

Mem. No.	Jt. No.	Type	End-Plate Dimensions Thick. (in.)	Width (in.)	Length (in.)	Bolt Diam. (in.)	Spec/Joint	Gages In/Out (in.)	Outside Flange Configuration ID	Desc.	Pitches 1st/2nd (in.)	Inside Flange Configuration ID	Desc.	Pitches 1st/2nd (in.)
1	2	KN(Face)	0.375	6.00	11.00	0.500	A325/-	3.00	11	Flush	3.00	11	Flush	3.00
2	1	KN(Face)	0.375	6.00	11.04	0.500	A325/-	3.00	11	Flush	3.00	11	Flush	3.00
5	2	SP	0.375	6.00	12.75	0.500	A325N/ST	3.00	31	Extended	3.00	11	Flush	6.69
6	1	SP	0.375	6.00	12.75	0.500	A325N/ST	3.00	31	Extended	3.00	11	Flush	6.69
7	2	SP	0.375	6.00	12.27	0.500	A325N/ST	3.00	31	Extended	2.75	11	Flush (0)	7.16
8	1	SP	0.375	6.00	12.27	0.500	A325N/ST	3.00	31	Extended	2.75	11	Flush (0)	7.16
9	2	SP	0.375	6.00	12.75	0.500	A325N/ST	3.00	31	Extended	3.00	11	Flush	6.69
10	1	SP	0.375	6.00	12.75	0.500	A325N/ST	3.00	31	Extended	3.00	11	Flush	6.69
13	2	KN(Face)	0.375	6.00	11.04	0.500	A325/-	3.00	11	Flush	3.00	11	Flush	3.00
14	2	KN(Face)	0.375	6.00	11.00	0.500	A325/-	3.00	11	Flush	3.00	11	Flush	3.00
15	2	CP	0.375	6.00	11.00	0.500	A325/-	3.00	11	Flush	3.00	11	Flush	3.00
16	2	CP	0.375	3.00	11.00	0.500	A325/-	***	11	Flush	-	11	Flush	0.00
17	2	CP	0.375	6.00	11.00	0.500	A325/-	3.00	11	Flush	3.00	11	Flush	3.00

Tabla No. 3.52 Conexiones a momento

Outside Flange Mem. No.	Jt. No.	Required Strength Ld Cs	Axial (k)	Shear (k)	Moment (in-k)	Design Proc.	Strength Ratios * Bolt Tension	Bolt Shear	Plate Bending	Shear Yielding	Shear Rupture	Bearing Tearing	Flange Weld	Web Weld
5	2	11	-0.5	7.2	217.6	AISC DG-16/Thin plate	0.754	0.220	0.695	0.405	0.535	0.107	0.959	0.516
6	1	11	-0.5	7.2	217.6	AISC DG-16/Thin plate	0.754	0.220	0.695	0.405	0.535	0.107	0.765	0.516
7	2	9	0.4	5.8	275.3	AISC DG-16/Thin plate	0.944	0.178	0.868	0.277	0.366	0.085	0.984	0.516
8	1	9	0.4	5.8	275.3	AISC DG-16/Thin plate	0.944	0.178	0.868	0.277	0.366	0.085	0.984	0.516
9	2	10	-0.5	7.2	216.9	AISC DG-16/Thin plate	0.744	0.220	0.702	0.405	0.535	0.107	0.762	0.516
10	1	10	-0.5	7.2	216.9	AISC DG-16/Thin plate	0.744	0.220	0.702	0.405	0.535	0.107	0.959	0.516

Inside Flange Mem. No.	Jt. No.	Required Strength Ld Cs	Axial (k)	Shear (k)	Moment (in-k)	Design Proc.	Strength Ratios * Bolt Tension	Bolt Shear	Plate Bending	Shear Yielding	Shear Rupture	Bearing Tearing	Flange Weld	Web Weld
5	2	45	1.2	1.7	57.9	AISC DG-16/Thick plate	0.658	0.077	0.943	0.000	0.000	0.042	0.959	0.516
6	1	45	1.2	1.7	57.9	AISC DG-16/Thick plate	0.658	0.077	0.943	0.000	0.000	0.042	0.719	0.516
7	2	49	1.2	1.8	66.9	AISC DG-16/Thin plate	0.552	0.080	0.418	0.000	0.000	0.046	1.000	0.516
8	1	49	1.2	1.8	66.9	AISC DG-16/Thin plate	0.552	0.080	0.418	0.000	0.000	0.046	1.000	0.516
9	2	61	1.2	1.7	57.6	AISC DG-16/Thick plate	0.654	0.077	0.971	0.000	0.000	0.042	0.719	0.516
10	1	61	1.2	1.7	57.6	AISC DG-16/Thick plate	0.654	0.077	0.971	0.000	0.000	0.042	0.959	0.516

Tabla No. 3.53 Conexiones articuladas

		Maximum Shear Case			Maximum Tension Case			Strength Ratios							
Mem. No.	Jt. No.	Ld Cs	Axial (k)	Shear (k)	Ld Cs	Axial (k)	Shear (k)	Bolt Tension	Bolt Shear	Bolt V + T	Plate Bending	Flange Yielding	Flange Bearing	Flange Weld	Web Weld
1	2	8	-0.3	4.4	41	0.9	1.3	0.028	0.208	0.000	0.028	0.007	0.056	0.082	0.171
2	2	8	-0.3	4.4	41	0.9	1.3	0.028	0.208	0.000	0.028	0.007	0.056	0.082	0.171
13	2	9	-0.3	4.4	65	0.9	1.3	0.028	0.208	0.000	0.028	0.007	0.056	0.082	0.171
14	2	9	-0.3	4.4	65	0.9	1.3	0.028	0.208	0.000	0.028	0.007	0.056	0.082	0.171
15	2	12	2.2	2.1	27	4.3	0.0	0.137	0.098	0.000	0.141	0.098	0.026	0.326	0.077
16	2	12	0.9	2.3	22	2.7	2.3	0.085	0.108	0.000	0.087	0.061	0.058	0.172	0.085
17	2	12	-0.1	2.1	61	4.3	0.0	0.137	0.098	0.000	0.141	0.098	0.026	0.263	0.077

Tabla No. 3.54 Diseño de los elementos estructurales en el marco (Caso de carga máximo)

			Controlling Cases		Required Strength				Available Strength				Strength Ratios	
Mem. No.	Loc. ft	Depth in.	Axial + Flexure	Shear	Axial Pr k	Shear Vr k	Mom-x Mrx in-k	Mom-y Mry in-k	Axial Pc k	Shear Vc k	Mom-x Mcx in-k	Mom-y Mcy in-k	Axial + Flexure	Shear
1	6.38	12.00	41		1.5		-25.8	71.2	173.7		449.5	156.4	0.52	
1	0.00	12.00		24		0.7				22.3				0.03
2	3.53	10.00	8		-0.2		155.1	0.0	74.4		690.5	156.1	0.23	
2	0.47	10.00		8		4.4				22.6				0.20
3	4.35	10.00	8		-0.1		248.1	0.0	74.4		603.3	156.1	0.41	
3	15.34	10.00		11		-5.3				22.6				0.24
4	4.98	10.00	11		0.5		-516.4	0.0	164.8		690.5	156.1	0.75	
4	4.98	10.00		11		-8.7				22.6				0.38
5	0.00	10.00	11		-0.6		-516.4	0.0	103.7		690.5	156.1	0.75	
5	0.00	10.00		11		9.2				22.6				0.41
6	11.01	10.00	11		-0.0		248.2	0.0	37.9		330.4	57.4	0.75	
6	0.00	10.00		11		7.2				21.7				0.33
7	4.99	10.00	9		0.4		-275.3	0.0	104.6		330.4	57.4	0.84	
7	4.99	10.00		11		-7.5				21.7				0.35
8	0.00	10.00	8		0.4		-275.3	0.0	104.6		330.4	57.4	0.84	
8	0.00	10.00		10		7.5				21.7				0.35
9	6.04	10.00	10		-0.0		248.2	0.0	37.9		330.4	57.4	0.75	
9	17.04	10.00		10		-7.2				21.7				0.33
10	3.04	10.00	10		-0.6		-516.4	0.0	103.7		690.5	156.1	0.75	
10	3.04	10.00		10		-9.2				22.6				0.41
11	0.00	10.00	10		0.5		-516.4	0.0	164.8		690.5	156.1	0.75	
11	0.00	10.00		10		8.7				22.6				0.38
12	11.00	10.00	9		-0.1		248.1	0.0	74.4		603.3	156.1	0.41	
12	0.00	10.00		10		5.3				22.6				0.24
13	0.00	10.00	9		-0.2		155.7	0.0	74.4		690.5	156.1	0.23	
13	3.07	10.00		9		-4.4				22.6				0.20
14	6.38	12.00	57		1.5		-25.8	-71.2	173.7		449.5	156.4	0.52	
14	0.00	12.00		25		-0.7				22.3				0.03
15	7.16	10.00	35		-9.2		64.0	0.0	36.6		183.6	39.0	0.56	
15	0.00	10.00		22		-2.2				21.5				0.10
16	7.94	10.00	22		2.7		-115.8	0.0	87.6		183.6	39.0	0.65	
16	0.00	10.00		22		-2.4				21.5				0.11
17	7.16	10.00	34		-9.2		-71.0	0.0	36.6		183.6	39.0	0.60	
17	0.00	10.00		22		-2.2				21.5				0.10

Tabla No. 3.55 Parámetros utilizados para el diseño por carga axial y flexión de los elementos

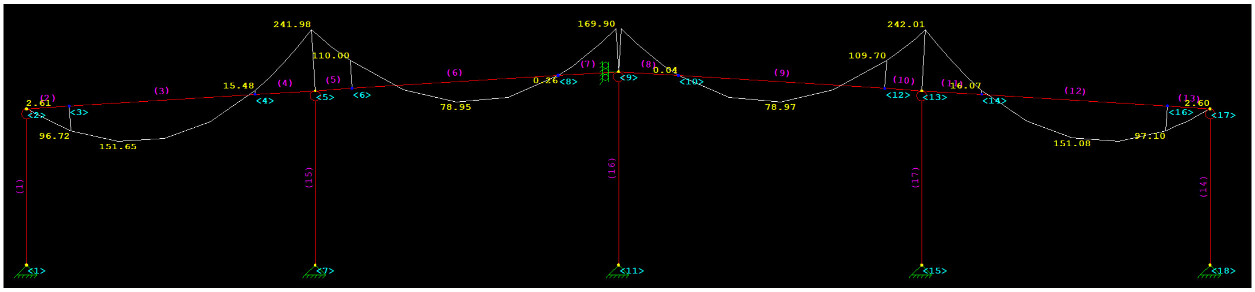
Mem. No.	Loc. ft	Lx in.	Ly/Lt in.	Lb in.	Ag in.2	Afn in.2	Ixx in.4	Iyy in.4	Sx in.3	Sy in.3	Zx in.3	Zy in.3	J in.4	Cw in.6	Cb	Rpg	Rpc	Aeff/ Ag
1	6.38	149.24	149.2	149.2	5.26	1.88	142.70	7.81	23.78	3.13	26.05	4.74	0.19	264.02	1.01	1.00	1.10	1.00
2	3.53	280.36	120.0	60.0	4.99	1.88	95.77	7.81	19.15	3.13	20.92	4.73	0.18	180.98	1.06	1.00	1.09	0.95
3	4.35	280.36	120.0	60.0	4.99	1.88	95.77	7.81	19.15	3.13	20.92	4.73	0.18	180.98	1.16	1.00	1.09	0.95
4	4.98	280.36	60.0	60.0	4.99	1.88	95.77	7.81	19.15	3.13	20.92	4.73	0.18	180.98	1.30	1.00	1.09	1.00
5	0.00	300.59	60.0	60.0	4.99	1.88	95.77	7.81	19.15	3.13	20.92	4.73	0.18	180.98	1.30	1.00	1.09	0.92
6	11.01	300.59	120.0	60.0	3.17	0.94	55.13	3.91	11.03	1.56	12.31	2.39	0.03	94.08	1.52	1.00	1.12	0.93
7	4.99	300.59	24.3	24.3	3.17	0.94	55.13	3.91	11.03	1.56	12.31	2.39	0.03	94.08	1.06	1.00	1.12	1.00
8	0.00	300.59	24.3	24.3	3.17	0.94	55.13	3.91	11.03	1.56	12.31	2.39	0.03	94.08	1.06	1.00	1.12	1.00
9	6.04	300.59	120.0	60.0	3.17	0.94	55.13	3.91	11.03	1.56	12.31	2.39	0.03	94.08	1.67	1.00	1.12	0.93
10	3.04	300.59	60.0	60.0	4.99	1.88	95.77	7.81	19.15	3.13	20.92	4.73	0.18	180.98	1.30	1.00	1.09	0.92
11	0.00	280.36	60.0	60.0	4.99	1.88	95.77	7.81	19.15	3.13	20.92	4.73	0.18	180.98	1.30	1.00	1.09	1.00
12	11.00	280.36	120.0	60.0	4.99	1.88	95.77	7.81	19.15	3.13	20.92	4.73	0.18	180.98	1.02	1.00	1.09	0.95
13	0.00	280.36	120.0	60.0	4.99	1.88	95.77	7.81	19.15	3.13	20.92	4.73	0.18	180.98	1.06	1.00	1.09	0.95
14	6.38	149.24	149.2	149.2	5.26	1.88	142.70	7.81	23.78	3.13	26.05	4.74	0.19	264.02	1.01	1.00	1.10	1.00
15	7.16	171.72	90.0	90.0	2.65	0.67	43.06	2.80	8.61	1.12	9.82	1.73	0.02	68.23	1.00	1.00	1.14	0.77
16	7.94	190.47	95.1	95.1	2.65	0.67	43.06	2.80	8.61	1.12	9.82	1.73	0.02	68.23	1.02	1.00	1.14	1.00
17	7.16	171.72	90.0	90.0	2.65	0.67	43.06	2.80	8.61	1.12	9.82	1.73	0.02	68.23	1.00	1.00	1.14	0.77

Tabla No. 3.56 Combinaciones de deflexión

No.	Origin	Factor	Def H	Def V	Application	Description
1	System	1.000	0	180	1.0 L	L
2	System	1.000	0	180	1.0 S	S
3	System	1.000	60	180	0.42 W1>	W1>
4	System	1.000	60	180	0.42 <W1	<W1
5	System	1.000	60	180	0.42 W2>	W2>
6	System	1.000	60	180	0.42 <W2	<W2
7	System	1.000	60	180	0.42 WPL	WPL
8	System	1.000	60	180	0.42 WPR	WPR

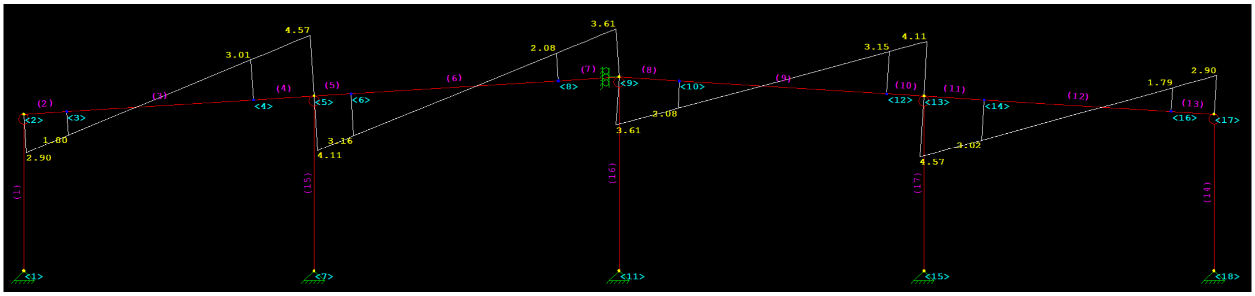
Figura No. 3.21 Diagramas envolventes de los elementos mecánicos del marco

Momento



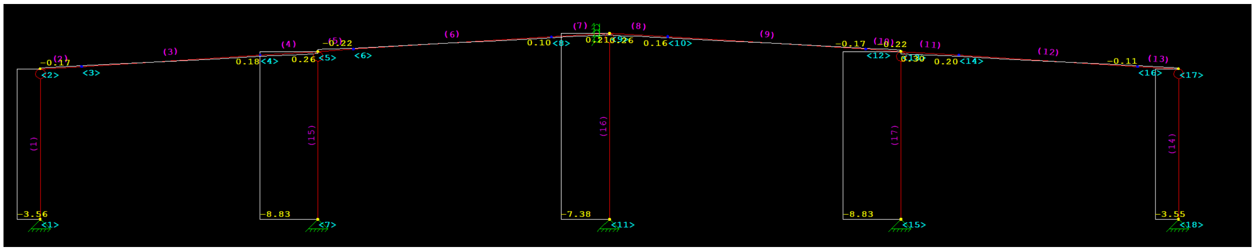
Valores mostrados en kip-in

Cortante



Valores mostrados en kips

Axial



Valores mostrados en kips

3.4.5. Diseño del sistema longitudinal de resistencia

A continuación, se presentan las combinaciones de carga utilizadas para el cálculo del sistema de longitudinal de resistencia (tabla No. 3.57), así como el diseño de los redondos roscados en cruz y sus conexiones en la cubierta entre los ejes E y K (tabla No. 3.58 y 3.59), en la cubierta entre los ejes E y A (tabla No. 3.60 y 3.61), en el muro en el eje A (tabla No. 3.62 y 3.63) y en el muro en el eje K (tabla No. 3.64 y 3.65).

Tabla No. 3.57 Combinaciones de Carga

No.	Factor	Application
1	1.000	1.0 D + 0.6 W1>
2	1.000	1.0 D + 0.6 <W1
3	1.000	1.0 D + 0.6 W2>
4	1.000	1.0 D + 0.6 <W2
5	1.000	1.0 D + 0.6 W3>
6	1.000	1.0 D + 0.6 <W3
7	1.000	1.0 D + 0.6 W4>
8	1.000	1.0 D + 0.6 <W4
9	1.000	0.6 MW
10	1.000	0.6 MW
11	1.000	0.6 MW
12	1.000	0.6 MW
13	1.000	1.0 D + 1.0 CG + 0.6 W1>
14	1.000	1.0 D + 1.0 CG + 0.6 <W1
15	1.000	1.0 D + 1.0 CG + 0.6 W2>
16	1.000	1.0 D + 1.0 CG + 0.6 <W2
17	1.000	1.0 D + 1.0 CG + 0.6 W3>
18	1.000	1.0 D + 1.0 CG + 0.6 <W3
19	1.000	1.0 D + 1.0 CG + 0.6 W4>
20	1.000	1.0 D + 1.0 CG + 0.6 <W4
21	1.000	0.6 D + 0.6 CU + 0.6 W1>
22	1.000	0.6 D + 0.6 CU + 0.6 <W1
23	1.000	0.6 D + 0.6 CU + 0.6 W2>
24	1.000	0.6 D + 0.6 CU + 0.6 <W2
25	1.000	0.6 D + 0.6 CU + 0.6 W3>
26	1.000	0.6 D + 0.6 CU + 0.6 <W3
27	1.000	0.6 D + 0.6 CU + 0.6 W4>
28	1.000	0.6 D + 0.6 CU + 0.6 <W4
29	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1>
30	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W1
31	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W2>
32	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2
33	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W3>
34	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W3
35	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W4>
36	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W4

Figura No. 3.22 Sistema de resistencia longitudinal en la cubierta entre los ejes E y K

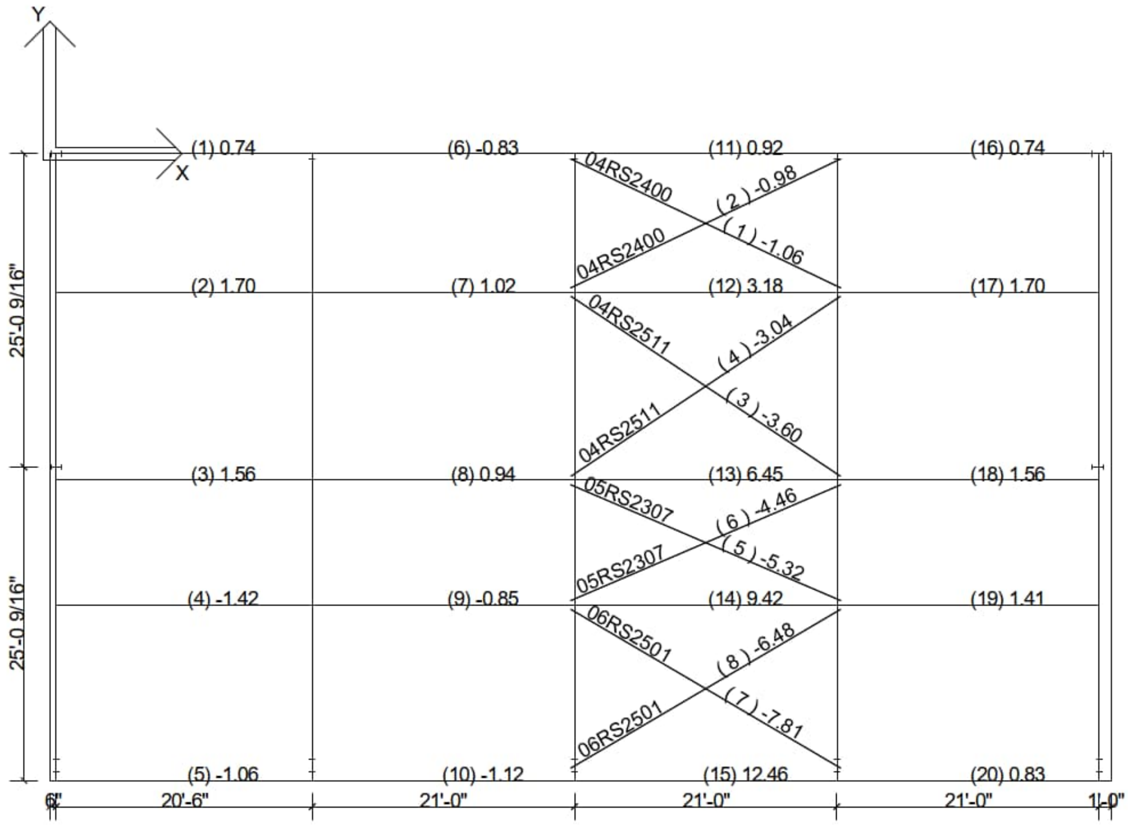


Tabla No. 3.58 Diseño de los redondos roscados en cruz

Mem. No.	Bracing Shape	Length (ft)	Angle	Design Axial (k)	Seismic Factor	Stress Factor	Stress Ratio	Governing Load Case	Design Status
1	R 0.5	23.93	29.9	-1.06	1.0000	1.0000	0.231	1.0D+1.0CG+0.75S+0.45<W4	passed
2	R 0.5	23.93	29.9	-0.98	1.0000	1.0000	0.214	1.0D+1.0CG+0.75S+0.45W3>	passed
3	R 0.5	25.91	37.3	-3.60	1.0000	1.0000	0.785	0.6MW Wall 3	passed
4	R 0.5	25.91	37.3	-3.04	1.0000	1.0000	0.663	1.0D+1.0CG+0.6W3>	passed
5	R 0.625	23.51	27.6	-5.32	1.0000	1.0000	0.716	0.6MW Wall 3	passed
6	R 0.625	23.51	27.6	-4.46	1.0000	1.0000	0.600	1.0D+1.0CG+0.6W3>	passed
7	R 0.75	25.02	35.6	-7.81	1.0000	1.0000	0.719	0.6MW Wall 3	passed
8	R 0.75	25.02	35.6	-6.48	1.0000	1.0000	0.596	1.0D+1.0CG+0.6W3>	passed

Tabla No. 3.59 Diseño de las conexiones de los redondos roscados en cruz

Mem.	End	Diagonal Connection Design Information
1	Left	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.75S+0.45<W4, Factored F = 1.06, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.75S+0.45<W4, Factored F = 1.06, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
2	Left	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.75S+0.45W3>, Factored F = 0.98, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.75S+0.45W3>, Factored F = 0.98, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
3	Left	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 3.60, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 3.60, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
4	Left	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 3.04, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 3.04, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
5	Left	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 5.32, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 5.32, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
6	Left	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 4.46, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 4.46, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
7	Left	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 7.81, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 7.81, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
8	Left	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 6.48, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 6.48, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.

Figura No. 3.23 Sistema de resistencia longitudinal en la cubierta entre los ejes E y A

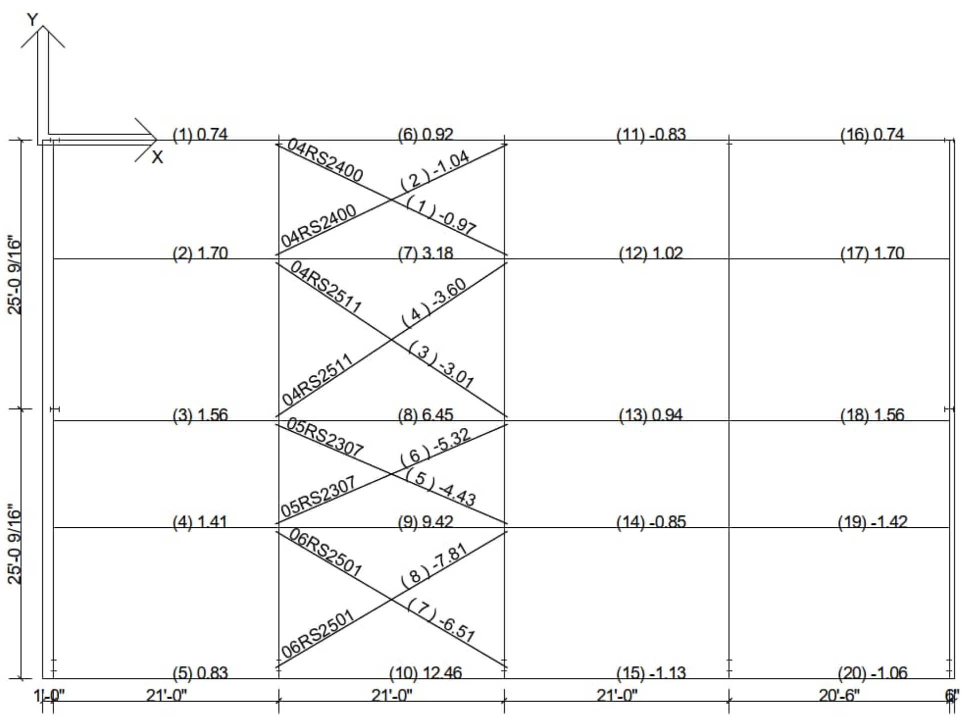


Tabla No. 3.60 Diseño de los redondos roscados en cruz

Mem. No.	Bracing Shape	Length (ft)	Angle	Design Axial (k)	Seismic Factor	Stress Factor	Stress Ratio	Governing Load Case	Design Status	Comment
1	R 0.5	23.93	29.9	-0.97	1.0000	1.0000	0.210	1.0D+1.0CG+0.75S+0.45W3>	passed	
2	R 0.5	23.93	29.9	-1.04	1.0000	1.0000	0.227	1.0D+1.0CG+0.75S+0.45<W4	passed	
3	R 0.5	25.91	37.3	-3.01	1.0000	1.0000	0.656	1.0D+1.0CG+0.6W3>	passed	
4	R 0.5	25.91	37.3	-3.60	1.0000	1.0000	0.785	0.6MW Wall 3	passed	
5	R 0.625	23.51	27.6	-4.43	1.0000	1.0000	0.596	1.0D+1.0CG+0.6W3>	passed	
6	R 0.625	23.51	27.6	-5.32	1.0000	1.0000	0.716	0.6MW Wall 3	passed	
7	R 0.75	25.02	35.6	-6.51	1.0000	1.0000	0.599	1.0D+1.0CG+0.6W3>	passed	
8	R 0.75	25.02	35.6	-7.81	1.0000	1.0000	0.719	0.6MW Wall 3	passed	

Tabla No. 3.61 Diseño de las conexiones de los redondos roscados en cruz

Mem.	End	Diagonal Connection Design Information
1	Left	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.75S+0.45W3>, Factored F = 0.97, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.75S+0.45W3>, Factored F = 0.97, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
2	Left	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.75S+0.45<W4, Factored F = 1.04, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.75S+0.45<W4, Factored F = 1.04, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
3	Left	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 3.01, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 3.01, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
4	Left	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 3.60, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 3.60, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
5	Left	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 4.43, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 4.43, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
6	Left	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 5.32, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 5.32, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
7	Left	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 6.51, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 6.51, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
8	Left	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 7.81, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 7.81, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.

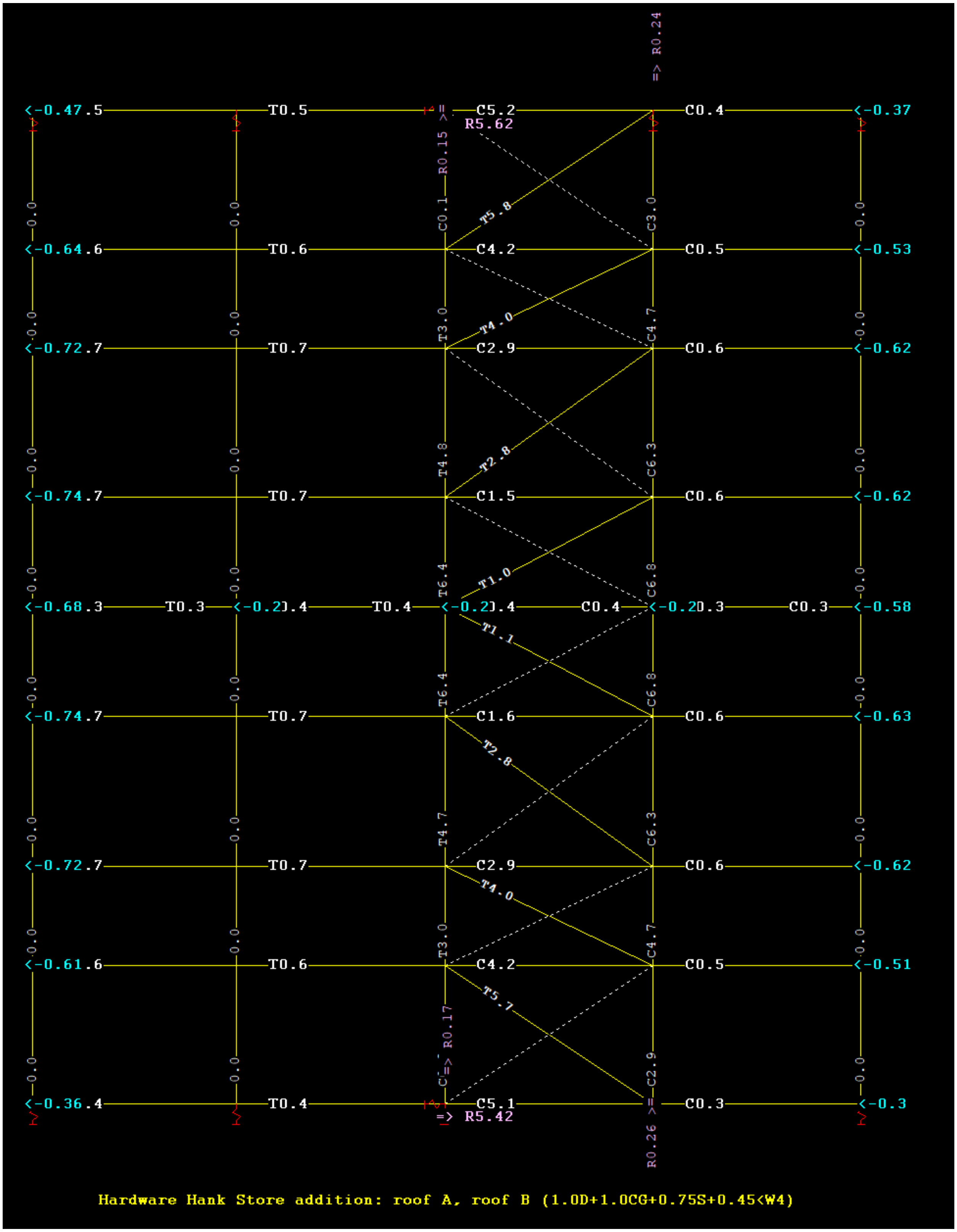


Figura No. 3.24 Análisis sistema de resistencia longitudinal en la cubierta entre los ejes E y A para la combinación de carga 1.0D+1.0Cg+0.75S+0.45<W4

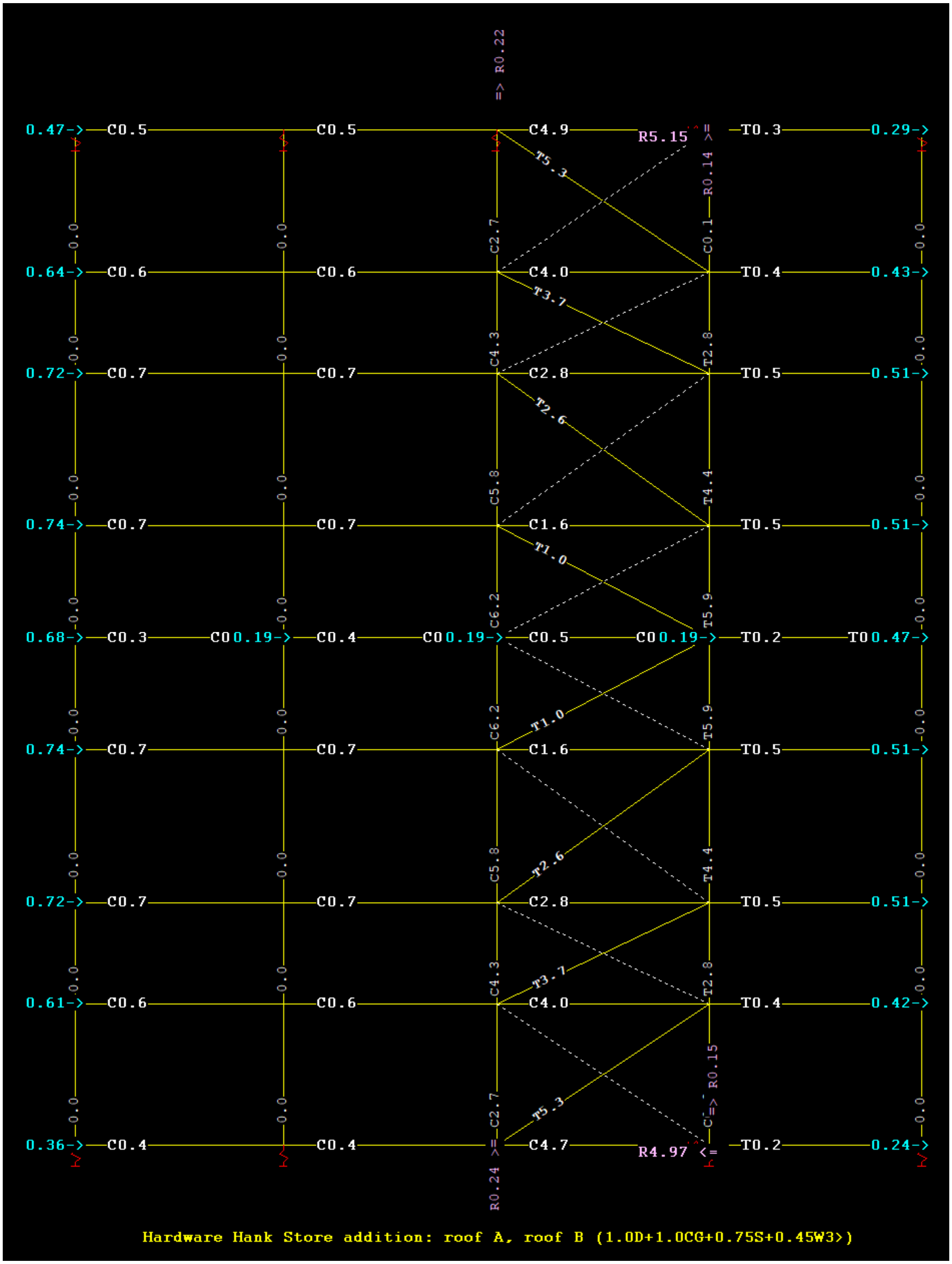


Figura No. 3.25 Análisis sistema de resistencia longitudinal en la cubierta para la combinación de carga 1.0D+1.0Cg+0.75S+0.45W3>

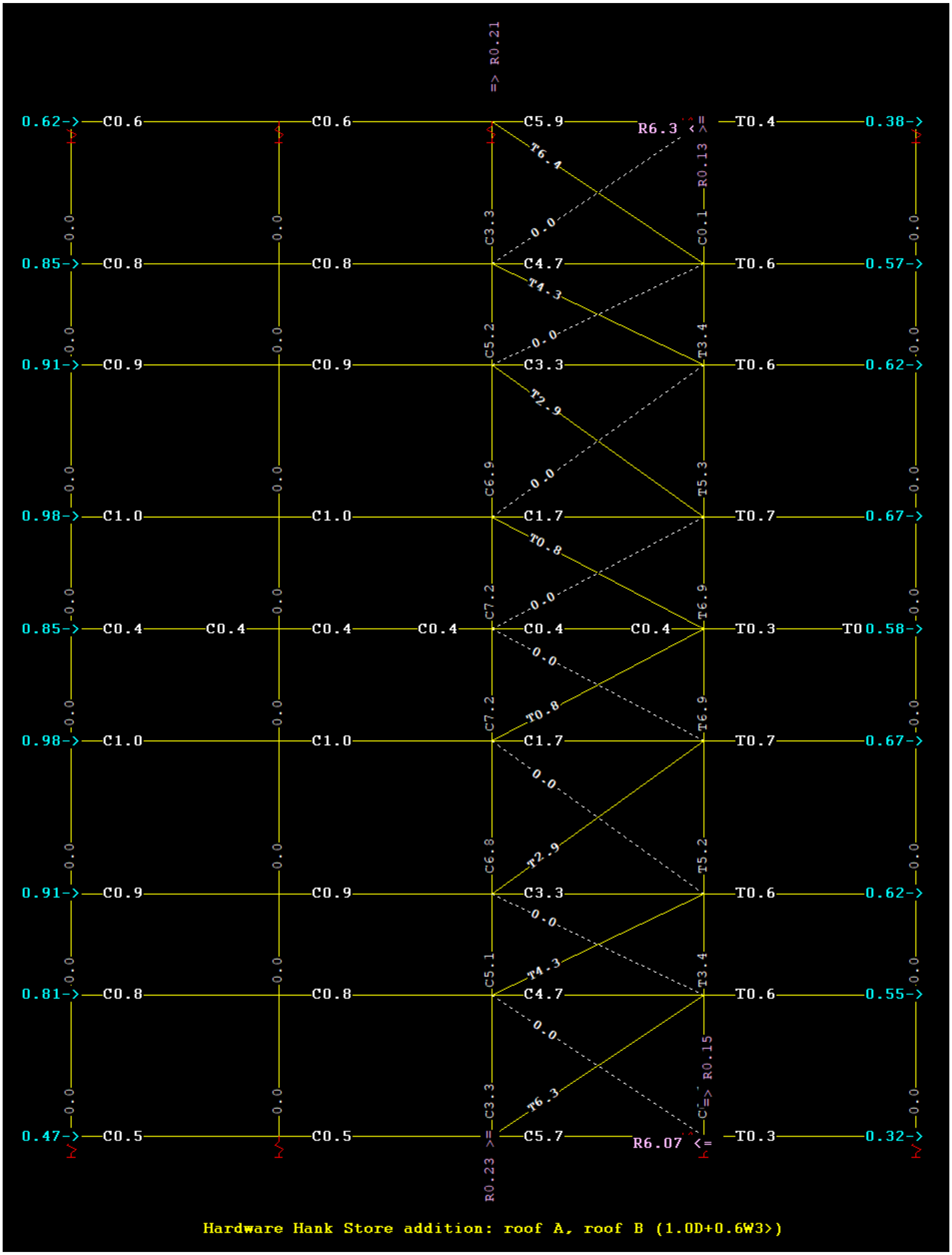


Figura No. 3.26 Análisis sistema de resistencia longitudinal en la cubierta para la combinación de carga 1.0D+0.6W3>

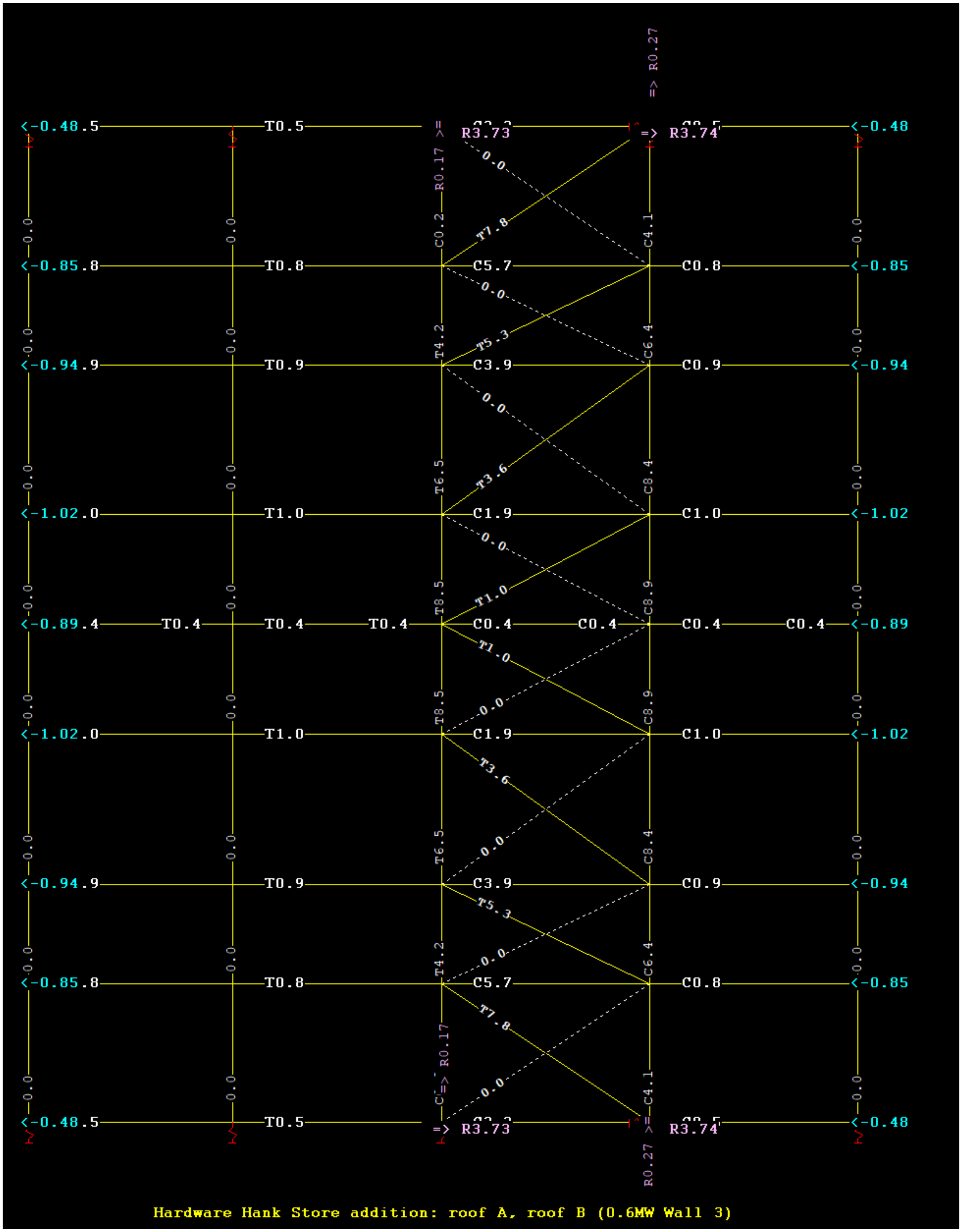


Figura No. 3.27 Análisis sistema de resistencia longitudinal en la cubierta para la combinación de carga 0.6MW

Figura No. 3.28 Sistema de resistencia longitudinal en el eje A

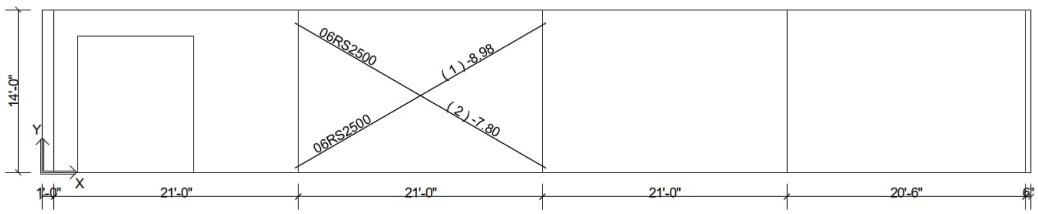


Tabla No. 3.62 Diseño de los redondos roscados en cruz

Mem. No.	Bracing Shape	Length (ft)	Angle	Design Axial (k)	Seismic Factor	Stress Factor	Stress Ratio	Governing Load Case
1	R 0.75	24.93	33.7	-8.98	1.0000	1.0000	0.826	0.6MW Wall 3
2	R 0.75	24.93	33.7	-7.80	1.0000	1.0000	0.718	1.0D+1.0CG+0.6W3>

Tabla No. 3.63 Diseño de las conexiones de los redondos roscados en cruz

Mem.	End	Diagonal Connection Design Information
1	Left	Slot: Web Thk = 0.134, Load Case 0.6MW Wall 3, Factored F = 8.98, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 8.98, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
2	Left	Slot: Web Thk = 0.164, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 7.80, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.134, Load Case 1.0D+1.0CG+0.6W3>, Factored F = 7.80, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.

Figura 3.29 Sistema de resistencia en el eje K

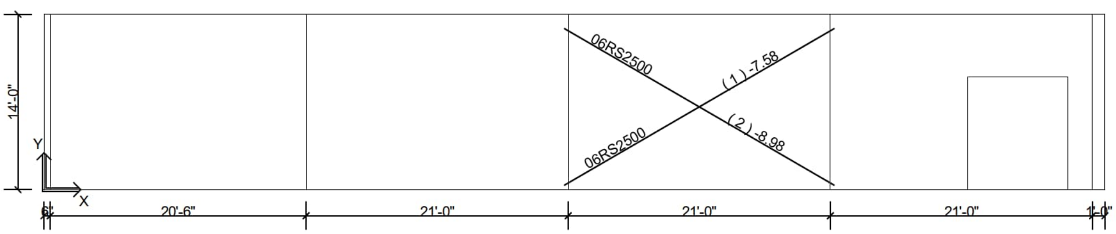


Tabla No. 3.64 Diseño de los redondos roscados en cruz

Mem. No.	Bracing Shape	Length (ft)	Angle	Design Axial (k)	Seismic Factor	Stress Factor	Stress Ratio	Governing Load Case	Design Status	Comment
1	R 0.75	24.93	33.7	-7.58	1.0000	1.0000	0.697	1.0D+0.6W1>	passed	
2	R 0.75	24.93	33.7	-8.98	1.0000	1.0000	0.826	0.6MW Wall 3	passed	

Tabla No. 3.65 Diseño de las conexiones de los redondos roscados en cruz

Mem.	End	Diagonal Connection Design Information
1	Left	Slot: Web Thk = 0.134, Load Case 1.0D+0.6W1>, Factored F = 7.58, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.164, Load Case 1.0D+0.6W1>, Factored F = 7.58, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
2	Left	Slot: Web Thk = 0.164, Load Case 0.6MW Wall 3, Factored F = 8.98, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.
	Right	Slot: Web Thk = 0.134, Load Case 0.6MW Wall 3, Factored F = 8.98, E factor = 1.000, stress increase = 1.000, slot offset, = 3.000, web-flange weld OK, web direct shear OK, web punching shear OK, tensile fracture of web OK, >> PASSED.

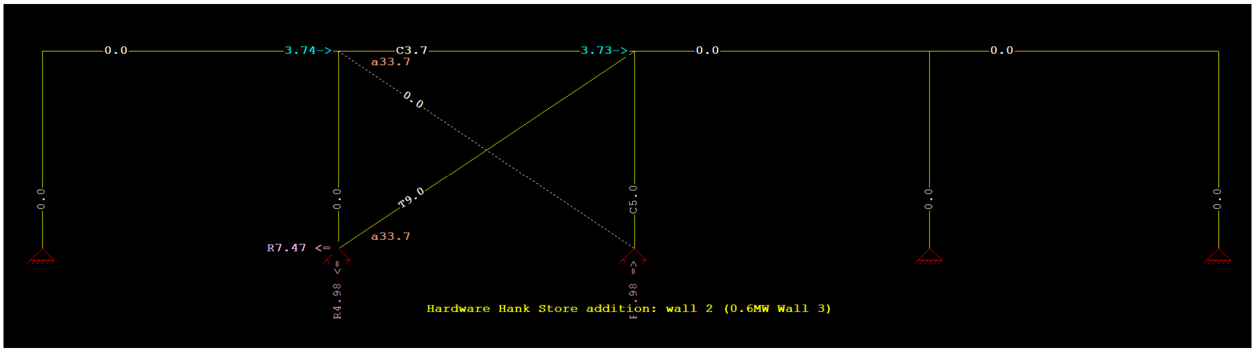


Figura No. 3.30 Análisis sistema de resistencia longitudinal en el eje A para la combinación de carga 0.6MW

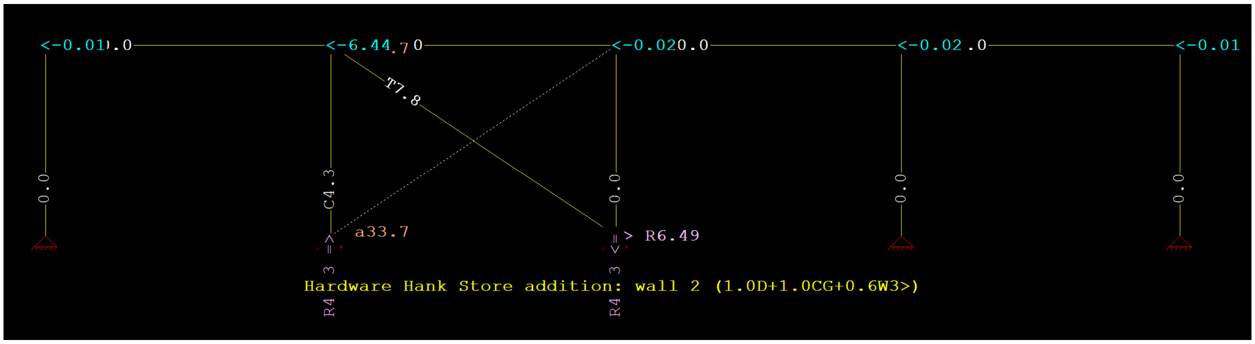


Figura No. 3.31 Análisis sistema de resistencia longitudinal en el eje A para la combinación de carga 1.0D+1.0CG+0.6W3>

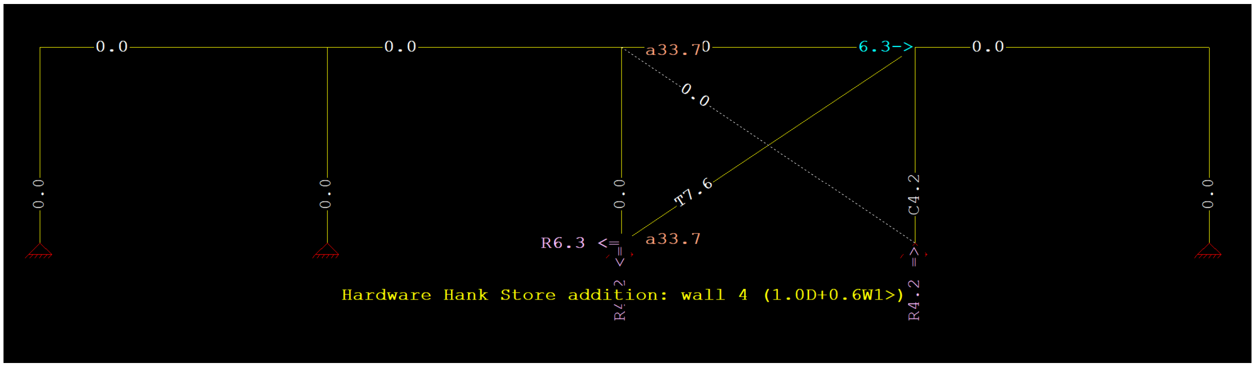


Figura No. 3.32 Análisis sistema de resistencia longitudinal en el eje K para la combinación de carga 1.0D+0.6W1>

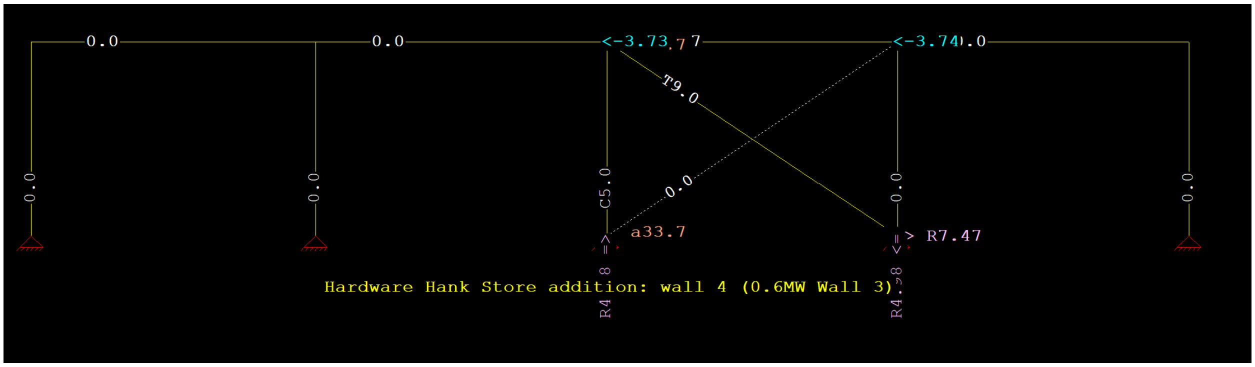


Figura No. 3.33 Análisis sistema de resistencia longitudinal en el eje K para la combinación de carga 0.6MW

3.4 Diseño del sistema secundario de resistencia

3.4.1 Largueros de acero

A continuación, se muestran las combinaciones de carga (tabla No. 3.66), las características geométricas, las relaciones de esfuerzo (tabla No. 3.67, 3.70, 3.73, 3.75 y 3.77) y las deflexiones de los largueros de acero (tabla No. 3.68, 3.71, 3.74, 3.76 y 3.78):

Tabla No. 3.66 Combinaciones de Carga

No.	Factor	Application
1	1.000	1.0 D + 1.0 CG + 1.0 S
2	1.000	1.0 D + 1.0 CG + 1.0 US1*
3	1.000	1.0 D + 1.0 CG + 1.0 *US1
4	1.000	1.0 D + 1.0 CG + 1.0 PF1
5	1.000	1.0 D + 1.0 CG + 1.0 PF1
6	1.000	1.0 D + 1.0 CG + 1.0 PH1
7	1.000	1.0 D + 1.0 CG + 1.0 PH1
8	1.000	1.0 D + 1.0 CG + 1.0 PF2
9	1.000	1.0 D + 1.0 CG + 1.0 PF2
10	1.000	1.0 D + 1.0 CG + 1.0 PF2
11	1.000	1.0 D + 1.0 CG + 0.6 W1> + 0.6 WB1>
12	1.000	1.0 D + 1.0 CG + 0.6 <W2 + 0.6 WB1>
13	1.000	0.6 D + 0.6 CU + 0.6 W1> + 0.6 WB1>
14	1.000	0.6 D + 0.6 CU + 0.6 <W2 + 0.6 WB1>
15	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1> + 0.45 WB1>
16	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2 + 0.45 WB1>
17	1.000	1.0 D + 1.0 CG + 0.6 W1> + 0.6 <WB1
18	1.000	1.0 D + 1.0 CG + 0.6 <W2 + 0.6 <WB1
19	1.000	0.6 D + 0.6 CU + 0.6 W1> + 0.6 <WB1
20	1.000	0.6 D + 0.6 CU + 0.6 <W2 + 0.6 <WB1
21	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1> + 0.45 <WB1
22	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2 + 0.45 <WB1
23	1.000	1.0 D + 1.0 CG + 0.6 W1> + 0.6 WB2>
24	1.000	1.0 D + 1.0 CG + 0.6 <W2 + 0.6 WB2>
25	1.000	0.6 D + 0.6 CU + 0.6 W1> + 0.6 WB2>
26	1.000	0.6 D + 0.6 CU + 0.6 <W2 + 0.6 WB2>
27	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1> + 0.45 WB2>
28	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2 + 0.45 WB2>
29	1.000	1.0 D + 1.0 CG + 0.6 W1> + 0.6 <WB2
30	1.000	1.0 D + 1.0 CG + 0.6 <W2 + 0.6 <WB2
31	1.000	0.6 D + 0.6 CU + 0.6 W1> + 0.6 <WB2
32	1.000	0.6 D + 0.6 CU + 0.6 <W2 + 0.6 <WB2
33	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1> + 0.45 <WB2
34	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2 + 0.45 <WB2
35	1.000	1.0 D + 1.0 CG + 0.6 W1> + 0.6 WB3>
36	1.000	1.0 D + 1.0 CG + 0.6 <W2 + 0.6 WB3>
37	1.000	0.6 D + 0.6 CU + 0.6 W1> + 0.6 WB3>
38	1.000	0.6 D + 0.6 CU + 0.6 <W2 + 0.6 WB3>
39	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1> + 0.45 WB3>
40	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2 + 0.45 WB3>

41	1.000	1.0 D + 1.0 CG + 0.6 W1> + 0.6 <WB3
42	1.000	1.0 D + 1.0 CG + 0.6 <W2 + 0.6 <WB3
43	1.000	0.6 D + 0.6 CU + 0.6 W1> + 0.6 <WB3
44	1.000	0.6 D + 0.6 CU + 0.6 <W2 + 0.6 <WB3
45	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1> + 0.45 <WB3
46	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2 + 0.45 <WB3
47	1.000	1.0 D + 1.0 CG + 0.6 W1> + 0.6 WB4>
48	1.000	1.0 D + 1.0 CG + 0.6 <W2 + 0.6 WB4>
49	1.000	0.6 D + 0.6 CU + 0.6 W1> + 0.6 WB4>
50	1.000	0.6 D + 0.6 CU + 0.6 <W2 + 0.6 WB4>
51	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1> + 0.45 WB4>
52	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2 + 0.45 WB4>
53	1.000	1.0 D + 1.0 CG + 0.6 W1> + 0.6 <WB4
54	1.000	1.0 D + 1.0 CG + 0.6 <W2 + 0.6 <WB4
55	1.000	0.6 D + 0.6 CU + 0.6 W1> + 0.6 <WB4
56	1.000	0.6 D + 0.6 CU + 0.6 <W2 + 0.6 <WB4
57	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 W1> + 0.45 <WB4
58	1.000	1.0 D + 1.0 CG + 0.75 S + 0.45 <W2 + 0.45 <WB4

Figura 3.32 Largueros en la cubierta entre los ejes E y K

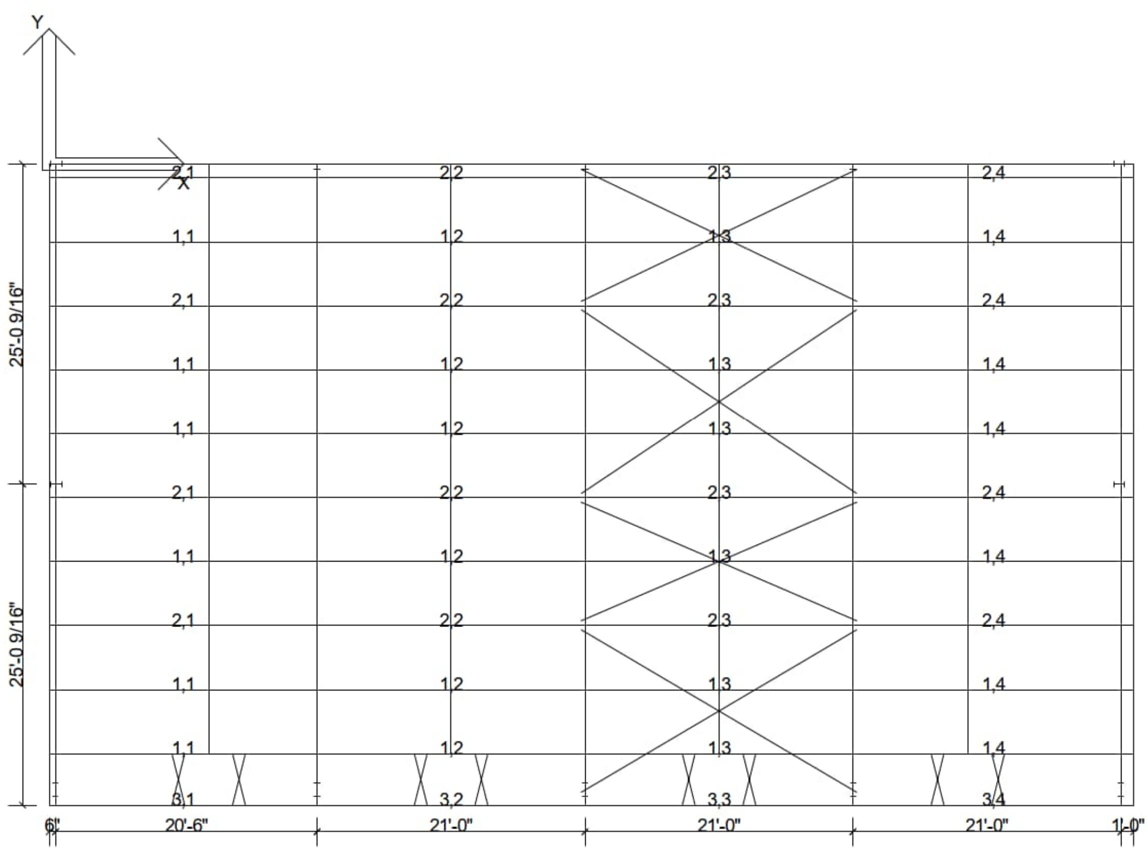


Tabla No. 3.67 Diseño de los largueros

Des	Len	Description - Fy(ksi)	Design	Detail	Exterior						Interior					Exterior					
Id	(ft)		Status	Lap (in.)	% Bnd	% Shr	% Cmb	% Wcp	Ld Cs	Lap (in.)	% Bnd	% Shr	% Cmb	% Wcp	Ld Cs	% Bnd	% Shr	% Cmb	% Wcp	Ld Cs	Lap (in.)
1,1	21.00	10.00x0.098 Z Con-60.0	Yes	46.5							0.95	0.00	0.61	0.00	3	0.67	0.30	0.74	0.00	3	46.5
1,2	21.00	10.00x0.068 Z Con-60.0	Yes	22.5	0.67	0.27	0.73	0.00	3	22.5	0.69	0.72	0.92	0.00	3	0.57	0.45	0.73	0.00	3	22.5
1,3	21.00	10.00x0.068 Z Con-60.0	Yes	22.5	0.57	0.45	0.72	0.00	3	22.5	0.70	0.72	0.92	0.00	3	0.69	0.27	0.74	0.00	3	22.5
1,4	22.00	10.00x0.098 Z Con-60.0	Yes	46.5	0.69	0.31	0.76	0.00	3	46.5	1.00	0.00	0.65	0.00	3						
2,1	21.00	10.00x0.098 Z Con-60.0	Yes	46.5							0.95	0.00	0.61	0.00	3	0.67	0.30	0.74	0.00	3	46.5
2,2	21.00	10.00x0.068 Z Con-60.0	Yes	22.5	0.67	0.27	0.73	0.00	3	22.5	0.69	0.72	0.92	0.00	3	0.57	0.45	0.73	0.00	3	22.5
2,3	21.00	10.00x0.068 Z Con-60.0	Yes	22.5	0.57	0.45	0.72	0.00	3	22.5	0.45	0.47	0.97	0.00	58	0.69	0.27	0.74	0.00	3	22.5
2,4	22.00	10.00x0.098 Z Con-60.0	Yes	46.5	0.69	0.31	0.76	0.00	3	46.5	1.00	0.00	0.65	0.00	3						
3,1	21.00	10.00x0.079 EZ Sim-60.0	Yes	0.0							0.69	0.00	0.69	0.00	1						
3,2	21.00	10.00x0.079 EZ Sim-60.0	Yes	0.0							0.73	0.00	0.00	0.00	1						
3,3	21.00	10.00x0.079 EZ Sim-60.0	Yes	0.0							0.42	0.00	0.96	0.00	34						
3,4	22.00	10.00x0.079 EZ Sim-60.0	Yes	0.0							0.76	0.00	0.76	0.00	1						

Tabla No. 3.68 Deflexiones máximas de los largueros

Design Id	Segment	Deflection(in.)	Ratio	Location(ft)	Load Case	Description
1	1	-0.41	(L/593)	9.00	1	1.0S
1	2	-0.17	(L/1521)	32.38	1	1.0S
1	3	-0.15	(L/1712)	51.38	1	1.0S
1	4	-0.47	(L/534)	74.88	1	1.0S
2	1	-0.41	(L/593)	9.00	1	1.0S
2	2	-0.17	(L/1521)	32.38	1	1.0S
2	3	-0.15	(L/1712)	51.38	1	1.0S
2	4	-0.47	(L/534)	74.88	1	1.0S
3	1	-0.65	(L/378)	11.00	1	1.0S
3	2	-0.72	(L/351)	31.50	1	1.0S
3	3	-0.55	(L/460)	52.50	1	1.0S
3	4	-0.71	(L/353)	73.50	1	1.0S

Tabla No. 3.69 Anclaje de los largueros

Bay	Thickness	Load(psf)	Ld Case	# Purlins	Length	Simple?	Diaphragm Width	Allowable Defl	Actual Defl
1	0.098	-50.73	3	10	21.00	N	50.10	1.400	0.625
2	0.068	-50.73	3	10	21.00	N	50.10	1.400	0.531
3	0.068	-50.73	3	10	21.00	N	50.10	1.400	0.530
4	0.098	-50.73	3	10	22.00	N	50.10	1.467	0.707

Reference Frm-Line	Located @	Force per Anch. Line(k)	Force per Anchor	Anch. Allow	Req'd AR Anchors	Actual AR, STD	Required Stiffness	Available Stiffness	Diaphragm Allow	Diaphragm Shr	Diaphragm Stress Ratio
1(0.00)	Frame	0.22D	0.02D (k)	0.53W	0	0, 10	0.889	20.982	0.069	0.004	0.061
	BR.1		0.10T (in-k)	4.35	1	1, 0			0.069	0.000	0.000
2(21.00)	Frame	0.09D	0.01D (k)	0.57W	0	0, 10	0.351	27.740	0.069	0.004	0.056
	BR.1		0.25T (in-k)	4.35	1	1, 0			0.069	0.000	0.000
3(42.00)	Frame	0.24U	0.02U (k)	0.53W	0	0, 10	0.955	22.848	0.069	0.002	0.031
	BR.1		0.25T (in-k)	4.35	1	1, 0			0.069	0.000	0.000
4(63.00)	Frame	0.07D	0.01D (k)	0.57W	0	0, 10	0.271	27.711	0.069	0.003	0.051
	BR.1		0.20T (in-k)	4.35	1	1, 0			0.069	0.000	0.000
5(85.00)	Frame	0.19D	0.02D (k)	0.53W	0	0, 10	0.776	20.971	0.069	0.004	0.053

Figura No. 3.33 Largueros en la cubierta entre los ejes E y A

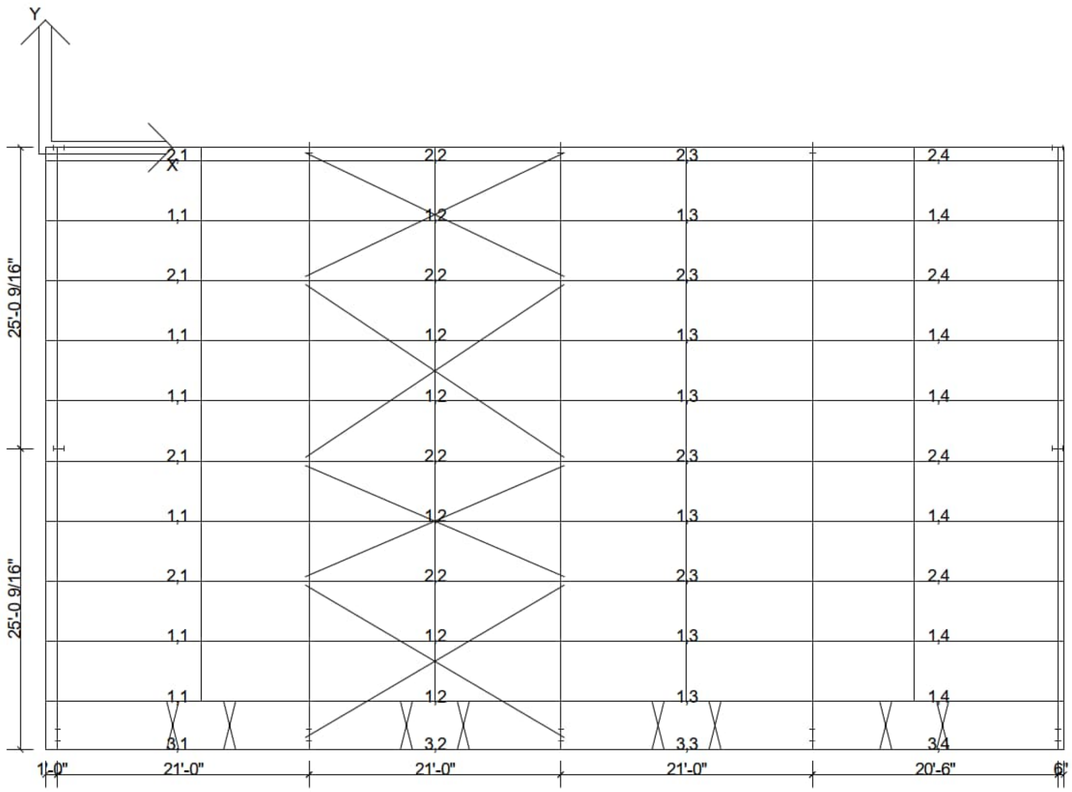


Tabla No. 3.70 Diseño de los largueros

Des Id	Len (ft)	Description - Fy(ksi)	Design Status	Detail Lap (in.)	Exterior % Bnd	% Shr	% Cmb	% Wcp	Ld Cs	Lap (in.)	Interior % Bnd	% Shr	% Cmb	% Wcp	Ld Cs	Exterior % Bnd	% Shr	% Cmb	% Wcp	Ld Cs	Lap (in.)
1,1	22.00	10.00x0.098 Z Con-60.0	Yes	46.5							0.99	0.00	0.00	0.00	2	0.69	0.31	0.76	0.00	2	46.5
1,2	21.00	10.00x0.068 Z Con-60.0	Yes	22.5	0.69	0.27	0.74	0.00	2	22.5	0.70	0.72	0.92	0.00	2	0.57	0.45	0.72	0.00	2	22.5
1,3	21.00	10.00x0.068 Z Con-60.0	Yes	22.5	0.57	0.45	0.73	0.00	2	22.5	0.69	0.72	0.92	0.00	2	0.67	0.27	0.73	0.00	2	22.5
1,4	21.00	10.00x0.098 Z Con-60.0	Yes	46.5	0.67	0.30	0.74	0.00	2	46.5	0.96	0.00	0.61	0.00	2						
2,1	22.00	10.00x0.098 Z Con-60.0	Yes	46.5							0.99	0.00	0.00	0.00	2	0.69	0.31	0.76	0.00	2	46.5
2,2	21.00	10.00x0.068 Z Con-60.0	Yes	22.5	0.69	0.27	0.74	0.00	2	22.5	0.45	0.47	0.97	0.00	58	0.57	0.45	0.72	0.00	2	22.5
2,3	21.00	10.00x0.068 Z Con-60.0	Yes	22.5	0.57	0.45	0.73	0.00	2	22.5	0.69	0.72	0.92	0.00	2	0.67	0.27	0.73	0.00	2	22.5
2,4	21.00	10.00x0.098 Z Con-60.0	Yes	46.5	0.67	0.30	0.74	0.00	2	46.5	0.96	0.00	0.61	0.00	2						
3,1	22.00	10.00x0.079 EZ Sim-60.0	Yes	0.0							0.76	0.00	0.76	0.00	1						
3,2	21.00	10.00x0.079 EZ Sim-60.0	Yes	0.0							0.42	0.00	0.96	0.00	58						
3,3	21.00	10.00x0.079 EZ Sim-60.0	Yes	0.0							0.73	0.00	0.00	0.00	1						
3,4	21.00	10.00x0.079 EZ Sim-60.0	Yes	0.0							0.69	0.00	0.69	0.00	1						

Tabla No. 3.71 Deflexiones máximas de los largueros

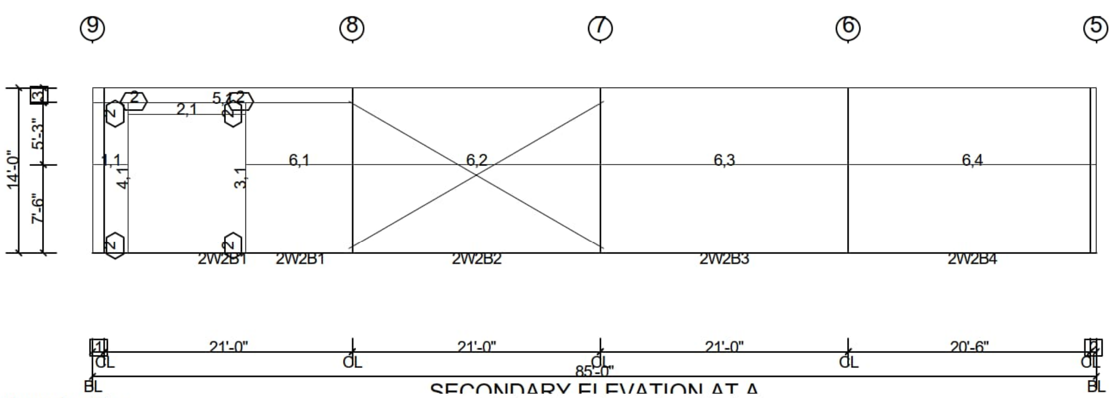
Design Id	Segment	Deflection(in.)	Ratio	Location(ft)	Load Case	Description
1	1	-0.47	(L/540)	10.00	1	1.0S
1	2	-0.15	(L/1714)	33.38	1	1.0S
1	3	-0.17	(L/1520)	52.38	1	1.0S
1	4	-0.42	(L/587)	75.88	1	1.0S
2	1	-0.47	(L/540)	10.00	1	1.0S
2	2	-0.15	(L/1714)	33.38	1	1.0S
2	3	-0.17	(L/1520)	52.38	1	1.0S
2	4	-0.42	(L/587)	75.88	1	1.0S
3	1	-0.71	(L/353)	11.50	1	1.0S
3	2	-0.55	(L/460)	32.50	1	1.0S
3	3	-0.72	(L/351)	53.50	1	1.0S
3	4	-0.65	(L/378)	74.00	1	1.0S

Tabla No. 3.72 Anclaje de los largueros

Bay	Thickness	Load(psf)	Ld Case	# Purlins	Length	Simple?	Diaphragm Width	Allowable Defl	Actual Defl
1	0.098	-50.73	2	10	22.00	N	50.10	1.467	0.707
2	0.068	-50.73	2	10	21.00	N	50.10	1.400	0.531
3	0.068	-50.73	2	10	21.00	N	50.10	1.400	0.530
4	0.098	-50.73	2	10	21.00	N	50.10	1.400	0.625

Reference Frm-Line	Located @	Force per Anch. Line(k)	Force per Anchor	Anch. Allow	Req'd AR Anchors	Actual AR, STD	Required Stiffness	Available Stiffness	Diaphragm Allow	Diaphragm Shr	Diaphragm Stress Ratio
1(0.00)	Frame	0.19D	0.02D (k)	0.53W	0	0, 10	0.776	20.971	0.069	0.004	0.053
	BR.1		0.20T (in-k)	4.35	1	1, 0			0.069	0.000	0.000
2(22.00)	Frame	0.07D	0.01D (k)	0.57W	0	0, 10	0.266	27.711	0.069	0.003	0.051
	BR.1		0.25T (in-k)	4.35	1	1, 0			0.069	0.000	0.000
3(43.00)	Frame	0.24U	0.02U (k)	0.53W	0	0, 10	0.955	22.848	0.069	0.002	0.031
	BR.1		0.25T (in-k)	4.35	1	1, 0			0.069	0.000	0.000
4(64.00)	Frame	0.09D	0.01D (k)	0.57W	0	0, 10	0.357	27.740	0.069	0.004	0.056
	BR.1		0.09T (in-k)	4.35	1	1, 0			0.069	0.000	0.000
5(85.00)	Frame	0.22D	0.02D (k)	0.53W	0	0, 10	0.889	20.982	0.069	0.004	0.061

Figura No. 3.34 Largueros en el eje A



Dimension Key
1 1'-0"
2 6"
3 1'-3"
4 3'-0"

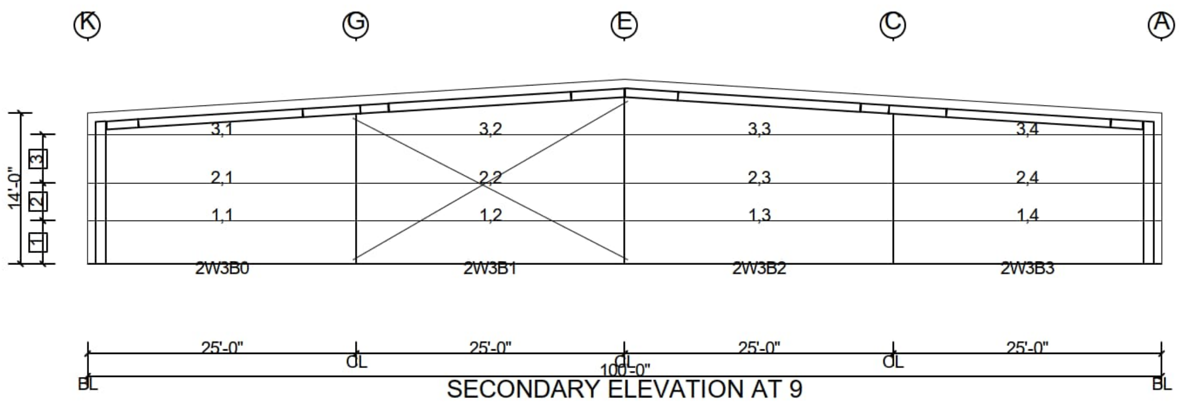
Tabla No. 3.73 Diseño de los largueros

Des Id	Len (ft)	Description - Fy(ksi)	Design Status	Detail Lap (in.)	Exterior						Interior					Exterior					
					% Bnd	% Shr	% Cmb	% Wcp	Ld Cs	Lap (in.)	% Bnd	% Shr	% Cmb	% Wcp	Ld Cs	% Bnd	% Shr	% Cmb	% Wcp	Ld Cs	Lap (in.)
1,1	25.00	8.50x0.068 Z Sim-60.0	Yes	0.0							0.96	0.00	0.00	0.00	1						
1,2	25.00	8.50x0.068 Z Sim-60.0	Yes	0.0							0.95	0.00	0.00	0.00	1						
1,3	25.00	8.50x0.068 Z Sim-60.0	Yes	0.0							0.95	0.00	0.00	0.00	1						
1,4	25.00	8.50x0.068 Z Sim-60.0	Yes	0.0							0.96	0.00	0.00	0.00	1						
2,1	25.00	8.50x0.060 Z Con-60.0	Yes	10.5							1.01	0.00	0.71	0.00	1	0.53	0.25	0.58	0.00	1	10.5
2,2	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.53	0.22	0.57	0.00	1	10.5	1.02	0.37	0.88	0.00	2	0.34	0.19	0.38	0.00	1	10.5
2,3	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.34	0.19	0.38	0.00	1	10.5	1.02	0.37	0.88	0.00	2	0.53	0.22	0.57	0.00	1	10.5
2,4	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.53	0.25	0.58	0.00	1	10.5	1.01	0.00	0.00	0.00	1						
3,1	25.00	8.50x0.060 Z Con-60.0	Yes	10.5							0.65	0.27	0.58	0.00	2	0.35	0.16	0.38	0.00	1	10.5
3,2	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.35	0.15	0.38	0.00	1	10.5	0.66	0.26	0.58	0.00	2	0.28	0.15	0.31	0.00	1	10.5
3,3	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.28	0.15	0.31	0.00	1	10.5	0.66	0.26	0.58	0.00	2	0.35	0.15	0.38	0.00	1	10.5
3,4	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.35	0.16	0.38	0.00	1	10.5	0.65	0.27	0.58	0.00	2						

Tabla No. 3.74 Deflexiones máximas de los largueros

Design Id	Segment	Deflection(in.)	Ratio	Location(ft)	Load Case	Description
1	1	0.98	(L/306)	12.50	1	0.42W1>
1	2	0.97	(L/308)	37.50	1	0.42W1>
1	3	0.97	(L/308)	62.50	1	0.42W1>
1	4	0.98	(L/306)	87.50	1	0.42W1>
2	1	0.87	(L/347)	11.00	1	0.42W1>
2	2	0.22	(L/1357)	38.88	1	0.42W1>
2	3	0.21	(L/1400)	61.38	1	0.42W1>
2	4	0.88	(L/341)	89.38	1	0.42W1>
3	1	0.50	(L/598)	10.50	1	0.42W1>
3	2	0.20	(L/1518)	38.38	1	0.42W1>
3	3	0.19	(L/1544)	61.88	1	0.42W1>
3	4	0.51	(L/586)	89.38	1	0.42W1>

Figura No. 3.35 Largueros en el eje 9



Dimension Key

1 4'-0"
2 3'-6"
3 4'-6"

Tabla No. 3.75 Diseño de los largueros

				Detail	Exterior						Interior					Exterior					
Des Id	Len (ft)	Description - Fy(ksi)	Design Status	Lap (in.)	% Bnd	% Shr	% Cmb	% Wcp	Ld Cs	Lap (in.)	% Bnd	% Shr	% Cmb	% Wcp	Ld Cs	% Bnd	% Shr	% Cmb	% Wcp	Ld Cs	Lap (in.)
1,1	25.00	8.50x0.068 Z Sim-60.0	Yes	0.0							0.96	0.00	0.00	0.00	1						
1,2	25.00	8.50x0.068 Z Sim-60.0	Yes	0.0							0.95	0.00	0.00	0.00	1						
1,3	25.00	8.50x0.068 Z Sim-60.0	Yes	0.0							0.95	0.00	0.00	0.00	1						
1,4	25.00	8.50x0.068 Z Sim-60.0	Yes	0.0							0.96	0.00	0.00	0.00	1						
2,1	25.00	8.50x0.060 Z Con-60.0	Yes	10.5							1.01	0.00	0.71	0.00	1	0.53	0.25	0.58	0.00	1	10.5
2,2	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.53	0.22	0.57	0.00	1	10.5	1.02	0.37	0.88	0.00	2	0.34	0.19	0.38	0.00	1	10.5
2,3	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.34	0.19	0.38	0.00	1	10.5	1.02	0.37	0.88	0.00	2	0.53	0.22	0.57	0.00	1	10.5
2,4	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.53	0.25	0.58	0.00	1	10.5	1.01	0.00	0.00	0.00	1						
3,1	25.00	8.50x0.060 Z Con-60.0	Yes	10.5							0.65	0.27	0.58	0.00	2	0.35	0.16	0.38	0.00	1	10.5
3,2	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.35	0.15	0.38	0.00	1	10.5	0.66	0.26	0.58	0.00	2	0.28	0.15	0.31	0.00	1	10.5
3,3	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.28	0.15	0.31	0.00	1	10.5	0.66	0.26	0.58	0.00	2	0.35	0.15	0.38	0.00	1	10.5
3,4	25.00	8.50x0.060 Z Con-60.0	Yes	10.5	0.35	0.16	0.38	0.00	1	10.5	0.65	0.27	0.58	0.00	2						

Tabla No. 3.76 Deflexiones máximas de los largueros

Design Id	Segment	Deflection(in.)	Ratio	Location(ft)	Load Case	Description
1	1	0.98	(L/306)	12.50	1	0.42W1>
1	2	0.97	(L/308)	37.50	1	0.42W1>
1	3	0.97	(L/308)	62.50	1	0.42W1>
1	4	0.98	(L/306)	87.50	1	0.42W1>
2	1	0.87	(L/347)	11.00	1	0.42W1>
2	2	0.22	(L/1357)	38.88	1	0.42W1>
2	3	0.21	(L/1400)	61.38	1	0.42W1>
2	4	0.88	(L/341)	89.38	1	0.42W1>
3	1	0.50	(L/598)	10.50	1	0.42W1>
3	2	0.20	(L/1518)	38.38	1	0.42W1>
3	3	0.19	(L/1544)	61.88	1	0.42W1>
3	4	0.51	(L/586)	89.38	1	0.42W1>

Figura No. 3.36 Largueros en el eje K

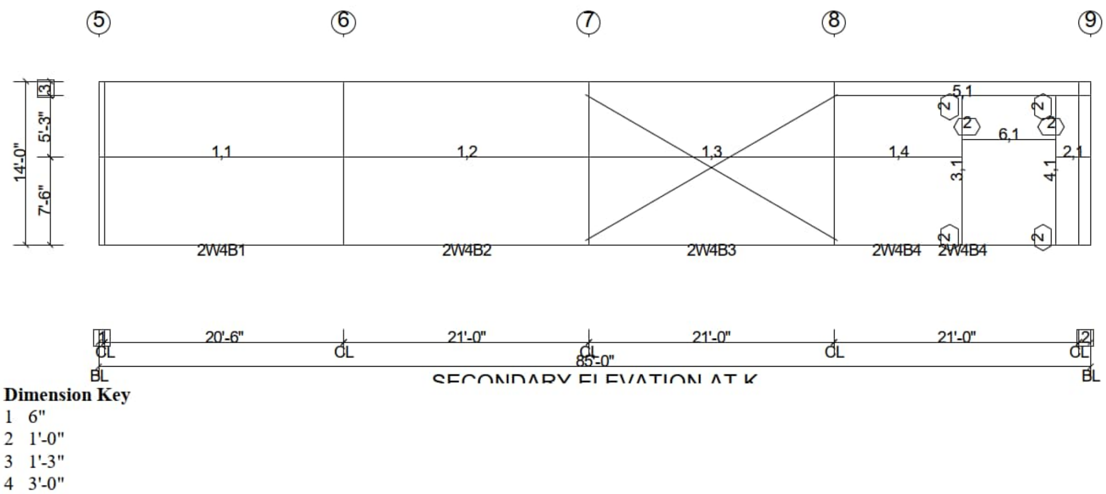


Tabla No. 3.77 Diseño de los largueros

Des Id	Len (ft)	Description - Fy(ksi)	Design Status	Detail Lap (in.)	Exterior % Bnd	Exterior % Shr	Exterior % Cmb	Exterior % Wcp	Exterior Ld Cs	Exterior Lap (in.)	Interior % Bnd	Interior % Shr	Interior % Cmb	Interior % Wcp	Interior Ld Cs	Exterior % Bnd	Exterior % Shr	Exterior % Cmb	Exterior % Wcp	Exterior Ld Cs	Exterior Lap (in.)
1,1	21.00	8.50x0.079 Z Sim-60.0	Yes	0.0							0.95	0.00	0.58	0.00	1						
1,2	21.00	8.50x0.079 Z Sim-60.0	Yes	0.0							1.00	0.00	0.00	0.00	1						
1,3	21.00	8.50x0.079 Z Sim-60.0	Yes	0.0							1.00	0.00	0.00	0.00	1						
1,4	11.00	8.50x0.060 Z Sim-60.0	Yes	0.0							0.41	0.00	0.00	0.00	1						
2,1	3.00	8.50x0.060 Z Sim-60.0	Yes	0.0							0.01	0.06	0.06	0.00	1						
3,1	12.75	8.50x0.060 C Sim-60.0	Yes	0.0							0.58	0.14	0.61	0.00	1						
4,1	12.75	8.50x0.060 C Sim-60.0	Yes	0.0							0.37	0.00	0.39	0.00	1						
5,1	22.00	8.50x0.068 Z Sim-60.0	Yes	0.0							0.90	0.08	0.86	0.00	1						
6,1	8.00	8.50x0.060 C Sim-60.0	Yes	0.0							0.07	0.00	0.00	0.00	1						

Tabla No. 3.78 Deflexiones máximas de los largueros

Design Id	Segment	Deflection(in.)	Ratio	Location(ft)	Load Case	Description
1	1	0.71	(L/346)	11.00	1	0.42W1>
1	2	0.78	(L/321)	31.50	1	0.42W1>
1	3	0.78	(L/321)	52.50	1	0.42W1>
1	4	0.08	(L/1744)	68.50	1	0.42W1>
2	1	-	-	-	-	-
3	1	0.18	(L/839)	6.50	1	0.42W1>
4	1	0.12	(L/1277)	6.50	1	0.42W1>
5	1	0.91	(L/276)	10.50	1	0.42W1>
6	1	-	-	-	-	-

3.4.2 Diseño de los paneles metálicos de recubrimiento

A continuación, se presentan los resultados del diseño de los paneles metálicos de recubrimiento. En las tablas 3.79, 3.80, 3.81, 3.82 y 3.83 se muestran las relaciones de esfuerzo de los paneles, así como las cargas actuantes de acuerdo con la zona en la que se encuentran. Adicionalmente en las tablas 3.84 y 3.85 contienen la información correspondiente a la resistencia de las láminas de panel en función al espaciamiento de los largueros a los cuales son fijados y a los tornillos/clips con los que se fijan.

Tabla No. 3.79 Diseño de los paneles metálicos de recubrimiento de la cubierta entre los ejes E y K

Zone	Units	Type	Description	Actual	Loc1	Allow.	Ratio	Dir.	Coef.
Entire Surface	psf	S	Standard Spacing is Adequate	36.13	0/0/0	121.000	0.30	IN	0.998
Unbalanced Snow	psf	*US1	Standard Spacing is Adequate	36.13	0/0/0	121.000	0.30	IN	0.998
Unbalanced Snow	psf	*US1	Standard Spacing is Adequate	51.01	0/0/0	121.000	0.42	IN	0.998
Side Zone	psf	<W2	Standard Spacing is Adequate	7.64	76/7/3	121.000	0.06	IN	0.480
Side Zone	psf	W1>	Standard Spacing is Adequate	24.50	76/7/3	31.000	0.79	OUT	-1.880
Side Zone	psf	<W2	Standard Spacing is Adequate	7.64	76/7/3	121.000	0.06	IN	0.480
Side Zone	psf	W1>	Standard Spacing is Adequate	24.50	76/7/3	31.000	0.79	OUT	-1.880
Corner Zone	psf	<W2	Standard Spacing is Adequate	7.64	82/2/6	121.000	0.06	IN	0.480
Corner Zone	psf	W1>	Standard Spacing is Adequate	29.66	82/2/6	31.000	0.96	OUT	-2.265
Corner Zone	psf	<W2	Standard Spacing is Adequate	7.64	76/7/3	121.000	0.06	IN	0.480
Corner Zone	psf	W1>	Standard Spacing is Adequate	29.66	76/7/3	31.000	0.96	OUT	-2.265
Side Zone	psf	<W2	Standard Spacing is Adequate	7.64	0/0/0	121.000	0.06	IN	0.480
Side Zone	psf	W1>	Standard Spacing is Adequate	24.50	0/0/0	31.000	0.79	OUT	-1.880
Misc. Edge Zone	psf	<W2	Standard Spacing is Adequate	7.64	68/2/6	121.000	0.06	IN	0.480
Misc. Edge Zone	psf	W1>	Standard Spacing is Adequate	24.50	68/2/6	31.000	0.79	OUT	-1.880
Misc. Edge Zone	psf	<W2	Standard Spacing is Adequate	7.64	68/2/6	121.000	0.06	IN	0.480
Misc. Edge Zone	psf	W1>	Standard Spacing is Adequate	24.50	68/2/6	31.000	0.79	OUT	-1.880
Misc. Edge Zone	psf	<W2	Standard Spacing is Adequate	7.64	0/0/0	121.000	0.06	IN	0.480
Misc. Edge Zone	psf	W1>	Standard Spacing is Adequate	24.50	0/0/0	31.000	0.79	OUT	-1.880
Interior Area	psf	<W2	Standard Spacing is Adequate	7.64	0/0/0	121.000	0.06	IN	0.480
Interior Area	psf	W1>	Standard Spacing is Adequate	13.77	0/0/0	31.000	0.44	OUT	-1.080

Tabla No. 3.80 Diseño de los paneles metálicos de recubrimiento de la cubierta entre los ejes E y K

Zone	Units	Type	Description	Actual	Loc1	Allow.	Ratio	Dir.	Coef.
Entire Surface	psf	S	Standard Spacing is Adequate	36.13	0/0/0	121.000	0.30	IN	0.998
Unbalanced Snow	psf	US1*	Standard Spacing is Adequate	36.13	0/0/0	121.000	0.30	IN	0.998
Unbalanced Snow	psf	US1*	Standard Spacing is Adequate	51.01	0/0/0	121.000	0.42	IN	0.998
Side Zone	psf	<W2	Standard Spacing is Adequate	7.64	8/4/13	121.000	0.06	IN	0.480
Side Zone	psf	W1>	Standard Spacing is Adequate	24.50	8/4/13	31.000	0.79	OUT	-1.880
Side Zone	psf	<W2	Standard Spacing is Adequate	7.64	85/0/0	121.000	0.06	IN	0.480
Side Zone	psf	W1>	Standard Spacing is Adequate	24.50	85/0/0	31.000	0.79	OUT	-1.880
Side Zone	psf	<W2	Standard Spacing is Adequate	7.64	2/9/10	121.000	0.06	IN	0.480
Side Zone	psf	W1>	Standard Spacing is Adequate	24.50	2/9/10	31.000	0.79	OUT	-1.880
Corner Zone	psf	<W2	Standard Spacing is Adequate	7.64	0/0/0	121.000	0.06	IN	0.480
Corner Zone	psf	W1>	Standard Spacing is Adequate	29.66	0/0/0	31.000	0.96	OUT	-2.265
Corner Zone	psf	<W2	Standard Spacing is Adequate	7.64	0/0/0	121.000	0.06	IN	0.480
Corner Zone	psf	W1>	Standard Spacing is Adequate	29.66	0/0/0	31.000	0.96	OUT	-2.265
Misc. Edge Zone	psf	<W2	Standard Spacing is Adequate	7.64	16/9/10	121.000	0.06	IN	0.480
Misc. Edge Zone	psf	W1>	Standard Spacing is Adequate	24.50	16/9/10	31.000	0.79	OUT	-1.880
Misc. Edge Zone	psf	<W2	Standard Spacing is Adequate	7.64	85/0/0	121.000	0.06	IN	0.480
Misc. Edge Zone	psf	W1>	Standard Spacing is Adequate	24.50	85/0/0	31.000	0.79	OUT	-1.880
Misc. Edge Zone	psf	<W2	Standard Spacing is Adequate	7.64	8/4/13	121.000	0.06	IN	0.480
Misc. Edge Zone	psf	W1>	Standard Spacing is Adequate	24.50	8/4/13	31.000	0.79	OUT	-1.880
Interior Area	psf	<W2	Standard Spacing is Adequate	7.64	16/9/10	121.000	0.06	IN	0.480
Interior Area	psf	W1>	Standard Spacing is Adequate	13.77	16/9/10	31.000	0.44	OUT	-1.080

Tabla No. 3.81 Diseño de los paneles metálicos de recubrimiento del muro en el eje A

Zone	Units	Type	Description	Actual	Loc1	Allow.	Ratio	Dir.	Coef.
End Zone	psf	W1>	Standard Spacing is Adequate	19.32	0/0/0	22.000	0.88	OUT	-1.440
End Zone	psf	<W2	Standard Spacing is Adequate	14.49	0/0/0	15.000	0.97	IN	1.080
Interior Area	psf	W1>	Standard Spacing is Adequate	15.70	5/7/3	22.000	0.71	OUT	-1.170
Interior Area	psf	<W2	Standard Spacing is Adequate	14.49	5/7/3	15.000	0.97	IN	1.080

Tabla No. 3.82 Diseño de los paneles metálicos de recubrimiento del muro en el eje 9

Zone	Units	Type	Description	Actual	Loc1	Allow.	Ratio	Dir.	Coef.
End Zone	psf	W1>	Standard Spacing is Adequate	19.32	0/0/0	22.000	0.88	OUT	-1.440
End Zone	psf	<W2	Standard Spacing is Adequate	14.49	0/0/0	15.000	0.97	IN	1.080
End Zone	psf	W1>	Standard Spacing is Adequate	19.32	94/4/13	22.000	0.88	OUT	-1.440
End Zone	psf	<W2	Standard Spacing is Adequate	14.49	94/4/13	15.000	0.97	IN	1.080
Interior Area	psf	W1>	Standard Spacing is Adequate	15.70	5/7/3	22.000	0.71	OUT	-1.170
Interior Area	psf	<W2	Standard Spacing is Adequate	14.49	5/7/3	15.000	0.97	IN	1.080

Tabla No. 3.83 Diseño de los paneles metálicos de recubrimiento del muro en el eje K

Zone	Units	Type	Description	Actual	Loc1	Allow.	Ratio	Dir.	Coef.
End Zone	psf	W1>	Standard Spacing is Adequate	19.32	79/4/13	22.000	0.88	OUT	-1.440
End Zone	psf	<W2	Standard Spacing is Adequate	14.49	79/4/13	15.000	0.97	IN	1.080
Interior Area	psf	W1>	Standard Spacing is Adequate	15.70	0/0/0	22.000	0.71	OUT	-1.170
Interior Area	psf	<W2	Standard Spacing is Adequate	14.49	0/0/0	15.000	0.97	IN	1.080

Tabla No. 3.84 Tabla de resistencia de los paneles metálicos MR24

Butler Manufacturing	24 Ga. MR-24® w/ Standard Clip	Job No.	21-010258-01	
		Page:	1	
	ASD - Panel Available Strength (psf)	Date:	4/29/22	
		Prepared By:	NHL	
		Reviewed By:	SS	
	Equal Support Spaces	Rev.:	21	1/11/2021

Reference: DP22.1

Panel Length (ft.)	# of Spans	Span # 1	# 2	# 3	# 4	# 5	# 6	Suction (-) ASD Panel	Suction (-) ASD Connection	Suction (-) Deflection Δ = L / 60	Pressure (+) ASD Panel	Pressure (+) Deflection Δ = L / 60
1.5 or 3	1 or 2	1.50	1.50	---	---	---	---	---	---	---	---	---
2 or 4	1 or 2	2.00	2.00	---	---	---	---	53	---	4378	267	6539
2.5 or 5	1 or 2	2.50	2.50	---	---	---	---	48	---	2242	174	3348
3 or 6	1 or 2	3.00	3.00	---	---	---	---	44	42	1297	122	1938
3.25 or 6.5	1 or 2	3.25	3.25	---	---	---	---	42	38	1020	105	1524
3.5 or 7	1 or 2	3.50	3.50	---	---	---	---	40	36	817	97	1220
3.75 or 7.5	1 or 2	3.75	3.75	---	---	---	---	38	33	664	97	992
4 or 8	1 or 2	4.00	4.00	---	---	---	---	36	31	547	97	817
4.25 or 8.5	1 or 2	4.25	4.25	---	---	---	---	34	29	456	97	681
4.5 or 9	1 or 2	4.50	4.50	---	---	---	---	32	28	384	97	574
4.75 or 9.5	1 or 2	4.75	4.75	---	---	---	---	30	26	327	97	488
5 or 10	1 or 2	5.00	5.00	---	---	---	---	28	25	280	97	419
4.50	3	1.50	1.50	1.50	---	---	---	---	---	---	---	---
6.00	3	2.00	2.00	2.00	---	---	---	61	---	8262	327	12340
7.50	3	2.50	2.50	2.50	---	---	---	54	50	4230	215	6318
9.00	3	3.00	3.00	3.00	---	---	---	50	42	2448	151	3656
9.75	3	3.25	3.25	3.25	---	---	---	48	38	1925	130	2876
10.50	3	3.50	3.50	3.50	---	---	---	45	36	1542	121	2302
11.25	3	3.75	3.75	3.75	---	---	---	43	33	1253	121	1872
12.00	3	4.00	4.00	4.00	---	---	---	41	31	1033	121	1542
12.75	3	4.25	4.25	4.25	---	---	---	38	29	861	121	1286
13.50	3	4.50	4.50	4.50	---	---	---	36	28	725	121	1083
14.25	3	4.75	4.75	4.75	---	---	---	34	26	617	121	921
15.00	3	5.00	5.00	5.00	---	---	---	31	25	529	121	790
6.00	≥ 4	1.50	1.50	1.50	1.50	etc.	---	---	---	---	---	---
8.00	≥ 4	2.00	2.00	2.00	2.00	etc.	---	61	---	8770	307	13099
10.00	≥ 4	2.50	2.50	2.50	2.50	etc.	---	54	50	4490	202	6707
12.00	≥ 4	3.00	3.00	3.00	3.00	etc.	---	50	42	2599	142	3881
13.00	≥ 4	3.25	3.25	3.25	3.25	etc.	---	48	38	2044	122	3053
14.00	≥ 4	3.50	3.50	3.50	3.50	etc.	---	45	36	1636	121	2444
15.00	≥ 4	3.75	3.75	3.75	3.75	etc.	---	43	33	1330	121	1987
16.00	≥ 4	4.00	4.00	4.00	4.00	etc.	---	41	31	1096	121	1637
17.00	≥ 4	4.25	4.25	4.25	4.25	etc.	---	38	29	914	121	1365
18.00	≥ 4	4.50	4.50	4.50	4.50	etc.	---	36	28	770	121	1150
19.00	≥ 4	4.75	4.75	4.75	4.75	etc.	---	34	26	655	121	978
20.00	≥ 4	5.00	5.00	5.00	5.00	etc.	---	31	25	561	121	838

Notes:

1. Panel available strength (resistance) load values are based on bending, shear, web crippling, combined bending and shear, and connection strengths (resistances), as applicable, in accordance with the 2016 AISI Specification using ASD Allowable Strength Design format.
   Panel suction loads derieved from full scale ASTM E1592 tests. Refer to DP 22.1.

Panel :	24 Ga.		Flexure: Compression on Outside of Panel			Shear:		
t_{base} =	0.0225	in.	$S_{x(+)}$ =	0.0895	in.³ / ft. width	Allowable Strength =	1.027	kips / ft. width panel
F_y =	50	ksi	$I_{x(+)}$ =	0.1995	in.⁴ / ft. width	Web Crippling - End:		
F_u =	65	ksi	Flexure: Compression on Inside of Panel			Allowable Strength =	na	kips / ft. width panel
E =	29500	ksi	$S_{x(-)}$ =	0.0679	in.³ / ft. width	Web Crippling - Int.:		
Weight =	1.17	psf	$I_{x(-)}$ =	0.0935	in.⁴ / ft. width	Allowable Strength =	na	kips / ft. width panel

Fastener : #12-14 SDS, T-30 Torx, Carbon — Fastener Spacing = 0.50 per foot width of panel

Pullover Allowable Strength = na lbs. per ft. width of panel

Pullout Allowable Strength = 125 lbs. per ft. width of panel from 0.06 in. secondary

2. Panel self-weight not included.
3. Ix (+) used for (+) positive load deflections. Ix (-) used for (-) suction load deflections.
4. Load reduction factor = 0.7 used for (-) suction deflection determinations.

Tabla No. 3.85 Tabla de resistencia de los paneles metálicos MR24

Butler Manufacturing	**26 Ga. Shadowall™**	**Job No.**	21-010258-01
		Page:	1
	ASD - Panel Available Strength (psf)	**Date:**	4/29/22
		Prepared By:	NHL
		Reviewed By:	SS
	Standard Wall Support Spaces	**Rev.:** 21	1/11/2021

Reference: DP 22.5

Panel		**Span Lengths, ft.**						**Suction (-) Loads**			**Pressure (+) Loads**	
Length (ft.)	**# of Spans**	**# 1**	**# 2**	**# 3**	**# 4**	**# 5**	**# 6**	**ASD - Available Strength Panel**	**ASD - Available Strength Connection**	**Deflection Δ = L / 60**	**ASD Panel**	**Deflection Δ = L / 60**
10	**2**	**7.50**	**2.50**	**---**	**---**	**---**	**---**	**21**	---	**70**	**17**	**60**
10	*3*	*4.00*	*3.50*	*2.50*	---	---	---	*72*	*67*	*462*	*57*	*393*
11	**2**	**7.50**	**3.50**	**---**	**---**	**---**	**---**	**20**	---	**69**	**18**	**58**
11	*3*	*4.00*	*3.50*	*3.50*	---	---	---	*70*	*67*	*439*	*60*	*373*
12	**2**	**7.50**	**4.50**	**---**	**---**	**---**	**---**	**20**	---	**69**	**17**	**59**
12	*3*	*4.00*	*3.50*	*4.50*	---	---	---	*52*	---	*284*	*49*	*242*
13	**2**	**7.50**	**5.50**	**---**	**---**	**---**	**---**	**21**	---	**73**	**16**	**62**
13	*3*	*4.00*	*3.50*	*5.50*	---	---	---	*35*	---	*157*	*33*	*134*
13	*4*	*4.00*	*3.50*	*4.00*	*1.50*	---	---	*70*	*67*	*442*	*60*	*375*
14	**2**	**7.50**	**6.50**	**---**	**---**	**---**	**---**	**22**	---	**81**	**15**	**68**
14	*3*	*4.00*	*3.50*	*6.50*	---	---	---	*26*	---	*97*	*23*	*83*
14	*4*	*4.00*	*3.50*	*4.00*	*2.50*	---	---	*66*	---	*375*	*49*	*319*
15	**3**	**7.50**	**5.00**	**2.50**	**---**	**---**	**---**	**20**	---	**69**	**17**	**59**
15	*4*	*4.00*	*3.50*	*5.00*	*2.50*	---	---	*66*	*59*	*371*	*50*	*315*
16	**3**	**7.50**	**5.00**	**3.50**	**---**	**---**	**---**	**20**	---	**69**	**18**	**58**
16	*4*	*4.00*	*3.50*	*5.00*	*3.50*	---	---	*68*	*59*	*406*	*45*	*345*
17	**3**	**7.50**	**5.00**	**4.50**	**---**	**---**	**---**	**20**	---	**67**	**18**	**57**
17	*4*	*4.00*	*3.50*	*5.00*	*4.50*	---	---	*57*	*53*	*380*	*36*	*323*
18	**3**	**7.50**	**5.00**	**5.50**	**---**	**---**	**---**	**20**	---	**66**	**19**	**56**
18	*4*	*4.00*	*3.50*	*5.00*	*5.50*	---	---	*38*	---	*180*	*28*	*153*
18	*5*	*4.00*	*3.50*	*5.00*	*4.00*	*1.50*	---	*69*	*56*	*403*	*45*	*343*
19	**3**	**7.50**	**5.00**	**6.50**	**---**	**---**	**---**	**19**	---	**64**	**19**	**54**
19	*4*	*4.00*	*3.50*	*5.00*	*6.50*	---	---	*27*	---	*104*	*22*	*88*
19	*5*	*4.00*	*3.50*	*5.00*	*5.00*	*1.50*	---	*60*	*50*	*474*	*38*	*403*
20	**4**	**7.50**	**5.00**	**5.00**	**2.50**	**---**	**---**	**20**	---	**68**	**18**	**58**
20	*5*	*4.00*	*3.50*	*5.00*	*5.00*	*2.50*	---	*60*	*50*	*510*	*38*	*433*
22	**4**	**7.50**	**5.00**	**5.00**	**4.50**	**---**	**---**	**20**	---	**68**	**18**	**58**
22	*5*	*4.00*	*3.50*	*5.00*	*5.00*	*4.50*	---	*59*	*50*	*347*	*39*	*295*
24	**4**	**7.50**	**5.00**	**5.00**	**6.50**	**---**	**---**	**20**	---	**69**	**17**	**59**
24	*5*	*4.00*	*3.50*	*5.00*	*5.00*	*6.50*	---	*26*	---	*100*	*23*	*85*
24	*6*	*4.00*	*3.50*	*5.00*	*5.00*	*5.00*	*1.50*	*64*	*50*	*439*	*41*	*373*

Notes:

1. Panel available strength (resistance) load values are based on bending, shear, web crippling, combined bending and shear, and connection strengths (resistances), as applicable, in accordance with the 2010 AISI Specification using ASD Allowable Strength Design format.

Panel :	26 Ga.		Flexure: Compression on Outside of Panel			Shear:			
t_{base} =	0.0180	in.	$S_{x(+)}$ =	0.0591	in.^{3} / ft. width	Allowable Strength =	0.602	kips / ft. width panel	
F_y =	50	ksi	$I_{x(+)}$ =	0.0510	in.^{4} / ft. width	Web Crippling - End:			
F_u =	65	ksi	Flexure: Compression on Inside of Panel			Allowable Strength =	0.184	kips / ft. width panel	
E =	29500	ksi	$S_{x(-)}$ =	0.0443	in.^{3} / ft. width	Web Crippling - Int.:			
Weight =	0.92	psf	$I_{x(-)}$ =	0.0420	in.^{4} / ft. width	Allowable Strength =	0.279	kips / ft. width panel	

Fastener : #12-14 SDS, T-30 Torx, Carbon — Fastener Spacing = 1.00 per foot width of panel

Pullover Allowable Strength = 277 lbs. per ft. width of panel

Pullout Allowable Strength = 250 lbs. per ft. width of panel from 0.06 in. secondary

2. Panel self-weight not included.
3. Ix (+) used for (+) positive load deflections. Ix (-) used for (-) suction load deflections.
4. Load reduction factor = 0.7 used for (-) suction deflection determinations.

BUTLER

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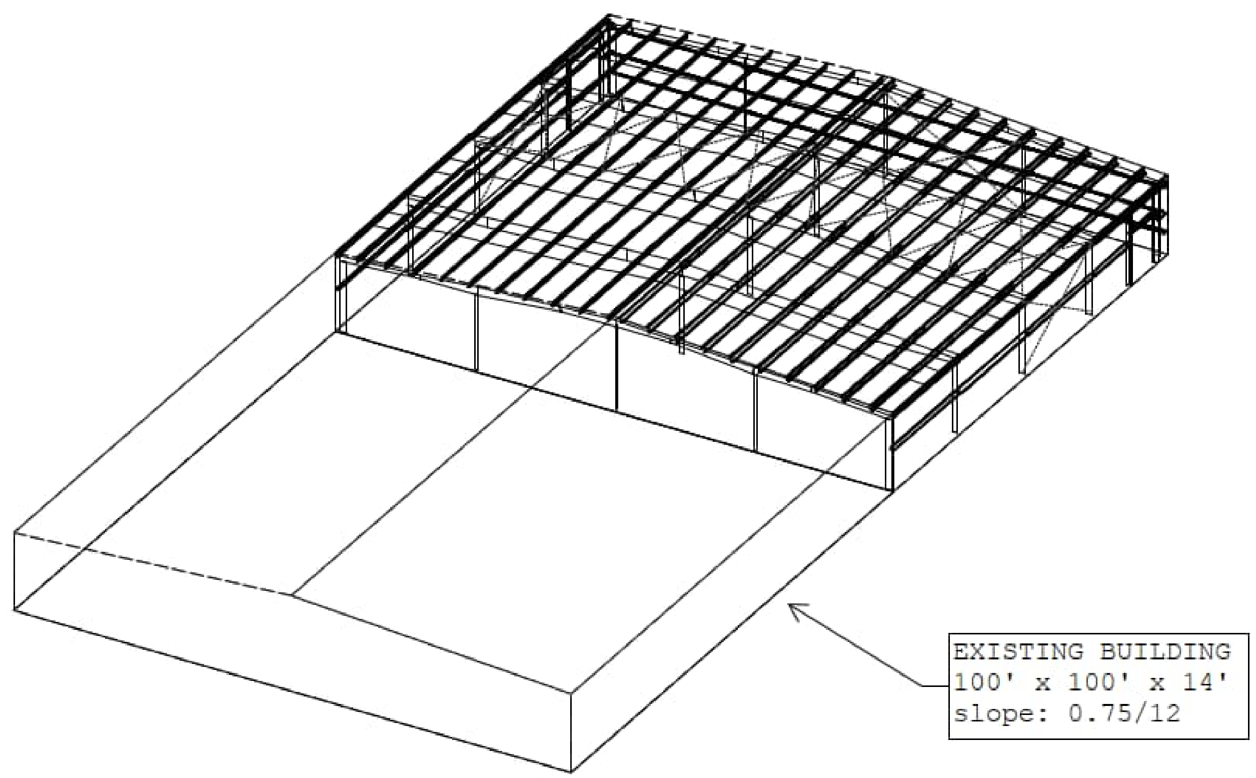
DRAWING RELEASE HISTORY		
TYPE	DATE	DESCRIPTION
Anchor Rod Drawings	5/19/21	FOR CONSTRUCTION
Permit Drawings Rev 0	5/21/21	PERMIT SET- For Building Dept. Approval
Erection Drawings Rev 0	6/22/21	FOR CONSTRUCTION

BUTLER ERECTION GUIDES

MR-24 ROOF INSTALLATION GUIDE 4797

ROOF OWNERS MAINTENANCE 5038

SHADOWALL INSTALLATION GUIDE 5176



GENERAL NOTES

MATERIALS	ASTM DESIGNATION	
3 PLATE WELDED SECTIONS	A529, A572, A1011, A1018	GRADE 55
COLD FORMED LIGHT GAGE SHAPES	A653, A1011	GRADE 60
BRACE RODS	A572, A510	GRADE 50
HOT ROLLED MILL SHAPES	A36, A529, A572, A588, A992	GRADE 36 OR 50
HOT ROLLED ANGLES	A529, A572, A588, A992	GRADE 50
HOLLOW STRUCTURAL SECTION (HSS)	A500	GRADE B
CLADDING	A653, A792	GRADE 50 OR GRADE 80

HIGH STRENGTH BOLT TIGHTENING REQUIREMENTS

IT IS THE RESPONSIBILITY OF THE ERECTOR TO ENSURE PROPER BOLT TIGHTNESS IN ACCORDANCE WITH APPLICABLE REGULATIONS. SEE RCSC SPECIFICATION FOR STRUCTURAL JOINTS USING HIGH STRENGTH BOLTS FOR MORE INFORMATION. SEE ERECTION GUIDE FOR BOLT TIGHTENING INSTRUCTIONS. THE FOLLOWING CRITERIA MAY BE USED TO DETERMINE THE BOLT TIGHTNESS (I.E.-SNUG TIGHT OR PRE-TENSION) UNLESS REQUIRED OTHERWISE BY LOCAL JURISDICTION OR CONTRACT.

ALL A490 BOLTS SHALL BE "PRE-TENSIONED". A325 BOLTS IN PRIMARY FRAMING AND BRACING CONNECTIONS MAY BE "SNUG-TIGHT" EXCEPT AS FOLLOWS;

PRE-TENSION A325 BOLTS IF BUILDING SUPPORTS A CRANE GREATER THAN 5 TON CAPACITY.

PRE-TENSION A325 BOLTS IF BUILDING SUPPORTS MACHINERY THAT CREATES VIBRATION, IMPACT, OR STRESS REVERSALS ON CONNECTIONS.

PRE-TENSION A325 BOLTS IF LOCATED IN HIGH SEISMIC AREAS. FOR IBC BASED CODES; HIGH SEISMIC IS DESIGN CATEGORY D, E OR F. SEE CODES AND LOADS SECTION BELOW FOR DETAILS.

PRE-TENSION ANY CONNECTION WITH DESIGNATION A325-SC. SLIP CRITICAL (SC) CONNECTIONS MUST BE FREE OF PAINT, OIL OR OTHER MATERIALS THAT REDUCE FRICTION AT CONTACT SURFACES. GALVANIZED OR LIGHTLY RUSTED SURFACES ARE ACCEPTABLE.

IN CANADA, ALL A325 AND A490 BOLTS SHALL BE "PRE-TENSIONED", EXCEPT FOR SECONDARY MEMBERS AND FLANGE BRACES.

SECONDARY MEMBERS AND FLANGE BRACE CONNECTIONS ARE ALWAYS "SNUG TIGHT", UNLESS INDICATED OTHERWISE IN ERECTION DRAWING DETAILS.

INSPECTION AND TESTING

SPECIAL INSPECTIONS AND TESTING REQUIRED BY AUTHORITY HAVING JURISDICTION (AHJ) DURING CONSTRUCTION AND/OR STEEL FABRICATION IS THE RESPONSIBILITY OF THE OWNER OR OWNERS AUTHORIZED AGENT. WHEN REQUIRED, THE OWNER SHALL EMPLOY A QUALITY ASSURANCE AGENCY (QAA) APPROVED BY THE AHJ. THE BUILDER IS RESPONSIBLE TO COORDINATE BETWEEN THE QAA FIRM AND BBNA FABRICATION FACILITIES. THE TYPE AND EXTENT OF SPECIAL INSPECTIONS AND NDT WELD TESTING MUST BE SPECIFICALLY STIPULATED IN CONTRACT DOCUMENTS OR BBNA WILL ASSUME SPECIAL INSPECTIONS AND/OR NDT TESTING ARE WAIVED AS PERMITTED BY THE BUILDING CODE BASED ON BBNA FACILITIES IAS AC472 ACCREDITATION.

NOTE:

BUTLER BUILDING ATTACHES TO EXISTING BUILDING AT GRID LINE 5 VIA FLASHING AND TRIM ONLY. THERE IS NO STRUCTURAL ATTACHMENT BETWEEN BUILDINGS. BMC IS NOT RESPONSIBLE FOR ANY LOADS IMPOSED ON THE EXISTING BUILDING.

SIB, REVIEWED PAGES 1-29 (6/28/2021)

THE BUTLER MFG. ENGINEER'S SEAL APPLIES ONLY TO THE WORK PRODUCT OF BUTLER MFG. AND DESIGN AND PERFORMANCE REQUIREMENTS SPECIFIED BY BUTLER. THE BUTLER MFG. ENGINEER'S SEAL DOES NOT APPLY TO THE PERFORMANCE OR DESIGN OF ANY OTHER PRODUCT OR COMPONENT FURNISHED BY BUTLER EXCEPT TO ANY DESIGN OR PERFORMANCE REQUIREMENTS SPECIFIED BY BUTLER.

THIS DRAWING, INCLUDING THE INFORMATION HEREON, REMAINS THE PROPERTY OF BUTLER MFG. IT IS PROVIDED SOLELY FOR ERECTING THE BUILDING DESCRIBED IN THE APPLICABLE PURCHASE ORDER AND MAY BE REPRODUCED ONLY FOR THAT PURPOSE. IT SHALL NOT BE MODIFIED, REPRODUCED OR USED FOR ANY OTHER PURPOSE WITHOUT PRIOR WRITTEN APPROVAL OF BUTLER MFG.

THE GENERAL CONTRACTOR AND/OR ERECTOR IS SOLELY RESPONSIBLE FOR ACCURATE GOOD QUALITY WORKMANSHIP IN ERECTING THIS BUILDING IN ACCORDANCE WITH THIS DRAWING, DETAILS REFERENCED IN THIS DRAWING, ALL APPLICABLE BUTLER MFG. ERECTION GUIDES, AND INDUSTRY STANDARDS PERTAINING TO PROPER ERECTION, INCLUDING THE CORRECT USE OF TEMPORARY BRACING.

B BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

COVER SHEET

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDERS PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION: 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 1

VPC FILENAME: 21-010258-01 5/19/2021 14:31:44

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Codes and Loads

WHEN MULTIPLE BUILDINGS ARE INVOLVED, SPECIFIC LOAD FACTORS FOR DIFFERING OCCUPANCIES, BUILDING DIMENSIONS, HEIGHTS, FRAMING SYSTEMS, ROOF SLOPES, ETC., MAY RESULT IN DIFFERENT LOAD APPLICATION FACTORS THAN INDICATED BELOW. SEE CALCULATIONS FOR FURTHER DETAILS. WIND LOADS ARE APPLIED TO OVERALL BUILDING ENVELOPE. COMMON WALLS BETWEEN CONNECTED SHAPES ARE NOT SUBJECT TO EXTERNAL WIND LOADS.

City: Browns Valley   County: Traverse   State: Minnesota   Country: United States

Building Code

Building Code: 2020 Minnesota State Building Code   Structural: 16AISC - ASD Rainfall: I: 5.00 inches per hour

Building Risk/Occupancy Category: II (Standard Occupancy Structure)   Cold Form: 16AISI - ASD f'c: 3000.00 psi Concrete

Dead and Collateral Loads
Collateral Gravity:5.00 psf
Collateral Uplift: 0.00 psf

Material Dead Weight
Roof Covering + Second. Dead Load: Varies
Frame Weight (assumed for seismic):0.00 psf - USR

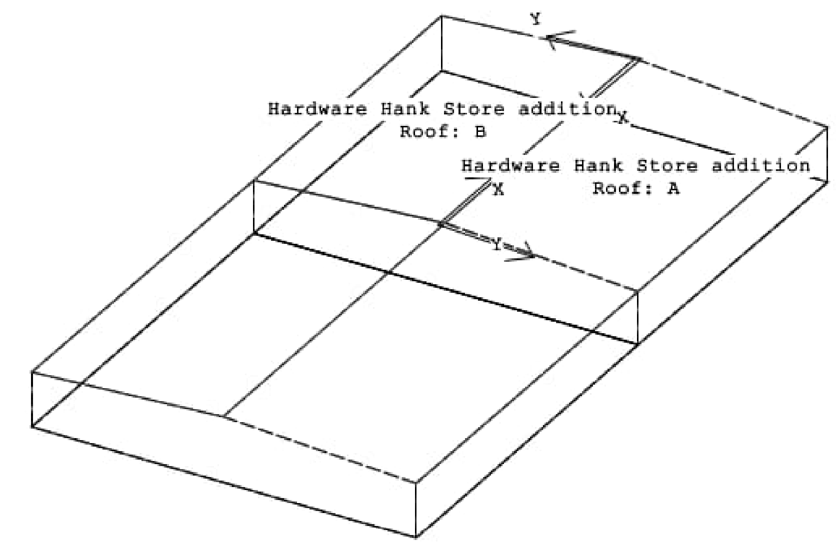
Roof Live Load
Roof Live Load: 20.00 psf Reducible

Wind Load
Wind Speed: Vult: 112.00 (Vasd: 86.75) mph
The 'Envelope Procedure' is Used
Primaries Wind Exposure: C - Kz: 0.849
Parts Wind Exposure Factor: 0.849
Wind Enclosure: Enclosed
Topographic Factor: Kzt: 1.0000
Ground Elevation Factor: Ke: 0.9650

NOT Windborne Debris Region
Base Elevation: 0/0/0
Site Elevation: 983.0 ft
Primary Zone Strip Width: 2a: 11/2/6
Parts / Portions Zone Strip Width:
Walls, a: 5/7/3
Roof(s), 0.6h: 8/4/13
Basic Wind Pressure: q: 22.36, (Parts) 22.36 psf

Snow Load
Ground Snow Load: pg: 50.00 psf
Flat Roof Snow: pf: 35.00 psf
Design Snow (Sloped): ps: 35.00 psf
Rain Surcharge: 0.00
Specified Minimum Roof Snow: 20.00 psf (Code)
Exposure Factor: 2 Partially Exposed - Ce: 1.00
Snow Importance: Is: 1.000
Thermal Factor: Heated - Ct: 1.00
Ground / Roof Conversion: 0.70
Unobstructed, Slippery

Seismic Load
N/A



Snow Buildup

Shape	Surface	Description	X Location	Y Location	Magnitude
Hardware Hank Store ad	Roof: A	Unbalanced Snow Load 1, Shifted Left : Roof: A	0.0 ft	0.0 ft	14.9 psf
			85.0 ft	0.0 ft	14.9 psf
			85.0 ft	31.0 ft	14.9 psf
			0.0 ft	31.0 ft	14.9 psf
Hardware Hank Store ad	Roof: B	Unbalanced Snow Load 1, Shifted Right : Roof: B	0.0 ft	31.0 ft	14.9 psf
			0.0 ft	0.0 ft	14.9 psf
			85.0 ft	0.0 ft	14.9 psf
			85.0 ft	31.0 ft	14.9 psf

1. The Snow Buildup loading shown is in addition to the flat or sloped roof snow.
2. The X and Y Location dimensions are from the point of origin of each surface.

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B

BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

CODES AND LOADS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION: 2021.1c

JOB #: 21-010258-01
DATE: 5/19/2021
DRAWN/CHECK: NHL /
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BUILDER/CONTRACTOR RESPONSIBILITIES

Butler Mfg. follows the guidelines as outlined in the AISC and MBMA Codes of Standard Practice. Butler Mfg. standard product specifications, design, fabrication, quality criteria shall govern all work unless stipulated otherwise in the contract documents. In case of discrepancies between Butler Mfg. structural plans and plans for other trades, Butler Mfg. structural plans shall govern.

It is the responsibility of the Builder to obtain approvals and permits from all governing agencies and jurisdictions as required. Approval of Butler Mfg drawings constitutes the builders acceptance of Butler interpretation of the contract purchase order. Unless specific design criteria concerning interface design and details are furnished as part of the contract, Butler Mfg. design assumptions shall govern.

Butler engineers are not Project Engineers or Engineer of Record for the overall project. Butler engineering supply sealed engineering design data and drawings for Butler supplied material as part of the overall project for use by others to obtain permits, approvals, and coordinate with other trades. All interface and/or compatibility of any materials not furnished by Butler are to be considered and coordinated by the builder or A/E firm.

CONSTRUCTION & ERECTION RESPONSIBILITY

The Builder is responsible for construction in strict accordance with Butler Mfg. "FOR CONSTRUCTION" drawings and all applicable product installation guides. Butler is not responsible for work done from any other Butler drawings that are not marked "FOR CONSTRUCTION", nor any drawings prepared by others.

As erected field assemblies of members shall be as specified in MBMA Code of Standard Practice (in Canada - CSA S16), which require L/500 tolerance of installed members. Occasional field work including shimming, cutting, coping, and drilling for final fit-up are considered part of erection. Specified field work and field welding conditions indicated on these drawings shall also be included in the erectors scope of work. See Erection Guide for shimming procedure. For building with top riding bridge cranes see Crane Data drawing for column plumb tolerance.

The building erector shall be properly licensed and experienced in erecting metal building systems. The Builder is responsible for having knowledge of, and shall comply with, all OSHA requirements and all other governing site safety criteria. The builder is responsible for designing, supplying, locating and installing temporary supports and bracing during erection of the building. Butler bracing is designed for code required loads after building completion and shall not be considered as adequate erection bracing. See Erection Guide.

Shimming of steel buildings during erection may be required to accomodate allowable tolerances during fabrication and erection. Special care should be taken by the building erector to shim connections where key dimensions must be maintained for building performance as even small tolerances can have a significant impact on critical dimensions such as height, clearances and plumbness, especially as the size of the member or building increases. Conditions where shimming should be expected can include but are not limited to large door openings, critical clear height requirements, cranes, buildings greater than 45 feet in height, clear spans greater than 125 feet and adjacent frames with different characteristics (like clear span frames adjacent to an endwall or modular frame). Shims are normally provided by the erector, but may be ordered upon request by contacting your Project Manager.

EXISTING STRUCTURES

Butler must be advised of any structure that is within 20 ft. of Butler's building. Load effects from snow drifting, wind effects, and seismic separation must be considered for both the new and existing structures. Butler has designed the new Butler building for these effects. The owner/builder are responsible for employing a Professional Engineer to review and verify the existing structure for all load effects from the adjacent Butler building.

BRACING

Tension brace rods work in pairs to balance forces caused by initial tensioning. Care must be taken while tightening brace rods so as not to cause accidental or misalignment of components. All rods must be installed loose and then tightened. Rods should not exhibit excessive sag. For long or heavy rods, or angles it may be necessary to support the rods at mid-bay by suspending them from secondary members.

Bracing for seismic or wind loading of objects or equipment that are not a part of the Butler structure must be designed by a qualified professional to deliver lateral loads to primary frames and rod bracing struts. Equipment bracing and suspension connections must not impose torsion or minor axis loads, or cause local distortion in any Butler components. Butler accepts no responsibility for design or installation of bracing systems not furnished by Butler.

FIELD WELDING

All field welding shall be done at the direction of a design professional, and done in accordance with governing requirements (AWS in USA, CWB in Canada) by welders qualified to perform the welding as directed by the applicable welding procedure specification (WPS). A WPS shall be prepared by the contractor for each welding variation specified. The contractor is responsible for any special welding inspection as required by local jurisdiction. Filler metal shall be 70 ksi (480 MPa) tensile strength. For welds in high seismic force resisting system (Seismic Cat D, E or F), minimum Charpy V-Notch toughness shall meet AISC-341 criteria (20 ft-lbs min @ 0Deg F). Interpass temperatures shall not exceed 550Deg F (300Deg C).

SIGNAGE

The Builder is responsible for furnishing signs as required by Code and the Building Department, including but not limited to, exits, occupancy limits, floor loading limits, and bulk storage limits. Floor loading signs shall clearly indicate maximum floor live load permitted. Bulk storage facilities shall have signs clearly posted on all loaded walls indicating the type of commodity stored and the maximum storage height. Signs shall be clearly visible when building is fully loaded to design level. Overloading of floors or walls may result in failure.

DELIVERIES

It is the responsibility of the builder to have adequate equipment available at the job site to unload trucks in a safe and timely manner. The Builder will be responsible for all retention charges from carriers as a result of job site unloading delays.

Claims for damage or shorts MUST be noted on the Bill-of-Lading or delivery receipt and filed against the carrier by the consignee as per Butler's Terms of Sales (F.O.B. Plant) under the Uniform Commercial Code. It is critical that damages or shorts be noted on the Bill-of-Lading or you have little recourse with the carrier. Immediately upon delivery of material, material quantities are verified by the Builder against quantities billed on the shipping document. Neither the Manufacturer nor the carrier is responsible for material shortages against quantities billed on the shipping document if such shortages are not noted on the shipping documents upon delivery of material and acknowledged by the carriers agent. For materials concealed in bundles, boxes, or crates, shortages must be reported immediately upon unpacking. Should products get wet, bundled and crated materials must be unpacked and unbundled immediately to provide drainage of trapped moisture. See Erection Guide for proper job site storage procedure.

SEALANTS

Sealants shall be applied in strict accordance with Butler details or weather tightness will be compromised. Sealant must be applied in temperatures and weather conditions consistent with labeling.

INDEPENDENT MEZZANINES

Independent mezzanines must be designed by a professional engineer. The engineer must ensure that proper isolation from the Butler building has been provided to avoid structural damage due to differential movements, or inadvertently apply loads to the Butler structure. Butler accepts no responsibility for the design of the independent mezzanine.

FIRE CODE COMPLIANCE

It is the responsibility of the project design professional and builder to comply with local fire code regulations including consideration of, but not limited to, building use and occupancy, all building construction materials, separation requirements, egress requirements, fire protection systems, etc. Builder shall advise Butler of any special requirements to be furnished by Butler.

FIELD MODIFICATIONS

Modifications to this building from details and instructions contained on these drawings must be approved in writing by Butler Mfg. engineers, or other licensed structural engineer. This includes, but is not limited to, removal of roof or wall cladding, removing or moving any flange braces or rod braces, cutting of openings for doors, windows or RTU's, correction of fabrication errors, etc. The owner shall not impose loads to this structure beyond what is specified for this building in the contract documents. Butler Mfg. accepts no responsibility for the consequences of any unauthorized additions, alterations, or added loads to this structure.

If the builder intends to invoice Butler Mfg. for modifications in excess of $1000, The builder must notify Butler Mfg. immediately, and obtain a Work Authorization from Butler Mfg prior to proceeding. All final claims must be submitted to Butler Mfg with all supporting documentation within 30 days of the building completion. Claims submitted without work authorizations, or after 30 days will not be accepted. Correction of minor misfits, shimming and plumbing, moderate amount of reaming, drilling, chipping / cutting and minor welding are considered by Code of Standard Practice to be part of erection are not subject to claim reimbursement.

CONCRETE/MASONRY/CONVENTIONAL STUD WALLS

The engineer responsible for the design of the wall system is responsible for coordinating with, or specifying to Butler Mfg. any wall to steel compatibility issues such as drift and deflection compatibility, special base details, and wall to Butler steel connections. All fasteners, sealant and counter flashing of wall systems are to be provided by contractor. The engineer responsible for the wall shall design the anchorage to Butler supporting elements consistent with Code required forces.

PANELS

Oil canning is an inherent characteristic of cold formed steel panels. It is the result of several factors that include induced stresses in the raw material delivered to Butler, fabrication methods, installation procedures, and post installation thermal forces. Thru fastened panels will exhibit some dimpling when installed, especially when insulation is installed between panels and secondary supports. Dimpling can be minimized by careful installation, taking care not to over drive fasteners.

Roof rumble is a phenomenon that is caused by wind gusts lifting up on the roof panels and then springing back into place. All panels experience this action to some degree, especially with concealed clip Standing Seam panels. Roof rumble noise may be minimized by providing a layer of blanket insulation between the panels and any hard support surface such as steel secondary members, substrates such as plywood, steel decking, or rigid board insulation. A minimum of 3 inch thick blanket is recommended over steel secondary members, or 2 inch over substrates.

Oil canning, dimpling, and roof rumble do not affect the structural integrity or weather tightness of the panels and is not grounds for rejection of panels.

The Standing Seam joint detail is designed with an interlocking feature for ease of installation. However, it is imperative that installed Standing Seam panels be secured to the secondary structural members and properly seamed prior to departure from the job site each day.

SKYLIGHTS

Local building departments may require added fall restraint due to conditions that may affect the skylight structural integrity. It is the responsibility of the builder to determine and provide any added fall restraint under the skylight as may be required by your building department.

RAIN WATER RUNOFF

Drainage systems must be designed by the project professional to comply with code requirements. Butler is not responsible for drainage designs, overflow scuppers, down piping, etc. The project professional and contractor are responsible to ensure that primary drains and overflow devices such as scuppers and auxiliary drains are provided as required for the required rain intensity at the building perimeter and at valley conditions to prevent ponding.

STEEL SHOP COAT

The purpose of Butler's shop coat is to provide protection for the steel members during transportation, during temporary job site storage and during erection. Standard shop formulation is not designed to perform as a finish coat when exposed to environmental conditions. Members shall be kept free of the ground and properly drained during job site storage. It is the Builder's responsibility to ensure that if a finish coat is being applied over Butler shop coat that the painting contractor verifies compatibility between his finish coat and Butler's shop coat.

BUTLER MFG. ACCREDITATIONS AND APPROVALS

Fabricator Approvals

IAS AC472 Approvals: (www.iasonline.org/services/metal-building-inspection)
Listed under BlueScope Buildings North America, Inc.
City of Los Angeles, CA #FB00031; City of Houston, TX 787;
City of Phoenix, AZ C19-02008; Clark County, NV 43 & 833, San Bernardino County, CA 289,
State of Utah, City of Richmond, Ca.

Design Approvals

IAS AC472 Approvals: (www.iasonline.org/services/metal-building-inspection)
Listed under Butler Manufacturing, a Division of BlueScope Buildings North America, Inc.

Canadian CSA A660 Certifications

(www.cwbgroup.org)
Listed under BlueScope Buildings North America, Inc.

Engineering Certifications of Authorization

USA--AR#576; FL#30427; ID#C-2470; IL#184-002849; KS#E-29; MS#E-0592;
MO#E-2010007736; NC#F-0998; OK#CA4170PE; SD#C-1787; TX#F4828; WV#C03059-00;
CAN--AB#P08900; NS#30123; ON#100148796; and YT#PP134

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B

BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

ERECTION NOTES

BUILDER:	[redacted]
CUSTOMER:	[redacted]
LOCATION:	Browns Valley, Minnesota
PROJECT:	[redacted]
BUILDERS PO#:	[redacted]

Butler Manufacturing
VPC VERSION: 2021.1c
a division of BlueScope Buildings North America, Inc.

JOB #:	21-010258-01
DATE:	5/19/2021
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PAGE:	3

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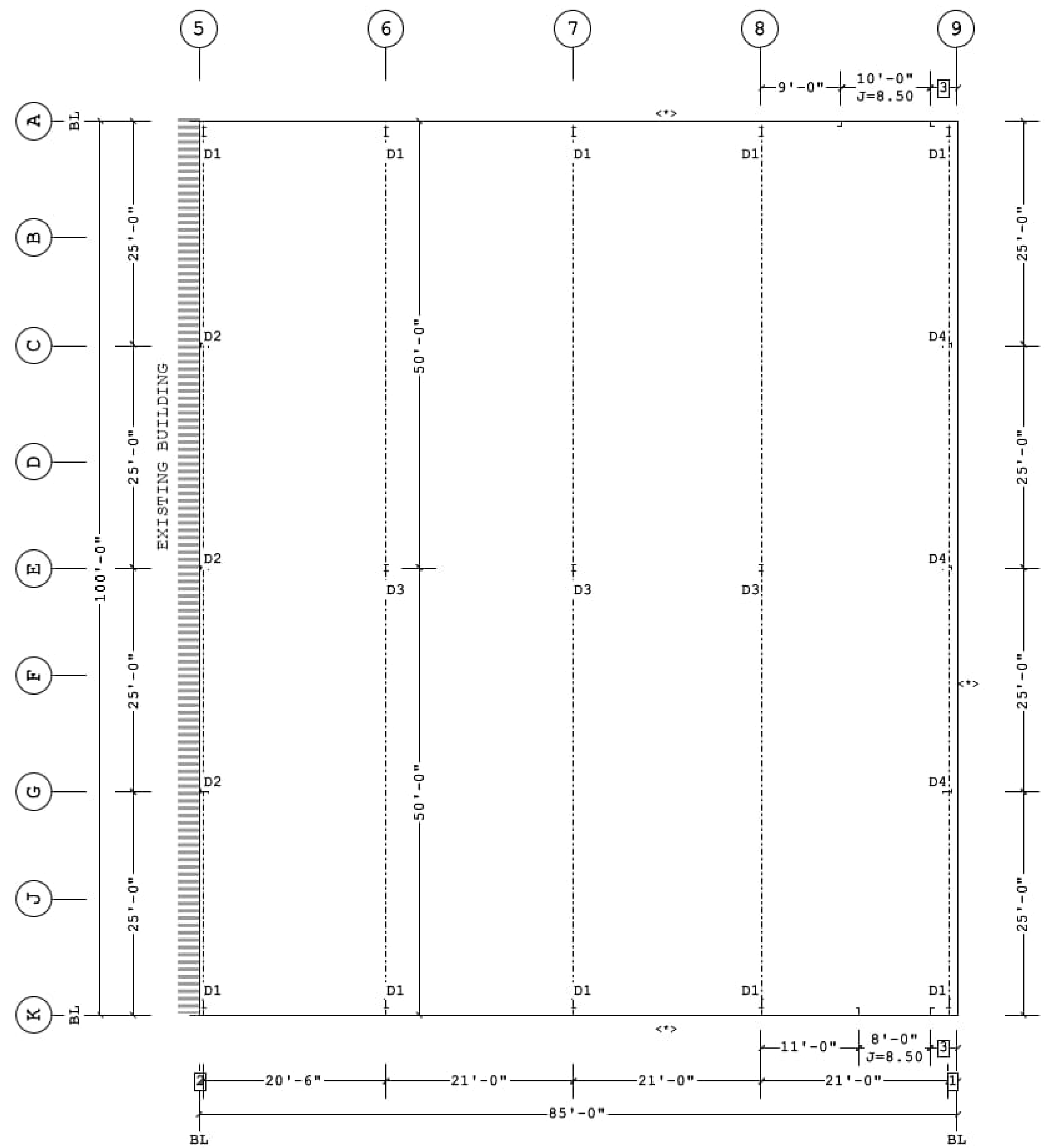

ANCHOR ROD PLAN

3 3'-0"
2 6"
1 1'-0"
Dimension Key

Finished Floor Elevation = 100'-0" (Unless Noted Otherwise)

FOR CONSTRUCTION

<*> THE BUILDING IS DESIGNED WITH BRACING DIAGONALS IN THE DESIGNATED BAYS. COLUMN BASE REACTIONS, BASE PLATES AND ANCHOR RODS ARE AFFECTED BY THIS BRACING AND DIAGONALS MAY NOT BE RELOCATED WITHOUT CONSULTING THE BUILDING SUPPLIERS ENGINEER.

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B BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

ANCHOR ROD PLAN

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION 2021.1c

JOB #: 21-010258-01
DATE: 5/19/2021
DRAWN/CHECK: NHL /
PAGE: 4

VPC FILENAME: 21-010258-01
5/19/2021 14:34:14
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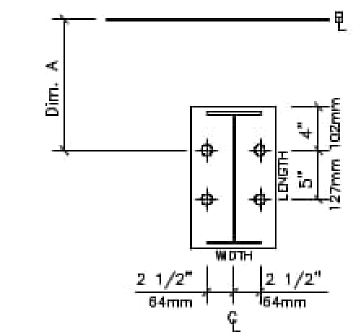
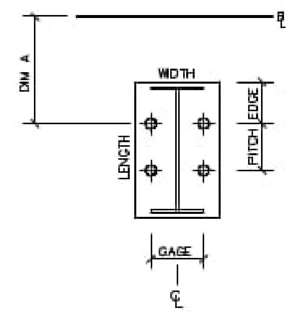
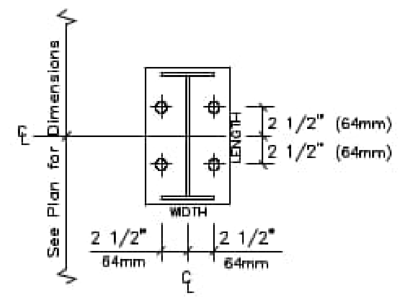


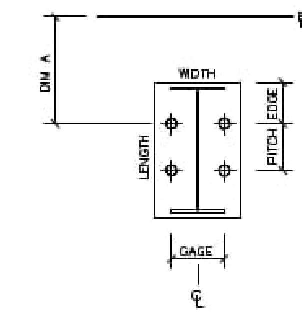
D1 (4)3/4" Dia. GR36 Anchor Rods
Plate W=8" L=1'-1"
Dim: A=1'-0"
Elev.=100'-0"



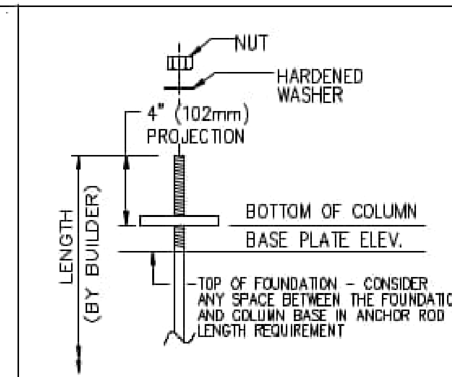
D2 (4)3/4" Dia. GR36 Anchor Rods
Plate W=8" L=11"
Dim: A=4 1/8"
Gage=5" Pitch=5" Edge Out=3"
Elev.=100'-0"



D3 (4)3/4" Dia. GR36 Anchor Rods
Plate W=8" L=11"
Elev.=100'-0"



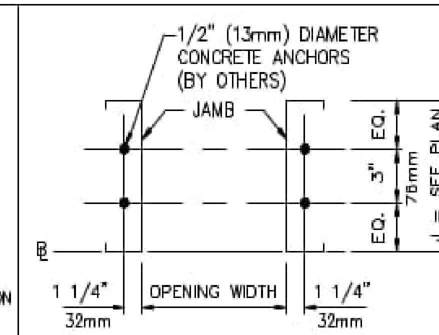
D4 (4)3/4" Dia. GR36 Anchor Rods
Plate W=8" L=11"
Dim: A=11"
Gage=5" Pitch=5" Edge Out=3"
Elev.=100'-0"



THE 4" PROJECTION ABOVE THE BOTTOM OF THE BASE PLATE IS A SUGGESTED MINIMUM TO ENSURE ADEQUATE ANCHOR ROD LENGTH. A DIFFERENT PROJECTION MAY BE REQUIRED BY THE FOUNDATION DESIGNER.

THE ANCHOR ROD PROJECTION MAY NEED TO BE CUT OFF IF THERE IS INTERFERENCE WITH OTHER PARTS.

SUGGESTED ANCHOR ROD PROJECTION



NOTE: 1" (25mm) PROJECTION ABOVE BOTTOM OF JAMB CLIP

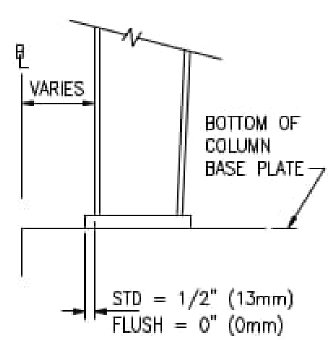
SEE PLAN FOR JAMB SIZES : J = SIZE

JAMB 'EQ.' VALUES:

7 EQ = 2" 51mm, 8.5 EQ = 2 3/4" 70mm

10 EQ = 3 1/2" 89mm, 11.5 EQ = 4 1/4" 108mm

FRAMED OPENING DETAIL



TYPICAL COLUMN BASE PLATE DETAIL

1. ANCHOR RODS, NUTS, HARDENED WASHERS AND ANY OTHER EMBEDDED ITEMS ARE TO BE FURNISHED BY CONTRACTOR.
2. ANCHOR ROD DIAMETERS WERE DETERMINED BY ALLOWABLE SHEAR AND TENSION PER AISC SPECIFICATIONS (FY=36KSI). (ASTM F1554 GRADE 36) ANCHOR ROD LENGTH, EFFECTS OF EMBEDDED ANCHOR ROD EDGE DIMENSIONS AND METHOD OF TRANSFERRING FORCES FROM ANCHOR RODS TO FOOTINGS ARE TO BE DETERMINED BY OTHERS.
3. UNLESS OTHERWISE SPECIFIED, ANCHOR RODS ARE DESIGNED AND DETAILED AS "CAST-IN-PLACE" ANCHOR RODS WITH "SNUG TIGHT" CONNECTIONS.
4. FOUNDATION MUST BE LEVEL, SQUARE AND SMOOTH. ANCHOR RODS MUST BE ACCURATELY PLACED AS SHOWN ON THIS DRAWING OR STEEL WILL NOT FIT. THE BUILDER IS RESPONSIBLE FOR ACCURATE SETTING OF ANCHOR RODS PER AISC CODE OF STANDARD PRACTICE, SEC 7.5 VARIATIONS ARE SUMMARIZED BELOW;
   a. CENTERS OF ANY TWO AR'S WITHIN A COLUMN BASE GROUP; +-1/8"
   b. CENTERS OF ADJACENT AR GROUPS; +-1/4"
   c. TOPS OF AR'S; +-1/2"
   d. ACCUMULATED DIM BETWEEN CENTERS OF AR GROUPS ALONG COLUMN LINE; +-1/4" PER 100FT., NOT TO EXCEED 1" TOTAL.
   e. DIM FROM CENTER OF ANY AR GROUP FROM COLUMN LINE; +-1/4"
5. DESIGN LOADS AND REACTIONS ARE FURNISHED IN THE REACTIONS REPORT.

FOR CONSTRUCTION

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B | BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

ANCHOR ROD PLAN - DETAILS

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDERS PO#: [redacted]

BUTLER
Butler Manufacturing
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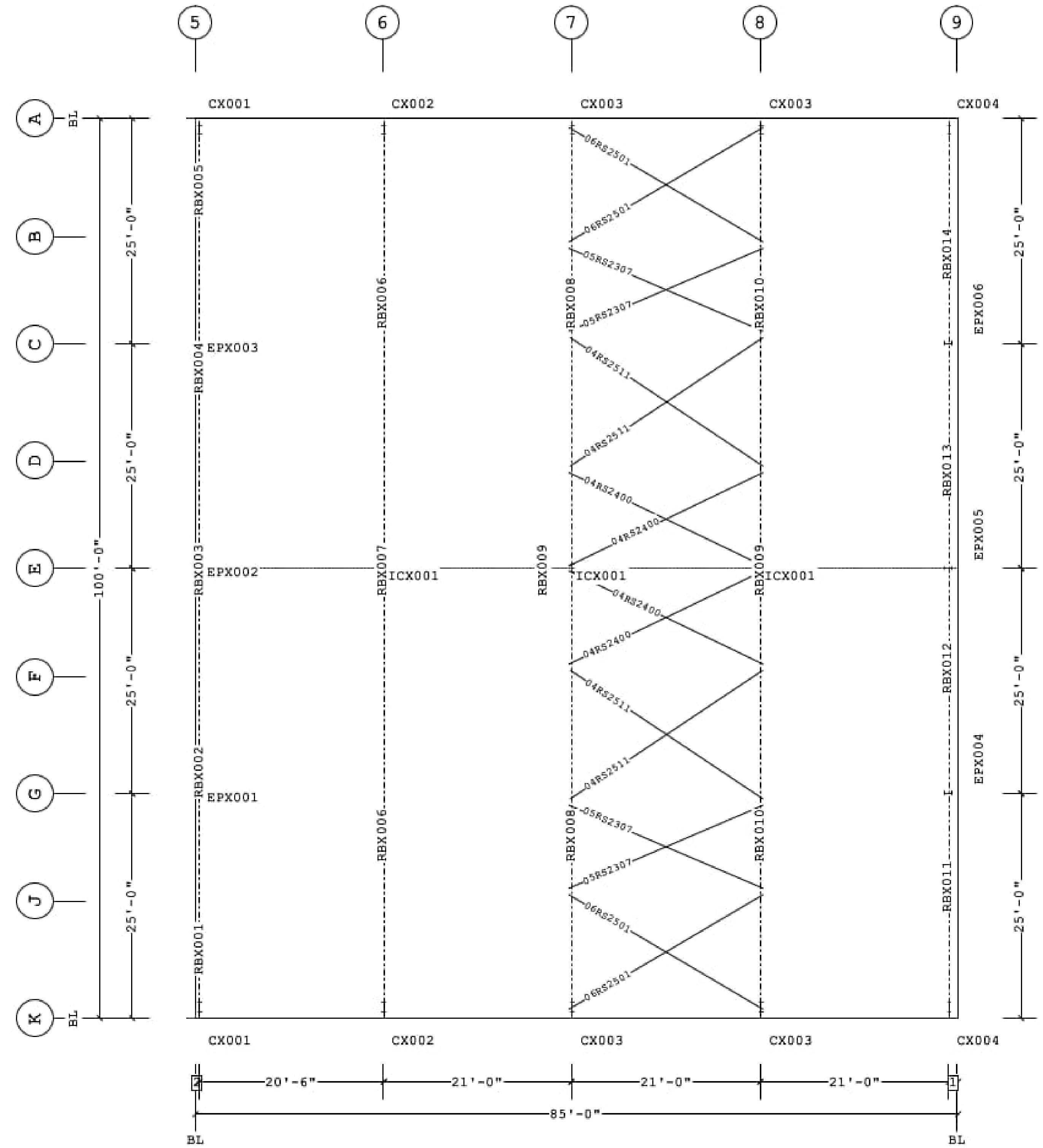
Bracing Part Schedule

Part	Qty	Length	Detail
04RS2400	4	24'-0"	BR01G2
04RS2511	4	25'-11"	BR01G2
05RS2307	4	23'-7"	BR01G2
06RS2501	4	25'-1"	BR01G2



2 6"
1 1'-0"
☐ Dimension Key

PRIMARY AND ROOF BRACING PLAN

Shape Name = Hardware Hank Store addition

FOR CONSTRUCTION

1. USE 1/2 X 1 1/2 A325T BOLT (49080) AND NUT (47120) W/O WASHERS. SNUG TIGHTEN BOLTS FOR ALL SECONDARY CONNECTIONS, SECONDARY CLIP CONNECTIONS, AND FLANGE BRACE CONNECTIONS, UNLESS NOTED OTHERWISE.
2. SLOT REINFORCEMENT PLATES NEED NOT BE LOCATED ON THE SAME SIDE OF THE WEB AS THE HILLSIDE WASHER.

THE BUTLER MFG. ENGINEER'S SEAL APPLIES ONLY TO THE WORK PRODUCT OF BUTLER MFG. AND DESIGN AND PERFORMANCE REQUIREMENTS SPECIFIED BY BUTLER. THE BUTLER MFG. ENGINEER'S SEAL DOES NOT APPLY TO THE PERFORMANCE OR DESIGN OF ANY OTHER PRODUCT OR COMPONENT FURNISHED BY BUTLER EXCEPT TO ANY DESIGN OR PERFORMANCE REQUIREMENTS SPECIFIED BY BUTLER.

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B
BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

PRIMARY AND ROOF BRACING PLAN

REV	DATE:	BY:	DESCRIPTION:

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDERS PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION: 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 6

VPC FILENAME: 21-010258-01
6/22/2021 13:16:45
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Frame Member Schedule

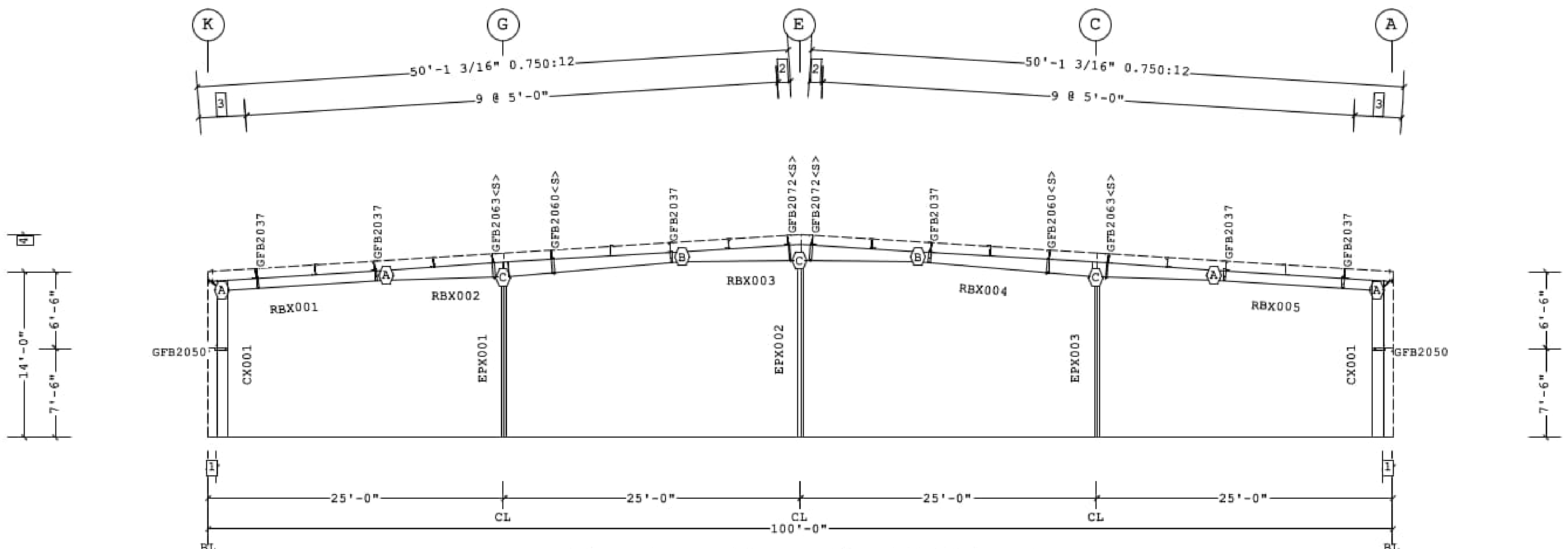
Part	Mem	Width	Thick	WebThk.	Depth1	Depth2	Approx.Lgth	Approx.Weight	Detail
CX001	1	5.0000	.1875	.1345	1'-0"	1'-0"	12'-5"	165#	
RBX001	2	5.0000	.1345	.1345	10"	10"	15'-0 7/16"	160#	
RBX002	3	5.0000	.1875	.1345	10"	1'-3"	25'-0 5/16"	334#	
	4	5.0000	.1875	.1345	1'-3"	10"			
RBX003	5	5.0000	.1875	.1345	10"	1'-4 7/16"	20'-0 1/8"	278#	
	6	5.0000	.1875	.1345	1'-4 7/16"	10"			
RBX004	7	5.0000	.1875	.1345	10"	1'-3"	25'-0 3/8"	334#	
	8	5.0000	.1875	.1345	1'-3"	10"			
RBX005	9	5.0000	.1345	.1345	10"	10"	15'-0 1/2"	160#	
CX001	10	5.0000	.1875	.1345	1'-0"	1'-0"	12'-5"	165#	
EPX001	11	5.0000	.1875	.1345	10"	10"	13'-5 15/16"	161#	BR25CA
EPX002	12	5.0000	.1345	.1345	10"	10"	14'-10 15/16"	150#	BR25CA
EPX003	13	5.0000	.1875	.1345	10"	10"	13'-5 15/16"	161#	BR25CA

Frame Clearances
Horiz. Clearance between members 1(CX001) and 10(CX001): 96'-7"
Vert. Clearance at member 1(CX001): 12'-5"
Vert. Clearance at member 10(CX001): 12'-5"
Vert. Clearance at member 11(EPX001): 13'-5 7/8"
Vert. Clearance at member 12(EPX002): 14'-10 15/16"
Vert. Clearance at member 13(EPX003): 13'-5 7/8"
Finished Floor Elevation = 100'-0" (Unless Noted Otherwise)

⬡Bolt Connection & Plate Schedule

Id	Qty	Grade	Bolt Dia.	Bolt Length	Plate Thick.	Rows Out	Rows In	PartNo
A	4	A325	3/4"	2 1/2"	3/8"	1	1	0097284
B	6	A325	3/4"	2 1/2"	3/8"	1	2	0097284
C	4	A325	1/2"	1 1/2"	3/8"	1	1	49080

<S> - (2) Washers (095872) req'd at Flange Brace to Secondary.



FRAME CROSS SECTION AT FRAME LINE(S) 5

4 17'-1 1/2" Ridge Ht.
3 4'-0 1/16"
2 1'-1 1/16"
1 8 1/2"
☐ Dimension Key

Shape Name = Hardware Hank Store addition Wall 4, Frame 1

FOR CONSTRUCTION

1. USE 1/2 X 1 1/2 A325T BOLT (49080) AND NUT (47120) W/O WASHERS. SNUG TIGHTEN BOLTS FOR ALL SECONDARY CONNECTIONS, SECONDARY CLIP CONNECTIONS, AND FLANGE BRACE CONNECTIONS, UNLESS NOTED OTHERWISE.
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BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

FRAME CROSS SECTION AT FRAME LINE(S) 5

REV	DATE:	BY:	DESCRIPTION:

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDERS PO#: [redacted]

Butler Manufacturing
VPC VERSION: 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 7

VPC FILENAME: 21-010258-01
6/22/2021 13:18:13
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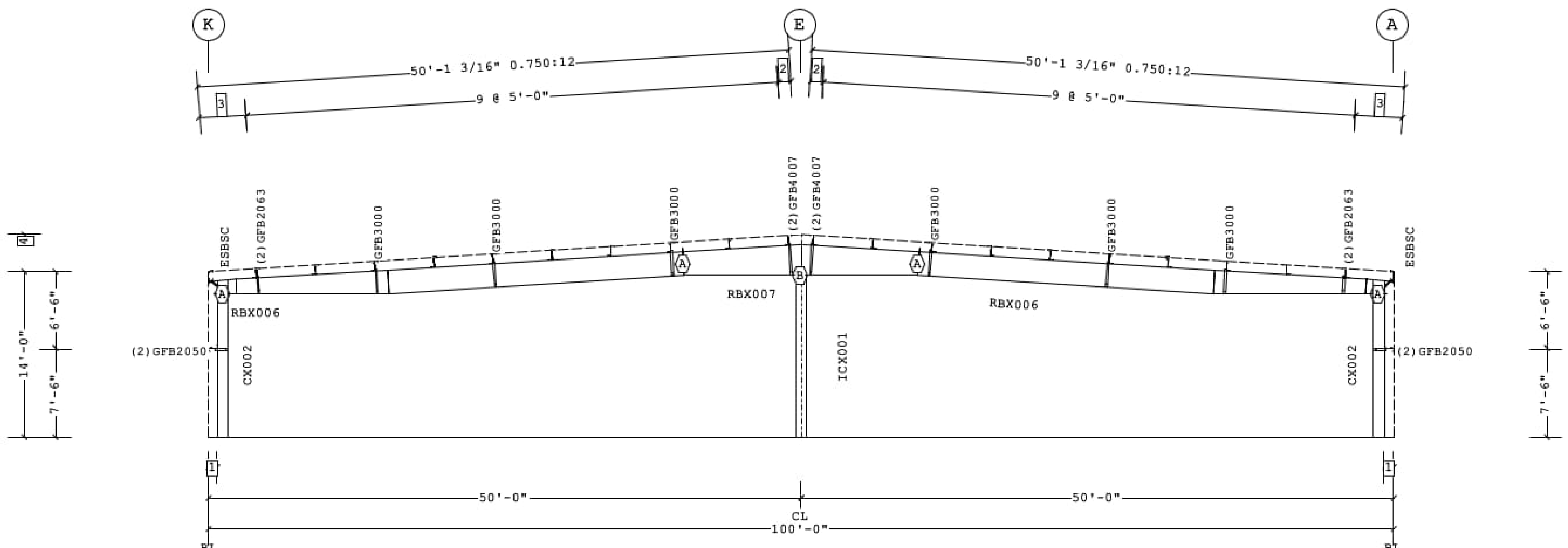
Frame Member Schedule

Part	Mem	Width	Thick	WebThk.	Depth1	Depth2	Approx.Lgth	Approx.Weight
CX002	1	5.0000	.3750	.1345	1'-0"	1'-0"	12'-1 3/16"	241#
RBX006	2	6.0000	.3750	.2500	1'-1 15/16"	1'-2 3/8"	40'-0 7/8"	1279#
	3	6.0000	.3750	.1644	1'-2 3/8"	2'-0"		
	4	6.0000	.5000	.1644	2'-0"	2'-0"		
RBX007	5	6.0000	.5000	.1644	2'-0"	2'-7 3/8"	20'-0"	768#
	6	6.0000	.5000	.1644	2'-7 3/8"	2'-0"		
RBX006	7	6.0000	.5000	.1644	2'-0"	2'-0"	40'-0 7/8"	1279#
	8	6.0000	.3750	.1644	2'-0"	1'-2 3/8"		
	9	6.0000	.3750	.2500	1'-2 3/8"	1'-1 15/16"		
CX002	10	5.0000	.3750	.1345	1'-0"	1'-0"	12'-1 3/16"	241#
ICX001	11	6.0000	.3750	.1345	10"	10"	13'-8 1/16"	285#

Frame Clearances
Horiz. Clearance between members 1(CX002) and 10(CX002): 96'-7"
Vert. Clearance at member 1(CX002): 12'-1 3/16"
Vert. Clearance at member 10(CX002): 12'-1 3/16"
Vert. Clearance at member 11(ICX001): 13'-8 1/16"
Finished Floor Elevation = 100'-0" (Unless Noted Otherwise)

Bolt Connection & Plate Schedule

Id	Qty	Grade	Bolt Dia.	Bolt Length	Plate Thick.	Rows Out	Rows In	PartNo
A	6	A325	3/4"	2 1/2"	1/2"	2	1	0097284
B	4	A325	1/2"	2"	3/8"	1	1	0097280



FRAME CROSS SECTION AT FRAME LINE(S) 6

4	17'-1 1/2" Ridge Ht.
3	4'-0 1/16"
2	1'-1 1/16"
1	8 1/2"

☐ Dimension Key

Shape Name = Hardware Hank Store addition Wall 4, Frame 2

FOR CONSTRUCTION

1. USE 1/2 X 1 1/2 A325T BOLT (49080) AND NUT (47120) W/O WASHERS. SNUG TIGHTEN BOLTS FOR ALL SECONDARY CONNECTIONS, SECONDARY CLIP CONNECTIONS, AND FLANGE BRACE CONNECTIONS, UNLESS NOTED OTHERWISE.
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B — BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

FRAME CROSS SECTION AT FRAME LINE(S) 6

REV:	DATE:	BY:	DESCRIPTION:

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION: 2021.1d
a division of BlueScope Buildings North America, Inc.

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 8

VPC FILENAME: 21-010258-01

6/25/2021 9:40:06

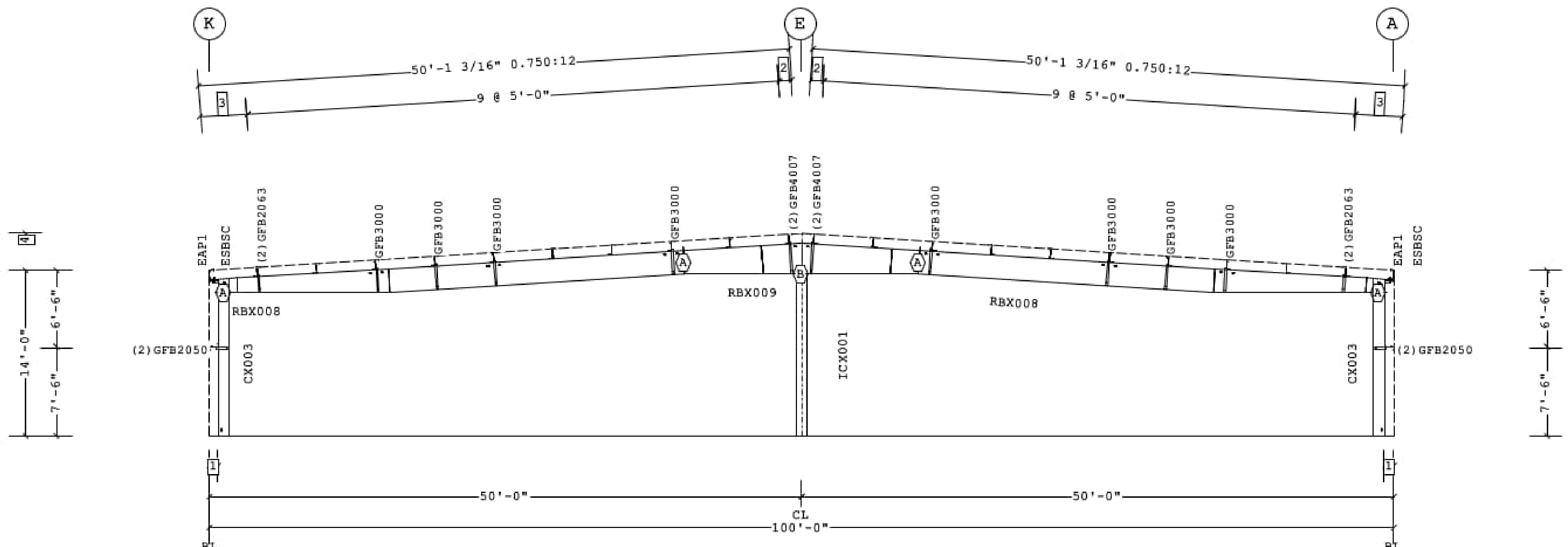
Frame Member Schedule

Part	Mem	Width	Thick	WebThk.	Depth1	Depth2	Approx.Lgth	Approx.Weight
CX003	1	5.0000	.3750	.1345	1'-0"	1'-0"	12'-1 3/16"	241#
RBX008	2	6.0000	.3750	.2500	1'-1 15/16"	1'-2 3/8"	40'-0 7/8"	1278#
	3	6.0000	.3750	.1644	1'-2 3/8"	2'-0"		
	4	6.0000	.5000	.1644	2'-0"	2'-0"		
RBX009	5	6.0000	.5000	.1644	2'-0"	2'-7 3/8"	20'-0"	785#
	6	6.0000	.5000	.1644	2'-7 3/8"	2'-0"		
RBX008	7	6.0000	.5000	.1644	2'-0"	2'-0"	40'-0 7/8"	1278#
	8	6.0000	.3750	.1644	2'-0"	1'-2 3/8"		
	9	6.0000	.3750	.2500	1'-2 3/8"	1'-1 15/16"		
CX003	10	5.0000	.3750	.1345	1'-0"	1'-0"	12'-1 3/16"	241#
ICX001	11	6.0000	.3750	.1345	10"	10"	13'-8 1/16"	285#

Frame Clearances
Horiz. Clearance between members 1(CX003) and 10(CX003): 96'-7"
Vert. Clearance at member 1(CX003): 12'-1 3/16"
Vert. Clearance at member 10(CX003): 12'-1 3/16"
Vert. Clearance at member 11(ICX001): 13'-8 1/16"
Finished Floor Elevation = 100'-0" (Unless Noted Otherwise)

Bolt Connection & Plate Schedule

Id	Qty	Grade	Bolt Dia.	Bolt Length	Plate Thick.	Rows Out	Rows In	PartNo
A	6	A325	3/4"	2 1/2"	1/2"	2	1	0097284
B	4	A325	1/2"	2"	3/8"	1	1	0097280



FRAME CROSS SECTION AT FRAME LINE(S) 7

4 17'-1 1/2" Ridge Ht.
3 4'-0 1/16"
2 1'-1 1/16"
1 8 1/2"
Dimension Key

Shape Name = Hardware Hank Store addition Wall 4, Frame 3

FOR CONSTRUCTION

1. USE 1/2 X 1 1/2 A325T BOLT (49080) AND NUT (47120) W/O WASHERS. SNUG TIGHTEN BOLTS FOR ALL SECONDARY CONNECTIONS, SECONDARY CLIP CONNECTIONS, AND FLANGE BRACE CONNECTIONS, UNLESS NOTED OTHERWISE.
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B
BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

FRAME CROSS SECTION AT FRAME LINE(S) 7

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

Butler Manufacturing
VPC VERSION 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 9

VPC FILENAME: 21-010258-01
6/22/2021 13:19:10
a division of BlueScope Buildings North America, Inc.

Frame Member Schedule

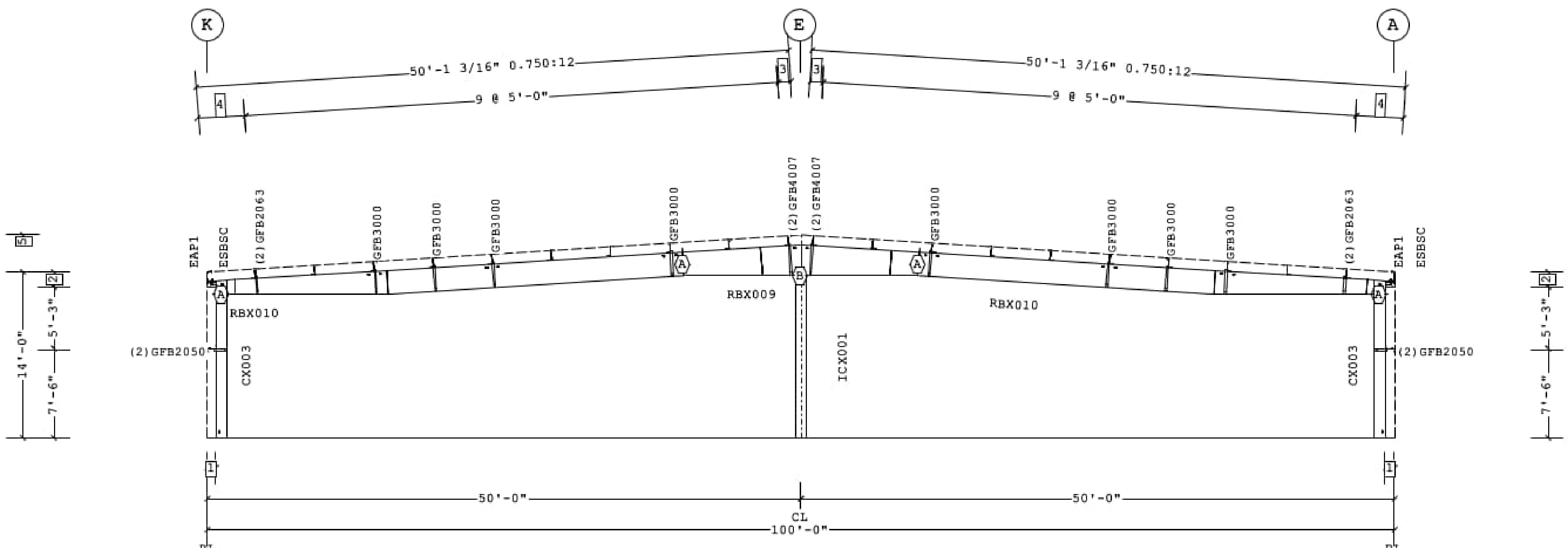
Part	Mem	Width	Thick	WebThk.	Depth1	Depth2	Approx.Lgth	Approx.Weight
CX003	1	5.0000	.3750	.1345	1'-0"	1'-0"	12'-1 3/16"	241#
RBX010	2	6.0000	.3750	.2500	1'-1 15/16"	1'-2 3/8"	40'-0 7/8"	1279#
	3	6.0000	.3750	.1644	1'-2 3/8"	2'-0"		
	4	6.0000	.5000	.1644	2'-0"	2'-0"		
RBX009	5	6.0000	.5000	.1644	2'-0"	2'-7 3/8"	20'-0"	785#
	6	6.0000	.5000	.1644	2'-7 3/8"	2'-0"		
RBX010	7	6.0000	.5000	.1644	2'-0"	2'-0"	40'-0 7/8"	1279#
	8	6.0000	.3750	.1644	2'-0"	1'-2 3/8"		
	9	6.0000	.3750	.2500	1'-2 3/8"	1'-1 15/16"		
CX003	10	5.0000	.3750	.1345	1'-0"	1'-0"	12'-1 3/16"	241#
ICX001	11	6.0000	.3750	.1345	10"	10"	13'-8 1/16"	285#

Frame Clearances

Horiz. Clearance between members 1(CX003) and 10(CX003): 96'-7"
Vert. Clearance at member 1(CX003): 12'-1 3/16"
Vert. Clearance at member 10(CX003): 12'-1 3/16"
Vert. Clearance at member 11(ICX001): 13'-8 1/16"
Finished Floor Elevation = 100'-0" (Unless Noted Otherwise)

Bolt Connection & Plate Schedule

Id	Qty	Grade	Bolt Dia.	Bolt Length	Plate Thick.	Rows Out	Rows In	PartNo
A	6	A325	3/4"	2 1/2"	1/2"	2	1	0097284
B	4	A325	1/2"	2"	3/8"	1	1	0097280



FRAME CROSS SECTION AT FRAME LINE(S) 8

5	17'-1 1/2" Ridge Ht.
4	4'-0 1/16"
3	1'-1 1/16"
2	1'-3"
1	8 1/2"

☐ Dimension Key

Shape Name = Hardware Hank Store addition Wall 4, Frame 4

FOR CONSTRUCTION

1. USE 1/2 X 1 1/2 A325T BOLT (49080) AND NUT (47120) W/O WASHERS. SNUG TIGHTEN BOLTS FOR ALL SECONDARY CONNECTIONS, SECONDARY CLIP CONNECTIONS, AND FLANGE BRACE CONNECTIONS, UNLESS NOTED OTHERWISE.
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B

BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

FRAME CROSS SECTION AT FRAME LINE(S) 8

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 10

VPC FILENAME: 21-010258-01
6/22/2021 13:19:21
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Frame Member Schedule

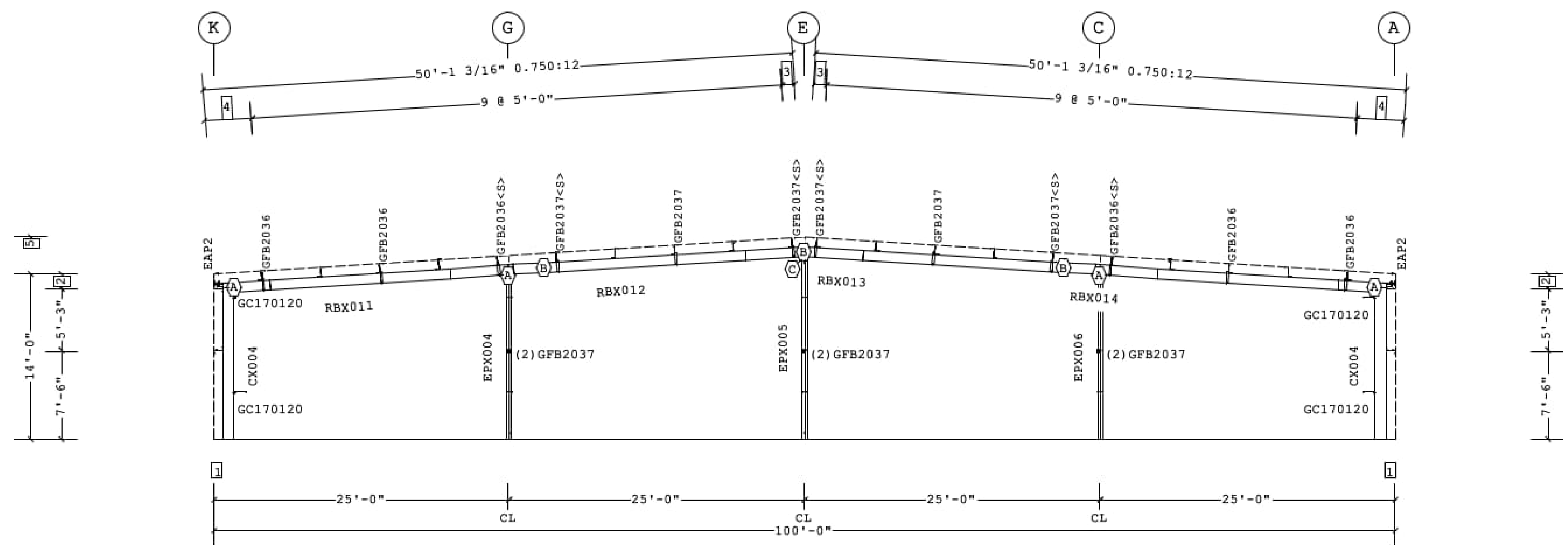
Part	Mem	Width	Thick	WebThk.	Depth1	Depth2	Approx.Lgth	Approx.Weight	Detail
CX004	1	5.0000	.3750	.1345	1'-0"	1'-0"	13'-3 3/16"	265#	
RBX011	2-5	5.0000	.3750	.1345	10"	10"	26'-4 5/8"	482#	
RBX012	6-7	5.0000	.1875	.1345	10"	10"	22'-0 9/16"	271#	
RBX013	8-9	5.0000	.1875	.1345	10"	10"	22'-0 7/16"	270#	
RBX014	10-13	5.0000	.3750	.1345	10"	10"	26'-4 3/4"	482#	
CX004	14	5.0000	.3750	.1345	1'-0"	1'-0"	13'-3 3/16"	265#	
EPX004	15	5.0000	.1345	.1345	10"	10"	13'-10 7/8"	146#	BR25CA
EPX005	16	5.0000	.1345	.1345	10"	10"	15'-5 7/16"	156#	BR25CA
EPX006	17	5.0000	.1345	.1345	10"	10"	13'-10 7/8"	146#	BR25CA

Frame Clearances
Horiz. Clearance between members 1(CX004) and 14(CX004): 96'-7"
Vert. Clearance at member 1(CX004): 12'-4 3/4"
Vert. Clearance at member 14(CX004): 12'-4 3/4"
Vert. Clearance at member 15(EPX004): 13'-10 11/16"
Vert. Clearance at member 16(EPX005): 15'-5 7/16"
Vert. Clearance at member 17(EPX006): 13'-10 11/16"
Finished Floor Elevation = 100'-0" (Unless Noted Otherwise)

Bolt Connection & Plate Schedule

Id	Qty	Grade	Bolt Dia.	Bolt Length	Plate Thick.	Rows Out	Rows In	Washer	PartNo
A	4	A325	1/2"	1 1/2"	3/8"	1	1		49080
B	6	A325	1/2"	1 1/2"	3/8"	2	1		49080
C	4	A325	1/2"	1 1/2"	3/8"	1	1	Yes	49080

<S> - (2) Washers (095872) req'd at Flange Brace to Secondary.



FRAME CROSS SECTION AT FRAME LINE(S) 9

5 17'-1 1/2" Ridge Ht.
4 4'-0 1/16"
3 1'-1 1/16"
2 1'-3"
1 8 1/2"
Dimension Key

Shape Name = Hardware Hank Store addition Wall 4, Frame 5

FOR CONSTRUCTION

1. USE 1/2 X 1 1/2 A325T BOLT (49080) AND NUT (47120) W/O WASHERS. SNUG TIGHTEN BOLTS FOR ALL SECONDARY CONNECTIONS, SECONDARY CLIP CONNECTIONS, AND FLANGE BRACE CONNECTIONS, UNLESS NOTED OTHERWISE.
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B
BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

FRAME CROSS SECTION AT FRAME LINE(S) 9

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 11

VPC FILENAME: 21-010258-01 6/22/2021 13:19:46
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Secondary Part Schedule

Mark	Part	Thick.	Depth	Lap	Detail
E1	10E2011414BDB31	0.0790	10"		RS12PH,RS12PA,RS12PJ
E2	10E2011414DDB31	0.0790	10"		RS12PA,RS12PE,RS12PJ
E3	10E2111414ADB31	0.0790	10"		RS12PF,RS12PE,RS12PJ
P1	10Z2411412B5A3	0.0980	10"	3'-10 1/2"	RS02T1,RS01U1
P2	10Z241141633B2	0.0680	10"	1'-10 1/2"	RS01U1
P3	10Z2511412A5B3	0.0980	10"	3'-10 1/2"	RS02T1,RS01U1

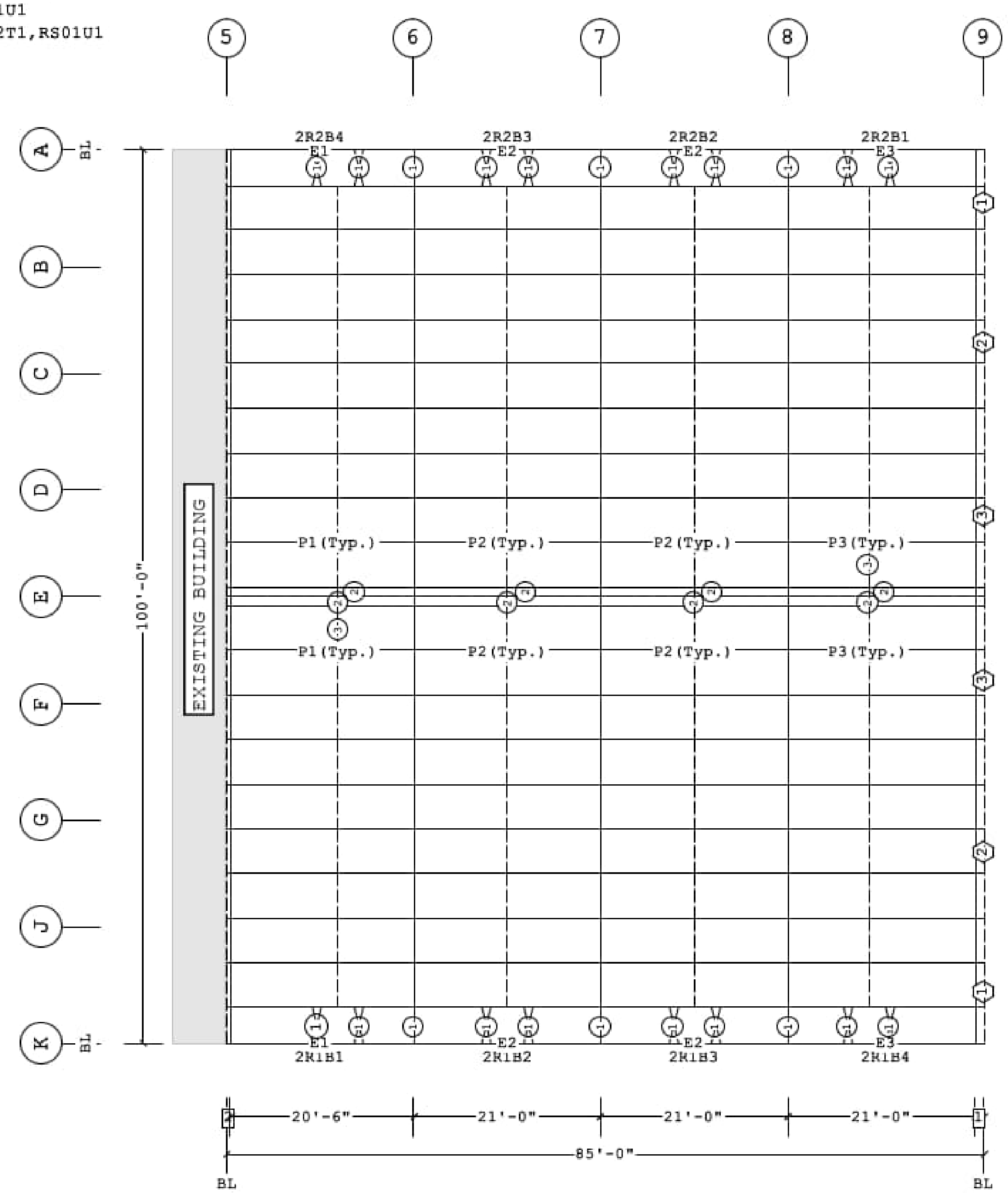
Part Mark Key

1	001SGA11055
2	001SGA19114
3	001SGA18065

Secondary Bracing Schedule

Id	Qty	Mark No	Spacing
1	38	PBA0404	4'-0 1/16"
2	8	CPBRA010512	1'-1 1/16"
3	72	CPBB050108(Typ.)	5'-0"

See SED:
BR09K5, BR09JG, BR09RY, BR09RZ, BR09PK
BR09PH, BR09JH, BR09K2



Dimension Key

2	6"
1	1'-0"

ROOF SECONDARY PLAN

Shape Name = Hardware Hank Store addition

FOR CONSTRUCTION

1. UNLESS NOTED, USE 1/2 X 1 1/2 A325T BOLT (49080) AND NUT (47120) W/O WASHERS. SNUG TIGHTEN BOLTS FOR ALL SECONDARY CONNECTIONS.
2. FLANGE BRACES ARE AN INTEGRAL PART OF THE STABILITY OF THE STRUCTURAL SYSTEM AND MUST BE PROPERLY INSTALLED PRIOR TO ERECTION OF WALL AND ROOF SHEETS.
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B

BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV	DATE:	BY:	DESCRIPTION

DRAWING SCALE: NTS

ROOF SECONDARY PLAN

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION: 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 13

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6/22/2021 13:21:33
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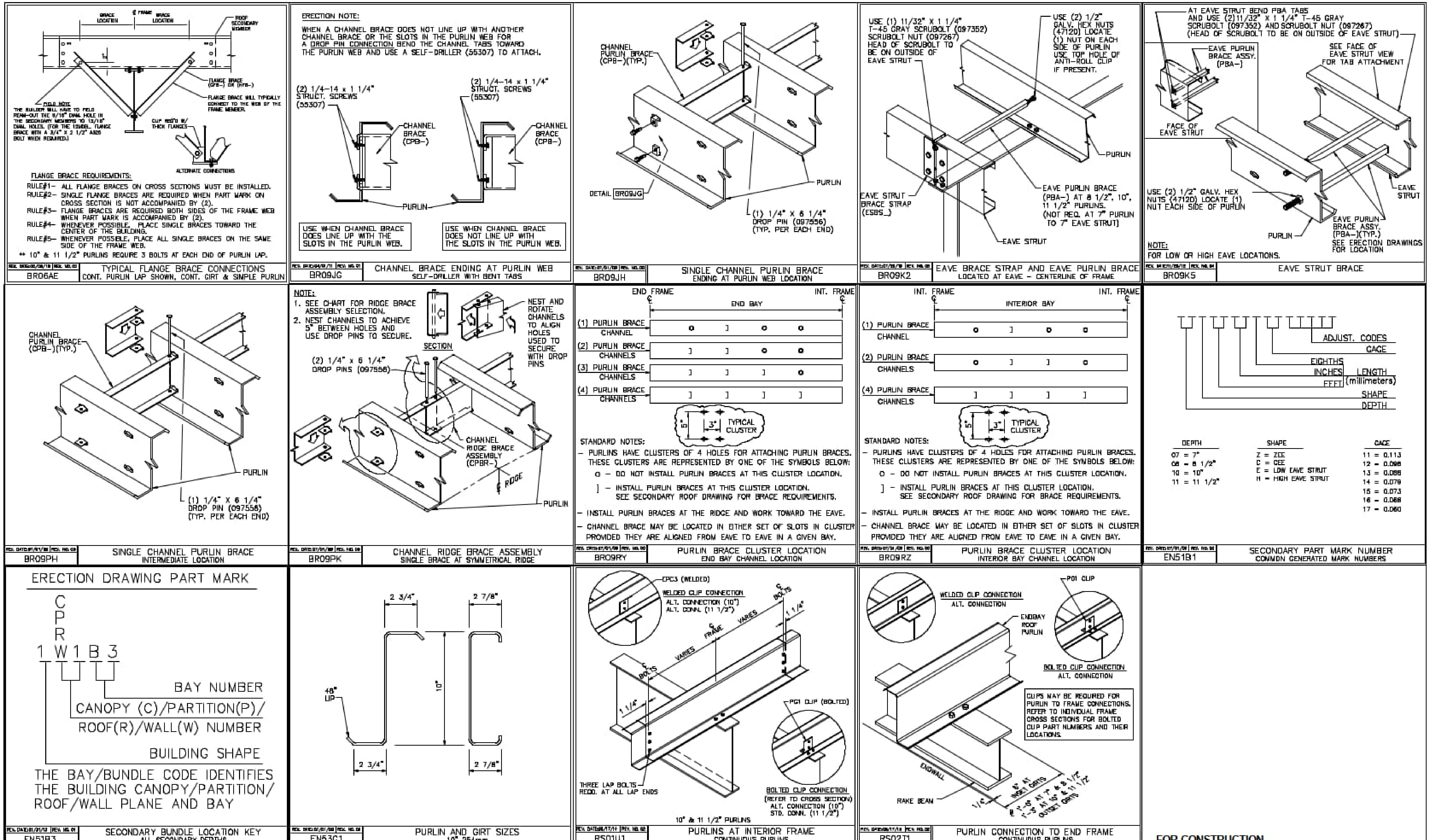

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B

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

ROOF SECONDARY SED'S

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S P.O#: [redacted]

BUTLER
Butler Manufacturing

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
VPC VERSION: 2021.1d
PAGE: 14

VPC FILENAME: 21-010258-01 5/19/2021 SEC/Sheet 14:32:00

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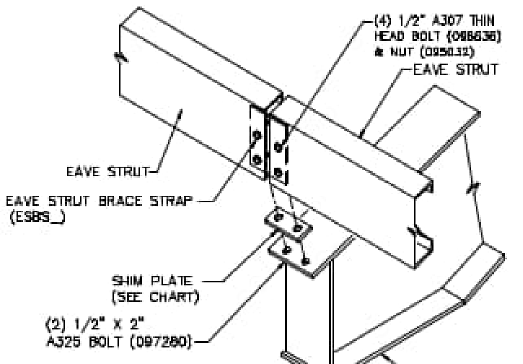
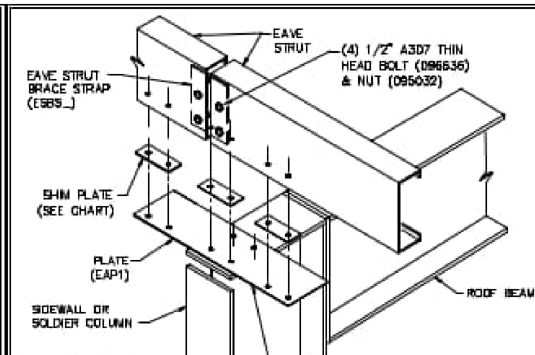


SHIM PLATE	
ROOF PITCH RANGE	PART NUMBER
.25 TO 1.99	N/A
2.0 TO 2.49	ESH1
2.5 TO 3.49	ESH3
3.5 TO 4.00	ESH3

RS12PA — EAVE STRUT CONNECTION AT INTERIOR FRAME



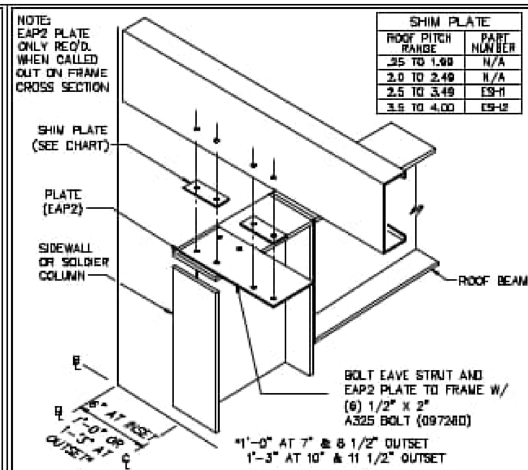
SHIM PLATE	
ROOF PITCH RANGE	PART NUMBER
.25 TO 1.99	N/A
2.0 TO 2.49	N/A
2.5 TO 3.49	ESH1
3.5 TO 4.00	ESH2

LOW EAVE STRUT SHOWN – HIGH EAVE STRUT USES SIMILAR PARTS.

RS12PE — EAVE STRUT W/ ATTACHMENT PLATE INTERIOR FRAME

NOTE: EAP2 PLATE ONLY REQ'D. WHEN CALLED OUT ON FRAME CROSS SECTION

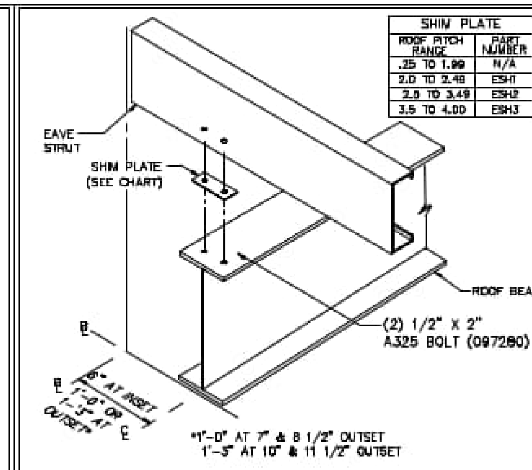
SHIM PLATE	
ROOF PITCH RANGE	PART NUMBER
.25 TO 1.99	N/A
2.0 TO 2.49	N/A
2.5 TO 3.49	ESH1
3.5 TO 4.00	ESH2



LOW EAVE STRUT SHOWN – HIGH EAVE STRUT USES SIMILAR PARTS.

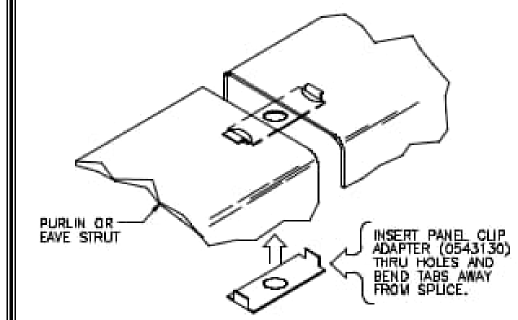
RS12PF — EAVE STRUT W/ ATTACHMENT PLATE END FRAME

SHIM PLATE	
ROOF PITCH RANGE	PART NUMBER
.25 TO 1.99	N/A
2.0 TO 2.49	ESH1
2.5 TO 3.49	ESH2
3.5 TO 4.00	ESH3



LOW EAVE STRUT SHOWN – HIGH EAVE STRUT SIMILAR

RS12PH — EAVE STRUT CONNECTION AT END FRAME



PANEL CLIP ADAPTER

USE A PANEL CLIP ADAPTER AT THE ENDS OF PURLINS OR EAVE STRUTS WHERE A PANEL CLIP OR PANEL EAVE ATTACHMENT MUST BE MADE.

RS12PJ — PANEL CLIP AT EAVE STRUT LOCATED WHERE STRUT STOPS BUT CONNECTION REQUIRED

FOR CONSTRUCTION

1. UNLESS NOTED, USE 1/2 X 1 1/2 A325T BOLT (49080) AND NUT (47120) W/O WASHERS. SNUG TIGHTEN BOLTS FOR ALL SECONDARY CONNECTIONS.
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B

BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

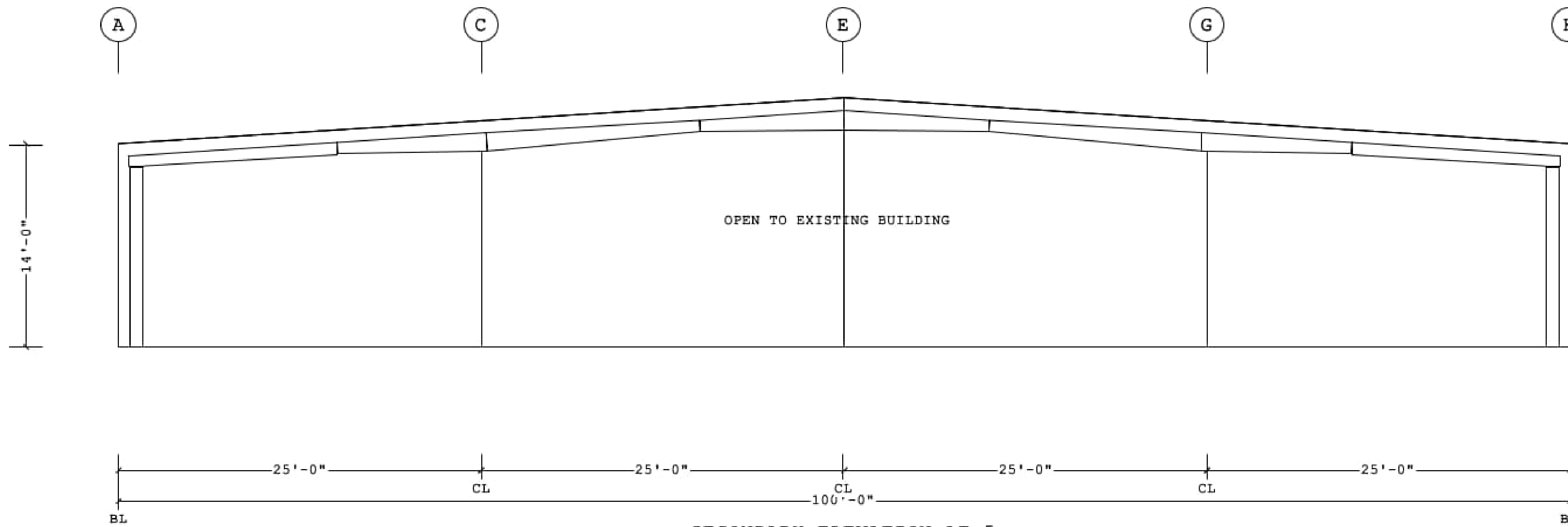
ROOF SECONDARY SED'S

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDERS PO#: [redacted]
VPC VERSION: 2021.1d

BUTLER
Butler Manufacturing
a division of BlueScope Buildings North America, Inc.

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 15

VPC FILENAME: 21-010258-01
5/19/2021 SEDSheet 14:32:02



SECONDARY ELEVATION AT 5

Shape Name = Hardware Hank Store addition, Wall = 1

FOR CONSTRUCTION

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BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

SECONDARY ELEVATION AT 5

REV:	DATE:	BY:	DESCRIPTION:

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

Butler Manufacturing
VPC VERSION: 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 16

VPC FILENAME: 21-010258-01

5/19/2021 14:32:04

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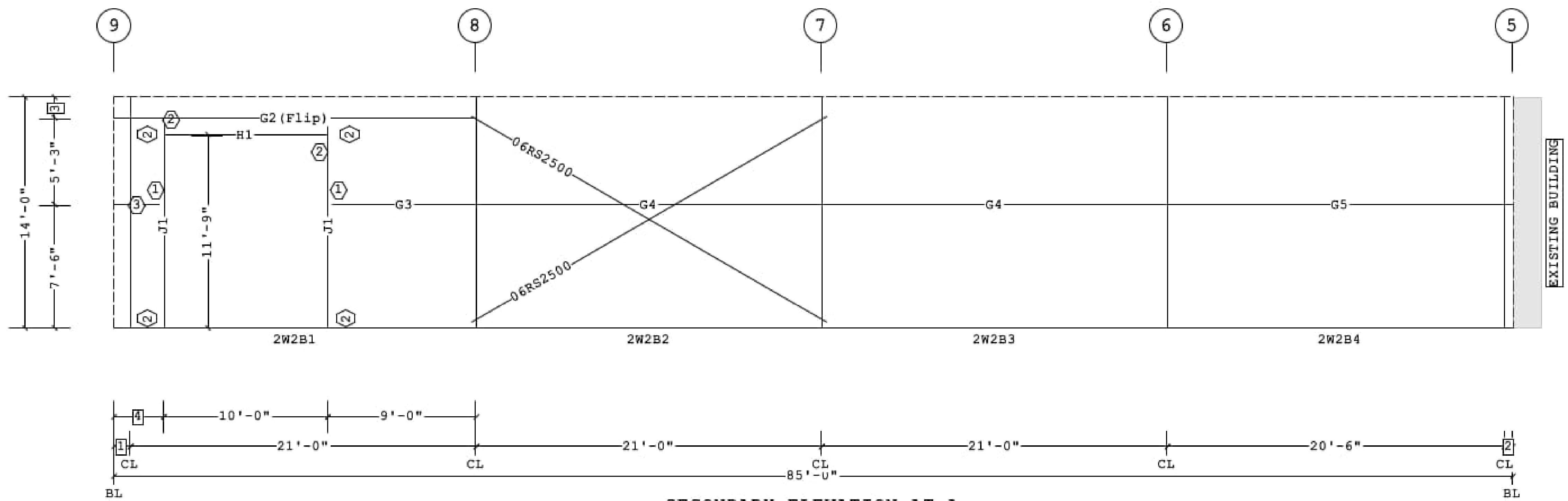
Secondary Part Schedule

Mark	Part	Thick.	Depth	Detail
G1	00108ZS020841700	0.0600	8 1/2"	WS12A2,WS20F2
G2(Flip)	08Z2111417AD00	0.0600	8 1/2"	WS12H6,WS01G2
G3	08Z0808417DG00	0.0600	8 1/2"	WS01G2,WS20F2
G4	08Z2011414DD00	0.0790	8 1/2"	WS01G2
G5	08Z2011414BD00	0.0790	8 1/2"	WS01G2,WS12H6
H1	00108JS1000017	0.0600	8 1/2"	WS20F9
J1	00208JS1205217	0.0600	8 1/2"	WS20F9,WS20F2,WS20B2,WS20B8

Bracing Part Schedule

Part	Qty	Length	Detail
06RS2500	2	25'-0"	BR01G2

NOTE:
EACH JAMB OF THE 10' X 11'-9" OHD DOOR WAS DESIGNED TO SUPPORT 300 LBS OF DOOR WEIGHT



SECONDARY ELEVATION AT A

Dimension Key		Part Mark Key	
4	3'-0"		
3	1'-3"	3	G1
2	6"	2	PG1
1	1'-0"	1	JTG1

Shape Name = Hardware Hank Store addition, Wall = 2

FOR CONSTRUCTION

1. UNLESS NOTED, USE 1/2 X 1 1/2 A325T BOLT (49080) AND NUT (47120) W/O WASHERS. SNUG TIGHTEN BOLTS FOR ALL SECONDARY CONNECTIONS.
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B — BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV:	DATE:	BY:	DESCRIPTION:

DRAWING SCALE: NTS

SECONDARY ELEVATION AT A

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION: 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 17

VPC FILENAME: 21-010258-01
6/22/2021 13:28:05
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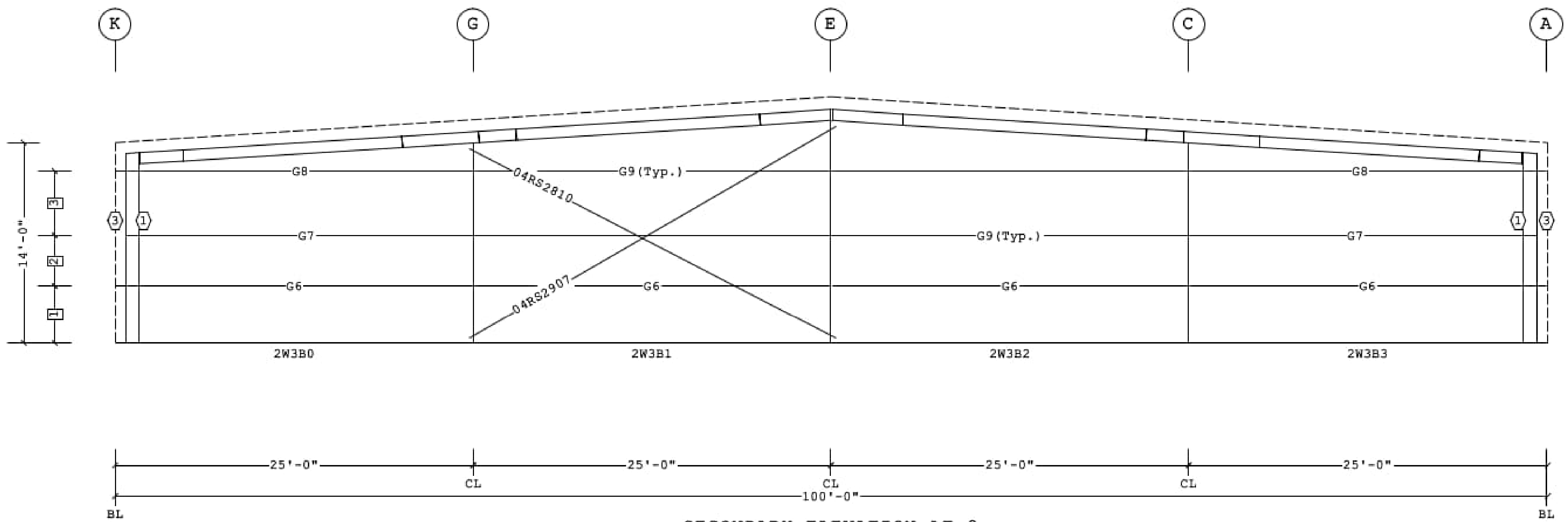
Secondary Part Schedule

Mark	Part	Thick.	Depth	Lap	Detail
G6	08Z2411416DD00	0.0680	8 1/2"		WS01G2,WS12H5
G7	08Z2502417Q100	0.0600	8 1/2"	10 1/2"	WS12A2,WS01G3
G8	08Z2511417D100	0.0600	8 1/2"	10 1/2"	WS01G3,WS12H5
G9	08Z26114171100	0.0600	8 1/2"	10 1/2"	WS01G3

Bracing Part Schedule

Part	Qty	Length	Detail
04RS2907	1	29'-7"	BR01G2
04RS2810	1	28'-10"	BR01G2



SECONDARY ELEVATION AT 9

3	4'-6"
2	3'-6"
1	4'-0"

Dimension Key

3	GFA106
1	VCC07003090

Part Mark Key

Shape Name = Hardware Hank Store addition, Wall = 3

FOR CONSTRUCTION

1. UNLESS NOTED, USE 1/2 X 1 1/2 A325T BOLT (49080) AND NUT (47120) W/O WASHERS. SNUG TIGHTEN BOLTS FOR ALL SECONDARY CONNECTIONS.
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B

BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

SECONDARY ELEVATION AT 9

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 18

VPC FILENAME: 21-010258-01

6/22/2021 13:30:22

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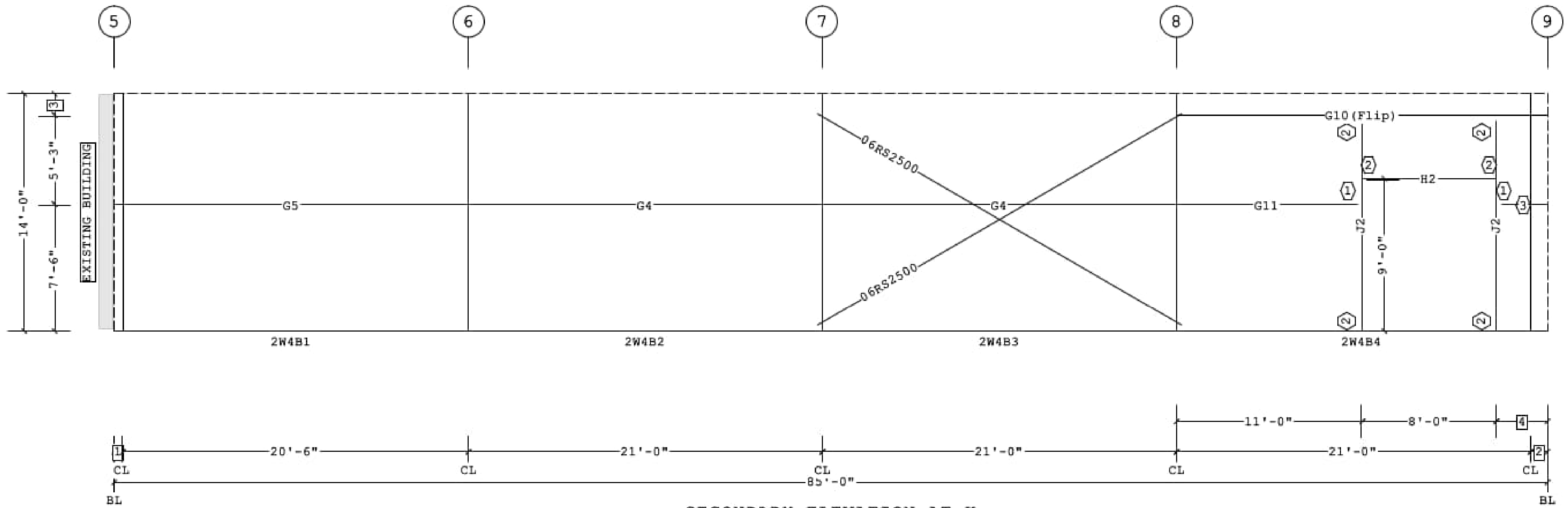
Secondary Part Schedule

Mark	Part	Thick.	Depth	Detail
G1	00108ZS020841700	0.0600	8 1/2"	WS12A2,WS20F2
G4	08Z2011414DD00	0.0790	8 1/2"	WS01G2
G5	08Z2011414BD00	0.0790	8 1/2"	WS12H6,WS01G2
G10(Flip)	08Z2111416AD00	0.0680	8 1/2"	WS12H6,WS01G2
G11	08Z1008417DG00	0.0600	8 1/2"	WS20F2,WS01G2
H2	00408JS0800017	0.0600	8 1/2"	WS20F9
J2	00308JS1205217	0.0600	8 1/2"	WS20F9,WS20F2,WS20B2,WS20B8

Bracing Part Schedule

Part	Qty	Length	Detail
06RS2500	2	25'-0"	BR01G2

NOTE:
EACH JAMB OF THE 8' X 9' OHD DOOR WAS DESIGNED TO SUPPORT 180 LBS OF DOOR WEIGHT



SECONDARY ELEVATION AT K

4	3'-0"
3	1'-3"
2	1'-0"
1	6"

Dimension Key

3	G1
2	PG1
1	JTG1

Part Mark Key

Shape Name = Hardware Hank Store addition, Wall = 4

FOR CONSTRUCTION

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B — BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

SECONDARY ELEVATION AT K

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION: 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 19

VPC FILENAME: 21-010258-01
6/22/2021 13:31:21
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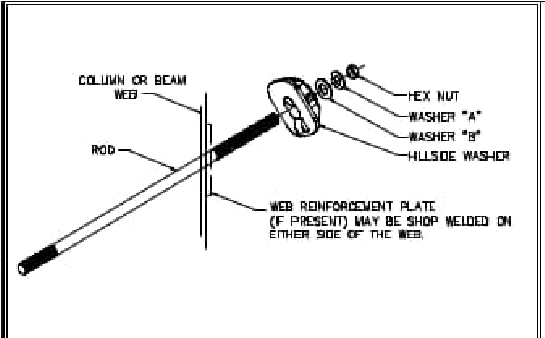
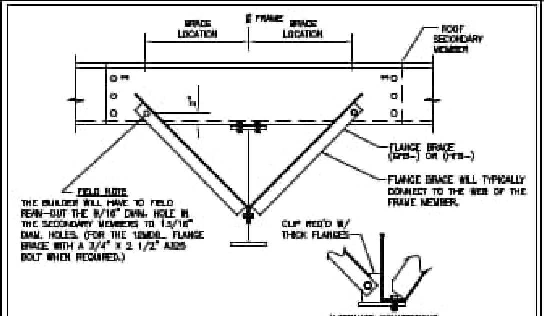


DESCRIPTION/PART NO				
ROD DIAM	NUT	HARD STEEL ROUND WASHER A	HARD STEEL WASHER B	HILLSIDE WASHER
3/8"	95321	3/8" FLAT WASHER (94408)	1/2" BEVEL SQUARE WASHER (46049)	543334
1/2"	98230	1/2" FLAT WASHER (90672)	3/4" FLAT ROUND WASHER (95846)	
5/8"	98233	5/8" FLAT WASHER (95045)		
3/4"	98238	3/4" FLAT WASHER (95846)	1" FLAT ROUND WASHER (95848)	543335
7/8"	93237	7/8" FLAT WASHER (95847)		
1"	93238	1" FLAT WASHER (95848)	1 1/8" FLAT ROUND WASHER (90848)	543338
1 1/8"	95239	1 1/8" FLAT WASHER (95848)		

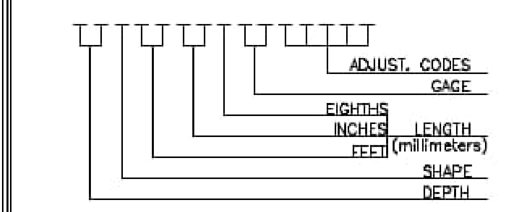
BR01C2 — ROD BRACE — WEB SLOT ASSEMBLY



FLANGE BRACE REQUIREMENTS:

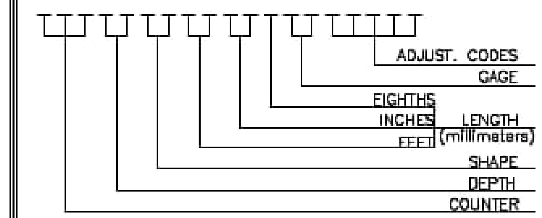
RULE#1– ALL FLANGE BRACES ON CROSS SECTIONS MUST BE INSTALLED.
RULE#2– SINGLE FLANGE BRACES ARE REQUIRED WHEN PART MARK ON CROSS SECTION IS NOT ACCOMPANIED BY (2).
RULE#3– FLANGE BRACES ARE REQUIRED BOTH SIDES OF THE FRAME WEB WHEN PART MARK IS ACCOMPANIED BY (2).
RULE#4– WHENEVER POSSIBLE, PLACE SINGLE BRACES TOWARD THE CENTER OF THE BUILDING.
RULE#5– WHENEVER POSSIBLE, PLACE ALL SINGLE BRACES ON THE SAME SIDE OF THE FRAME WEB.
** 10" & 11 1/2" PURLINS REQUIRE 3 BOLTS AT EACH END OF PURLIN LAP.

BR06AE — TYPICAL FLANGE BRACE CONNECTIONS — CONT. PURLIN LAP SHOWN, CONT. GIRT & SIMPLE PURLIN



DEPTH	SHAPE	GAGE
07 = 7"	Z = ZEE	11 = 0.113
08 = 8 1/2"	C = CEE	12 = 0.098
10 = 10"	E = LOW EAVE STRUT	13 = 0.088
11 = 11 1/2"	H = HIGH EAVE STRUT	14 = 0.079
		15 = 0.073
		16 = 0.068
		17 = 0.060

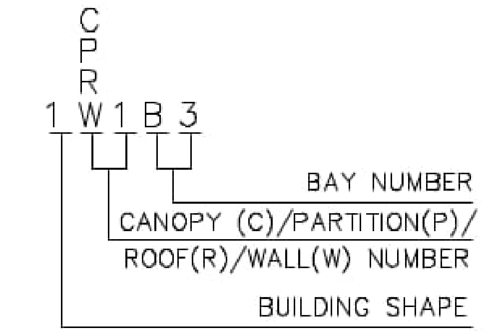
EN51B1 — SECONDARY PART MARK NUMBER — COMMON GENERATED MARK NUMBERS



DEPTH	SHAPE	GAGE
07 = 7"	ZS = ZEE	11 = 0.113
08 = 8 1/2"	CS = CEE	12 = 0.098
10 = 10"	ES = LOW EAVE STRUT	13 = 0.088
11 = 11 1/2"	HS = HIGH EAVE STRUT	14 = 0.079
	BB = BACK TO BACK CEE	15 = 0.073
	FB = FACE TO BACK CEE	16 = 0.068
	FF = FACE TO FACE CEE	17 = 0.060

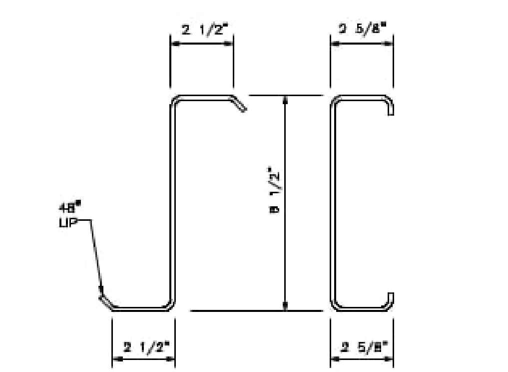
EN51B2 — SPECIAL SECONDARY PART MARK KEY — COMMON GENERATED MARK NUMBERS

ERECTION DRAWING PART MARK

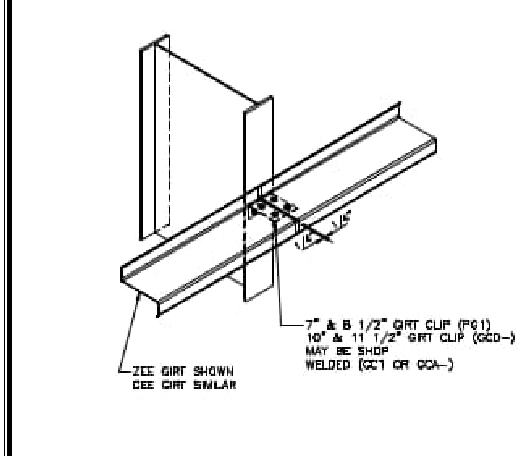


THE BAY/BUNDLE CODE IDENTIFIES THE BUILDING CANOPY/PARTITION/ ROOF/WALL PLANE AND BAY

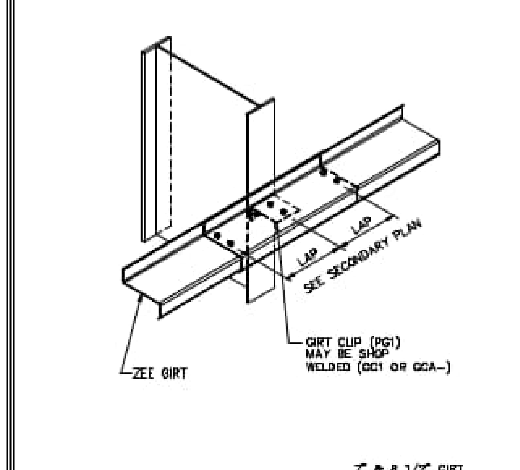
EN51B3 — SECONDARY BUNDLE LOCATION KEY — ALL SECONDARY DEPTHS



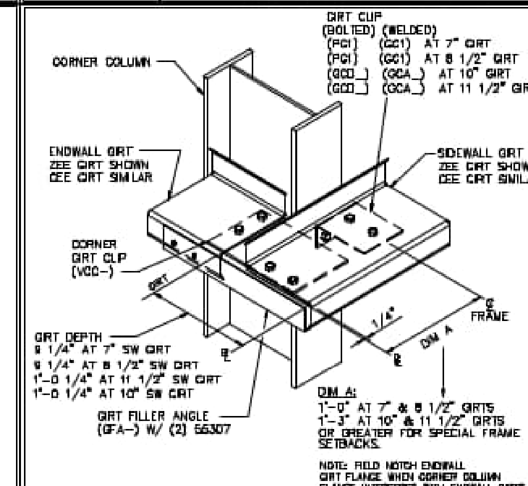
EN53F1 — PURLIN AND GIRT SIZES — 8 1/2" 216mm



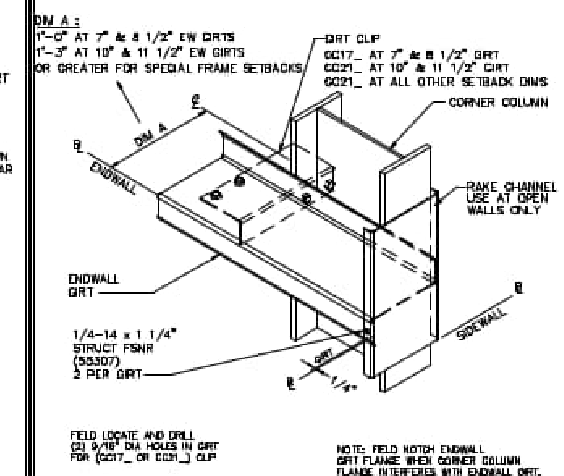
WS01G2 — GIRT CONN. AT COLUMN — OUTSET SIMPLE GIRTS



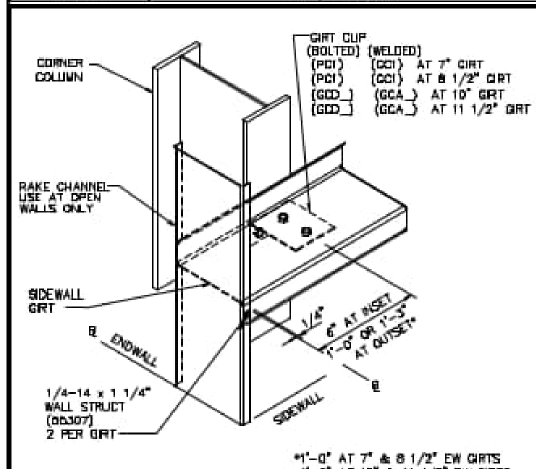
WS01C3 — GIRT CONN. AT COLUMN — OUTSET CONTINUOUS GIRT



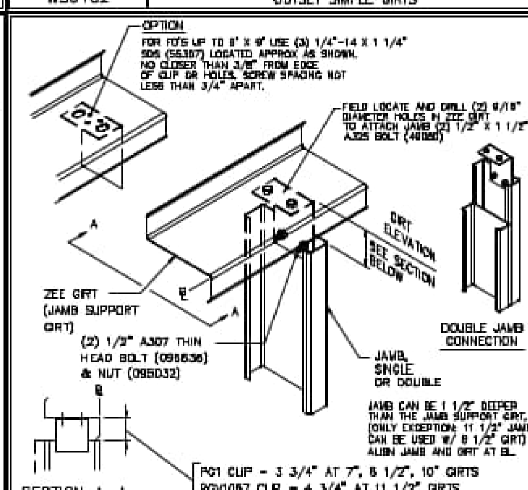
WS12A2 — GIRT CONN. AT CORNER COLUMN — ANY OUTSET GIRT AT EW, ANY GIRT AT SW



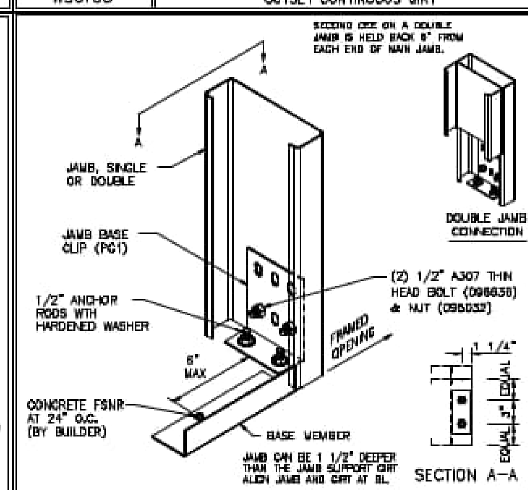
WS12H5 — GIRT CONN. AT CORNER COLUMN — ANY OUTSET GIRT AT EW, NO SW GIRT



WS12H6 — GIRT CONN. AT CORNER COLUMN — NO EW GIRT, ANY OUTSET GIRT AT SW

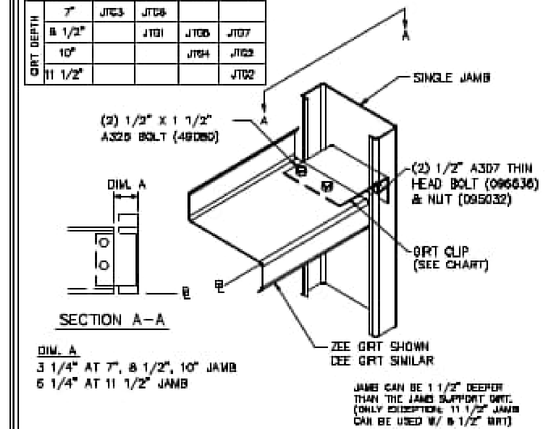


WS20B2 — JAMB TO GIRT — SINGLE OR DOUBLE JAMB, ANY ZEE GIRT



WS20B8 — JAMB BASE ATTACHMENT — SINGLE OR DOUBLE JAMB

GIRT TO JAMB CLIP		JAMB DEPTH 7"	8 1/2"	10"	11 1/2"
GIRT DEPTH	7"	JTC3	JTC8		
	8 1/2"		JTC1	JTC6	JTC7
	10"			JTC4	JTC5
	11 1/2"				JTC2



WS20F2 — GIRT TO JAMB — SINGLE JAMB

FOR CONSTRUCTION

1. UNLESS NOTED, USE 1/2 X 1 1/2 A325T BOLT (49080) AND NUT (47120) W/O WASHERS. SNUG TIGHTEN BOLTS FOR ALL SECONDARY CONNECTIONS.
2. FLANGE BRACES ARE AN INTEGRAL PART OF THE STABILITY OF THE STRUCTURAL SYSTEM AND MUST BE PROPERLY INSTALLED PRIOR TO ERECTION OF WALL AND ROOF SHEETS.
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BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

WALL SECONDARY SED'S

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER — Butler Manufacturing — VPC VERSION 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 20

VPC FILENAME: 21-010258-01
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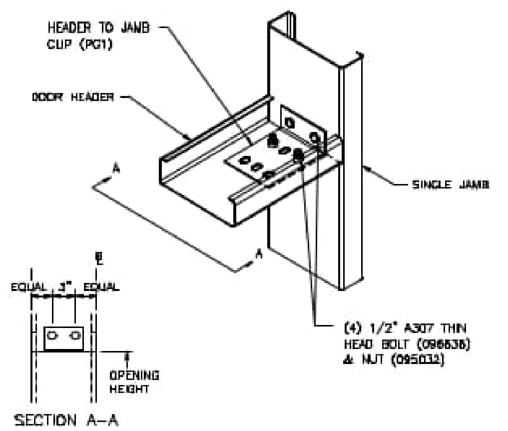

WS20F9

HEADER TO JAMB
ANY HEADER, ANY SINGLE JAMB

FOR CONSTRUCTION

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B

BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

WALL SECONDARY SED'S

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

Butler Manufacturing
VPC VERSION: 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 21

VPC FILENAME: 21-010258-01

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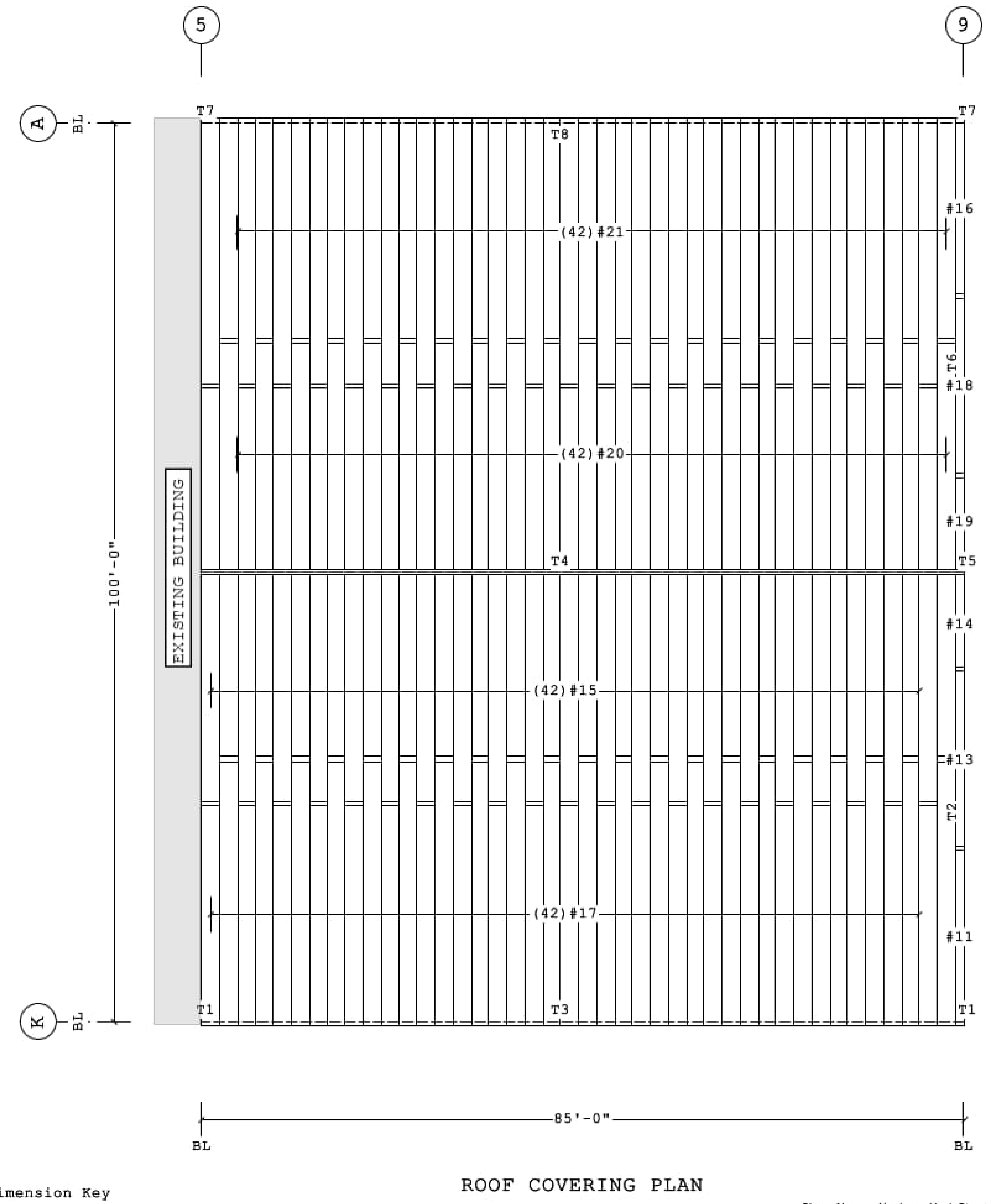

ROOF COVERING PLAN

Trim Schedule

Id	Parts	Color	Details
T1	0630043	Cool Solar White	
T2	(2.5)MRGT20L,(4.2)SHCL12,(4.9)WA10A	Cool Solar White	KV403,PV167
T3	(8)CLE12C,(3.5)GTR25,(8)SHCL12	Cool Solar White	MV252,NV110,NV116
T4	(4.3)RC20	Plain AlZn	ENB004,NV667
T5	0560173,MRRET,RBT2,TC1,(0.1)WA10A	Cool Solar White	
T6	(2.5)MRGT20R,(4.2)SHCL12,(4.9)WA10A	Cool Solar White	KV404,PV167
T7	0630043	Cool Solar White	
T8	(8)CLE12C,(3.5)GTR25,(8)SHCL12	Cool Solar White	MV252,NV110,NV116

Covering Schedule

Id	Qty	Start Length	Qty	Stagger Length	Type	Gage	OP	Fin.	Color	Direction
#13	1	20'-6"			MR12	24	86	Z	AZ	Right to Left
#14	1	10'-9 3/8"			MR12	24	87	Z	AZ	Right to Left
#11	1	20'-0 1/8"			MR12	24	89	Z	AZ	Right to Left
#17	21	30'-0 1/8"	21	25'-0 1/8"	MR24	24	13	Z	AZ	Right to Left
#15	21	20'-9 3/8"	21	25'-9 3/8"	MR24	24	11	Z	AZ	Right to Left
#20	21	20'-9 3/8"	21	25'-9 3/8"	MR24	24	11	Z	AZ	Right to Left
#21	21	30'-0 1/8"	21	25'-0 1/8"	MR24	24	13	Z	AZ	Right to Left
#18	1	20'-6"			MR12	24	86	Z	AZ	Right to Left
#19	1	10'-9 3/8"			MR12	24	87	Z	AZ	Right to Left
#16	1	20'-0 1/8"			MR12	24	89	Z	AZ	Right to Left

Oper. Code:86=SQ,NT
Oper. Code:87=SQ,SQ
Oper. Code:89=SQ,NT
Oper. Code:13=SQ,NT
Oper. Code:11=SQ,SQ
Finish:Z=AlZn
Color:AZ=Plain AlZn

Covering Mark Schedule

Id	Qty	Start Panel	Qty	Stagger/Last Panel	Direction
#13	1	MR12200602486ZAZ			Right to Left
#14	1	MR12100932487ZAZ			Right to Left
#11	1	MR12200012489ZAZ			Right to Left
#17	21	MR24300012413ZAZ	21	MR24250012413ZAZ	Right to Left
#15	21	MR24200932411ZAZ	21	MR24250932411ZAZ	Right to Left
#20	21	MR24200932411ZAZ	21	MR24250932411ZAZ	Right to Left
#21	21	MR24300012413ZAZ	21	MR24250012413ZAZ	Right to Left
#18	1	MR12200602486ZAZ			Right to Left
#19	1	MR12100932487ZAZ			Right to Left
#16	1	MR12200012489ZAZ			Right to Left

Planograph Schedule

Id	Details
T1	P-080572,P-081236,P-103223,P-104542,P-104714
T2	P-081167,P-081183,P-GAI
T3	P-081189,P-103223,P-104714
T4	P-080573,P-080575,P-080578,P-080949,P-ZRSLO
T5	P-081167,P-081243,P-GAI
T6	P-081167,P-081183,P-GAI
T7	P-080572,P-081236,P-103223,P-104542,P-104714
T8	P-081189,P-103223,P-104714

NOTE:
-BUILDIG ATTACHMENT VIA TRIM ONLY
-TRANSITION TRIMS TO EXISTING TO BE PROVIDED BY BUILDER

Shape Name = Hardware Hank Store addition

FOR CONSTRUCTION

1. PRE-DRILLING 1/8 DIAMETER HOLES FOR STRUCTURAL FASTENERS MAY BE REQUIRED FOR HEAVY GAGE NESTED ZEE's AND/OR FASTENERS TO STRUCTURAL BEAMS
2. STEEL PANELS ARE AN INTEGRAL PART OF THE STRUCTURAL SYSTEM. REMOVAL OR ALTERATION WITHOUT PRIOR AUTHORIZATION IS PROHIBITED.
3. DUE TO MANUFACTURING LIMITATIONS SHORT PANELS MAY REQUIRE FIELD CUTTING, SEE THE COVERING SCHEDULE FOR CUT LENGTHS.
4. SEE JOB DETAILS FOR COVERING AND TRIM FASTENER SPECIFICATION.

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B

BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV.	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

ROOF COVERING PLAN

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 22

VPC FILENAME: 21-010258-01

6/22/2021 18:23:42

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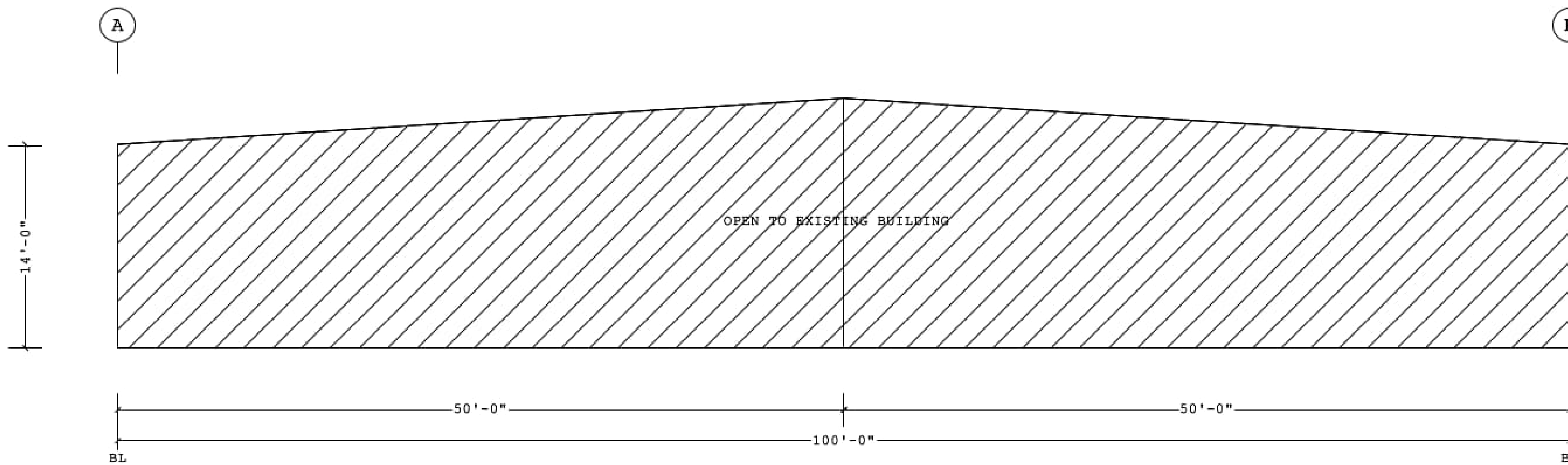

COVERING ELEVATION AT 5

Shape Name = Hardware Hank Store addition, Wall = 1

FOR CONSTRUCTION

1. PRE-DRILLING 1/8 DIAMETER HOLES FOR STRUCTURAL FASTENERS MAY BE REQUIRED FOR HEAVY GAGE NESTED ZEE's AND/OR FASTENERS TO STRUCTURAL BEAMS
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B BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

COVERING ELEVATION AT 5

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION: 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 23

VPC FILENAME: 21-010258-01
5/19/2021 14:32:14
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Covering Mark Schedule

Id	Qty	Start Panel	Direction	Start Dim.
#1	24	SHU14002263KSY	Left to Right	0'-0",12'-0",80'-0"
#2	3	SHU02023263KSY	Left to Right	3'-0"
#3	2	SHU14002263KSW	Left to Right	74'-0"

Covering Schedule

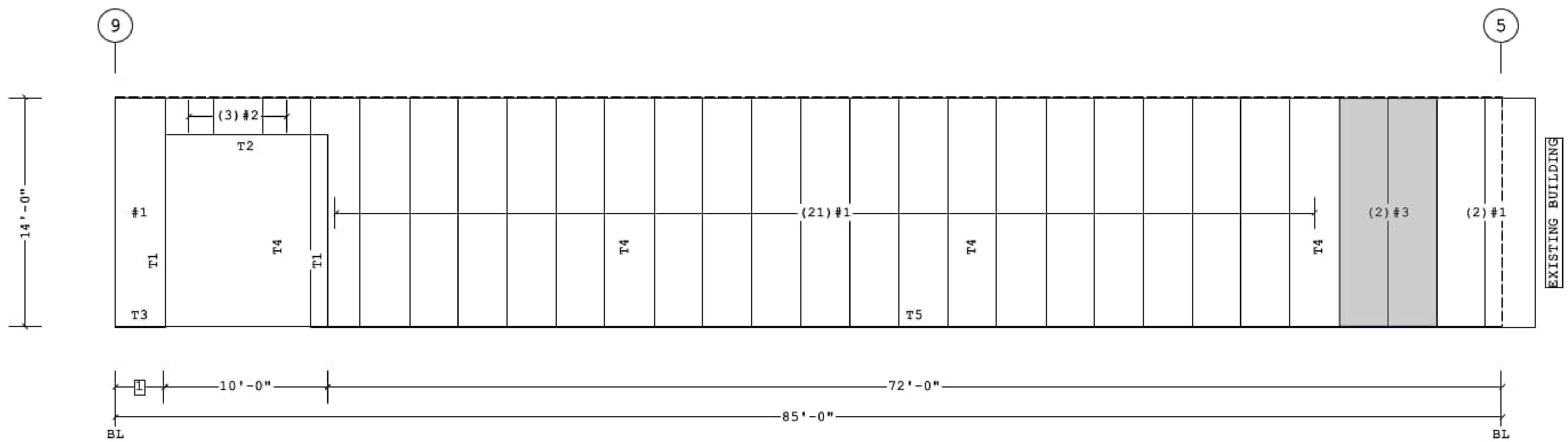
Id	Qty	Type	Start Length	Gage	OP	Fin.	Color	Direction
#1	24	SHU	14'-0 1/4"	26	3	K	SY	Left to Right
#2	3	SHU	2'-2 3/8"	26	3	K	SY	Left to Right
#3	2	SHU	14'-0 1/4"	26	3	K	SW	Left to Right

Oper. Code:3=SQ,SQ
Finish:K=Butler-Cote
Color:SY=Cool Shell Gray
Color:SW=Cool Solar White

Trim Schedule

Id	Parts	Color	Details
T1	OHDTS12	Cool Shell Gray	WCB033
T2	DGS12	Cool Shell Gray	NV125,NV566
T3	(0.2)BG2415,(0.2)BT12A	Cool Shell Gray	ENB006,GV386,GV443,NV115, NV120,NV128,NV664,WCB082, WCB083,WCB084,WCB086
T4	0640492,4CE75,(1.5)CP410	Cool Solar White	KV851
T5	(4.8)BG2415,(6)BT12A	Cool Shell Gray	ENB006,GV386,GV443,NV115, NV120,NV128,NV664,WCB082, WCB083,WCB084,WCB086

NOTE:
-Panels Cool Solar White to be field located per Builder requirement.
-Transition trims to be provided by the Builder



1 3'-0"
Dimension Key

COVERING ELEVATION AT A

Planograph Schedule

Id	Details
T1	P-081201,P-090120
T2	P-081203
T3	P-081180,P-081189,P-081505
T4	P-105224,P-105225,P-105228
T5	P-081180,P-081189,P-081505

Fastener Schedule

Part	Color	Description
0097364-112	Cool Shell Gray	(T-1) 1/4-14 x 3/4", T-30 Torx Hd w/Washer Panel to Panel
0097365-112	Cool Shell Gray	(T-3) #12-14 x 1 1/4", T-30 Torx Hd w/Washer Panel to Structural

Shape Name = Hardware Hank Store addition, Wall = 2

FOR CONSTRUCTION

1. PRE-DRILLING 1/8 DIAMETER HOLES FOR STRUCTURAL FASTENERS MAY BE REQUIRED FOR HEAVY GAGE NESTED ZEE's AND/OR FASTENERS TO STRUCTURAL BEAMS
2. STEEL PANELS ARE AN INTEGRAL PART OF THE STRUCTURAL SYSTEM. REMOVAL OR ALTERATION WITHOUT PRIOR AUTHORIZATION IS PROHIBITED.
3. DUE TO MANUFACTURING LIMITATIONS SHORT PANELS MAY REQUIRE FIELD CUTTING, SEE THE COVERING SCHEDULE FOR CUT LENGTHS.
4. SEE JOB DETAILS FOR COVERING AND TRIM FASTENER SPECIFICATION.

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B

BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

REV.	DATE:	BY:	DESCRIPTION

DRAWING SCALE: NTS

COVERING ELEVATION AT A

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER
Butler Manufacturing
VPC VERSION: 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 24

VPC FILENAME: 21-010258-01
6/25/2021 12:16:33
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Covering Mark Schedule

Id	Qty	Start Panel	Last Panel	Increment	Direction	Start Dim.
#4	2	SHU14004263KSY	SHU14026263KSY	2 1/4"	Left to Right	0'-0"
#5	13	SHU14094263KSY	SHU17004263KSY	2 1/4"	Left to Right	12'-0"
#6	17	SHU16110263KSY	SHU13110263KSY	-2 1/4"	Left to Right	51'-0"
#7	2	SHU14050263KSW	SHU14072263KSW	2 1/4"	Left to Right	6'-0"

Trim Schedule

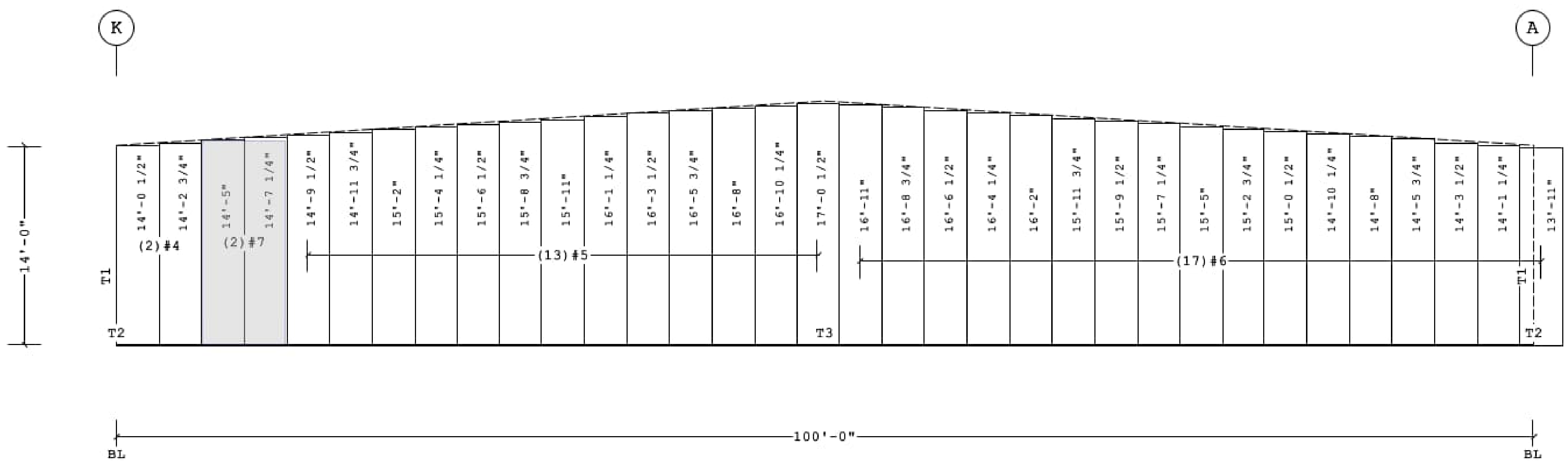
Id	Parts	Color	Details
T1	(2.5)0620163,(2)SHOCT12	Cool Solar White	NV118
T2	CTB2L,CTB2R	Cool Shell Gray	ENB006,NV664
T3	(6.7)BG2415,(8.3)BT12A	Cool Shell Gray	ENB006,GV386,GV443,NV115,NV120,NV128,NV664,WCB082,WCB083,WCB084,WCB086

Covering Schedule

Id	Qty	Type	Start Length	Gage	OP	Fin.	Color	Increment	Direction
#4	2	SHU	14'-0 1/2"	26	3	K	SY	2 1/4"	Left to Right
#5	13	SHU	14'-9 1/2"	26	3	K	SY	2 1/4"	Left to Right
#6	17	SHU	16'-11"	26	3	K	SY	-2 1/4"	Left to Right
#7	2	SHU	14'-5"	26	3	K	SW	2 1/4"	Left to Right

Oper. Code:3=SQ,SQ
Finish:K=Butler-Cote
Color:SY=Cool Shell Gray
Color:SW=Cool Solar White

NOTE:
Panels Cool Solar White to be field located per Builder requirement.



COVERING ELEVATION AT 9

Planograph Schedule

Id	Details
T1	P-081180,P-081185
T2	P-081180,P-081505
T3	P-081180,P-081189,P-081505

Fastener Schedule

Part	Color	Description
0097364-112	Cool Shell Gray	(T-1) 1/4-14 x 3/4", T-30 Torx Hd w/Washer Panel to Panel
0097365-112	Cool Shell Gray	(T-3) #12-14 x 1 1/4", T-30 Torx Hd w/Washer Panel to Structural

Shape Name = Hardware Hank Store addition, Wall = 3

FOR CONSTRUCTION

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3. DUE TO MANUFACTURING LIMITATIONS SHORT PANELS MAY REQUIRE FIELD CUTTING, SEE THE COVERING SCHEDULE FOR CUT LENGTHS.
4. SEE JOB DETAILS FOR COVERING AND TRIM FASTENER SPECIFICATION.

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B
BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

COVERING ELEVATION AT 9

REV:	DATE:	BY:	DESCRIPTION:

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

Butler Manufacturing
VPC VERSION: 2021.1d

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 25

VPC FILENAME: 21-010258-01
6/22/2021 18:11:25
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Covering Mark Schedule

Id	Qty	Start Panel	Direction	Start Dim.
#8	25	SHU14002263KSY	Left to Right	0'-0",12'-0",81'-0"
#9	2	SHU04113263KSY	Left to Right	75'-0"
#10	2	SHU14002263KSW	Left to Right	6'-0"

Covering Schedule

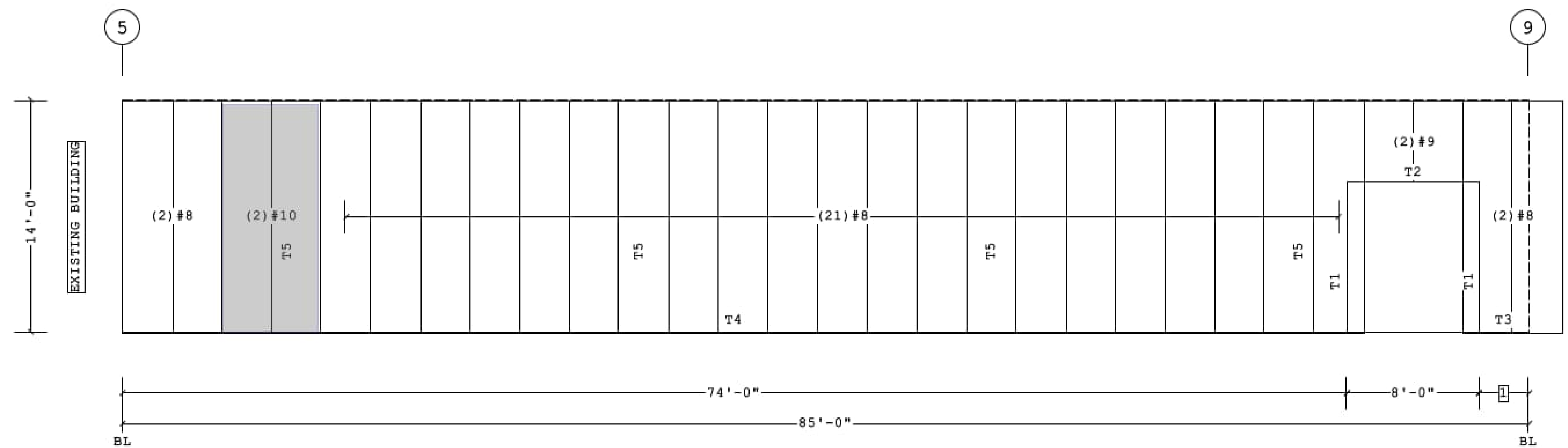
Id	Qty	Type	Start Length	Gage	OP	Fin.	Color	Direction
#8	25	SHU	14'-0 1/4"	26	3	K	SY	Left to Right
#9	2	SHU	4'-11 3/8"	26	3	K	SY	Left to Right
#10	2	SHU	14'-0 1/4"	26	3	K	SW	Left to Right

Oper. Code:3=SQ,SQ
Finish:K=Butler-Cote
Color:SY=Cool Shell Gray
Color:SW=Cool Solar White

Trim Schedule

Id	Parts	Color	Details
T1	(0.7)OHDTS12	Cool Shell Gray	WCB033
T2	DGS12	Cool Shell Gray	NV125,NV566
T3	(0.2)BG2415,(0.2)BT12A	Cool Shell Gray	ENB006,GV386,GV443,NV115, NV120,NV128,NV664,WCB082, WCB083,WCB084,WCB086
T4	(4.9)BG2415,(6.2)BT12A	Cool Shell Gray	ENB006,GV386,GV443,NV115, NV120,NV128,NV664,WCB082, WCB083,WCB084,WCB086
T5	0640492,4CE75,(1.5)CP410	Cool Solar White	KV851

NOTE:
-Panels Cool Solar White to be field located per Builder requirement.
-Transition trims to be provided by the Builder



1 3'-0"
Dimension Key

COVERING ELEVATION AT K

Planograph Schedule

Id	Details
T1	P-081201,P-090120
T2	P-081203
T3	P-081180,P-081189,P-081505
T4	P-081180,P-081189,P-081505
T5	P-105224,P-105225,P-105228

Fastener Schedule

Part	Color	Description
0097364-112	Cool Shell Gray	(T-1) 1/4-14 x 3/4", T-30 Torx Hd w/Washer Panel to Panel
0097365-112	Cool Shell Gray	(T-3) #12-14 x 1 1/4", T-30 Torx Hd w/Washer Panel to Structural

Shape Name = Hardware Hank Store addition, Wall = 4

FOR CONSTRUCTION

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BUTLER MANUFACTURING
1540 GENESSEE ST. KANSAS CITY, MO 64102

COVERING ELEVATION AT K

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

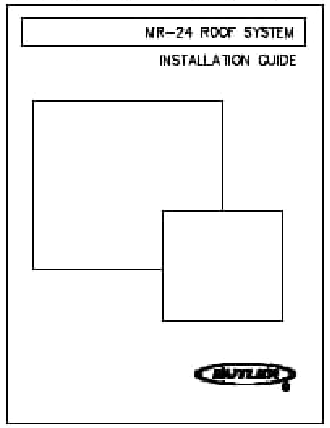
BUTLER
Butler Manufacturing
VPC VERSION: 2021.1d
a division of BlueScope Buildings North America, Inc.

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
PAGE: 26

VPC FILENAME: 21-010258-01
6/25/2021 12:18:51

ROOF PANEL ERECTION GUIDE REQUIRED FOR THIS PROJECT:

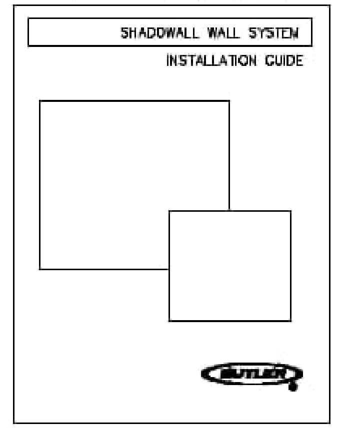
REFER TO:



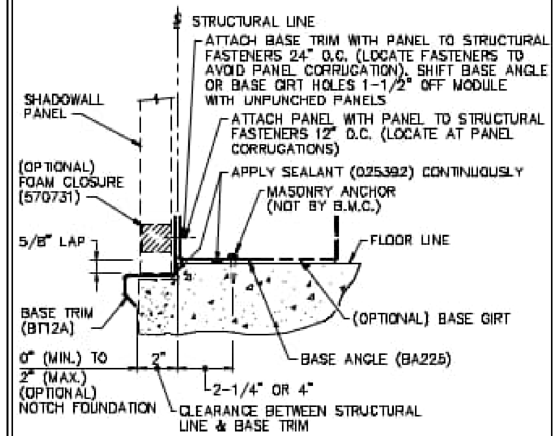
ENB004 — MR-24 ROOF SYSTEM

WALL PANEL ERECTION GUIDE REQUIRED FOR THIS PROJECT:

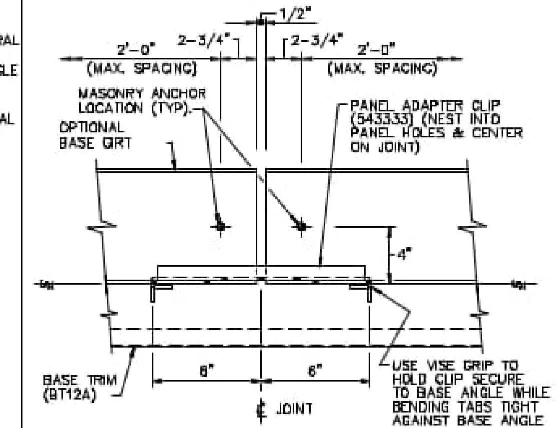
REFER TO:



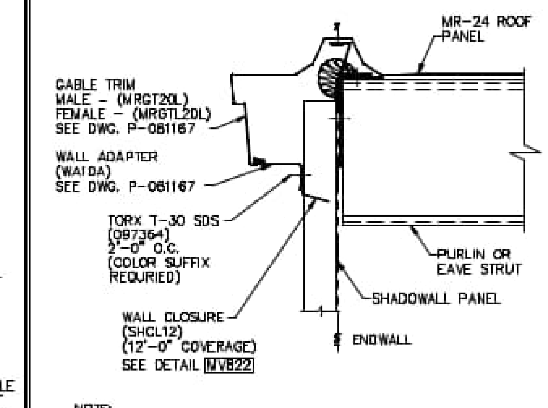
ENB006 — SHADOWALL WALL SYSTEM



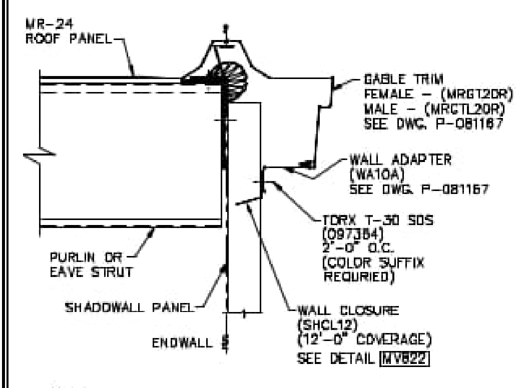
GV386 — SHADOWALL - BASE TRIM INSTALLATION — LAPPED & NOTCHED FOUNDATION AT FLOOR LINE



GV443 — OPTIONAL BASE CHANNEL — JOINT DETAIL - AT FLOOR LINE

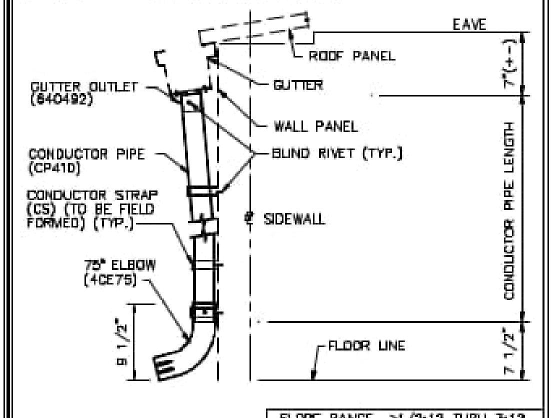


KV403 — GABLE TRIM LEFT WITH MR-24 ROOF — SHADOWALL WALL PANEL WITH CLOSURE



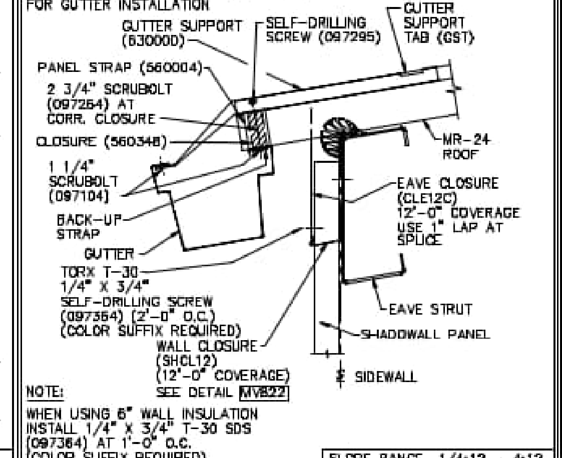
KV404 — GABLE TRIM RIGHT WITH MR-24 ROOF — SHADOWALL WALL PANEL WITH CLOSURE

SEE DRAWING P-105224, P-105225, AND P-105228 FOR DOWNSPOUT INSTALLATION AND RIVET COLOR PART MARK INFORMATION



KV851 — 4 INCH DOWNSPOUT AT WALL — BUTLERIB II AND SHADOWALL

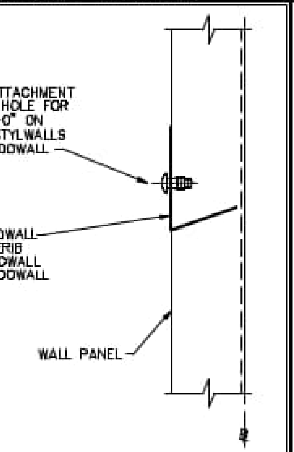
SEE DRAWINGS P-103223 AND P-104714 FOR GUTTER INSTALLATION



MV252 — GUTTER WITH WTHR. SEAL WITH MR-24 ROOF — SHADOWALL WALL PANEL WITH WALL CLSR

FOR METAL WALL CLOSURE ATTACHMENT FIELD DRILL 9/64" DIAMETER HOLE FOR ◆BLIND RIVET (097580) AT 2'-0" ON CENTER FOR BUTLERIB AND STYLWALLS AND (2) PER 1'-0" FOR SHADOWALL

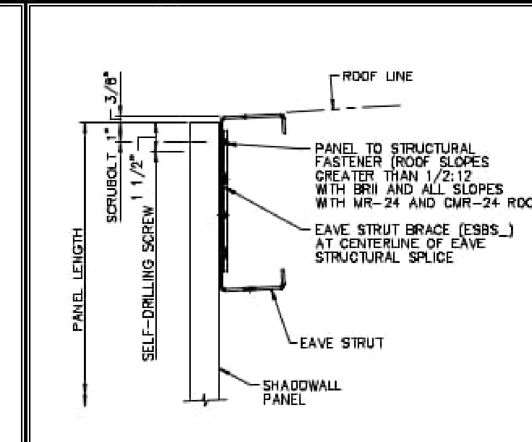
METAL WALL CLOSURE AT ENDWALL SEE DETAIL PV166 FOR BUTLERIB SEE DETAIL PV167 FOR SHADOWALL SEE DETAIL MV631 FOR eSHADOWALL (FIELD CUT AS REQUIRED)



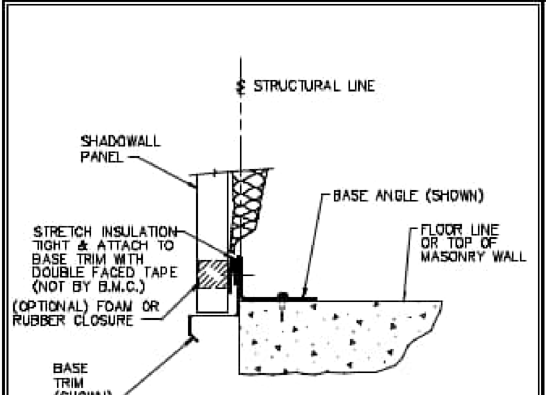
SIDEWALL CLOSURE SCHEDULE	
WALL SYSTEM	
BUTLERIB II	SHADOWALL eSHADOWALL
(BRCL12) (12'-0")	(SHCL12) (12'-0")

◆SEE DRAWING P-081784 FOR BLIND RIVET COLOR INFORMATION

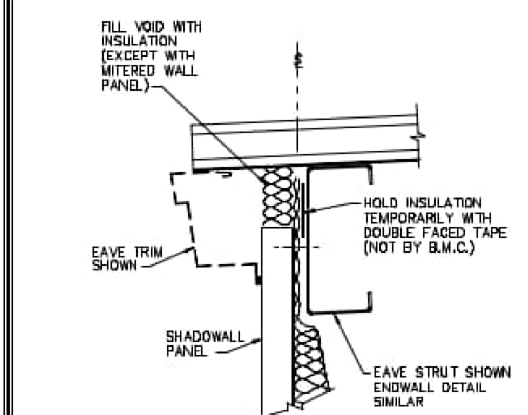
MV822 — OPTIONAL METAL CLOSURE ATTACHMENT — FOR BUTLERIB, SHADOWALL AND eSHADOWALL PANELS



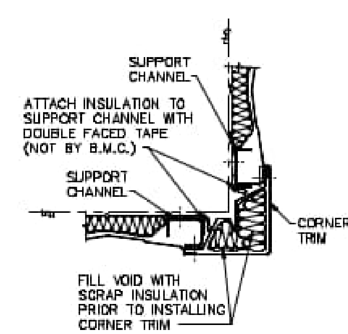
NV110 — SIDEWALL PANEL TOP CONNECTION — AT FRAME EAVE STRUT SPLICE



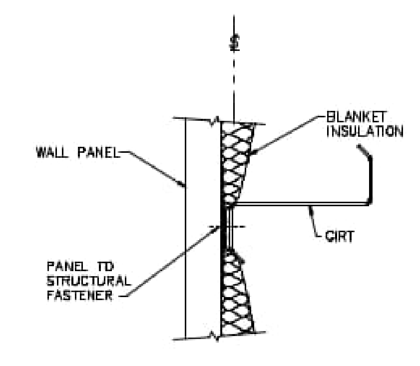
NV115 — 0"-4" INSULATION AT BASE - BASE TRIM — SHADOWALL WALL PANEL



NV116 — 0"-4" INSULATION AT TOP OF WALL-WIDESPAN — SHADOWALL WALL PANEL



NV118 — 0"-4" INSULATION AT OUTSIDE CORNER — SHADOWALL WALL PANEL



NV120 — 0"-4" INSULATION AT WALL STRUCTURAL — SHADOWALL WALL PANEL

FOR CONSTRUCTION

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B — BUTLER MANUFACTURING 1540 GENESSEE ST. KANSAS CITY, MO 64102

COVERING & TRIM SED'S

REV	DATE	BY	DESCRIPTION

DRAWING SCALE: NTS

BUILDER: [redacted]
CUSTOMER: [redacted]
LOCATION: Browns Valley, Minnesota
PROJECT: [redacted]
BUILDER'S PO#: [redacted]

BUTLER — Butler Manufacturing

JOB #: 21-010258-01
DATE: 6/22/2021
DRAWN/CHECK: JMM / HMR
VPC VERSION: 2021.1d
PAGE: 27

VPC FILENAME: 21-010258-01 6/22/2021 SEDSheet 13:45:44

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5. Conclusiones

El diseño estructural de la nave industrial prefabricada de acero localizada en Browns Ville, Minnesota, se realizó de manera exhaustiva y cuidadosa para asegurar la seguridad y la estabilidad de la estructura. La combinación de cargas se consideró cuidadosamente para cumplir con los requisitos del código de construcción local y la norma ASCE 7-16.

Garantizar un diseño estructural adecuado puede contribuir a mejorar la eficiencia en costos y tiempos de construcción, y aumentar la flexibilidad en el diseño de la nave industrial. También puede permitir la optimización de los recursos disponibles y la reducción de los impactos ambientales asociados con la construcción y operación del edificio.

En este edificio en particular, al comparar el peso de la estructura antes del proceso de diseño y el peso de la estructura ya diseñada, se obtiene que existe un ahorro de 3.6% de acero estructural. Dicho ahorro se logro al optimizar el diseño del sistema primario y secundario de resistencia de tal manera que sus relaciones de esfuerzo se encontrarán lo más cerca posible del 1.00.

	Peso estructural después de diseño (lbs)	Peso estructural antes del diseño	A/Q Ratio
Marcos de acero	16,000	16,683	95.9%
Contraventeos	478	499	95.8%
Largueros de cubierta y muro	13,234	13,634	97.1%
Totals (tons)	14.86	15.41	96.4%
Difference in Weight (tons)	-0.55		

Es importante tener en cuenta que nunca se debe buscar la rentabilidad en detrimento de la integridad estructural. La correcta selección de materiales y dimensiones es crucial para garantizar la seguridad de los usuarios de la edificación.

El diseño de la nave industrial descrito en este trabajo se llevó a cabo como parte de mis funciones como diseñador estructural en la empresa BlueScope Buildings North America, específicamente por parte de la unidad de ingeniería ubicada en la Ciudad de México.

El departamento de ingeniería de BBNA provee soluciones de construcción y estructurales seguras, creativas, de calidad y económicamente eficientes para clientes internos (project managers, especialistas de montaje en campo, manufactura, etc) y para clientes externos con una calidad de servicio al cliente superior.

Durante los últimos nueve años me he desempeñado activamente dentro del departamento de ingeniería de BBNA con distintas responsabilidades que cambiaron de acuerdo con mi crecimiento en la compañía. En este tiempo, tuve la oportunidad de participar en el proceso de ingeniería de más de doscientas estructuras metálicas prefabricadas, algunas como ingeniero de detalle y más adelante como ingeniero estructural.

Asimismo, he tenido la fortuna de formar parte de un equipo que incluye ingenieros brillantes, nacionales y extranjeros, con muchos años previos de experiencia que enriquecieron y aceleraron mi desarrollo como profesional. Dichos ingenieros me han tendido la mano siempre que lo he necesitado y han compartido sus conocimientos conmigo de manera completamente desinteresada, acción que me ha inspirado a actuar de la misma manera con ingenieros menos experimentados.

Al pertenecer a un equipo de ingeniería con trabajadores de diferentes nacionalidades, el uso del idioma inglés fue mandatorio, por lo que he incrementado sustancialmente mi lenguaje técnico, así como mis habilidades de comunicación oral y escrita en dicho idioma.

Otra cosa que agradezco enormemente es la exposición que he tenido al trabajar con códigos de construcción internacionales. Muchos de los proyectos en los que he estado involucrado fueron construidos a lo largo de todo el continente americano, desde la Patagonia (donde el mayor reto consistió en las altas cargas de nieve) hasta los estados americanos de California y Florida (donde la alta sismicidad y las grandes velocidades de viento regían respectivamente).

Puede parecer que actualmente solo utilizo los conocimientos adquiridos en las materias de la rama estructural de la carrera. Sin embargo, creo fervientemente que todas y cada una de las materias estudiadas en mi periodo como alumno de la Facultad de Ingeniería fomentaron el desarrollo de un pensamiento crítico en mi persona, lo que a su vez contribuyó a mi desarrollo como un profesional más completo capaz de trabajar bajo presión y de tomar decisiones difíciles cuando la situación así lo requiere.

Por último, me parece importante recalcar que hoy en día el mundo laboral requiere de ingenieros capaces de trabajar en equipos multidisciplinarios y de transmitir efectivamente conceptos ingenieriles a personas con diferentes antecedentes universitarios, y es aquí donde las materias de humanidades de la carrera brillan por su importancia.

A continuación, se presenta una descripción breve de mi trayectoria en el departamento de ingeniería de BBNA incluyendo las actividades y responsabilidades inherentes a los puestos de trabajo desempeñados.

Engineering Technician I

Durante el periodo comprendido entre enero del 2015 y mayo de 2016 me desempeñé en la compañía como ingeniero de detalle con las siguientes funciones:

- Llevar a cabo la ingeniería de detalle de partes de un edificio y crear planos de fabricación de dichas partes.
- Crear planos de montaje final, planos de aprobación. planos para obtener el permiso de una dependencia gubernamental y planos de varillas de anclaje.
- Colaborar con los miembros pertenecientes al equipo para cada proyecto para discutir problemas y retos con la finalidad de ayudar a crear soluciones.

Designer I

Durante el periodo comprendido entre junio de 2016 y noviembre del 2020 me desempeñé en la compañía como diseñador estructural 1 con las siguientes funciones:

- Proveer diseños de elementos y conexiones estructurales eficientes que cumplan con los requerimientos del cliente sin comprometer la rentabilidad y mejoramiento continuo de la compañía.
- Garantizar la integridad estructural y la seguridad del edificio.
- Desarrollar el propio conocimiento de códigos estructurales, productos y procedimientos.
- Avalar que las necesidades del cliente de diseño estructural se cumplan en tiempo y forma.
- Colaborar con los miembros pertenecientes al equipo para cada proyecto para discutir problemas y retos con la finalidad de ayudar a crear soluciones que faciliten el desarrollo del proceso de ingeniería de manera eficiente y efectiva.
- Aprovechar la orientación de un mentor y/o ingeniero líder para promover el desarrollo propio.

Designer II

Desde diciembre del 2020 hasta la actualidad me desempeño en la empresa como diseñador estructural II con las siguientes funciones:

- Proveer diseños de elementos y conexiones estructurales eficientes que cumplan con los requerimientos del cliente sin comprometer la rentabilidad y mejoramiento continuo de la compañía.
- Garantizar la integridad estructural y la seguridad del edificio.
- Desarrollar el propio conocimiento de códigos estructurales, productos y procedimientos.
- Avalar que las necesidades del cliente de diseño estructural se cumplan en tiempo y forma.
- Colaborar con los miembros pertenecientes al equipo para cada proyecto para discutir problemas y retos con la finalidad de ayudar a crear soluciones que faciliten el desarrollo del proceso de ingeniería de manera eficiente y efectiva.
- Brindar tutoría y asistencia técnica en cuanto a diseño estructural se refiere a ingenieros con menos experiencia y/o clientes externos.

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