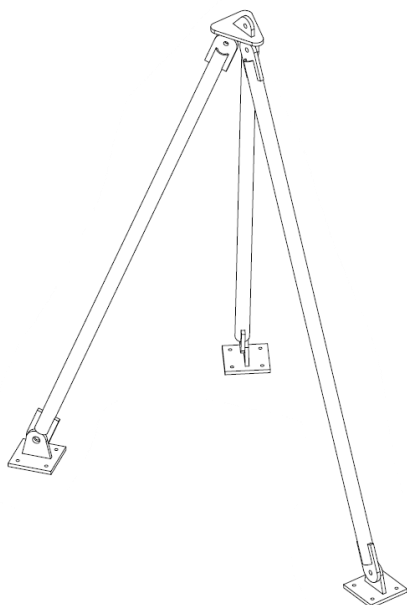


## CERTIFICACIÓN EQUIPO

### TRIPODE PARA ANCLAJE DE LINEA DE VIDA HORIZONTAL CERTIFICADA

**Capacidad:**

- Horizontal: 5000 lb (22.2 kN)
- Vertical: 3600 lb (15.6 kN)

**Uso:** Anclaje Sistemas de línea de vida horizontal temporal certificada

**Material de fabricación:** Acero Inoxidable A304 mínimo

**Soldadura:** E308L-16 o Equivalente

**Fijación:** Anclajes químicos M10 + Anchorfix 3001 70 mm o equivalente

**Documentos de Respaldo:**

Memorias de calculo de platina corona, platina base, pata compresión, pata tracción y anclajes



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## Simulación de pata Compresión

**Fecha:** miércoles, 22 de mayo de 2024

**Diseñador:** Mario Andrés Yory Rocha, IC,  
MSc (c)

**Nombre de estudio:** Análisis estático

**Tipo de análisis:** Análisis estático



Descripción

Pata de soporte a compresión de sistema tripode para  
anclaje para protección contra caídas

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Uso definido .....3

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Propiedades de estudio .....5

Unidades .....6

Propiedades de material .....6

Cargas y sujeciones .....7

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SAS**

Mario Andrés Yory Rocha, IC, MSc (c)  
22/05/2024

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## Uso definido


### Comentarios:

El sistema se debe emplear unicamente como punto de anclaje para una linea de vida horizontal que asegure maximo 5000 lb de forma horizontal y 3600 lb de forma vertical

## Información de modelo



### Sólidos

Nombre de documento y referencia	Tratado como	Propiedades volumétricas	Ruta al documento/Fecha de modificación
Redondeo5 	Sólido	<b>Masa:</b> 11.8051 kg <b>Volumen:</b> 0.00147563 m <sup>3</sup> <b>Densidad:</b> 8,000 kg/m <sup>3</sup> <b>Peso:</b> 115.69 N	C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID\pata2.SLDPRT May 30 08:45:57 2023

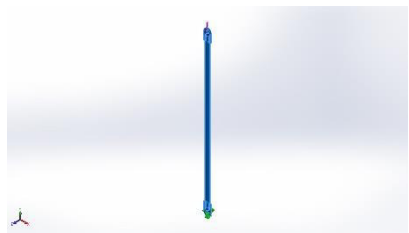
## Propiedades de estudio

<b>Nombre de estudio</b>	Análisis estático
<b>Tipo de análisis</b>	Análisis estático
<b>Tipo de malla</b>	Malla sólida
<b>Efecto térmico:</b>	Activar
<b>Opción térmica</b>	Incluir cargas térmicas
<b>Temperatura a tensión cero</b>	298 Kelvin
<b>Incluir los efectos de la presión de fluidos desde SOLIDWORKS Flow Simulation</b>	Desactivar
<b>Tipo de solver</b>	Automático
<b>Efecto de rigidización por tensión (Inplane):</b>	Desactivar
<b>Muelle blando:</b>	Desactivar
<b>Desahogo inercial:</b>	Desactivar
<b>Opciones de unión rígida incompatibles</b>	Automático
<b>Gran desplazamiento</b>	Desactivar
<b>Calcular fuerzas de cuerpo libre</b>	Activar
<b>Fricción</b>	Desactivar
<b>Utilizar método adaptativo:</b>	Desactivar
<b>Carpeta de resultados</b>	Documento de SOLIDWORKS (C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID)

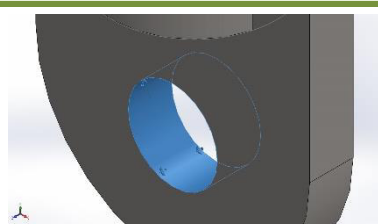
## Unidades

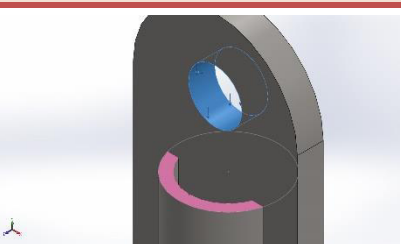
Sistema de unidades:	Métrico (MKS)
Longitud/Desplazamiento	mm
Temperatura	Kelvin
Velocidad angular	Rad/seg
Presión/Tensión	N/m <sup>2</sup>

## Propiedades de material

Referencia de modelo	Propiedades	Componentes
	<p><b>Nombre:</b> AISI 304</p> <p><b>Tipo de modelo:</b> Isotrópico elástico lineal</p> <p><b>Criterio de error predeterminado:</b> Desconocido</p> <p><b>Límite elástico:</b> 2.06807e+08 N/m<sup>2</sup></p> <p><b>Límite de tracción:</b> 5.17017e+08 N/m<sup>2</sup></p> <p><b>Módulo elástico:</b> 1.9e+11 N/m<sup>2</sup></p> <p><b>Coefficiente de Poisson:</b> 0.29</p> <p><b>Densidad:</b> 8,000 kg/m<sup>3</sup></p> <p><b>Módulo cortante:</b> 7.5e+10 N/m<sup>2</sup></p> <p><b>Coefficiente de dilatación térmica:</b> 1.8e-05 /Kelvin</p>	<p>Sólido</p> <p>1 (Redondeo5)(pata2)</p>
Datos de curva:N/A		

## Cargas y sujeciones

Nombre de sujeción	Imagen de sujeción	Detalles de sujeción		
Fijo-1		<b>Entidades:</b> 1 cara(s) <b>Tipo:</b> Geometría fija		
<b>Fuerzas resultantes</b>				
Componentes	X	Y	Z	Resultante
Fuerza de reacción(N)	0.499013	37,702.6	-3.42569	37,702.6
Momento de reacción(N.m)	0	0	0	0

Nombre de carga	Cargar imagen	Detalles de carga		
Fuerza-1		<b>Entidades:</b> 1 cara(s) <b>Referencia:</b> Cara< 1 > <b>Tipo:</b> Aplicar fuerza <b>Valores:</b> ---; ---; -37,700 N		



## Información de malla

<b>Tipo de malla</b>	Malla sólida
<b>Mallador utilizado:</b>	Malla basada en curvatura de combinado
<b>Puntos jacobianos para malla de alta calidad</b>	16 Puntos
<b>Tamaño máximo de elemento</b>	14.5783 mm
<b>Tamaño mínimo del elemento</b>	4.85937 mm
<b>Calidad de malla</b>	Elementos cuadráticos de alto orden

## Información de malla - Detalles

<b>Número total de nodos</b>	18023
<b>Número total de elementos</b>	9054
<b>Cociente máximo de aspecto</b>	5.1651
<b>% de elementos cuyo cociente de aspecto es &lt; 3</b>	89.5
<b>El porcentaje de elementos cuyo cociente de aspecto es &gt; 10</b>	0
<b>Porcentaje de elementos distorsionados</b>	0
<b>Tiempo para completar la malla (hh:mm:ss):</b>	00:00:03
<b>Nombre de computadora:</b>	ANDRES-YORY

## Fuerzas resultantes

### Fuerzas de reacción

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N	0.499013	37,702.6	-3.42569	37,702.6

### Momentos de reacción

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N.m	0	0	0	0

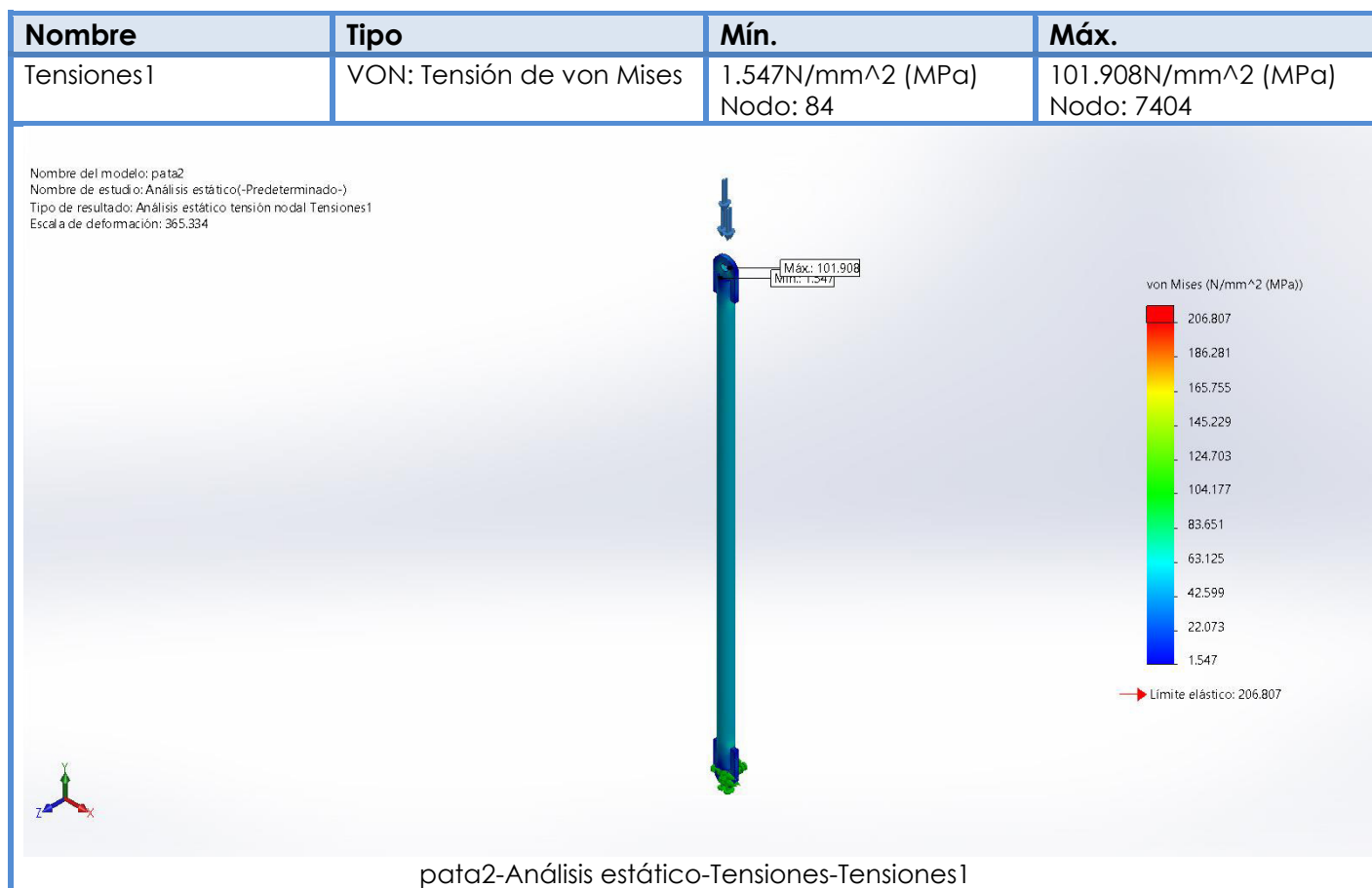
### Fuerzas de cuerpo libre

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N	146.425	-84.9206	-361.194	398.889

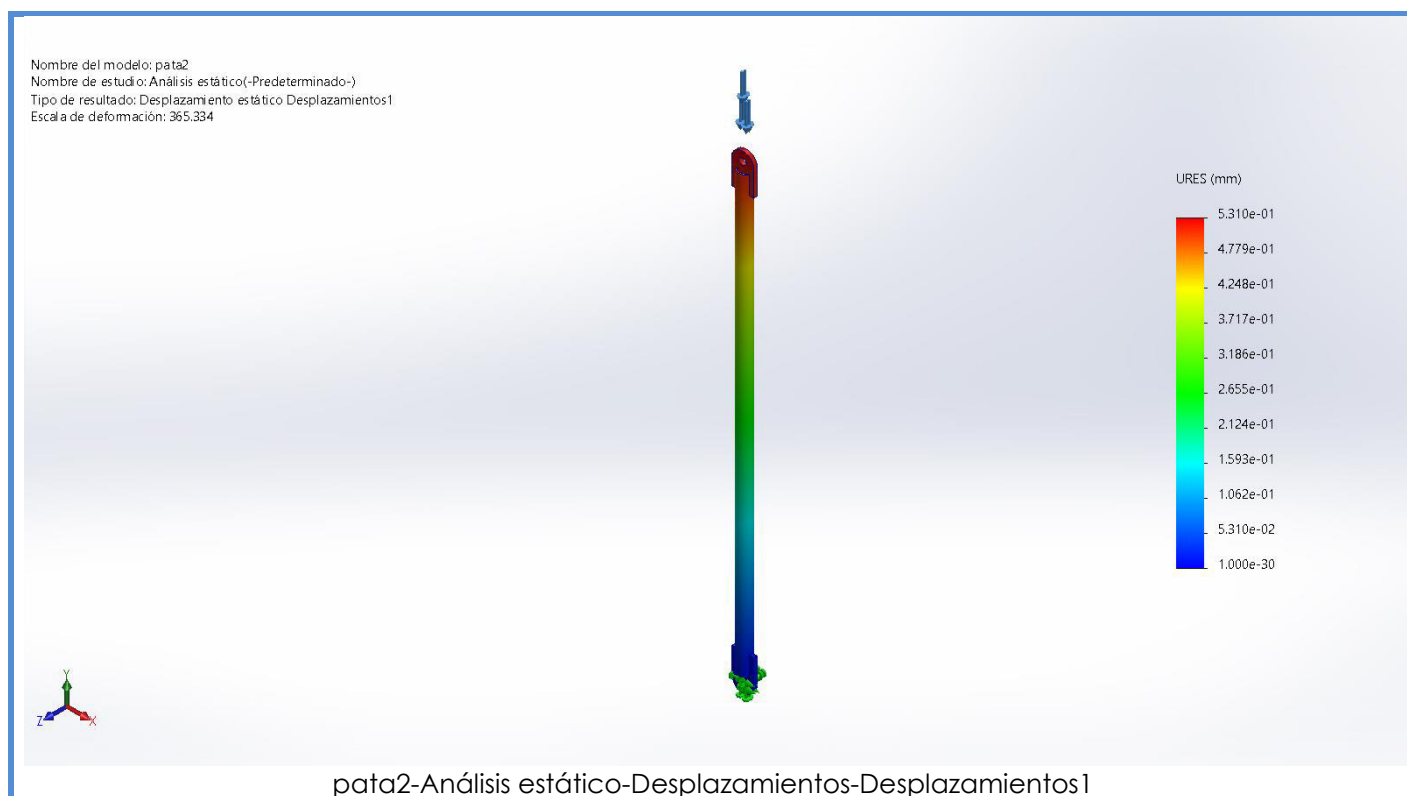
### Momentos de cuerpo libre

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N.m	0	0	0	1e-33

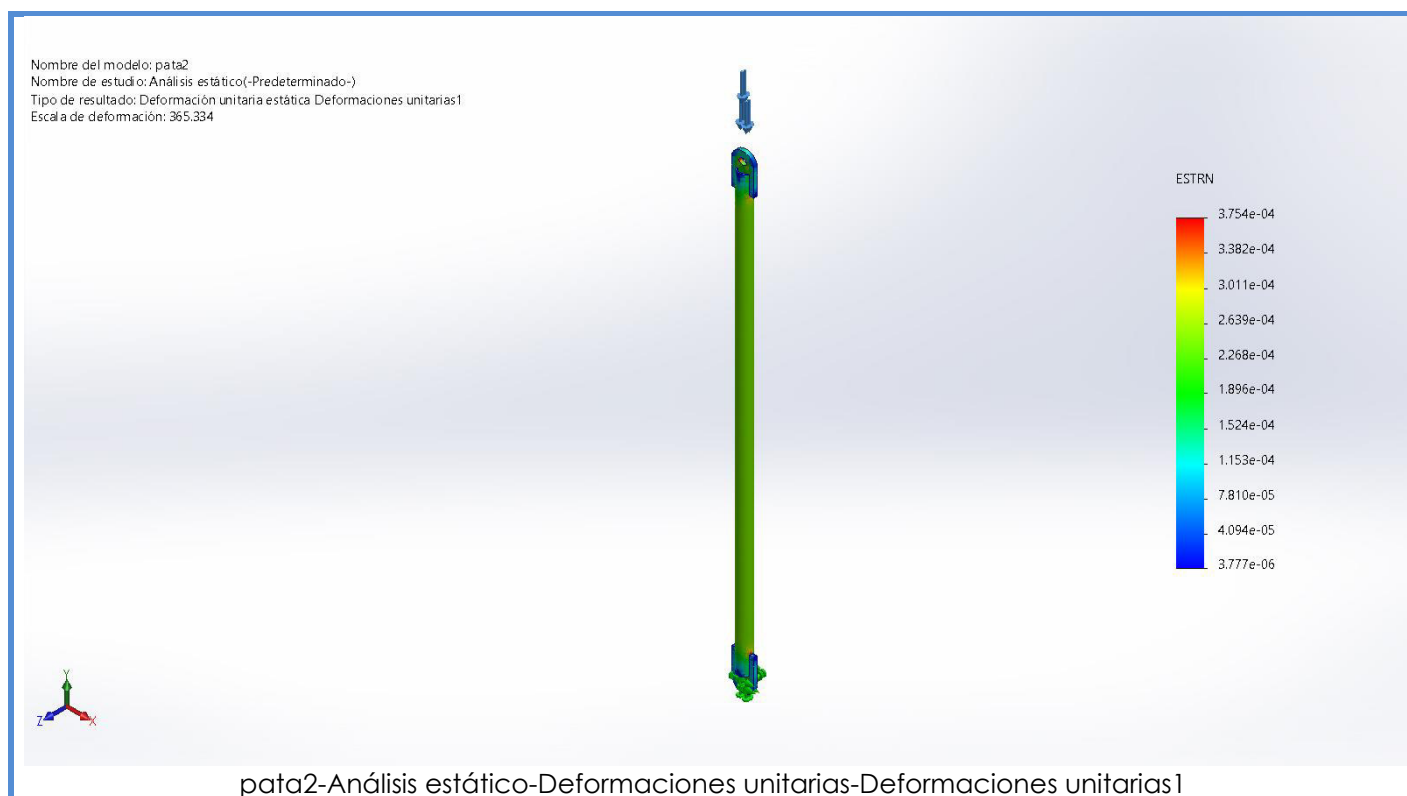
## Resultados del estudio



Nombre	Tipo	Mín.	Máx.
Desplazamientos1	URES: Desplazamientos resultantes	0.000e+00mm Nodo: 51	5.310e-01mm Nodo: 2786



Nombre	Tipo	Mín.	Máx.
Deformaciones unitarias1	ESTRN: Deformación unitaria equivalente	3.777e-06 Elemento: 4426	3.754e-04 Elemento: 4861



Nombre	Tipo	Mín.	Máx.
Factor de seguridad1	Automático	2.029 Nodo: 7404	3.000 Nodo: 1

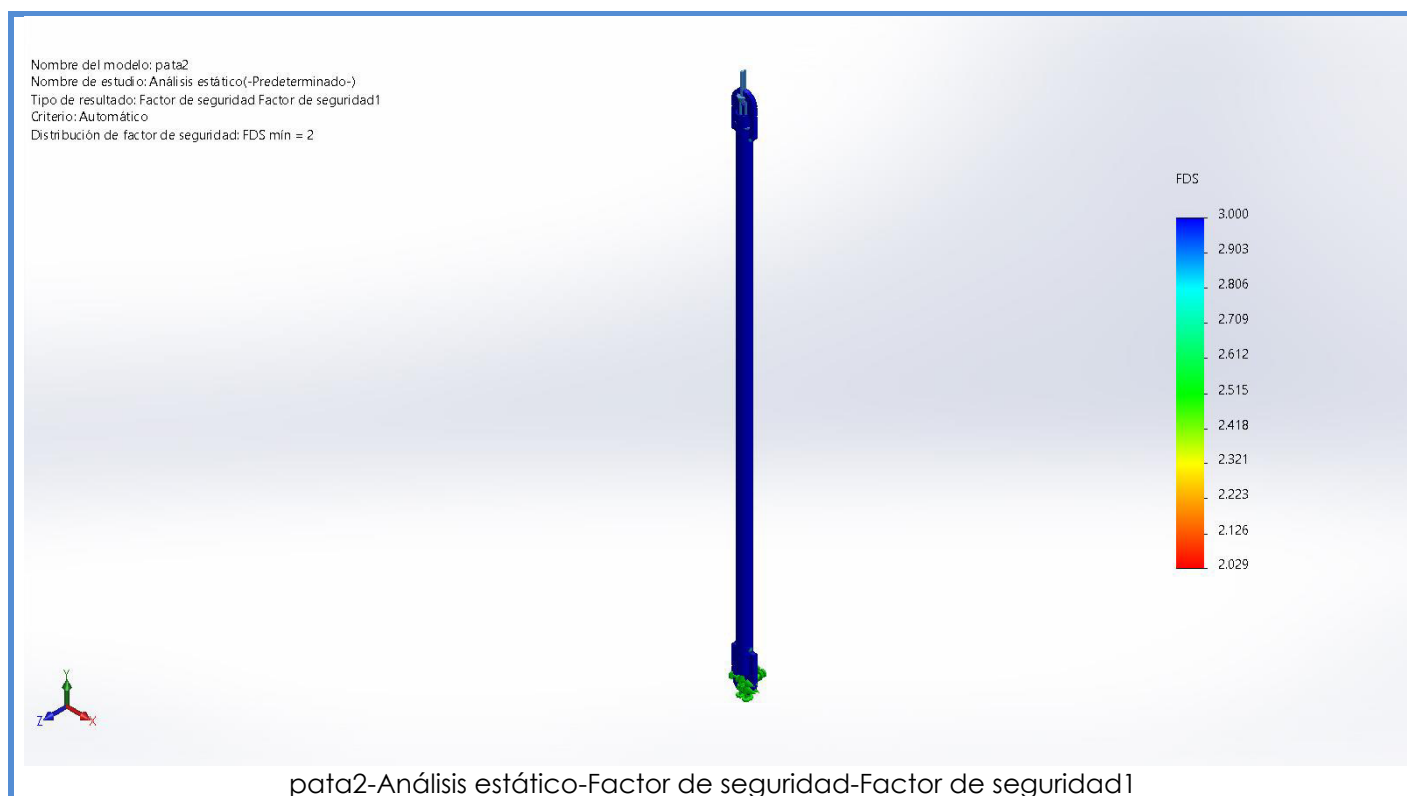


Imagen-1

## Conclusión

### Comentarios:

Sistema Competente para soportar un sistema de línea de vida horizontal certificado en conjunto con los demás componentes del tripode



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## Simulación de pata

**Fecha:** miércoles, 22 de mayo de 2024

**Diseñador:** Mario Andrés Yory Rocha, IC,  
MSc (c)

**Nombre de estudio:** Análisis estático

**Tipo de análisis:** Análisis estático



Descripción

Pata de soporte a Tracción Sistema tripode de anclaje horizontal para linea de vida certificada

Tabla de contenidos

Descripción .....2

Uso definido .....3

Información de modelo .....4

Propiedades de estudio .....5

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22/05/2024

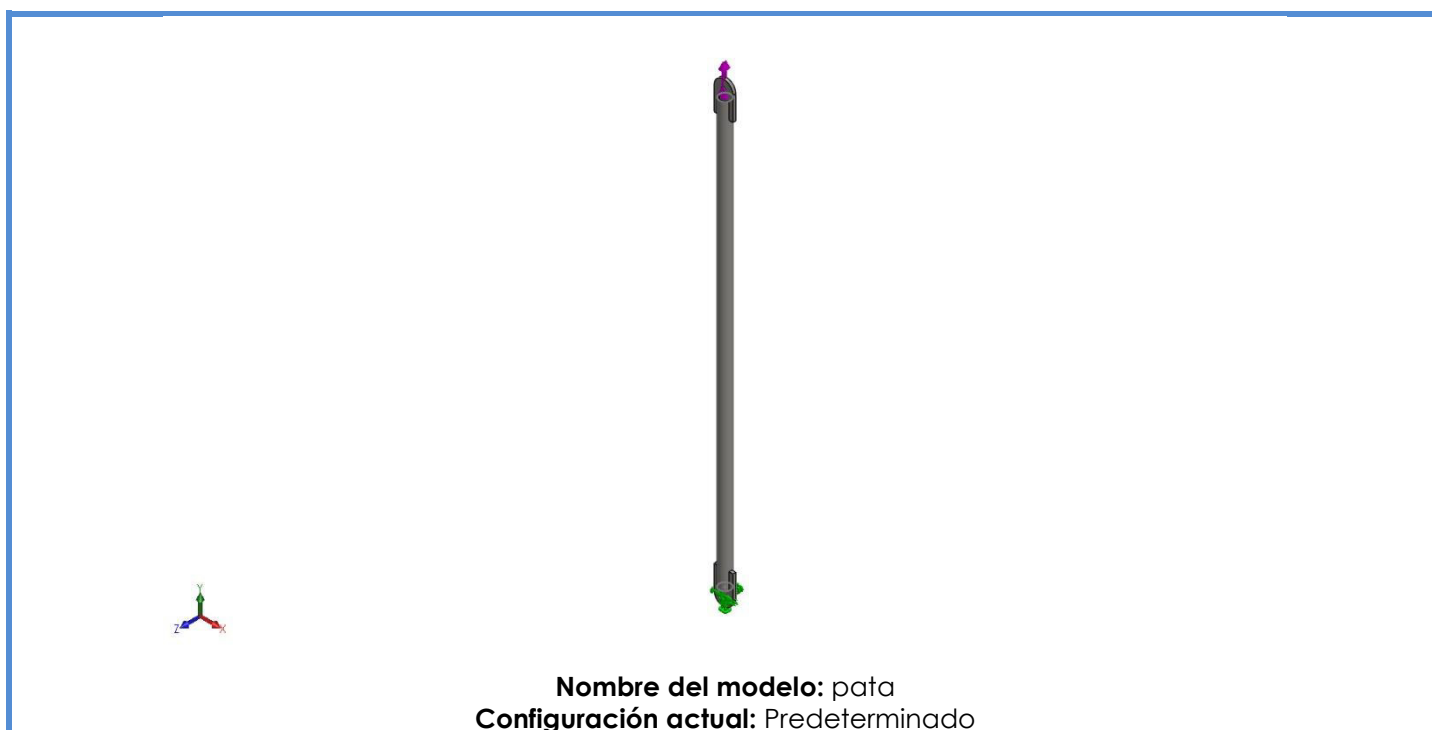
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## Uso definido


### **Comentarios:**

El sistema se debe emplear unicamente como punto de anclaje para una linea de vida horizontal que asegure maximo 5000 lb de forma horizontal y 3600 lb de forma vertical

## Información de modelo



### Sólidos

Nombre de documento y referencia	Tratado como	Propiedades volumétricas	Ruta al documento/Fecha de modificación
Redondeo5 	Sólido	Masa:11.8721 kg Volumen:0.00148401 m <sup>3</sup> Densidad:8,000 kg/m <sup>3</sup> Peso:116.346 N	C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID\pata.SLDPRT May 30 09:03:34 2023

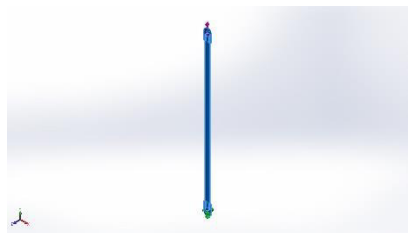
## Propiedades de estudio

<b>Nombre de estudio</b>	Análisis estático
<b>Tipo de análisis</b>	Análisis estático
<b>Tipo de malla</b>	Malla sólida
<b>Efecto térmico:</b>	Activar
<b>Opción térmica</b>	Incluir cargas térmicas
<b>Temperatura a tensión cero</b>	298 Kelvin
<b>Incluir los efectos de la presión de fluidos desde SOLIDWORKS Flow Simulation</b>	Desactivar
<b>Tipo de solver</b>	Automático
<b>Efecto de rigidización por tensión (Inplane):</b>	Desactivar
<b>Muelle blando:</b>	Desactivar
<b>Desahogo inercial:</b>	Desactivar
<b>Opciones de unión rígida incompatibles</b>	Automático
<b>Gran desplazamiento</b>	Desactivar
<b>Calcular fuerzas de cuerpo libre</b>	Activar
<b>Fricción</b>	Desactivar
<b>Utilizar método adaptativo:</b>	Desactivar
<b>Carpeta de resultados</b>	Documento de SOLIDWORKS (C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID)

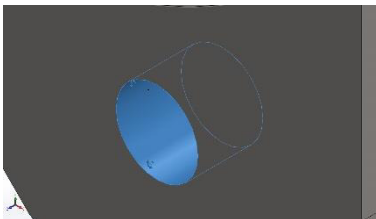
## Unidades

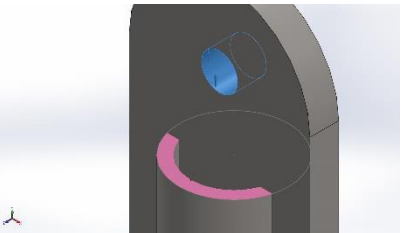
Sistema de unidades:	Métrico (MKS)
Longitud/Desplazamiento	mm
Temperatura	Kelvin
Velocidad angular	Rad/seg
Presión/Tensión	N/m <sup>2</sup>

## Propiedades de material

Referencia de modelo	Propiedades	Componentes
	<p><b>Nombre:</b> AISI 304</p> <p><b>Tipo de modelo:</b> Isotrópico elástico lineal</p> <p><b>Criterio de error predeterminado:</b> Desconocido</p> <p><b>Límite elástico:</b> 2.06807e+08 N/m<sup>2</sup></p> <p><b>Límite de tracción:</b> 5.17017e+08 N/m<sup>2</sup></p> <p><b>Módulo elástico:</b> 1.9e+11 N/m<sup>2</sup></p> <p><b>Coefficiente de Poisson:</b> 0.29</p> <p><b>Densidad:</b> 8,000 kg/m<sup>3</sup></p> <p><b>Módulo cortante:</b> 7.5e+10 N/m<sup>2</sup></p> <p><b>Coefficiente de dilatación térmica:</b> 1.8e-05 /Kelvin</p>	<p>Sólido</p> <p>1 (Redondeo5)(pata)</p>
Datos de curva:N/A		

## Cargas y sujeciones

Nombre de sujeción	Imagen de sujeción	Detalles de sujeción		
Fijo-1		<b>Entidades:</b> 1 cara(s) <b>Tipo:</b> Geometría fija		
<b>Fuerzas resultantes</b>				
Componentes	X	Y	Z	Resultante
Fuerza de reacción(N)	-0.390067	-9,949.38	0.243673	9,949.38
Momento de reacción(N.m)	0	0	0	0

Nombre de carga	Cargar imagen	Detalles de carga		
Fuerza-1		<b>Entidades:</b> 1 cara(s) <b>Referencia:</b> Cara< 1 > <b>Tipo:</b> Aplicar fuerza <b>Valores:</b> ---; ---; 9,950 N		

## Información de malla

<b>Tipo de malla</b>	Malla sólida
<b>Mallador utilizado:</b>	Malla basada en curvatura de combinado
<b>Puntos jacobianos para malla de alta calidad</b>	16 Puntos
<b>Tamaño máximo de elemento</b>	13.1269 mm
<b>Tamaño mínimo del elemento</b>	4.37558 mm
<b>Calidad de malla</b>	Elementos cuadráticos de alto orden

## Información de malla - Detalles

<b>Número total de nodos</b>	21709
<b>Número total de elementos</b>	10967
<b>Cociente máximo de aspecto</b>	8.4843
<b>% de elementos cuyo cociente de aspecto es &lt; 3</b>	95.6
<b>El porcentaje de elementos cuyo cociente de aspecto es &gt; 10</b>	0
<b>Porcentaje de elementos distorsionados</b>	0
<b>Tiempo para completar la malla (hh:mm:ss):</b>	00:00:02
<b>Nombre de computadora:</b>	ANDRES-YORY

## Fuerzas resultantes

### Fuerzas de reacción

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N	-0.390067	-9,949.38	0.243673	9,949.38

### Momentos de reacción

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N.m	0	0	0	0

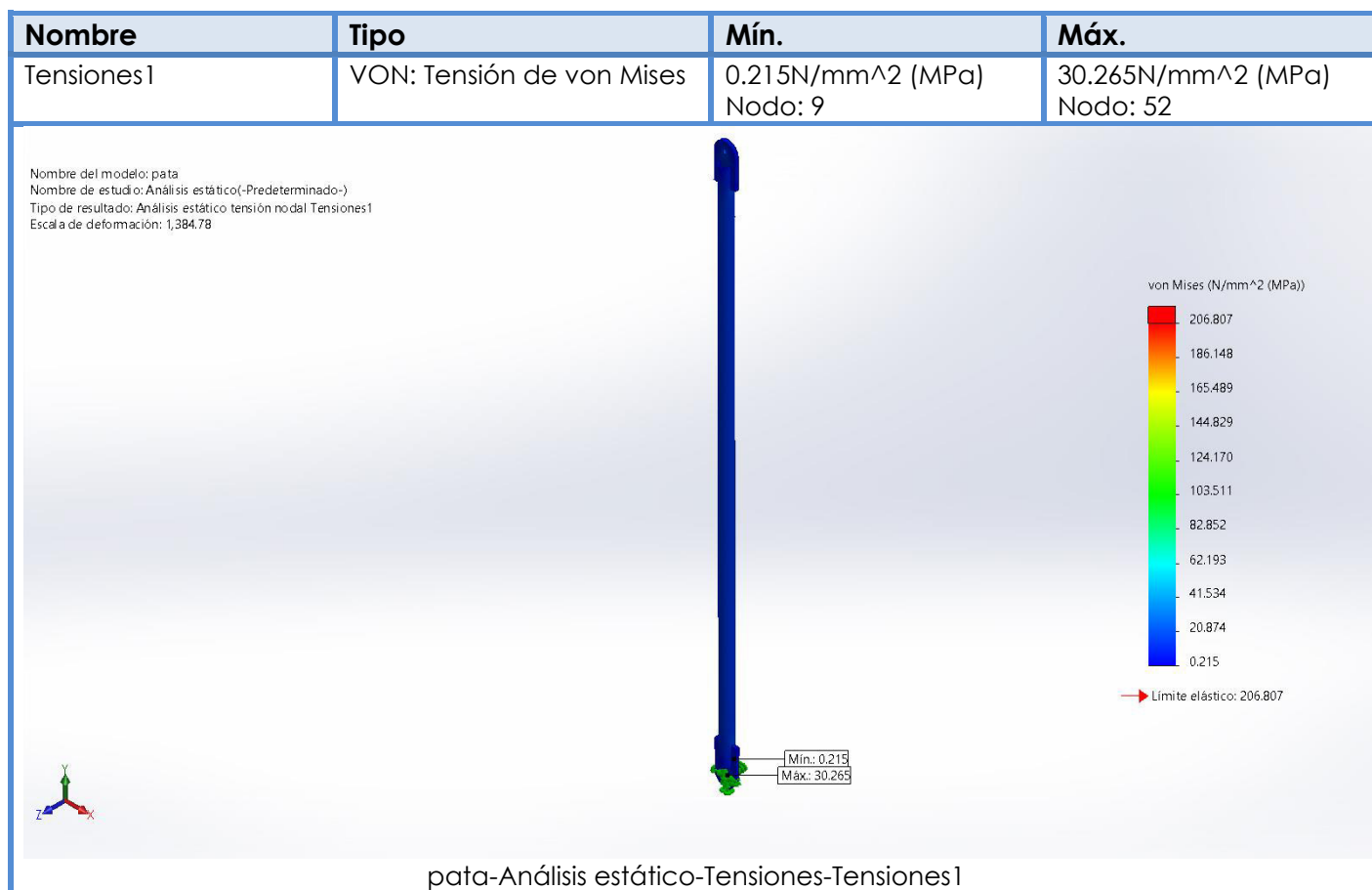
### Fuerzas de cuerpo libre

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N	29.9802	-27.4205	-26.8395	48.6935

### Momentos de cuerpo libre

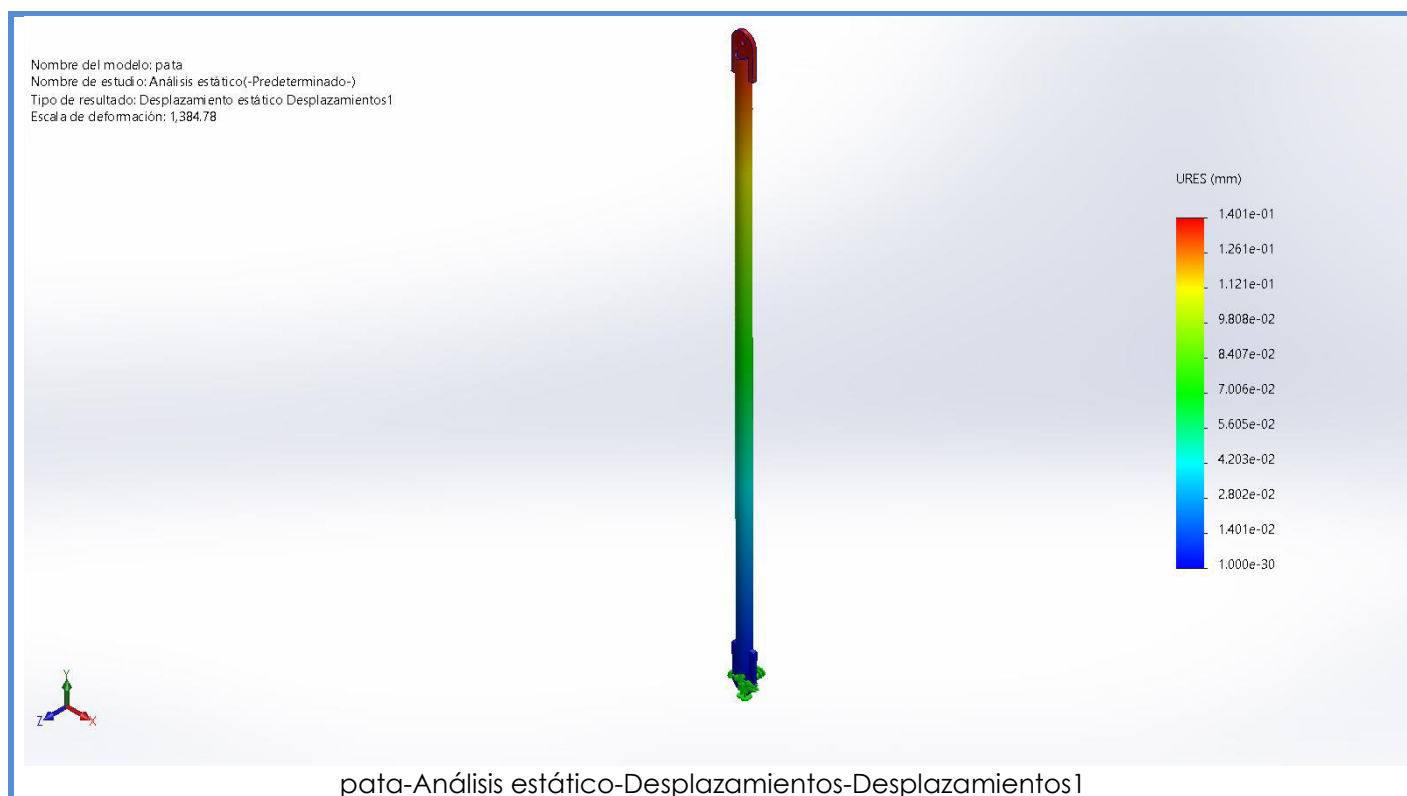
Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N.m	0	0	0	1e-33

## Resultados del estudio



Nombre	Tipo	Mín.	Máx.
Desplazamientos1	URES: Desplazamientos resultantes	0.000e+00mm Nodo: 51	1.401e-01mm Nodo: 3198

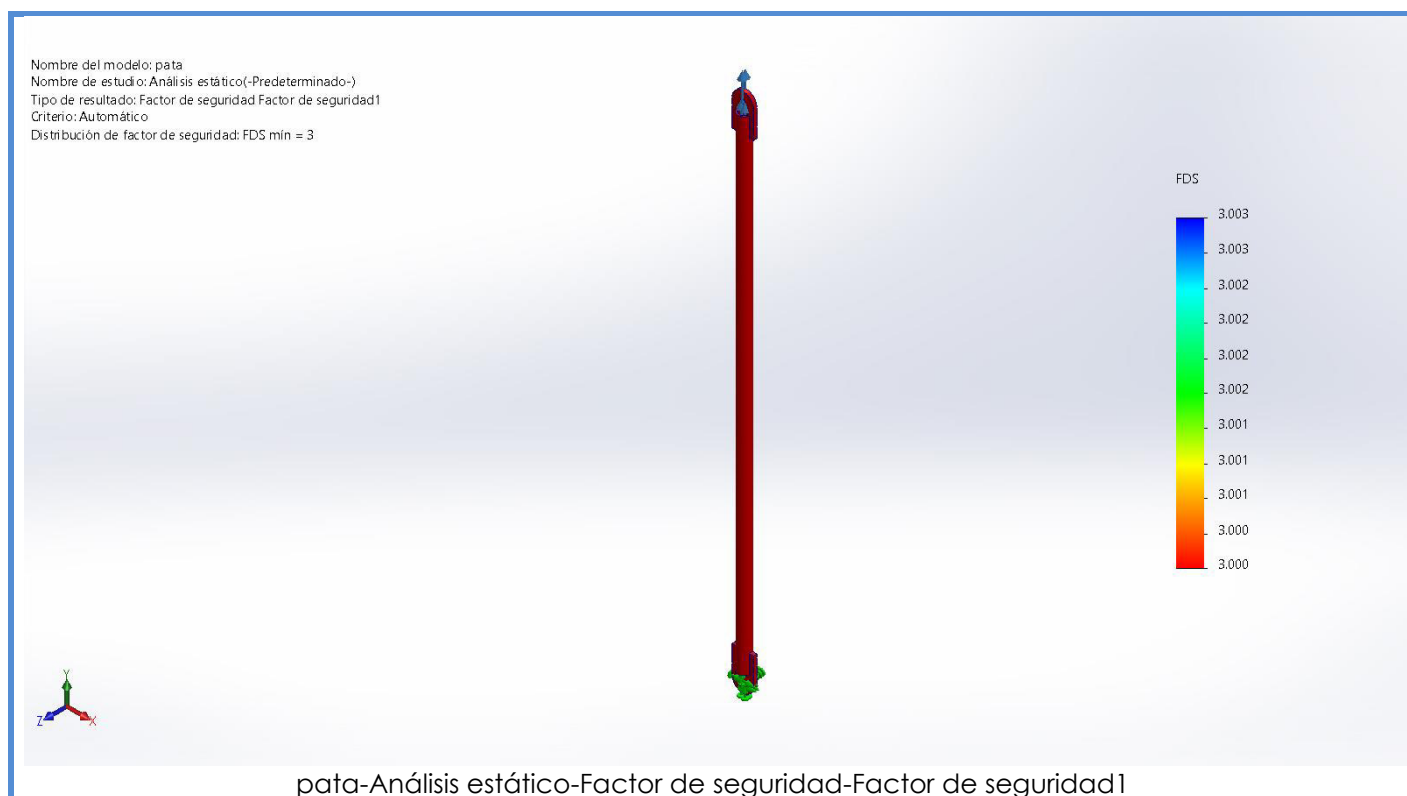




Nombre	Tipo	Mín.	Máx.
Deformaciones unitarias1	ESTRN: Deformación unitaria equivalente	1.307e-06 Elemento: 9581	1.128e-04 Elemento: 1358



Nombre	Tipo	Mín.	Máx.
Factor de seguridad1	Automático	3.000 Nodo: 1	3.000 Nodo: 1



## Conclusión

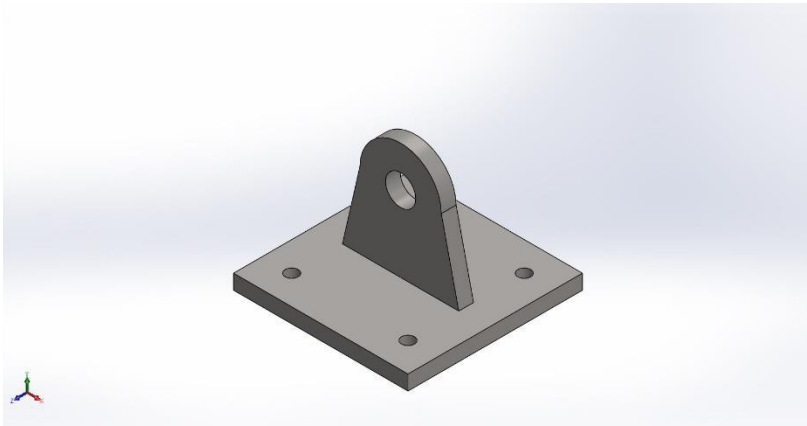
### Comentarios:

Sistema Competente para soportar un sistema de línea de vida horizontal certificado en conjunto con los demás componentes del tripode



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## Simulación de Platina Base Frontal

**Fecha:** miércoles, 22 de mayo de 2024

**Diseñador:** Mario Andrés Yory Rocha, IC,  
MSc (c)

**Nombre de estudio:** Análisis estático 2

**Tipo de análisis:** Análisis estático



Descripción

Pata frontal de anclaje para tripode de sujeción de  
línea de vida horizontal temporal certificada

Tabla de contenidos

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Propiedades de estudio .....5

Unidades .....6

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22/05/2024

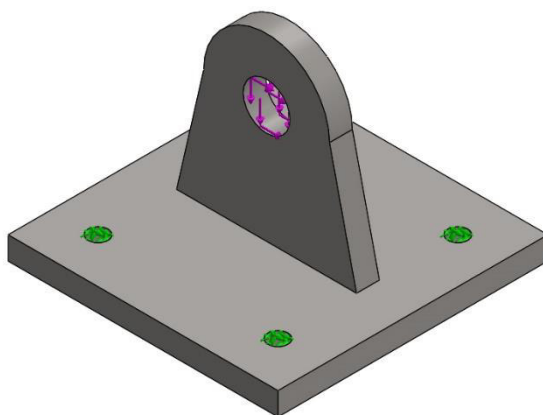
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## Uso definido

### **Comentarios:**

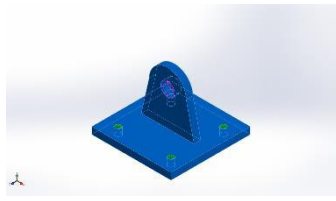
El sistema se debe emplear unicamente como punto de anclaje para una linea de vida horizontal que asegure maximo 5000 lb de forma horizontal y 3600 lb de forma vertical

## Información de modelo



**Nombre del modelo:** Platina Base Frontal  
**Configuración actual:** Predeterminado

### Sólidos

Nombre de documento y referencia	Tratado como	Propiedades volumétricas	Ruta al documento/Fecha de modificación
Cortar-Extruir2 	Sólido	<b>Masa:2.95028 kg</b> <b>Volumen:0.000368785 m<sup>3</sup></b> <b>Densidad:8,000 kg/m<sup>3</sup></b> <b>Peso:28.9127 N</b>	<b>C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID\Platina Base Frontal.SLDPRT</b> May 30 09:24:40 2023

## Propiedades de estudio

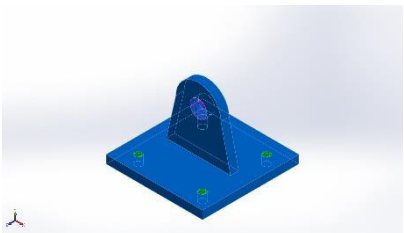
<b>Nombre de estudio</b>	Análisis estático 2
<b>Tipo de análisis</b>	Análisis estático
<b>Tipo de malla</b>	Malla sólida
<b>Efecto térmico:</b>	Activar
<b>Opción térmica</b>	Incluir cargas térmicas
<b>Temperatura a tensión cero</b>	298 Kelvin
<b>Incluir los efectos de la presión de fluidos desde SOLIDWORKS Flow Simulation</b>	Desactivar
<b>Tipo de solver</b>	Automático
<b>Efecto de rigidización por tensión (Inplane):</b>	Desactivar
<b>Muelle blando:</b>	Desactivar
<b>Desahogo inercial:</b>	Desactivar
<b>Opciones de unión rígida incompatibles</b>	Automático
<b>Gran desplazamiento</b>	Desactivar
<b>Calcular fuerzas de cuerpo libre</b>	Activar
<b>Fricción</b>	Desactivar
<b>Utilizar método adaptativo:</b>	Desactivar
<b>Carpeta de resultados</b>	Documento de SOLIDWORKS (C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID)



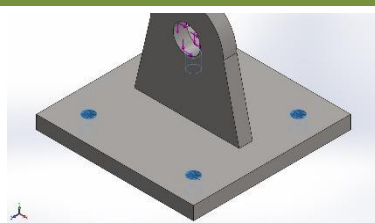
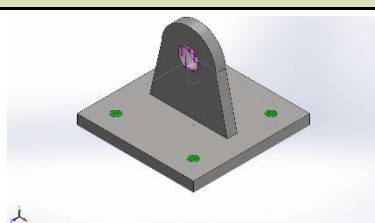
## Unidades

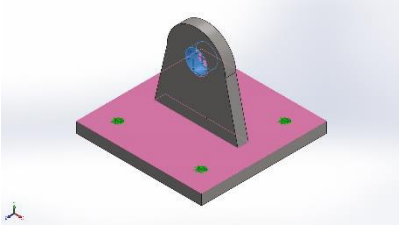
<b>Sistema de unidades:</b>	Métrico (MKS)
<b>Longitud/Desplazamiento</b>	mm
<b>Temperatura</b>	Kelvin
<b>Velocidad angular</b>	Rad/seg
<b>Presión/Tensión</b>	N/m <sup>2</sup>

## Propiedades de material

Referencia de modelo	Propiedades	Componentes
	<p><b>Nombre:</b> AISI 304</p> <p><b>Tipo de modelo:</b> Isotrópico elástico lineal</p> <p><b>Criterio de error predeterminado:</b> Desconocido</p> <p><b>Límite elástico:</b> 2.06807e+08 N/m<sup>2</sup></p> <p><b>Límite de tracción:</b> 5.17017e+08 N/m<sup>2</sup></p> <p><b>Módulo elástico:</b> 1.9e+11 N/m<sup>2</sup></p> <p><b>Coeficiente de Poisson:</b> 0.29</p> <p><b>Densidad:</b> 8,000 kg/m<sup>3</sup></p> <p><b>Módulo cortante:</b> 7.5e+10 N/m<sup>2</sup></p> <p><b>Coeficiente de dilatación térmica:</b> 1.8e-05 /Kelvin</p>	Sólido 1 (Cortar-Extruir2) (Platina Base)
Datos de curva:N/A		

## Cargas y sujeciones

Nombre de sujeción	Imagen de sujeción	Detalles de sujeción		
Fijo-1		<b>Entidades:</b> 4 cara(s) <b>Tipo:</b> Geometría fija		
Fuerzas resultantes				
Componentes	X	Y	Z	Resultante
Fuerza de reacción(N)	-15,440	-57.5187	-7.05719e-05	15,440.1
Momento de reacción(N.m)	0	0	0	0
Fuerzas resultantes				
Rodillo/Control deslizante-1		<b>Entidades:</b> 1 cara(s) <b>Tipo:</b> Rodillo/Control deslizante		
Fuerzas resultantes				
Componentes	X	Y	Z	Resultante
Fuerza de reacción(N)	-930.652	34,488.3	-18.0623	34,500.8
Momento de reacción(N.m)	0	0	0	0

Nombre de carga	Cargar imagen	Detalles de carga
Fuerza-1		<p><b>Entidades:</b> 1 cara(s)  <b>Referencia:</b> Cara&lt; 1 &gt;  <b>Tipo:</b> Aplicar fuerza  <b>Valores:</b> 15,440; ---; -34,400 N</p>

## Información de malla

<b>Tipo de malla</b>	Malla sólida
<b>Mallador utilizado:</b>	Malla basada en curvatura de combinado
<b>Puntos jacobianos para malla de alta calidad</b>	16 Puntos
<b>Tamaño máximo de elemento</b>	7.17308 mm
<b>Tamaño mínimo del elemento</b>	2.391 mm
<b>Calidad de malla</b>	Elementos cuadráticos de alto orden

## Información de malla - Detalles

<b>Número total de nodos</b>	15142
<b>Número total de elementos</b>	8760
<b>Cociente máximo de aspecto</b>	4.2536
<b>% de elementos cuyo cociente de aspecto es &lt; 3</b>	99.3
<b>El porcentaje de elementos cuyo cociente de aspecto es &gt; 10</b>	0
<b>Porcentaje de elementos distorsionados</b>	0
<b>Tiempo para completar la malla (hh:mm:ss):</b>	00:00:02
<b>Nombre de computadora:</b>	ANDRES-YORY

## Fuerzas resultantes

### Fuerzas de reacción

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N	-15,440	34,400	-7.05719e-05	37,706.2

### Momentos de reacción

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N.m	0	0	0	0

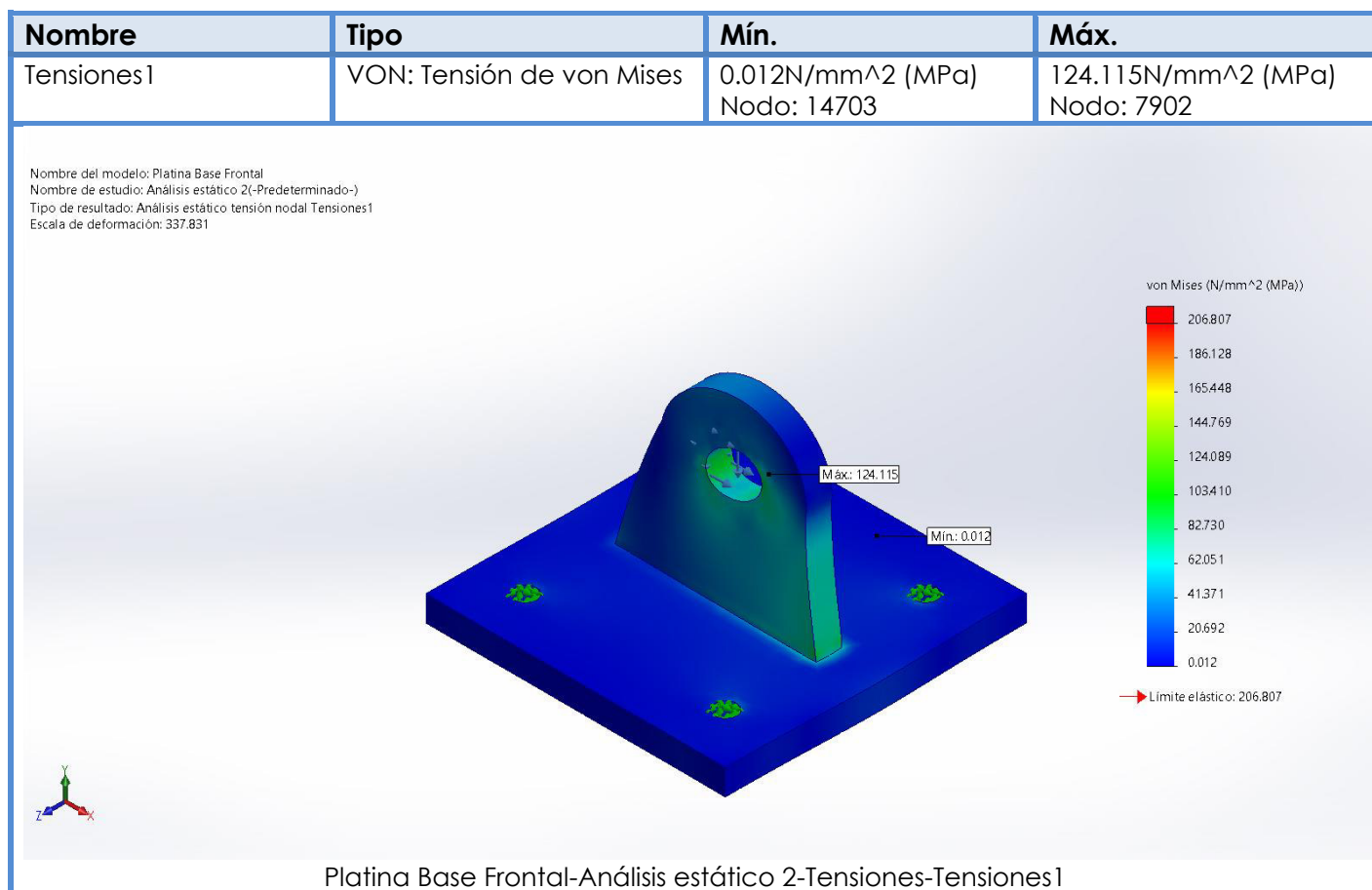
### Fuerzas de cuerpo libre

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N	0.00119019	0.00378847	5.14984e-05	0.00397136

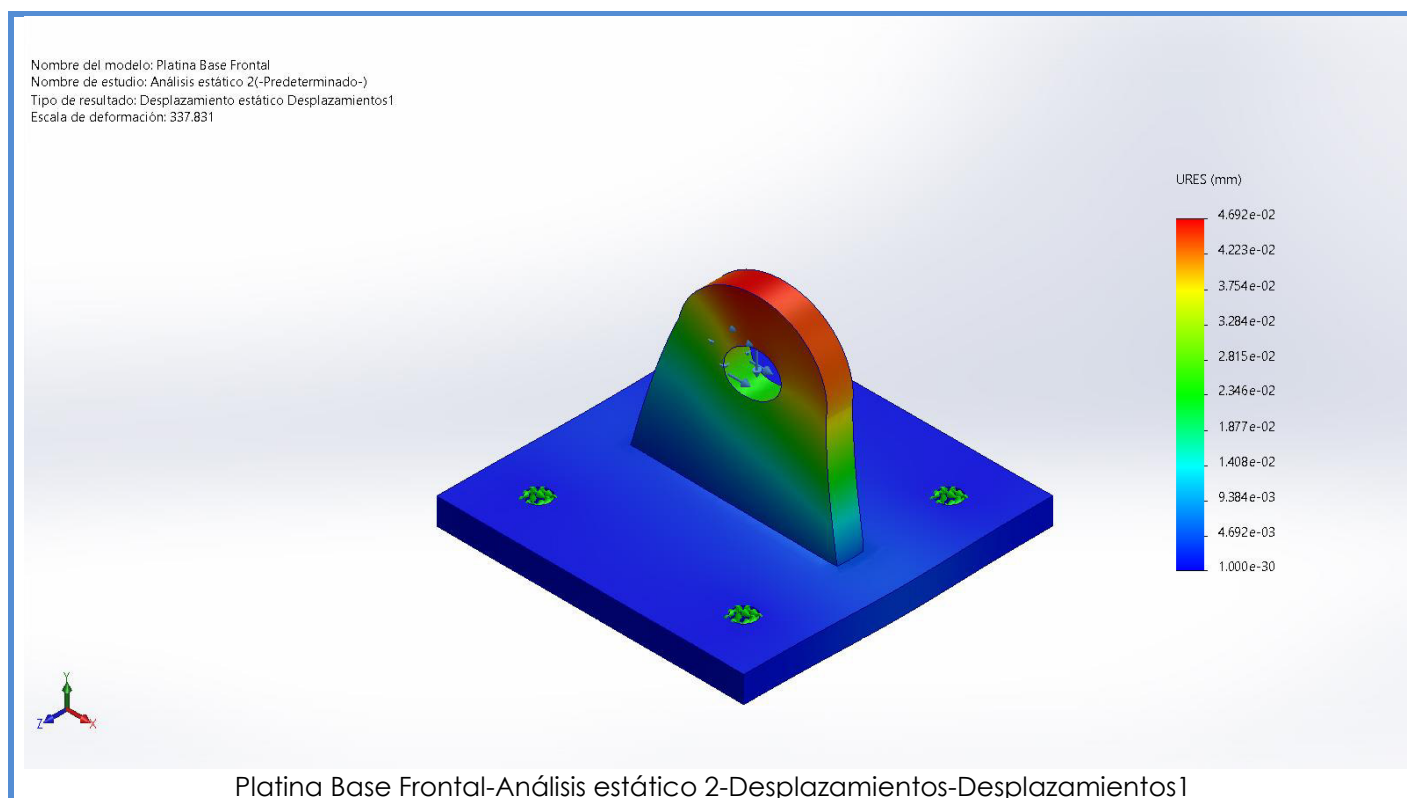
### Momentos de cuerpo libre

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N.m	0	0	0	1e-33

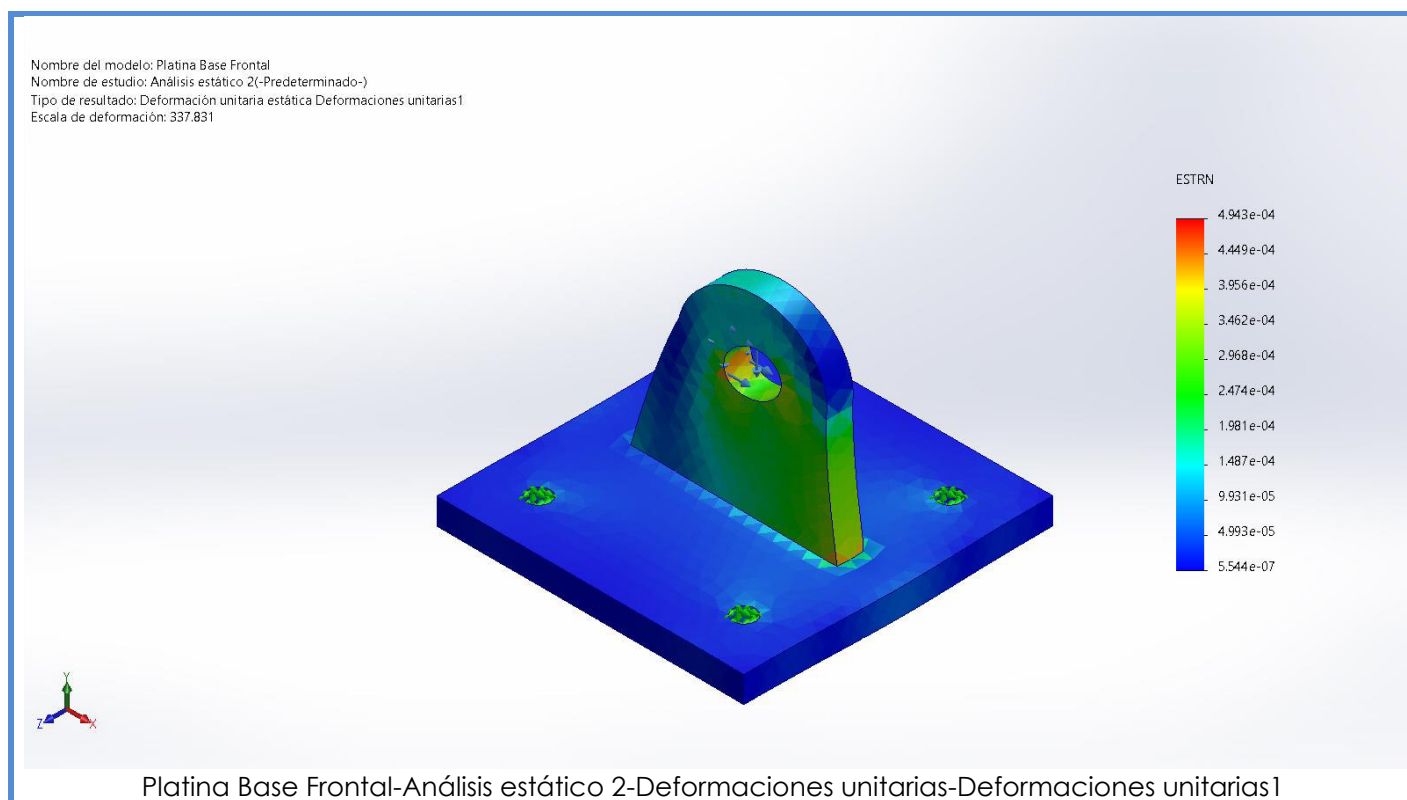
## Resultados del estudio



Nombre	Tipo	Mín.	Máx.
Desplazamientos1	URES: Desplazamientos resultantes	0.000e+00mm Nodo: 13	4.692e-02mm Nodo: 46

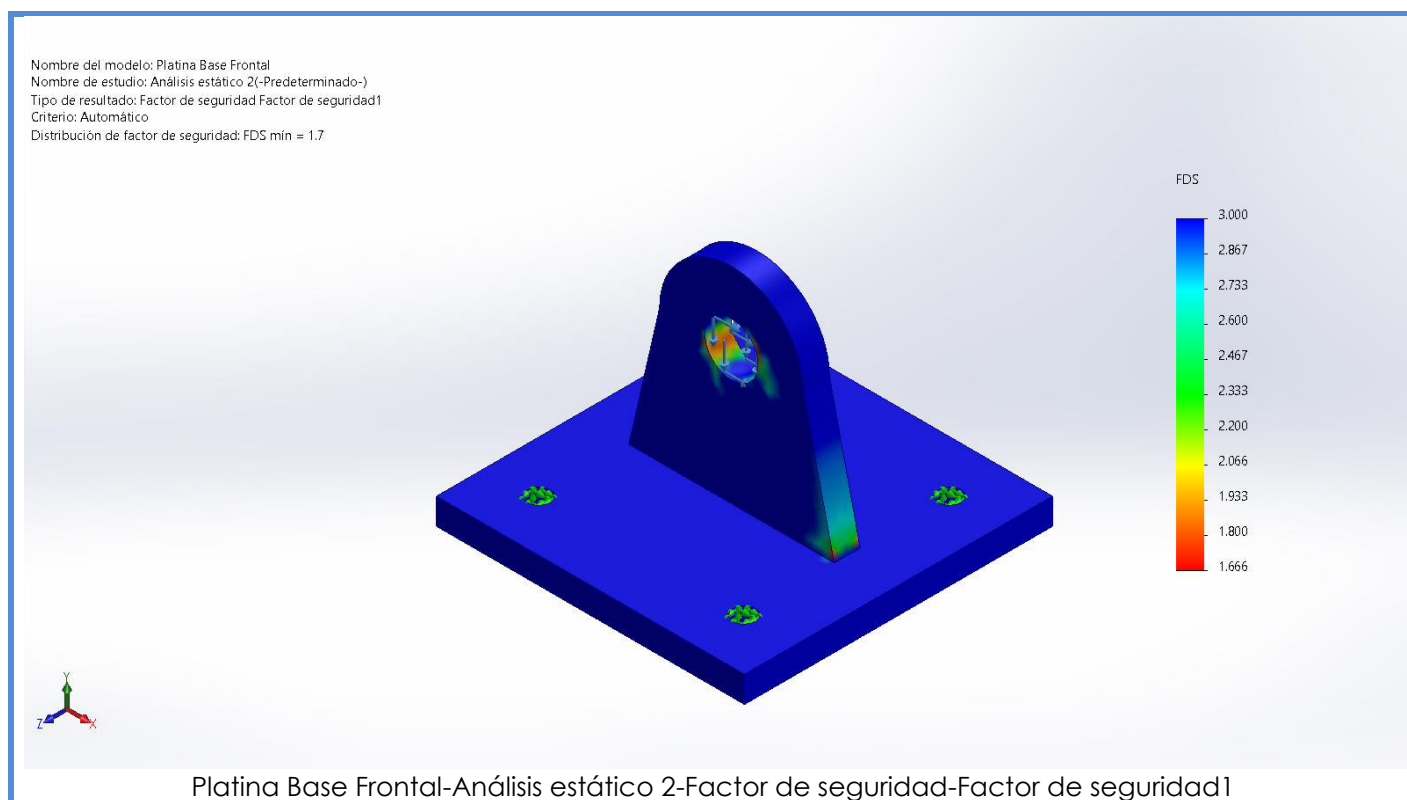


Nombre	Tipo	Mín.	Máx.
Deformaciones unitarias1	ESTRN: Deformación unitaria equivalente	5.544e-07 Elemento: 6640	4.943e-04 Elemento: 7439



Nombre	Tipo	Mín.	Máx.
Factor de seguridad1	Automático	1.666 Nodo: 7902	3.000 Nodo: 3





## Conclusión

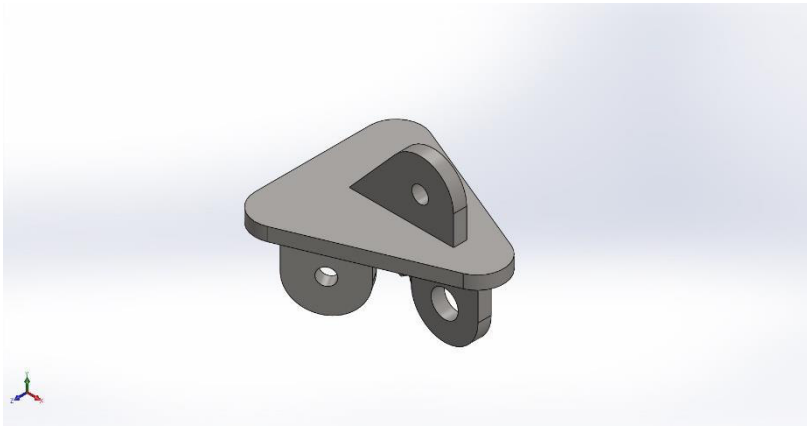
### Comentarios:

Sistema Competente para soportar un sistema de línea de vida horizontal certificado en conjunto con los demás componentes del tripode



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Diseños y Aplicaciones de Ingeniería Civil SAS  
[www.daicsas.com](http://www.daicsas.com)



## Simulación de Platina Corona

**Fecha:** miércoles, 22 de mayo de 2024

**Diseñador:** Mario Andrés Yory Rocha

**Nombre de estudio:** Análisis estático 1

**Tipo de análisis:** Análisis estático



Descripción

Platina Cabezal de Tripode para anclaje horizontal

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## Uso definido

### Comentarios:

El sistema se debe emplear unicamente como punto de anclaje para una linea de vida horizontal que asegure maximo 5000 lb de forma horizontal y 3600 lb de forma vertical

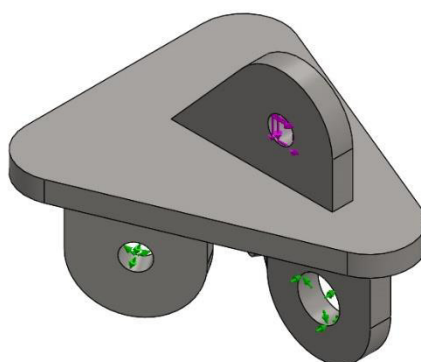


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Mario Andrés Yory Rocha  
22/05/2024

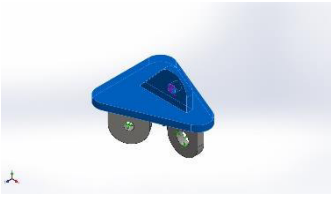
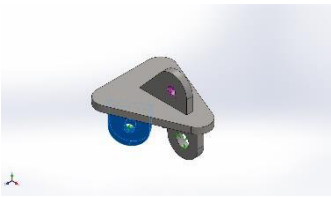
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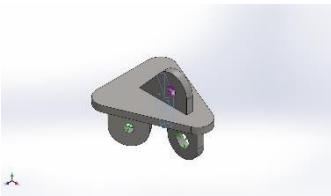
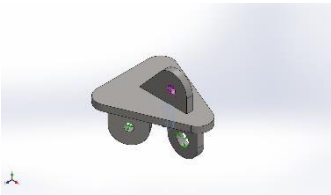
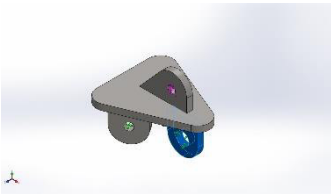
## Información de modelo



**Nombre del modelo:** Platina Corona  
**Configuración actual:** Predeterminado<Como mecanizada>

### Sólidos

Nombre de documento y referencia	Tratado como	Propiedades volumétricas	Ruta al documento/Fecha de modificación
Cortar-Extruir1 	Sólido	<b>Masa:</b> 2.35371 kg <b>Volumen:</b> 0.000294214 m <sup>3</sup> <b>Densidad:</b> 8,000 kg/m <sup>3</sup> <b>Peso:</b> 23.0664 N	C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID\Platina Corona.SLDPRT May 23 12:30:51 2023
Redondeo10 	Sólido	<b>Masa:</b> 0.390086 kg <b>Volumen:</b> 4.87608e-05 m <sup>3</sup> <b>Densidad:</b> 8,000 kg/m <sup>3</sup> <b>Peso:</b> 3.82285 N	C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID\Platina Corona.SLDPRT May 23 12:30:51 2023

<p>Redondeo9</p> 	Sólido	<p>Masa:0.390086 kg Volumen:4.87608e-05 m<sup>3</sup> Densidad:8,000 kg/m<sup>3</sup> Peso:3.82285 N</p>	<p>C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID\Platina Corona.SLDPRT May 23 12:30:51 2023</p>
<p>Saliente-Extruir11</p> 	Sólido	<p>Masa:0.0231648 kg Volumen:2.8956e-06 m<sup>3</sup> Densidad:8,000 kg/m<sup>3</sup> Peso:0.227015 N</p>	<p>C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID\Platina Corona.SLDPRT May 23 12:30:51 2023</p>
<p>Cortar-Extruir14</p> 	Sólido	<p>Masa:0.356572 kg Volumen:4.45715e-05 m<sup>3</sup> Densidad:8,000 kg/m<sup>3</sup> Peso:3.4944 N</p>	<p>C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID\Platina Corona.SLDPRT May 23 12:30:51 2023</p>

## Propiedades de estudio

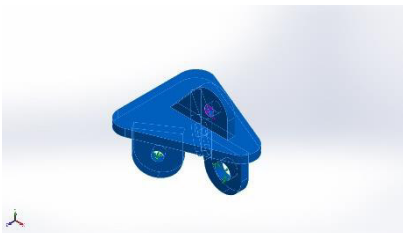
<b>Nombre de estudio</b>	Análisis estático 1
<b>Tipo de análisis</b>	Análisis estático
<b>Tipo de malla</b>	Malla sólida
<b>Efecto térmico:</b>	Activar
<b>Opción térmica</b>	Incluir cargas térmicas
<b>Temperatura a tensión cero</b>	298 Kelvin
<b>Incluir los efectos de la presión de fluidos desde SOLIDWORKS Flow Simulation</b>	Desactivar
<b>Tipo de solver</b>	Automático
<b>Efecto de rigidización por tensión (Inplane):</b>	Desactivar
<b>Muelle blando:</b>	Desactivar
<b>Desahogo inercial:</b>	Desactivar
<b>Opciones de unión rígida incompatibles</b>	Automático
<b>Gran desplazamiento</b>	Desactivar
<b>Calcular fuerzas de cuerpo libre</b>	Activar
<b>Fricción</b>	Desactivar
<b>Utilizar método adaptativo:</b>	Desactivar
<b>Carpeta de resultados</b>	Documento de SOLIDWORKS (C:\Users\mario\OneDrive\DAIC\DAIC\1. CLIENTES\34. ECOPETROL\CRL - ECOPETROL\MODELACIÓN SOLID)



## Unidades

<b>Sistema de unidades:</b>	Métrico (MKS)
<b>Longitud/Desplazamiento</b>	mm
<b>Temperatura</b>	Kelvin
<b>Velocidad angular</b>	Rad/seg
<b>Presión/Tensión</b>	N/m <sup>2</sup>

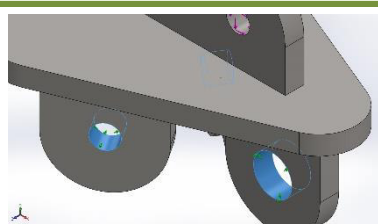
## Propiedades de material


Referencia de modelo	Propiedades	Componentes
	<p><b>Nombre:</b> AISI 304</p> <p><b>Tipo de modelo:</b> Isotrópico elástico lineal</p> <p><b>Criterio de error predeterminado:</b> Desconocido</p> <p><b>Límite elástico:</b> 2.06807e+08 N/m<sup>2</sup></p> <p><b>Límite de tracción:</b> 5.17017e+08 N/m<sup>2</sup></p> <p><b>Módulo elástico:</b> 1.9e+11 N/m<sup>2</sup></p> <p><b>Coefficiente de Poisson:</b> 0.29</p> <p><b>Densidad:</b> 8,000 kg/m<sup>3</sup></p> <p><b>Módulo cortante:</b> 7.5e+10 N/m<sup>2</sup></p> <p><b>Coefficiente de dilatación térmica:</b> 1.8e-05 /Kelvin</p>	<p>Sólido 2(Cortar-Extruir1)(Platina Corona), Sólido 12(Redondeo10)(Platina Corona), Sólido 14(Redondeo9)(Platina Corona), Sólido 16(Saliente-Extruir11)(Platina Corona), Sólido 19(Cortar-Extruir14)(Platina Corona)</p>
Datos de curva:N/A		

### Comentarios:

Fabricación en Acero Inoxidable con un limite de fluencia minimo de 206 MPa

## Cargas y sujeciones

Nombre de sujeción	Imagen de sujeción	Detalles de sujeción		
Bisagra fija-6		<b>Entidades:</b> 3 cara(s) <b>Tipo:</b> Bisagra fija		
<b>Fuerzas resultantes</b>				
Componentes	X	Y	Z	Resultante
Fuerza de reacción(N)	-22,242.4	16,015.1	-0.0931149	27,408.2
Momento de reacción(N.m)	0	0	0	0

Nombre de carga	Cargar imagen	Detalles de carga		
Fuerza-1		<b>Entidades:</b> 1 cara(s) <b>Referencia:</b> Cara< 1 > <b>Tipo:</b> Aplicar fuerza <b>Valores:</b> 5,000; ---; -3,600 lbf		

### Comentarios:

Conexión a través de Pasadores Inoxidables  
Cargas de Diseño:

- 5000 lb (horizontal)
- 3600 lb (vertical)

## Información de malla

<b>Tipo de malla</b>	Malla sólida
<b>Mallador utilizado:</b>	Malla basada en curvatura de combinado
<b>Puntos jacobianos para malla de alta calidad</b>	16 Puntos
<b>Tamaño máximo de elemento</b>	5.73609 mm
<b>Tamaño mínimo del elemento</b>	1.91201 mm
<b>Calidad de malla</b>	Elementos cuadráticos de alto orden

## Información de malla - Detalles

<b>Número total de nodos</b>	35145
<b>Número total de elementos</b>	21468
<b>Cociente máximo de aspecto</b>	5.6734
<b>% de elementos cuyo cociente de aspecto es &lt; 3</b>	99.8
<b>El porcentaje de elementos cuyo cociente de aspecto es &gt; 10</b>	0
<b>Porcentaje de elementos distorsionados</b>	0
<b>Tiempo para completar la malla (hh:mm:ss):</b>	00:00:03
<b>Nombre de computadora:</b>	ANDRES-YORY

## Fuerzas resultantes

### Fuerzas de reacción

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N	-22,242.4	16,015.1	-0.0931149	27,408.2

### Momentos de reacción

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N.m	0	0	0	0

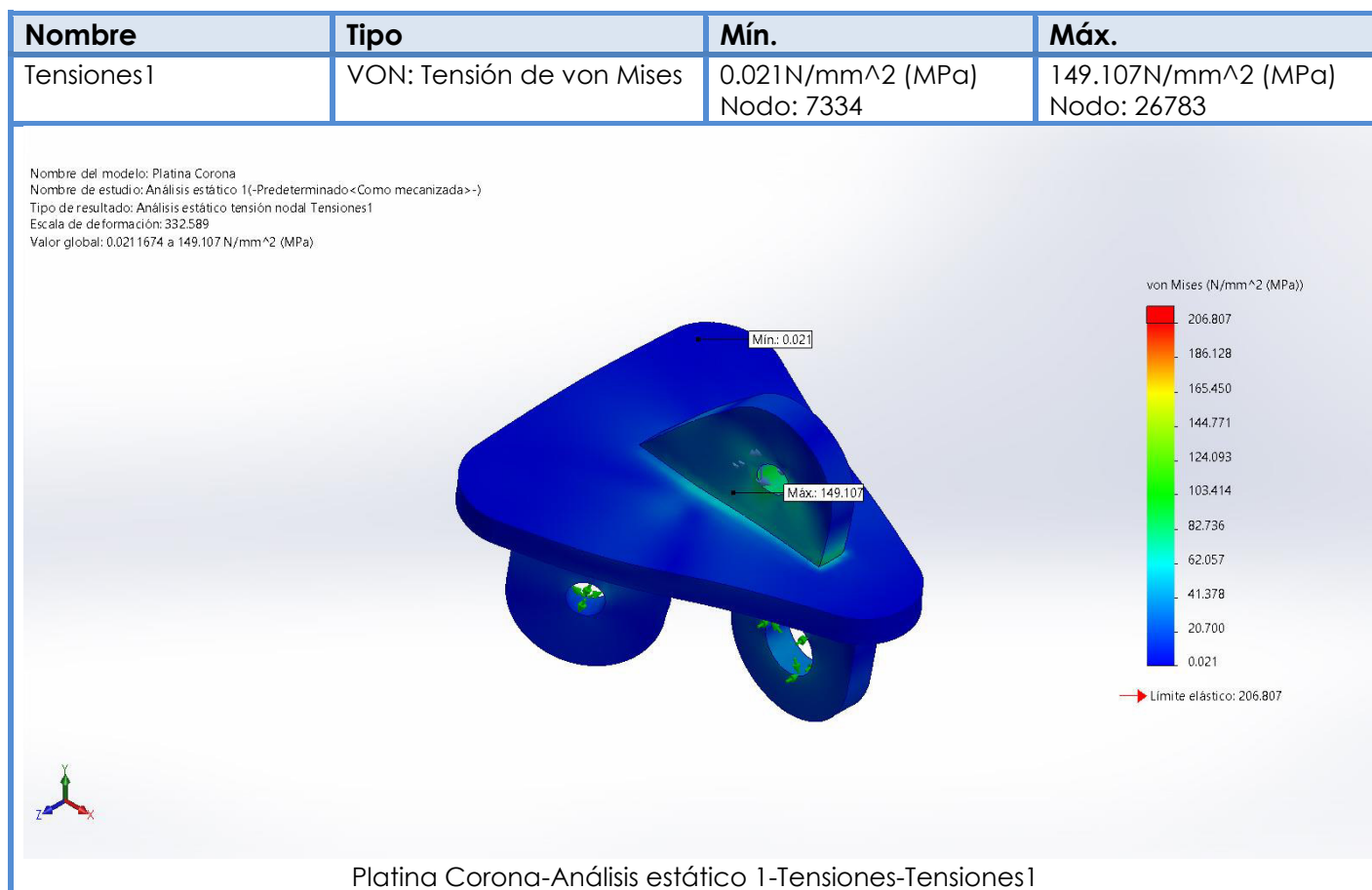
### Fuerzas de cuerpo libre

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N	-0.0982879	1.10392	2.58198	2.80979

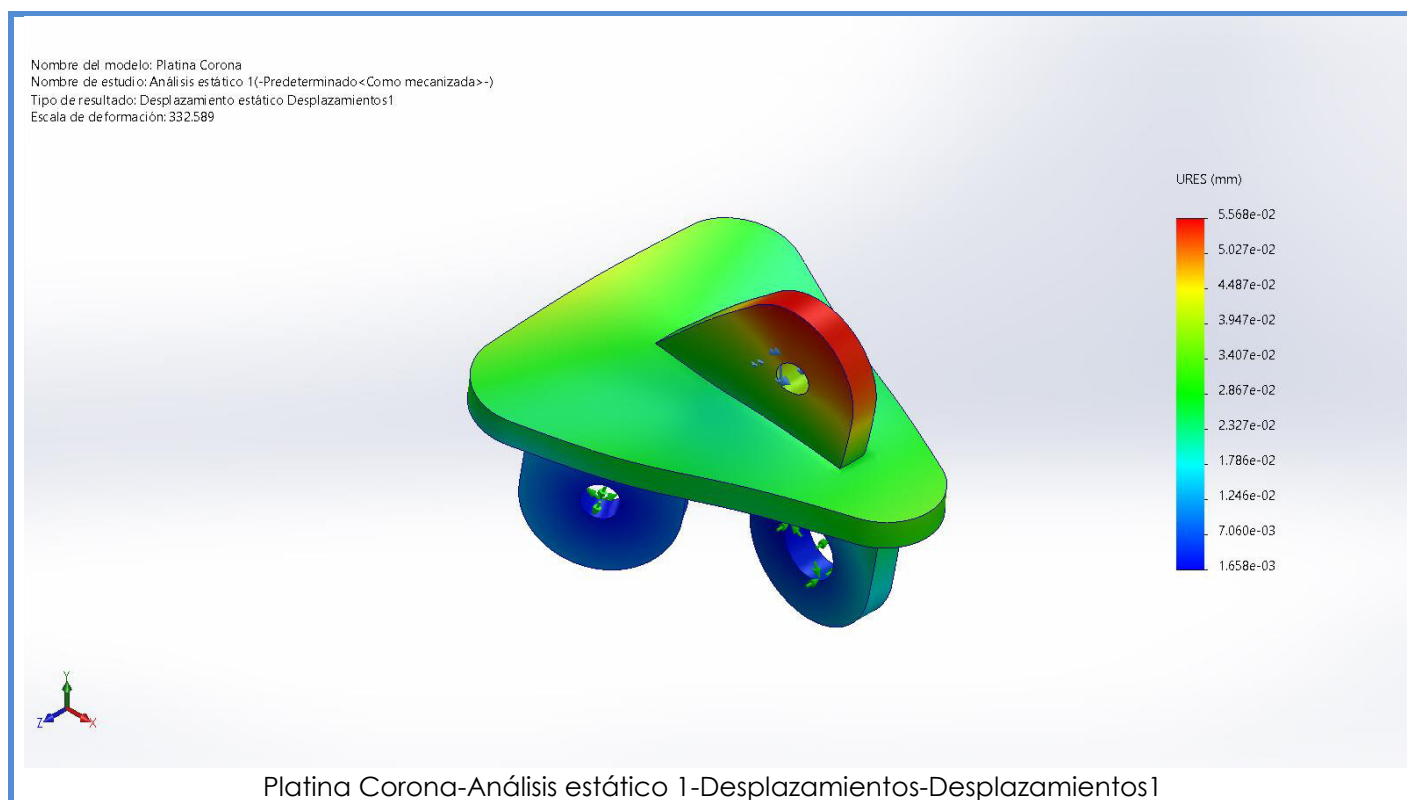
### Momentos de cuerpo libre

Conjunto de selecciones	Unidades	Sum X	Sum Y	Sum Z	Resultante
Todo el modelo	N.m	0	0	0	1e-33

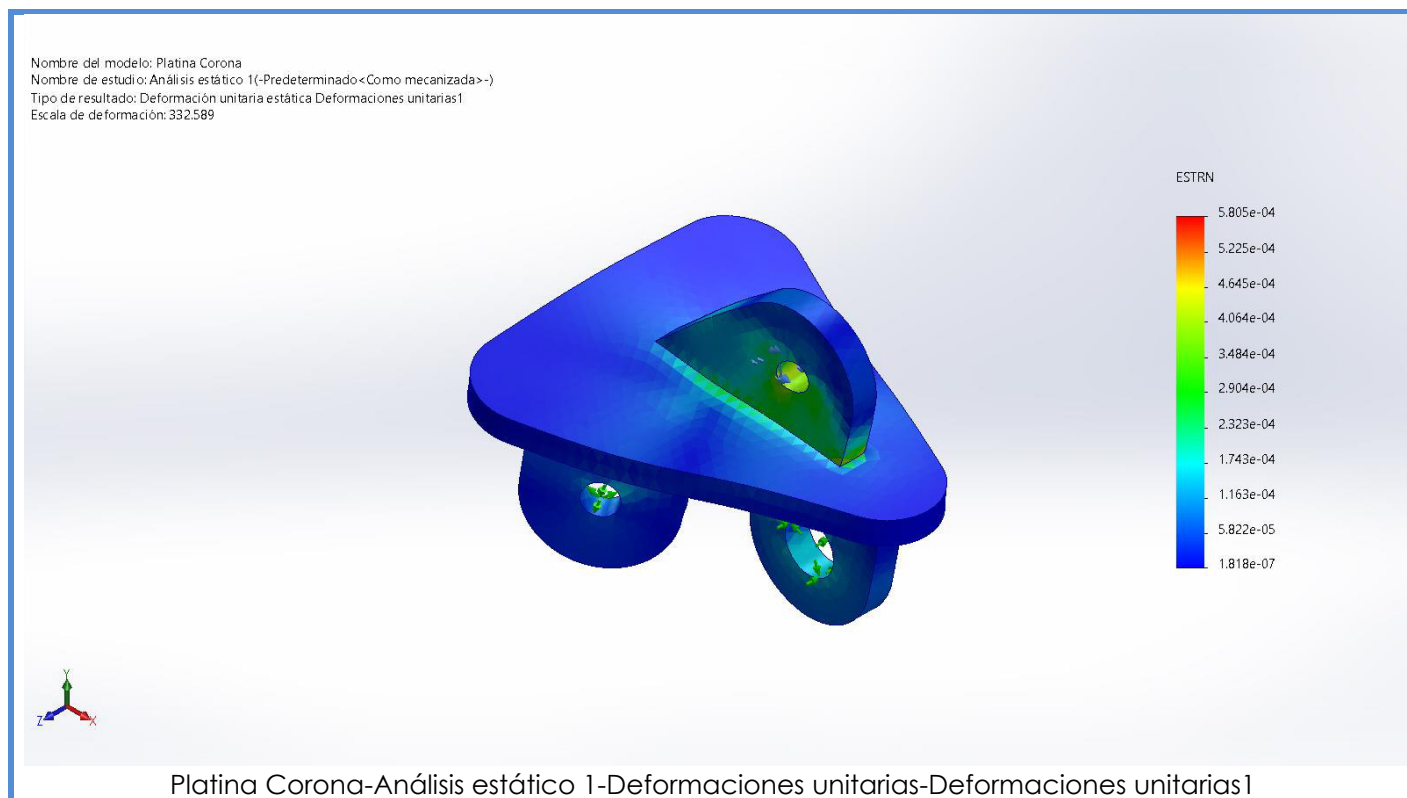
## Resultados del estudio



Nombre	Tipo	Mín.	Máx.
Desplazamientos1	URES: Desplazamientos resultantes	1.658e-03mm Nodo: 22440	5.568e-02mm Nodo: 11433



Nombre	Tipo	Mín.	Máx.
Deformaciones unitarias1	ESTRN: Deformación unitaria equivalente	1.818e-07 Elemento: 1609	5.805e-04 Elemento: 21107



Nombre	Tipo	Mín.	Máx.
Factor de seguridad1	Automático	1.387 Nodo: 26783	3.000 Nodo: 2

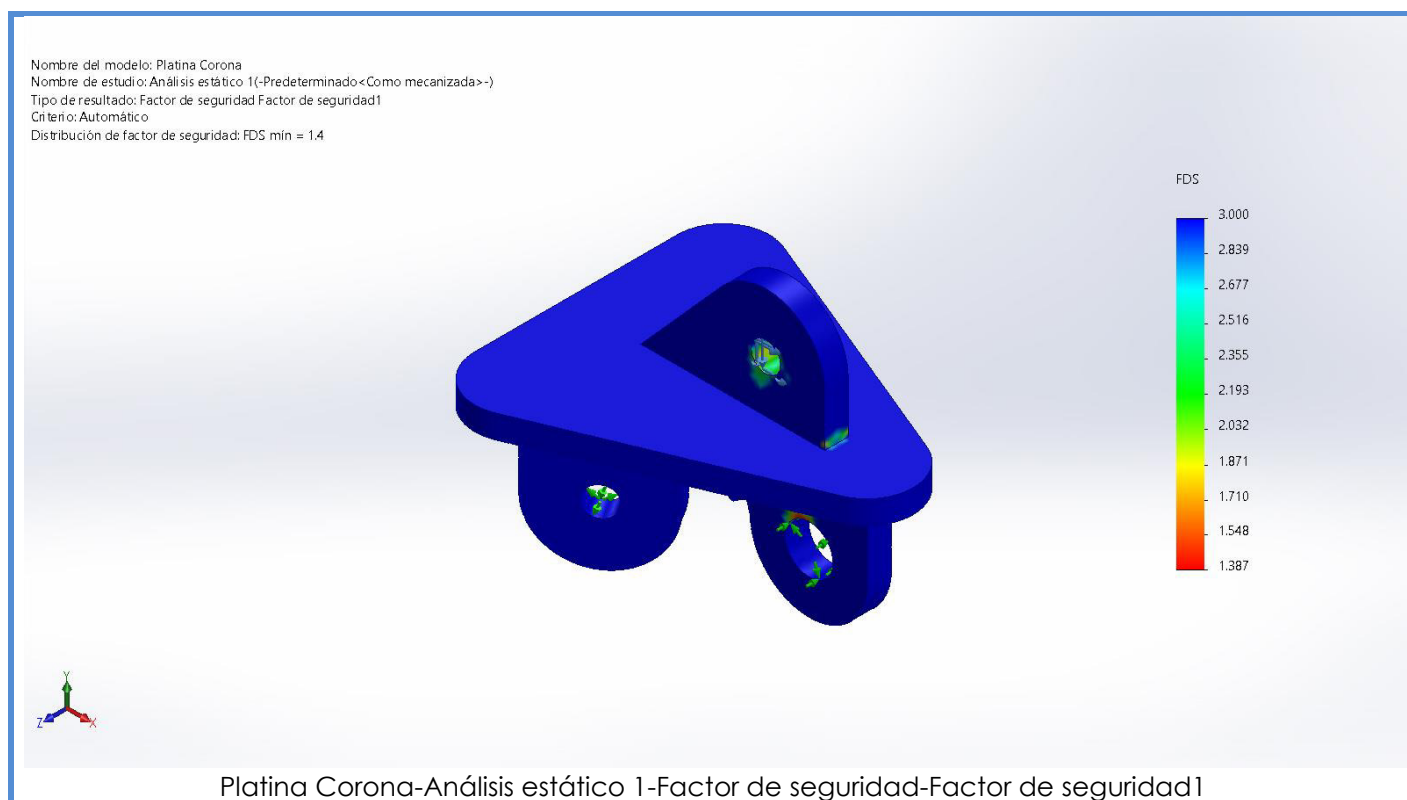


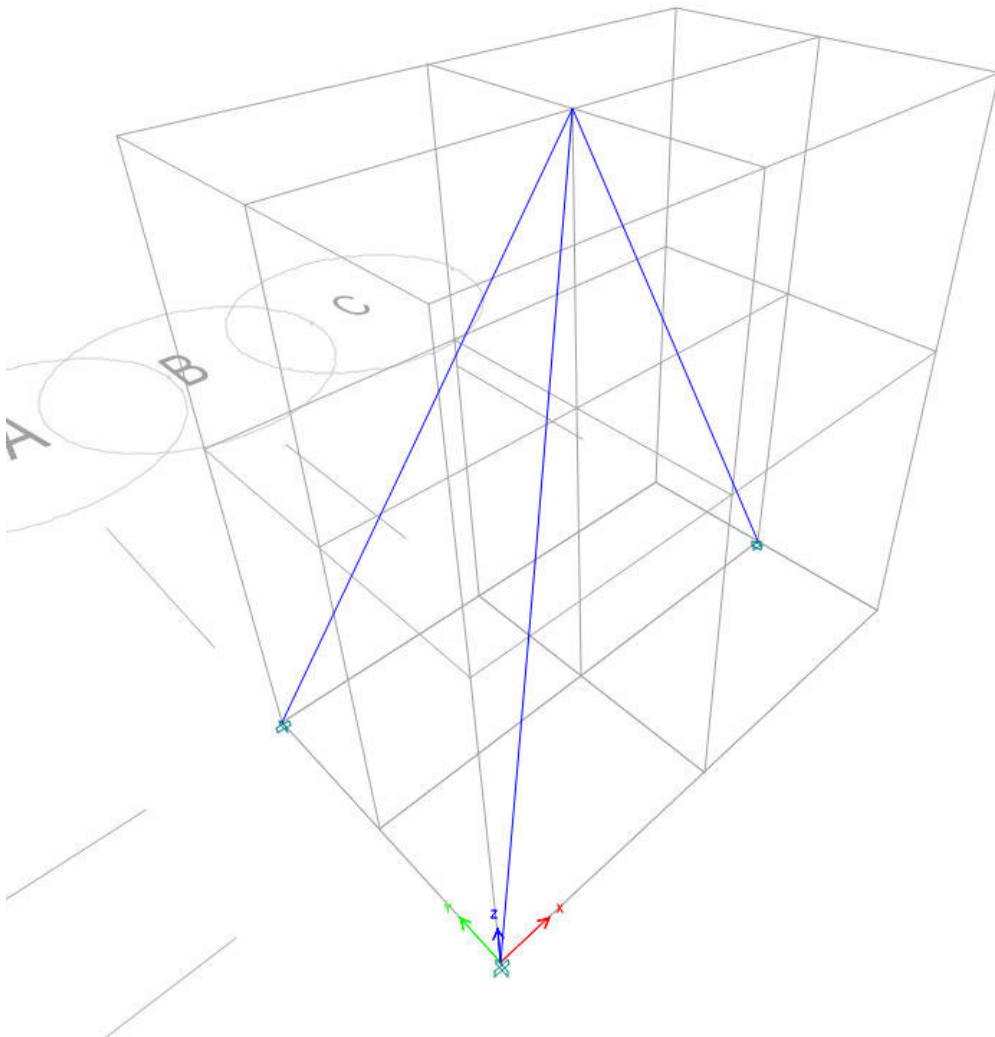
Imagen-1

## Conclusión

### Comentarios:

Sistema Competente para soportar un sistema de línea de vida horizontal certificado en conjunto con los demás componentes del tripode





## **Reporte de Analisis y Diseno de Mastil - 1.75 m**

Model File: MASTIL 1, Revision 0  
22/05/2024

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# 1 Structure Data

This chapter provides model geometry information, including items such as story levels, point coordinates, and element connectivity.

## 1.1 Story Data

**Table 1.1 - Story Definitions**

Tower	Name	Height m	Master Story	Similar To	Splice Story	Color
T1	Story2	0.75	Yes	None	No	Yellow
T1	Story1	1	No	Story2	No	Gray8Dark

## 1.2 Grid Data

**Table 1.2 - Grid Definitions - General**

Tower	Name	Type	Ux m	Uy m	Rz deg	Story Range	Bubble Size mm	Color
T1	G1	Cartesian	0	0	0	Default	1250	Gray6

**Table 1.3 - Grid Definitions - Grid Lines**

Name	Grid Line Type	ID	Ordinate m	Bubble Location	Visible
G1	X (Cartesian)	A	0	End	Yes
G1	X (Cartesian)	B	0.75	End	Yes
G1	X (Cartesian)	C	1.65	End	Yes
G1	Y (Cartesian)	1	0	Start	Yes
G1	Y (Cartesian)	2	0.5	Start	Yes
G1	Y (Cartesian)	3	1	Start	Yes

## 1.3 Point Coordinates

**Table 1.4 - Point Bays**

Label	Is Auto Point	X m	Y m	DZBelow m
1	No	0	0	0
2	No	0.75	0.5	0
3	No	0	1	0
4	No	0.375	0.75	0.125
5	No	0.375	0.25	0.125
6	No	1.2	0.5	0.125
8	No	1.65	0.5	0

## 1.4 Line Connectivity

**Table 1.5 - Brace Bays**

Label	PointBayI	PointBayJ	IEndStory
D4	3	4	Below
D5	4	2	Below
D6	1	5	Below
D7	5	2	Below
D8	8	6	Below
D9	6	2	Below

## 1.5 Mass

**Table 1.6 - Mass Source Definition**

Name	Is Default	Include Lateral Mass?	Include Vertical Mass?	Lump Mass?	Source Self Mass?	Source Added Mass?	Source Load Patterns?	Move Mass Centroid?
MsSrc1	Yes	Yes	No	Yes	Yes	Yes	No	No

**Table 1.7 - Mass Summary by Story**

Story	UX kg	UY kg	UZ kg
Story2	5.98	5.98	0
Story1	0	0	0
Base	17.93	17.93	0

**Table 1.8 - Mass Summary by Group**

Group	Self Mass kg	Self Weight kN	Mass X kg	Mass Y kg	Mass Z kg
All	23.91	0	23.91	23.91	0

## 1.6 Groups

**Table 1.9 - Group Definitions**

Name	Color	Steel Design?	Concrete Design?	Composite Design?
All	Yellow	No	No	No

## 2 Properties

This chapter provides property information for materials, frame sections, shell sections, and links.

### 2.1 Materials

**Table 2.1 - Material Properties - General**

Material	Type	SymType	Grade	Color	Notes
4000Psi	Concrete	Isotropic	fc 4000 psi	Gray8Dark	
A36	Steel	Isotropic	Grade 36	Green	
A416Gr270	Tendon	Uniaxial	Grade 270	Green	
A500GrB46	Steel	Isotropic	Grade B, Fy 46 (HSS Rect.)	Magenta	
A53GrB	Steel	Isotropic	Grade B	Yellow	
A615Gr60	Rebar	Uniaxial	Grade 60	Blue	
A992Fy50	Steel	Isotropic	Grade 50	Yellow	
Acero Inoxidable A304	Steel	Isotropic	A304	Cyan	

**Table 2.2 - Material Properties - Steel Data (Part 1 of 2)**

Material	Fy MPa	Fu MPa	Fye MPa	Fue MPa	SSCurveOpt	SSHysType	SHard mm/mm	SMax mm/mm	SRup mm/mm
A36	248.21	399.9	372.32	439.89	Simple	Kinematic	0.02	0.14	0.2
A500GrB46	317.16	399.9	348.87	439.89	Simple	Kinematic	0.018	0.12	0.18
A53GrB	241.32	413.69	265.45	455.05	Simple	Kinematic	0.02	0.14	0.2
A992Fy50	344.74	448.16	379.21	492.98	Simple	Kinematic	0.015	0.11	0.17
Acero Inoxidable A304	205	515	205	515	Simple	Kinematic	0.015	0.11	0.17

**Table 2.2 - Material Properties - Steel Data (Part 2 of 2)**

Material	FinalSlope
A36	-0.1
A500GrB46	-0.1
A53GrB	-0.1
A992Fy50	-0.1
Acero Inoxidable A304	-0.1

**Table 2.3 - Material Properties - Concrete Data**

Material	Fc MPa	LtWtConc	IsUserFr	SSCurveOpt	SSHysType	SFc mm/mm	SCap mm/mm	FinalSlope	FAngle deg	DAngle deg
4000Psi	27.58	No	No	Mander	Concrete	0.002219	0.005	-0.1	0	0

**Table 2.4 - Material Properties - Rebar Data**

Material	Fy MPa	Fu MPa	Fye MPa	Fue MPa	SSCurveOpt	SSHysType	SHard mm/mm	SCap mm/mm	FinalSlope
A615Gr60	413.69	620.53	455.05	682.58	Simple	Kinematic	0.01	0.09	-0.1

**Table 2.5 - Material Properties - Tendon Data**

Material	Fy MPa	Fu MPa	SSCurveOpt	SSHysType	FinalSlope
A416Gr270	1689.91	1861.58	270 ksi	Kinematic	-0.1

## 2.2 Frame Sections

Table 2.6 - Frame Section Property Definitions - Summary (Part 1 of 4)

Name	Material	Shape	Color	Area cm <sup>2</sup>	J cm <sup>4</sup>	I33 cm <sup>4</sup>	I22 cm <sup>4</sup>	I23 cm <sup>4</sup>	IMajor cm <sup>4</sup>
L1.5x1.5x1/8	A36	Steel Angle	Gray8Dark	2.3	0.1	3.1	3.1	1.8	4.9
PL 2"x1/4"	Acero Inoxidable A304	Steel Plate	Red	3.2	0.4	0.1	6.9		
PTE 2X2X2.5	A500GrB46	Steel Tube	Red	4.7	28.2	17.8	17.8		
PTE 3X3X2.5	A500GrB46	Steel Tube	Cyan	7.2	100.1	64.4	64.4		
PTE2X2X2	A500GrB46	Steel Tube	Magenta	3.8	23.2	14.9	14.9		
SCH 40 1.5"	Acero Inoxidable A304	Steel Pipe	Magenta	5.2	25.8	12.9	12.9		

Table 2.6 - Frame Section Property Definitions - Summary (Part 2 of 4)

Name	IMinor cm <sup>4</sup>	MajorAngle deg	As2 cm <sup>2</sup>	As3 cm <sup>2</sup>	S33Pos cm <sup>3</sup>	S33Neg cm <sup>3</sup>	S22Pos cm <sup>3</sup>	S22Neg cm <sup>3</sup>	Z33 cm <sup>3</sup>	Z22 cm <sup>3</sup>	R33 mm
L1.5x1.5x1/8	1.3	-45	1.1	1.1	1.1	3	3	1.1	2	2	11.7
PL 2"x1/4"			2.7	2.7	0.3	0.3	2.7	2.7	0.5	4.1	1.8
PTE 2X2X2.5			2.4	2.4	7	7	7	7	8.3	8.3	19.5
PTE 3X3X2.5			3.7	3.7	16.9	16.9	16.9	16.9	19.7	19.7	29.9
PTE2X2X2			2	1.9	5.8	5.8	5.8	5.8	6.9	6.9	19.8
SCH 40 1.5"			2.6	2.6	5.3	5.3	5.3	5.3	7.3	7.3	15.8

Table 2.6 - Frame Section Property Definitions - Summary (Part 3 of 4)

Name	Cw cm <sup>6</sup>	Fillet Radius mm	CG Offset 3 mm	CG Offset 2 mm	PNA Offset 3 mm	PNA Offset 2 mm	SC Offset 3 mm	SC Offset 2 mm	Area Modifier	As2 Modifier	As3 Modifier
L1.5x1.5x1/8	0.1	6	8.7	-8.7	16.1	-16.1	17.4	-17.4	1	1	1
PL 2"x1/4"			0	0	0	0			1	1	1
PTE 2X2X2.5		5	0	0	0	0			1	1	1
PTE 3X3X2.5		5	0	0	0	0			1	1	1
PTE2X2X2		4	0	0	0	0			1	1	1
SCH 40 1.5"			0	0	0	0			1	1	1

Table 2.6 - Frame Section Property Definitions - Summary (Part 4 of 4)

Name	I33 Modifier	I22 Modifier	Mass Modifier	Weight Modifier
L1.5x1.5x1/8	1	1	1	1
PL 2"x1/4"	1	1	1	1
PTE 2X2X2.5	1	1	1	1
PTE 3X3X2.5	1	1	1	1
PTE2X2X2	1	1	1	1
SCH 40 1.5"	1	1	1	1

Table 2.7 - Frame Section Property Definitions - Steel Angle (Part 1 of 2)

Name	Material	From File?	Total Depth mm	Total Width mm	Horizontal Leg Thickness mm	Vertical Leg Thickness mm	Fillet Radius mm	Mirror About 2-axis	Mirror About 3-axis	Area Modifier
L1.5x1.5x1/8	A36	No	38.1	38.1	3	3	6	No	No	1

Table 2.7 - Frame Section Property Definitions - Steel Angle (Part 2 of 2)

Name	As2 Modifier	As3 Modifier	J Modifier	I22 Modifier	I33 Modifier	Mass Modifier	Weight Modifier	Color	Notes
L1.5x1.5x1/8	1	1	1	1	1	1	1	Gray8Dark	

Table 2.8 - Frame Section Property Definitions - Steel Pipe (Part 1 of 2)

Name	Material	From File?	Outside Diameter mm	Wall Thickness mm	Area Modifier	As2 Modifier	As3 Modifier	J Modifier
SCH 40 1.5"	Acero Inoxidable A304	No	48.3	3.7	1	1	1	1

Table 2.8 - Frame Section Property Definitions - Steel Pipe (Part 2 of 2)

Name	I22 Modifier	I33 Modifier	Mass Modifier	Weight Modifier	Color	Notes
SCH 40 1.5"	1	1	1	1	Magenta	

Table 2.9 - Frame Section Property Definitions - Steel Plate (Part 1 of 2)

Name	Material	Depth mm	Width mm	Area Modifier	As2 Modifier	As3 Modifier	J Modifier	I22 Modifier	I33 Modifier
PL 2"x1/4"	Acero Inoxidable A304	6.4	50.8	1	1	1	1	1	1

Table 2.9 - Frame Section Property Definitions - Steel Plate (Part 2 of 2)

Name	Mass Modifier	Weight Modifier	Color	Notes
PL 2"x1/4"	1	1	Red	

Table 2.10 - Frame Section Property Definitions - Steel Tube (Part 1 of 2)

Name	Material	From File?	Total Depth mm	Total Width mm	Flange Thickness mm	Web Thickness mm	Corner Radius mm	Area Modifier	As2 Modifier
PTE 2X2X2.5	A500GrB46	No	50.8	50.8	2.5	2.5	5	1	1
PTE 3X3X2.5	A500GrB46	No	76.2	76.2	2.5	2.5	5	1	1
PTE2X2X2	A500GrB46	No	50.8	50.8	2	2	4	1	1

Table 2.10 - Frame Section Property Definitions - Steel Tube (Part 2 of 2)

Name	As3 Modifier	J Modifier	I22 Modifier	I33 Modifier	Mass Modifier	Weight Modifier	Color	Notes
PTE 2X2X2.5	1	1	1	1	1	1	Red	
PTE 3X3X2.5	1	1	1	1	1	1	Cyan	
PTE2X2X2	1	1	1	1	1	1	Magenta	



### 3 Assignments

This chapter provides a listing of the assignments applied to the model.

#### 3.1 Joint Assignments

**Table 3.1 - Joint Assignments - Summary**

Story	Label	UniqueName	Diaphragm	Restraints
Story2	2	2	From Area	
Story1	4	5	From Area	
Story1	5	6	From Area	
Story1	6	7	From Area	
Base	1	3	From Area	UX; UY; UZ; RX; RY; RZ
Base	3	1	From Area	UX; UY; UZ; RX; RY; RZ
Base	8	4	From Area	UX; UY; UZ; RX; RY; RZ

**Table 3.2 - Joint Assignments - Restraints**

Story	Label	UniqueName	UX	UY	UZ	RX	RY	RZ
Base	1	3	Yes	Yes	Yes	Yes	Yes	Yes
Base	3	1	Yes	Yes	Yes	Yes	Yes	Yes
Base	8	4	Yes	Yes	Yes	Yes	Yes	Yes

#### 3.2 Frame Assignments

**Table 3.3 - Frame Assignments - Summary**

Story	Label	UniqueName	Design Type	Length m	Analysis Section	Design Section	Min Number Stations	Releases
Story2	D5	5	Brace	0.9843	SCH 40 1.5"	SCH 40 1.5"	3	
Story2	D7	7	Brace	0.9843	SCH 40 1.5"	SCH 40 1.5"	3	
Story2	D9	9	Brace	0.9839	SCH 40 1.5"	SCH 40 1.5"	3	
Story1	D4	4	Brace	0.9843	SCH 40 1.5"	SCH 40 1.5"	3	Yes
Story1	D6	6	Brace	0.9843	SCH 40 1.5"	SCH 40 1.5"	3	
Story1	D8	8	Brace	0.9839	SCH 40 1.5"	SCH 40 1.5"	3	Yes

**Table 3.4 - Frame Assignments - Section Properties**

Story	Label	UniqueName	Shape	Auto Select List	Section Property
Story2	D5	5	Steel Pipe	N.A.	SCH 40 1.5"
Story2	D7	7	Steel Pipe	N.A.	SCH 40 1.5"
Story2	D9	9	Steel Pipe	N.A.	SCH 40 1.5"
Story1	D4	4	Steel Pipe	N.A.	SCH 40 1.5"
Story1	D6	6	Steel Pipe	N.A.	SCH 40 1.5"
Story1	D8	8	Steel Pipe	N.A.	SCH 40 1.5"

## 4 Loads

This chapter provides loading information as applied to the model.

### 4.1 Load Patterns

**Table 4.1 - Load Pattern Definitions**

Name	Is Auto Load	Type	Self Weight Multiplier
~LLRF	Yes	Other	0
Dead	No	Dead	1
Live	No	Live	0

### 4.2 Applied Loads

#### 4.2.1 Point Loads

**Table 4.2 - Joint Loads Assignments - Force**

Story	Label	UniqueName	Load Pattern	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X Dimension mm	Y Dimension mm
Story2	2	2	Live	22.2411	0	-16.0136	0	0	0	0	0

### 4.3 Load Cases

**Table 4.3 - Load Case Definitions - Summary**

Name	Type
Dead	Linear Static
Live	Linear Static
Modal	Modal - Eigen

### 4.4 Load Combinations

**Table 4.4 - Load Combination Definitions**

Name	Type	Is Auto	Load Name	SF	Notes
Comb1	Linear Add	No	Dead	1.2	
Comb1			Live	1	

## 5 Analysis Results

This chapter provides analysis results.

### 5.1 Structure Results

**Table 5.1 - Base Reactions**

Output Case	Case Type	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X m	Y m	Z m
Dead	LinStatic	0	0	0.2344	0.1172	-0.1524	0	0	0	0
Live	LinStatic	-22.2411	0	16.0136	8.0068	-50.9321	11.1206	0	0	0
Comb1	Combination	-22.2411	0	16.2949	8.1475	-51.115	11.1206	0	0	0

### 5.2 Story Results

**Table 5.2 - Story Drifts**

Story	Output Case	Case Type	Direction	Drift	Label	X m	Y m	Z m
Story2	Dead	LinStatic	X	7.4E-05	2	0.75	0.5	1.75
Story2	Dead	LinStatic	Y	4.7E-05	2	0.75	0.5	1.75
Story2	Live	LinStatic	X	0.000732	2	0.75	0.5	1.75
Story2	Comb1	Combination	X	0.000643	2	0.75	0.5	1.75

### 5.3 Point Results

**Table 5.3 - Joint Reactions**

Story	Label	Unique Name	Output Case	Case Type	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Base	1	3	Dead	LinStatic	0.0147	0.0109	0.0758	0.0031	-0.0055	0.0005
Base	1	3	Live	LinStatic	-3.1974	-2.121	-7.4185	0.0016	-0.0234	0.0058
Base	1	3	Comb1	Combination	-3.1798	-2.108	-7.3275	0.0053	-0.0299	0.0063
Base	3	1	Dead	LinStatic	0.0166	-0.0112	0.0696	0	0	0
Base	3	1	Live	LinStatic	-3.1803	2.1193	-7.4217	0	0	0
Base	3	1	Comb1	Combination	-3.1603	2.1059	-7.3382	0	0	0
Base	8	4	Dead	LinStatic	-0.0313	0.0003	0.089	0	0	0
Base	8	4	Live	LinStatic	-15.8634	0.0017	30.8538	0	0	0
Base	8	4	Comb1	Combination	-15.901	0.0021	30.9606	0	0	0

**Table 5.4 - Joint Displacements**

Story	Label	Unique Name	Output Case	Case Type	Ux mm	Uy mm	Uz mm	Rx rad	Ry rad	Rz rad
Story2	2	2	Dead	LinStatic	0.001	-0.0002296	-0.001	-1.9E-05	-3.5E-05	-6E-06
Story2	2	2	Live	LinStatic	1.269	0.0002015	-0.312	-3.1E-05	0.000749	-0.000178
Story2	2	2	Comb1	Combination	1.269	-7.408E-05	-0.313	-5.5E-05	0.000707	-0.000185
Story1	4	5	Dead	LinStatic	0.066	-0.041	-0.041	-1.9E-05	-2.4E-05	-3E-06
Story1	4	5	Live	LinStatic	0.629	0.025	-0.146	-0.000105	0.000722	-0.000154
Story1	4	5	Comb1	Combination	0.707	-0.025	-0.195	-0.000128	0.000693	-0.000158
Story1	5	6	Dead	LinStatic	0.034	0.014	-0.019	-1E-06	5E-06	-1.3E-05
Story1	5	6	Live	LinStatic	0.459	0.01	-0.084	-4.7E-05	0.000765	-0.000187
Story1	5	6	Comb1	Combination	0.5	0.027	-0.107	-4.9E-05	0.000772	-0.000203
Story1	6	7	Dead	LinStatic	-0.052	-0.007	-0.028	1E-06	4E-05	5E-06
Story1	6	7	Live	LinStatic	0.553	-0.04	-0.198	7.8E-05	0.00047	-0.000122
Story1	6	7	Comb1	Combination	0.491	-0.049	-0.231	7.9E-05	0.000518	-0.000117
Base	1	3	Dead	LinStatic	0	0	0	0	0	0
Base	1	3	Live	LinStatic	0	0	0	0	0	0

Table 5.4 - Joint Displacements (continued)

Story	Label	Unique Name	Output Case	Case Type	Ux mm	Uy mm	Uz mm	Rx rad	Ry rad	Rz rad
Base	1	3	Comb1	Combination	0	0	0	0	0	0
Base	3	1	Dead	LinStatic	0	0	0	0	0	0
Base	3	1	Live	LinStatic	0	0	0	0	0	0
Base	3	1	Comb1	Combination	0	0	0	0	0	0
Base	8	4	Dead	LinStatic	0	0	0	0	0	0
Base	8	4	Live	LinStatic	0	0	0	0	0	0
Base	8	4	Comb1	Combination	0	0	0	0	0	0

## 5.4 Line Results

Table 5.5 - Element Forces - Braces (Part 1 of 2)

Story	Brace	Unique Name	Station m	Output Case	Case Type	P kN	V2 kN	V3 kN	T kN-m	M2 kN-m	M3 kN-m
Story2	D5	5	0	Dead	LinStatic	-0.0363	0.0038	-0.0001	0	0.0001	0.005
Story2	D5	5	0.4921	Dead	LinStatic	-0.0189	0.0128	-0.0001	0	0.0001	0.0009
Story2	D5	5	0.9843	Dead	LinStatic	-0.0016	0.0217	-0.0001	0	0.0002	-0.0076
Story2	D5	5	0	Live	LinStatic	8.3479	0.0009	-0.0007	0	0.0007	-0.0009
Story2	D5	5	0.4921	Live	LinStatic	8.3479	0.0009	-0.0007	0	0.0011	-0.0013
Story2	D5	5	0.9843	Live	LinStatic	8.3479	0.0009	-0.0007	0	0.0014	-0.0017
Story2	D5	5	0	Comb1	Combination	8.3043	0.0055	-0.0008	0	0.0008	0.0052
Story2	D5	5	0.4921	Comb1	Combination	8.3252	0.0162	-0.0008	0	0.0012	-0.0002
Story2	D5	5	0.9843	Comb1	Combination	8.346	0.027	-0.0008	0	0.0016	-0.0108
Story2	D7	7	0	Dead	LinStatic	-0.041	-0.0006	0.0009	-0.0002	-0.0003	0.0031
Story2	D7	7	0.4921	Dead	LinStatic	-0.0236	0.0084	0.0009	-0.0002	-0.0007	0.0012
Story2	D7	7	0.9843	Dead	LinStatic	-0.0063	0.0173	0.0009	-0.0002	-0.0012	-0.0051
Story2	D7	7	0	Live	LinStatic	8.352	-0.0141	0.0088	0.0002	0.0043	-0.0065
Story2	D7	7	0.4921	Live	LinStatic	8.352	-0.0141	0.0088	0.0002	-1.497E-05	0.0005
Story2	D7	7	0.9843	Live	LinStatic	8.352	-0.0141	0.0088	0.0002	-0.0044	0.0074
Story2	D7	7	0	Comb1	Combination	8.3028	-0.0148	0.0099	-0.0001	0.004	-0.0027
Story2	D7	7	0.4921	Comb1	Combination	8.3237	-0.0041	0.0099	-0.0001	-0.0009	0.0019
Story2	D7	7	0.9843	Comb1	Combination	8.3445	0.0067	0.0099	-0.0001	-0.0058	0.0013
Story2	D9	9	0	Dead	LinStatic	-0.0588	0.005	-0.0003	0	0.0003	0.0039
Story2	D9	9	0.492	Dead	LinStatic	-0.0414	0.0139	-0.0003	0	0.0005	-0.0008
Story2	D9	9	0.9839	Dead	LinStatic	-0.024	0.0229	-0.0003	0	0.0006	-0.0098
Story2	D9	9	0	Live	LinStatic	-34.693	-0.0038	-0.0017	0	0.0017	0.0038
Story2	D9	9	0.492	Live	LinStatic	-34.693	-0.0038	-0.0017	0	0.0025	0.0056
Story2	D9	9	0.9839	Live	LinStatic	-34.693	-0.0038	-0.0017	0	0.0033	0.0075
Story2	D9	9	0	Comb1	Combination	-34.7635	0.0022	-0.0021	0	0.002	0.0084
Story2	D9	9	0.492	Comb1	Combination	-34.7427	0.0129	-0.0021	0	0.003	0.0047
Story2	D9	9	0.9839	Comb1	Combination	-34.7218	0.0236	-0.0021	0	0.004	-0.0043
Story1	D4	4	0	Dead	LinStatic	-0.071	-0.014	-0.0001	0	0	0
Story1	D4	4	0.4921	Dead	LinStatic	-0.0537	-0.0051	-0.0001	0	4.186E-05	0.0047
Story1	D4	4	0.9843	Dead	LinStatic	-0.0363	0.0038	-0.0001	0	0.0001	0.005
Story1	D4	4	0	Live	LinStatic	8.3479	0.0009	-0.0007	0	0	0
Story1	D4	4	0.4921	Live	LinStatic	8.3479	0.0009	-0.0007	0	0.0004	-0.0004
Story1	D4	4	0.9843	Live	LinStatic	8.3479	0.0009	-0.0007	0	0.0007	-0.0009
Story1	D4	4	0	Comb1	Combination	8.2626	-0.016	-0.0008	0	0	0
Story1	D4	4	0.4921	Comb1	Combination	8.2835	-0.0052	-0.0008	0	0.0004	0.0052
Story1	D4	4	0.9843	Comb1	Combination	8.3043	0.0055	-0.0008	0	0.0008	0.0052
Story1	D6	6	0	Dead	LinStatic	-0.0758	-0.0185	0.0009	-0.0002	0.0006	-0.0063

Table 5.5 - Element Forces - Braces (Part 1 of 2, continued)

Story	Brace	Unique Name	Station m	Output Case	Case Type	P kN	V2 kN	V3 kN	T kN-m	M2 kN-m	M3 kN-m
Story1	D6	6	0.4921	Dead	LinStatic	-0.0584	-0.0095	0.0009	-0.0002	0.0002	0.0006
Story1	D6	6	0.9843	Dead	LinStatic	-0.041	-0.0006	0.0009	-0.0002	-0.0003	0.0031
Story1	D6	6	0	Live	LinStatic	8.352	-0.0141	0.0088	0.0002	0.013	-0.0203
Story1	D6	6	0.4921	Live	LinStatic	8.352	-0.0141	0.0088	0.0002	0.0087	-0.0134
Story1	D6	6	0.9843	Live	LinStatic	8.352	-0.0141	0.0088	0.0002	0.0043	-0.0065
Story1	D6	6	0	Comb1	Combination	8.2611	-0.0363	0.0099	-0.0001	0.0137	-0.0279
Story1	D6	6	0.4921	Comb1	Combination	8.282	-0.0255	0.0099	-0.0001	0.0089	-0.0127
Story1	D6	6	0.9843	Comb1	Combination	8.3028	-0.0148	0.0099	-0.0001	0.004	-0.0027
Story1	D8	8	0	Dead	LinStatic	-0.0935	-0.0129	-0.0003	0	0	0
Story1	D8	8	0.492	Dead	LinStatic	-0.0761	-0.0039	-0.0003	0	0.0002	0.0041
Story1	D8	8	0.9839	Dead	LinStatic	-0.0588	0.005	-0.0003	0	0.0003	0.0039
Story1	D8	8	0	Live	LinStatic	-34.693	-0.0038	-0.0017	0	0	0
Story1	D8	8	0.492	Live	LinStatic	-34.693	-0.0038	-0.0017	0	0.0008	0.0019
Story1	D8	8	0.9839	Live	LinStatic	-34.693	-0.0038	-0.0017	0	0.0017	0.0038
Story1	D8	8	0	Comb1	Combination	-34.8052	-0.0193	-0.0021	0	0	0
Story1	D8	8	0.492	Comb1	Combination	-34.7843	-0.0085	-0.0021	0	0.001	0.0068
Story1	D8	8	0.9839	Comb1	Combination	-34.7635	0.0022	-0.0021	0	0.002	0.0084

Table 5.5 - Element Forces - Braces (Part 2 of 2)

Story	Brace	Unique Name	Station m	Element	Elem Station m	Location
Story2	D5	5	0	5	0	
Story2	D5	5	0.4921	5	0.4921	
Story2	D5	5	0.9843	5	0.9843	
Story2	D5	5	0	5	0	
Story2	D5	5	0.4921	5	0.4921	
Story2	D5	5	0.9843	5	0.9843	
Story2	D5	5	0	5	0	
Story2	D5	5	0.4921	5	0.4921	
Story2	D5	5	0.9843	5	0.9843	
Story2	D7	7	0	7	0	
Story2	D7	7	0.4921	7	0.4921	
Story2	D7	7	0.9843	7	0.9843	
Story2	D7	7	0	7	0	
Story2	D7	7	0.4921	7	0.4921	
Story2	D7	7	0.9843	7	0.9843	
Story2	D7	7	0	7	0	
Story2	D7	7	0.4921	7	0.4921	
Story2	D7	7	0.9843	7	0.9843	
Story2	D9	9	0	9	0	
Story2	D9	9	0.492	9	0.492	
Story2	D9	9	0.9839	9	0.9839	
Story2	D9	9	0	9	0	
Story2	D9	9	0.492	9	0.492	
Story2	D9	9	0.9839	9	0.9839	
Story2	D9	9	0	9	0	
Story2	D9	9	0.492	9	0.492	
Story2	D9	9	0.9839	9	0.9839	

Table 5.5 - Element Forces - Braces (Part 2 of 2, continued)

Story	Brace	Unique Name	Station m	Element	Elem Station m	Location
Story1	D4	4	0	4	0	
Story1	D4	4	0.4921	4	0.4921	
Story1	D4	4	0.9843	4	0.9843	
Story1	D4	4	0	4	0	
Story1	D4	4	0.4921	4	0.4921	
Story1	D4	4	0.9843	4	0.9843	
Story1	D4	4	0	4	0	
Story1	D4	4	0.4921	4	0.4921	
Story1	D4	4	0.9843	4	0.9843	
Story1	D6	6	0	6	0	
Story1	D6	6	0.4921	6	0.4921	
Story1	D6	6	0.9843	6	0.9843	
Story1	D6	6	0	6	0	
Story1	D6	6	0.4921	6	0.4921	
Story1	D6	6	0.9843	6	0.9843	
Story1	D6	6	0	6	0	
Story1	D6	6	0.4921	6	0.4921	
Story1	D6	6	0.9843	6	0.9843	
Story1	D8	8	0	8	0	
Story1	D8	8	0.492	8	0.492	
Story1	D8	8	0.9839	8	0.9839	
Story1	D8	8	0	8	0	
Story1	D8	8	0.492	8	0.492	
Story1	D8	8	0.9839	8	0.9839	
Story1	D8	8	0	8	0	
Story1	D8	8	0.492	8	0.492	
Story1	D8	8	0.9839	8	0.9839	

Table 5.6 - Element Joint Forces - Frame

Story	Frame	Unique Name	Frame Element	Joint	Output Case	Case Type	F1 kN	F2 kN	F3 kN	M1 kN-m	M2 kN-m	M3 kN-m
Story2	D5	5	5	5	Dead	LinStatic	0.0166	-0.0112	0.0305	0.0027	0.0042	3.833E-05
Story2	D5	5	5	2	Dead	LinStatic	-0.0166	0.0112	0.0086	0.0043	0.0062	-0.0001
Story2	D5	5	5	5	Live	LinStatic	-3.1803	2.1193	-7.4217	-0.001	-0.0004	0.0003
Story2	D5	5	5	2	Live	LinStatic	3.1803	-2.1193	7.4217	0.002	0.0007	-0.0007
Story2	D5	5	5	5	Comb1	Combination	-3.1603	2.1059	-7.3851	0.0023	0.0047	0.0004
Story2	D5	5	5	2	Comb1	Combination	3.1603	-2.1059	7.432	0.0072	0.0082	-0.0007
Story2	D7	7	7	6	Dead	LinStatic	0.0147	0.0109	0.0367	-0.0014	0.0028	0.0001
Story2	D7	7	7	2	Dead	LinStatic	-0.0147	-0.0109	0.0023	-0.0038	0.0036	0.0004
Story2	D7	7	7	6	Live	LinStatic	-3.1974	-2.121	-7.4185	0.0003	-0.0076	0.0018
Story2	D7	7	7	2	Live	LinStatic	3.1974	2.121	7.4185	0.0009	-0.0082	0.0022
Story2	D7	7	7	6	Comb1	Combination	-3.1798	-2.108	-7.3744	-0.0014	-0.0042	0.0019
Story2	D7	7	7	2	Comb1	Combination	3.1798	2.108	7.4213	-0.0036	-0.0039	0.0026
Story2	D9	9	9	7	Dead	LinStatic	-0.0313	0.0003	0.05	0.0003	-0.0039	0.0001
Story2	D9	9	9	2	Dead	LinStatic	0.0313	-0.0003	-0.0109	-0.0005	-0.0098	-0.0003
Story2	D9	9	9	7	Live	LinStatic	-15.8634	0.0017	30.8538	0.0015	-0.0038	0.0008

Table 5.6 - Element Joint Forces - Frame (continued)

Story	Frame	Unique Name	Frame Element	Joint	Output Case	Case Type	F1 kN	F2 kN	F3 kN	M1 kN-m	M2 kN-m	M3 kN-m
Story2	D9	9	9	2	Live	LinStatic	15.8634	-0.0017	-30.8538	-0.0029	0.0075	-0.0015
Story2	D9	9	9	7	Comb1	Combination	-15.901	0.0021	30.9138	0.0018	-0.0084	0.0009
Story2	D9	9	9	2	Comb1	Combination	15.901	-0.0021	-30.8669	-0.0036	-0.0043	-0.0018
Story1	D4	4	4	1	Dead	LinStatic	0.0166	-0.0112	0.0696	0	0	0
Story1	D4	4	4	5	Dead	LinStatic	-0.0166	0.0112	-0.0305	-0.0027	-0.0042	-3.833E-05
Story1	D4	4	4	1	Live	LinStatic	-3.1803	2.1193	-7.4217	0	0	0
Story1	D4	4	4	5	Live	LinStatic	3.1803	-2.1193	7.4217	0.001	0.0004	-0.0003
Story1	D4	4	4	1	Comb1	Combination	-3.1603	2.1059	-7.3382	0	0	0
Story1	D4	4	4	5	Comb1	Combination	3.1603	-2.1059	7.3851	-0.0023	-0.0047	-0.0004
Story1	D6	6	6	3	Dead	LinStatic	0.0147	0.0109	0.0758	0.0031	-0.0055	0.0005
Story1	D6	6	6	6	Dead	LinStatic	-0.0147	-0.0109	-0.0367	0.0014	-0.0028	-0.0001
Story1	D6	6	6	3	Live	LinStatic	-3.1974	-2.121	-7.4185	0.0016	-0.0234	0.0058
Story1	D6	6	6	6	Live	LinStatic	3.1974	2.121	7.4185	-0.0003	0.0076	-0.0018
Story1	D6	6	6	3	Comb1	Combination	-3.1798	-2.108	-7.3275	0.0053	-0.0299	0.0063
Story1	D6	6	6	6	Comb1	Combination	3.1798	2.108	7.3744	0.0014	0.0042	-0.0019
Story1	D8	8	8	4	Dead	LinStatic	-0.0313	0.0003	0.089	0	0	0
Story1	D8	8	8	7	Dead	LinStatic	0.0313	-0.0003	-0.05	-0.0003	0.0039	-0.0001
Story1	D8	8	8	4	Live	LinStatic	-15.8634	0.0017	30.8538	0	0	0
Story1	D8	8	8	7	Live	LinStatic	15.8634	-0.0017	-30.8538	-0.0015	0.0038	-0.0008
Story1	D8	8	8	4	Comb1	Combination	-15.901	0.0021	30.9606	0	0	0
Story1	D8	8	8	7	Comb1	Combination	15.901	-0.0021	-30.9138	-0.0018	0.0084	-0.0009

## 5.5 Modal Results

Table 5.7 - Modal Load Participation Ratios

Case	ItemType	Item	Static %	Dynamic %
Modal	Acceleration	UX	100	100
Modal	Acceleration	UY	100	100
Modal	Acceleration	UZ	0	0

Table 5.8 - Modal Direction Factors

Case	Mode	Period sec	UX	UY	UZ	RZ
Modal	1	0.007	0	1	0	0
Modal	2	0.004	1	0	0	0

## 6 Design Data

This chapter provides design data and results.

### 6.1 Steel Frame Design

**Table 6.1 - Steel Frame Design Preferences - AISC 360-16**

Item	Value
Multi-Response Design	Step-by-Step - All
Frame Type	SMF
Seismic Design Category	D
Importance Factor	1
Design System Rho	1
Design System Sds	0.5
Design System R	8
Design System Omega0	3
Design System Cd	5.5
Design Provision	LRFD
Analysis Method	Direct Analysis
Second Order Method	General 2nd Order
Stiffness Reduction Method	Tau-b Fixed
Add Notional Load Case	No
Beta Factor	1.3
Beta Omega Factor	1.6
Phi (Bending)	0.9
Phi (Compression)	0.9
Phi (Tension-Yielding)	0.9
Phi (Tension-Fracture)	0.75
Phi (Shear)	0.9
Phi (Shear-Short Webbed Rolled I)	1
Phi (Torsion)	0.9
Ignore Seismic Code?	No
Ignore Special Seismic Load?	No
Doubler Plate Plug-Welded?	Yes
HSS Welding Type	ERW
Reduced HSS Thickness	No
Consider Deflection?	Yes
DL Ratio	120
SDL+LL Ratio	120
LL Ratio	360
Total Ratio	240
Total Camber Limit	240
Pattern Live Load Factor	0.75
D/C Ratio Limit	0.95
Maximum Iterations	1

**Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 1 of 6)**

Story	Label	Unique Name	Design Type	Design Section	Frame Type	Omega0	Connection Type
Story2	D5	5	Brace	Program Determined	Program Determined	0	Program Determined
Story2	D7	7	Brace	Program Determined	Program Determined	0	Program Determined
Story2	D9	9	Brace	Program Determined	Program Determined	0	Program Determined
Story1	D4	4	Brace	Program Determined	Program Determined	0	Program Determined



Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 1 of 6, continued)

Story	Label	Unique Name	Design Type	Design Section	Frame Type	Omega0	Connection Type
Story1	D6	6	Brace	Program Determined	Program Determined	0	Program Determined
Story1	D8	8	Brace	Program Determined	Program Determined	0	Program Determined

Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 2 of 6)

Relative Hinge Distance Sh/L Left	Yield Line Yc/h Parameter	Relative Hinge Distance Sh/L Right	BRB Beta Factor	BRB Beta*Omega Factor	Perform RBS Capacity Design	Check Deflection?
0	0	0	0	0	Program Determined	Program Determined
0	0	0	0	0	Program Determined	Program Determined
0	0	0	0	0	Program Determined	Program Determined
0	0	0	0	0	Program Determined	Program Determined
0	0	0	0	0	Program Determined	Program Determined
0	0	0	0	0	Program Determined	Program Determined

Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 3 of 6)

DL Ratio	SDL+LL Ratio	LL Ratio	Total Ratio	Camber Ratio	Specified Camber mm	Net Area Ratio	LLRF	Unbraced Length Ratio Major	Unbraced Length Ratio Minor	Unbraced Length Ratio (LTB)
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0

Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 4 of 6)

Effective Length Factor 1 Minor	Effective Length Factor 2 Major	Effective Length Factor 2 Minor	Effective Length Factor (KLTB)	Moment Coefficient (Cm Major)	Moment Coefficient (Cm Minor)	Bending Coefficient (Cb)	Nonsway Moment Factor (B1 Major)	Nonsway Moment Factor (B1 Minor)	Sway Moment Factor (B2 Major)
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 5 of 6)

Reduce HSS Thickness?	HSS Welding Type?	Yield stress, Fy MPa	Expected to specified Fy ratio, Ry	Compressive Capacity, Pnc kN	Tensile Capacity, Pnt kN	Major Bending Capacity, Mn3 kN-m	Minor Bending Capacity, Mn2 kN-m
Program Determined	Program Determined	0	0	0	0	0	0
Program Determined	Program Determined	0	0	0	0	0	0
Program Determined	Program Determined	0	0	0	0	0	0

Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 5 of 6, continued)

Reduce HSS Thickness?	HSS Welding Type?	Yield stress, Fy MPa	Expected to specified Fy ratio, Ry	Compressive Capacity, Pnc kN	Tensile Capacity, Pnt kN	Major Bending Capacity, Mn3 kN-m	Minor Bending Capacity, Mn2 kN-m
Program Determined	Program Determined	0	0	0	0	0	0
Program Determined	Program Determined	0	0	0	0	0	0
Program Determined	Program Determined	0	0	0	0	0	0

Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 6 of 6)

Minor Shear Capacity, Vn3 kN	D/C Ratio Limit
0	0
0	0
0	0
0	0
0	0
0	0

Table 6.3 - Steel Brace Envelope - AISC 360-16 (Part 1 of 2)

UniqueName	Story	Label	Design Section	Moment Interaction Check	PMM Combo	V22 Ratio	V33 Ratio	Section Class
5	Story2	D5	SCH 40 1.5"	$0.052 = 0.044 + 0.008 + 0.001$	Comb1	0.001	0	Seismic HD
7	Story2	D7	SCH 40 1.5"	$0.048 = 0.044 + 0.001 + 0.004$	Comb1	0.001	0.0003471	Seismic HD
9	Story2	D9	SCH 40 1.5"	$0.739 = 0.734 + 0.006 + 0.001$	Comb1	0.001	0	Seismic HD
4	Story1	D4	SCH 40 1.5"	$0.047 = 0.044 + 0.004 + 0.001$	Comb1	0.001	0	Seismic HD
6	Story1	D6	SCH 40 1.5"	$0.066 = 0.043 + 0.021 + 0.01$	Comb1	0.001	0.0003471	Seismic HD
8	Story1	D8	SCH 40 1.5"	$0.739 = 0.734 + 0.006 + 0.001$	Comb1	0.001	0	Seismic HD

Table 6.3 - Steel Brace Envelope - AISC 360-16 (Part 2 of 2)

UniqueName	Conn. P I-End kN	Conn. P J-End kN
5	8.346	8.346
7	8.3445	8.3445
9	-34.7635	-34.7635
4	8.3043	8.3043
6	8.3028	8.3028
8	-34.8052	-34.8052

Table 6.4 - Steel Frame Design Summary - AISC 360-16 (Part 1 of 2)

UniqueName	Story	Label	Design Type	Design Section	Status	PMM Combo	PMM Ratio	P Ratio	M Major Ratio	M Minor Ratio
5	Story2	D5	Brace	SCH 40 1.5"	No Message	(T)	0.052	0.044	0.008	0.001
7	Story2	D7	Brace	SCH 40 1.5"	No Message	(T)	0.048	0.044	0.001	0.004
9	Story2	D9	Brace	SCH 40 1.5"	No Message	Comb1(C)	0.739	0.734	0.006	0.001
4	Story1	D4	Brace	SCH 40 1.5"	No Message	(T)	0.047	0.044	0.004	0.001

Table 6.4 - Steel Frame Design Summary - AISC 360-16 (Part 1 of 2, continued)

UniqueName	Story	Label	Design Type	Design Section	Status	PMM Combo	PMM Ratio	P Ratio	M Major Ratio	M Minor Ratio
6	Story1	D6	Brace	SCH 40 1.5"	No Message	(T)	0.066	0.043	0.021	0.01
8	Story1	D8	Brace	SCH 40 1.5"	No Message	Comb1(C)	0.739	0.734	0.006	0.001

Table 6.4 - Steel Frame Design Summary - AISC 360-16 (Part 2 of 2)

UniqueName	V Major Combo	V Major Ratio	V Minor Combo	V Minor Ratio
5	Comb1	0.001	Comb1	0
7	Comb1	0.001	Comb1	0.0003471
9	Comb1	0.001	Comb1	0
4	Comb1	0.001	Comb1	0
6	Comb1	0.001	Comb1	0.0003471
8	Comb1	0.001	Comb1	0

## ETABS Steel Frame Design

AISC 360-16 Steel Section Check (Envelope Details)

### Element Details

Level	Element	Unique Name	Section	Combo	Location	Frame Type	Classification
Story1	D4	4	SCH 40 1.5"	Comb1	984.3	Special Moment Frame	Compact

### LLRF and Demand/Capacity Ratio

L (mm)	LLRF	Stress Ratio Limit
984.3	1	0.95

### Analysis and Design Parameters

Provision	Analysis	2nd Order	Reduction
LRFD	Direct Analysis	General 2nd Order	Tau-b Fixed

### Stiffness Reduction Factors

$\alpha P_r / P_y$	$\alpha P_r / P_e$	$\tau_b$	EA factor	EI factor
-0.079	-0.131	1	0.8	0.8

### Design Code Parameters

$\phi_b$	$\phi_b$	$\phi_{TY}$	$\phi_{TF}$	$\phi_V$	$\phi_{V-RI}$	$\phi_{VT}$
0.9	0.9	0.9	0.75	0.9	1	1

### Section Properties

A (cm <sup>2</sup> )	J (cm <sup>4</sup> )	I <sub>33</sub> (cm <sup>4</sup> )	I <sub>22</sub> (cm <sup>4</sup> )	A <sub>v3</sub> (cm <sup>2</sup> )	A <sub>v2</sub> (cm <sup>2</sup> )
5.2	25.8	12.9	12.9	2.6	2.6

### Design Properties

S <sub>33</sub> (cm <sup>3</sup> )	S <sub>22</sub> (cm <sup>3</sup> )	Z <sub>33</sub> (cm <sup>3</sup> )	Z <sub>22</sub> (cm <sup>3</sup> )	r <sub>33</sub> (mm)	r <sub>22</sub> (mm)	C <sub>w</sub> (cm <sup>6</sup> )
5.3	5.3	7.3	7.3	15.8	15.8	Not required

### Material Properties

E (MPa)	f <sub>y</sub> (MPa)	R <sub>y</sub>	C <sub>pr</sub>	$\alpha$
193000	205	1	1.4	NA

### HSS Section Parameters

HSS Welding	Reduce HSS Thickness?
ERW	No

### Stress Check forces and Moments

Location (mm)	P <sub>u</sub> (kN)	M <sub>u33</sub> (kN-m)	M <sub>u22</sub> (kN-m)	V <sub>u2</sub> (kN)	V <sub>u3</sub> (kN)	T <sub>u</sub> (kN-m)
984.3	8.3043	0.0052	0.0008	0.0055	-0.0008	0

**Axial Force & Biaxial Moment Design Factors (H1.2,H1-1b)**

	<b>L Factor</b>	<b>K<sub>1</sub></b>	<b>K<sub>2</sub></b>	<b>B<sub>1</sub></b>	<b>B<sub>2</sub></b>	<b>C<sub>m</sub></b>
Major Bending	2	1	1	1	1	1
Minor Bending	2	1	1	1	1	1

**Parameters for Lateral Torsion Buckling**

<b>L<sub>ltb</sub></b>	<b>K<sub>ltb</sub></b>	<b>C<sub>b</sub></b>
2	1	1.21

**Demand/Capacity (D/C) Ratio**

<b>D/C Ratio =</b>	<b>(P<sub>r</sub>/2P<sub>c</sub>) + (M<sub>r33</sub>/M<sub>c33</sub>) + (M<sub>r22</sub>/M<sub>c22</sub>)</b>
0.047 =	0.044 + 0.004 + 0.001

**Axial Force and Capacities**

<b>P<sub>u</sub> Force (kN)</b>	<b>φP<sub>nc</sub> Capacity (kN)</b>	<b>φP<sub>nt</sub> Capacity (kN)</b>
8.3043	47.3521	95.161

**Moments and Capacities**

	<b>M<sub>u</sub> Moment (kN-m)</b>	<b>φM<sub>n</sub> Capacity (kN-m)</b>	<b>φM<sub>n</sub> No LTB (kN-m)</b>	<b>φM<sub>n</sub> Cb=1 (kN-m)</b>
Major Bending	0.0052	1.3533	1.3533	1.3533
Minor Bending	0.0008	1.3533		

**Torsion Moment and Capacities**

<b>T<sub>u</sub> Moment (kN-m)</b>	<b>T<sub>n</sub> Capacity (kN-m)</b>	<b>φT<sub>n</sub> Capacity (kN-m)</b>
0	1.414	1.2726

**Shear Design**

	<b>V<sub>u</sub> Force (kN)</b>	<b>φV<sub>n</sub> Capacity (kN)</b>	<b>Stress Ratio</b>
Major Shear	0.016	28.5483	0.001
Minor Shear	0.0008	28.5483	2.888E-05

**End Reaction Axial Forces**

<b>Left End Reaction (kN)</b>	<b>Load Combo</b>	<b>Right End Reaction (kN)</b>	<b>Load Combo</b>
8.3043	Comb1	8.3043	Comb1

**Element Details**

<b>Level</b>	<b>Element</b>	<b>Unique Name</b>	<b>Element Type</b>	<b>Section</b>
Story1	D4	4	Special Moment Frame	SCH 40 1.5"

**DEFLECTION DESIGN**

<b>Deflection Type</b>	<b>L mm</b>	<b>Deflection Value mm</b>	<b>Deflection Limit mm</b>	<b>Deflection Ratio</b>	<b>Load Combo</b>	<b>Station Location mm</b>	<b>Check Status</b>
Dead Load	984.3	0	8.2	0	Comb1	984.3	OK
Super DL + Live Load	984.3	0	8.2	0	Comb1	984.3	OK
Live Load	984.3	0	2.7	0	Comb1	984.3	OK

**DEFLECTION DESIGN (continued)**

<b>Deflection Type</b>	<b>L mm</b>	<b>Deflection Value mm</b>	<b>Deflection Limit mm</b>	<b>Deflection Ratio</b>	<b>Load Combo</b>	<b>Station Location mm</b>	<b>Check Status</b>
Total Load	984.3	0	4.1	0	Comb1	984.3	OK
Total - Camber	984.3	0	4.1	0	Comb1	984.3	OK

## ETABS Steel Frame Design

AISC 360-16 Steel Section Check (Envelope Details)

### Element Details

Level	Element	Unique Name	Section	Combo	Location	Frame Type	Classification
Story2	D5	5	SCH 40 1.5"	Comb1	984.3	Special Moment Frame	Compact

### LLRF and Demand/Capacity Ratio

L (mm)	LLRF	Stress Ratio Limit
984.3	1	0.95

### Analysis and Design Parameters

Provision	Analysis	2nd Order	Reduction
LRFD	Direct Analysis	General 2nd Order	Tau-b Fixed

### Stiffness Reduction Factors

$\alpha P_r / P_y$	$\alpha P_r / P_e$	$\tau_b$	EA factor	EI factor
-0.079	-0.132	1	0.8	0.8

### Design Code Parameters

$\phi_b$	$\phi_b$	$\phi_{TY}$	$\phi_{TF}$	$\phi_V$	$\phi_{V-RI}$	$\phi_{VT}$
0.9	0.9	0.9	0.75	0.9	1	1

### Section Properties

A (cm <sup>2</sup> )	J (cm <sup>4</sup> )	I <sub>33</sub> (cm <sup>4</sup> )	I <sub>22</sub> (cm <sup>4</sup> )	A <sub>v3</sub> (cm <sup>2</sup> )	A <sub>v2</sub> (cm <sup>2</sup> )
5.2	25.8	12.9	12.9	2.6	2.6

### Design Properties

S <sub>33</sub> (cm <sup>3</sup> )	S <sub>22</sub> (cm <sup>3</sup> )	Z <sub>33</sub> (cm <sup>3</sup> )	Z <sub>22</sub> (cm <sup>3</sup> )	r <sub>33</sub> (mm)	r <sub>22</sub> (mm)	C <sub>w</sub> (cm <sup>6</sup> )
5.3	5.3	7.3	7.3	15.8	15.8	Not required

### Material Properties

E (MPa)	f <sub>y</sub> (MPa)	R <sub>y</sub>	C <sub>pr</sub>	$\alpha$
193000	205	1	1.4	NA

### HSS Section Parameters

HSS Welding	Reduce HSS Thickness?
ERW	No

### Stress Check forces and Moments

Location (mm)	P <sub>u</sub> (kN)	M <sub>u33</sub> (kN-m)	M <sub>u22</sub> (kN-m)	V <sub>u2</sub> (kN)	V <sub>u3</sub> (kN)	T <sub>u</sub> (kN-m)
984.3	8.346	-0.0108	0.0016	0.027	-0.0008	0

**Axial Force & Biaxial Moment Design Factors (H1.2,H1-1b)**

	<b>L Factor</b>	<b>K<sub>1</sub></b>	<b>K<sub>2</sub></b>	<b>B<sub>1</sub></b>	<b>B<sub>2</sub></b>	<b>C<sub>m</sub></b>
Major Bending	2	1	1	1	1	1
Minor Bending	2	1	1	1	1	1

**Parameters for Lateral Torsion Buckling**

<b>L<sub>ltb</sub></b>	<b>K<sub>ltb</sub></b>	<b>C<sub>b</sub></b>
2	1	2.779

**Demand/Capacity (D/C) Ratio**

<b>D/C Ratio =</b>	<b>(P<sub>r</sub>/2P<sub>c</sub>) + (M<sub>r33</sub>/M<sub>c33</sub>) + (M<sub>r22</sub>/M<sub>c22</sub>)</b>
0.052 =	0.044 + 0.008 + 0.001

**Axial Force and Capacities**

<b>P<sub>u</sub> Force (kN)</b>	<b>φP<sub>nc</sub> Capacity (kN)</b>	<b>φP<sub>nt</sub> Capacity (kN)</b>
8.346	47.3521	95.161

**Moments and Capacities**

	<b>M<sub>u</sub> Moment (kN-m)</b>	<b>φM<sub>n</sub> Capacity (kN-m)</b>	<b>φM<sub>n</sub> No LTB (kN-m)</b>	<b>φM<sub>n</sub> Cb=1 (kN-m)</b>
Major Bending	0.0108	1.3533	1.3533	1.3533
Minor Bending	0.0016	1.3533		

**Torsion Moment and Capacities**

<b>T<sub>u</sub> Moment (kN-m)</b>	<b>T<sub>n</sub> Capacity (kN-m)</b>	<b>φT<sub>n</sub> Capacity (kN-m)</b>
0	1.414	1.2726

**Shear Design**

	<b>V<sub>u</sub> Force (kN)</b>	<b>φV<sub>n</sub> Capacity (kN)</b>	<b>Stress Ratio</b>
Major Shear	0.027	28.5483	0.001
Minor Shear	0.0008	28.5483	2.888E-05

**End Reaction Axial Forces**

<b>Left End Reaction (kN)</b>	<b>Load Combo</b>	<b>Right End Reaction (kN)</b>	<b>Load Combo</b>
8.346	Comb1	8.3460	Comb1

**Element Details**

<b>Level</b>	<b>Element</b>	<b>Unique Name</b>	<b>Element Type</b>	<b>Section</b>
Story2	D5	5	Special Moment Frame	SCH 40 1.5"

**DEFLECTION DESIGN**

<b>Deflection Type</b>	<b>L mm</b>	<b>Deflection Value mm</b>	<b>Deflection Limit mm</b>	<b>Deflection Ratio</b>	<b>Load Combo</b>	<b>Station Location mm</b>	<b>Check Status</b>
Dead Load	984.3	0	8.2	0	Comb1	984.3	OK
Super DL + Live Load	984.3	0	8.2	0	Comb1	984.3	OK
Live Load	984.3	0	2.7	0	Comb1	984.3	OK



**DEFLECTION DESIGN (continued)**

<b>Deflection Type</b>	<b>L mm</b>	<b>Deflection Value mm</b>	<b>Deflection Limit mm</b>	<b>Deflection Ratio</b>	<b>Load Combo</b>	<b>Station Location mm</b>	<b>Check Status</b>
Total Load	984.3	0	4.1	0	Comb1	984.3	OK
Total - Camber	984.3	0	4.1	0	Comb1	984.3	OK

## ETABS Steel Frame Design

AISC 360-16 Steel Section Check (Envelope Details)

### Element Details

Level	Element	Unique Name	Section	Combo	Location	Frame Type	Classification
Story1	D6	6	SCH 40 1.5"	Comb1	0	Special Moment Frame	Compact

### LLRF and Demand/Capacity Ratio

L (mm)	LLRF	Stress Ratio Limit
984.3	1	0.95

### Analysis and Design Parameters

Provision	Analysis	2nd Order	Reduction
LRFD	Direct Analysis	General 2nd Order	Tau-b Fixed

### Stiffness Reduction Factors

$\alpha P_r / P_y$	$\alpha P_r / P_e$	$\tau_b$	EA factor	EI factor
-0.078	-0.13	1	0.8	0.8

### Design Code Parameters

$\phi_b$	$\phi_b$	$\phi_{TY}$	$\phi_{TF}$	$\phi_V$	$\phi_{V-RI}$	$\phi_{VT}$
0.9	0.9	0.9	0.75	0.9	1	1

### Section Properties

A (cm <sup>2</sup> )	J (cm <sup>4</sup> )	I <sub>33</sub> (cm <sup>4</sup> )	I <sub>22</sub> (cm <sup>4</sup> )	A <sub>v3</sub> (cm <sup>2</sup> )	A <sub>v2</sub> (cm <sup>2</sup> )
5.2	25.8	12.9	12.9	2.6	2.6

### Design Properties

S <sub>33</sub> (cm <sup>3</sup> )	S <sub>22</sub> (cm <sup>3</sup> )	Z <sub>33</sub> (cm <sup>3</sup> )	Z <sub>22</sub> (cm <sup>3</sup> )	r <sub>33</sub> (mm)	r <sub>22</sub> (mm)	C <sub>w</sub> (cm <sup>6</sup> )
5.3	5.3	7.3	7.3	15.8	15.8	Not required

### Material Properties

E (MPa)	f <sub>y</sub> (MPa)	R <sub>y</sub>	C <sub>pr</sub>	$\alpha$
193000	205	1	1.4	NA

### HSS Section Parameters

HSS Welding	Reduce HSS Thickness?
ERW	No

### Stress Check forces and Moments

Location (mm)	P <sub>u</sub> (kN)	M <sub>u33</sub> (kN-m)	M <sub>u22</sub> (kN-m)	V <sub>u2</sub> (kN)	V <sub>u3</sub> (kN)	T <sub>u</sub> (kN-m)
0	8.2611	-0.0279	0.0137	-0.0363	0.0099	-0.0001

**Axial Force & Biaxial Moment Design Factors (H1.2,H1-1b)**

	<b>L Factor</b>	<b>K<sub>1</sub></b>	<b>K<sub>2</sub></b>	<b>B<sub>1</sub></b>	<b>B<sub>2</sub></b>	<b>C<sub>m</sub></b>
Major Bending	2	1	1	1	1	1
Minor Bending	2	1	1	1	1	1

**Parameters for Lateral Torsion Buckling**

<b>L<sub>ltb</sub></b>	<b>K<sub>ltb</sub></b>	<b>C<sub>b</sub></b>
2	1	1.814

**Demand/Capacity (D/C) Ratio**

<b>D/C Ratio =</b>	<b>(P<sub>r</sub>/2P<sub>c</sub>) + (M<sub>r33</sub>/M<sub>c33</sub>) + (M<sub>r22</sub>/M<sub>c22</sub>)</b>
0.066 =	0.043 + 0.021 + 0.01

**Axial Force and Capacities**

<b>P<sub>u</sub> Force (kN)</b>	<b>φP<sub>nc</sub> Capacity (kN)</b>	<b>φP<sub>nt</sub> Capacity (kN)</b>
8.2611	47.3521	95.161

**Moments and Capacities**

	<b>M<sub>u</sub> Moment (kN-m)</b>	<b>φM<sub>n</sub> Capacity (kN-m)</b>	<b>φM<sub>n</sub> No LTB (kN-m)</b>	<b>φM<sub>n</sub> Cb=1 (kN-m)</b>
Major Bending	0.0279	1.3533	1.3533	1.3533
Minor Bending	0.0137	1.3533		

**Torsion Moment and Capacities**

<b>T<sub>u</sub> Moment (kN-m)</b>	<b>T<sub>n</sub> Capacity (kN-m)</b>	<b>φT<sub>n</sub> Capacity (kN-m)</b>
-0.0001	1.414	1.2726

**Shear Design**

	<b>V<sub>u</sub> Force (kN)</b>	<b>φV<sub>n</sub> Capacity (kN)</b>	<b>Stress Ratio</b>
Major Shear	0.0363	28.5483	0.001
Minor Shear	0.0099	28.5483	3.471E-04

**End Reaction Axial Forces**

<b>Left End Reaction (kN)</b>	<b>Load Combo</b>	<b>Right End Reaction (kN)</b>	<b>Load Combo</b>
8.3028	Comb1	8.3028	Comb1

**Element Details**

<b>Level</b>	<b>Element</b>	<b>Unique Name</b>	<b>Element Type</b>	<b>Section</b>
Story1	D6	6	Special Moment Frame	SCH 40 1.5"

**DEFLECTION DESIGN**

<b>Deflection Type</b>	<b>L mm</b>	<b>Deflection Value mm</b>	<b>Deflection Limit mm</b>	<b>Deflection Ratio</b>	<b>Load Combo</b>	<b>Station Location mm</b>	<b>Check Status</b>
Dead Load	984.3	0	8.2	0	Comb1	984.3	OK
Super DL + Live Load	984.3	0	8.2	0	Comb1	984.3	OK
Live Load	984.3	0	2.7	0	Comb1	984.3	OK

**DEFLECTION DESIGN (continued)**

<b>Deflection Type</b>	<b>L mm</b>	<b>Deflection Value mm</b>	<b>Deflection Limit mm</b>	<b>Deflection Ratio</b>	<b>Load Combo</b>	<b>Station Location mm</b>	<b>Check Status</b>
Total Load	984.3	0	4.1	0	Comb1	984.3	OK
Total - Camber	984.3	0	4.1	0	Comb1	984.3	OK

## ETABS Steel Frame Design

AISC 360-16 Steel Section Check (Envelope Details)

### Element Details

Level	Element	Unique Name	Section	Combo	Location	Frame Type	Classification
Story2	D7	7	SCH 40 1.5"	Comb1	984.3	Special Moment Frame	Compact

### LLRF and Demand/Capacity Ratio

L (mm)	LLRF	Stress Ratio Limit
984.3	1	0.95

### Analysis and Design Parameters

Provision	Analysis	2nd Order	Reduction
LRFD	Direct Analysis	General 2nd Order	Tau-b Fixed

### Stiffness Reduction Factors

$\alpha P_r / P_y$	$\alpha P_r / P_e$	$\tau_b$	EA factor	EI factor
-0.079	-0.132	1	0.8	0.8

### Design Code Parameters

$\phi_b$	$\phi_b$	$\phi_{TY}$	$\phi_{TF}$	$\phi_V$	$\phi_{V-RI}$	$\phi_{VT}$
0.9	0.9	0.9	0.75	0.9	1	1

### Section Properties

A (cm <sup>2</sup> )	J (cm <sup>4</sup> )	I <sub>33</sub> (cm <sup>4</sup> )	I <sub>22</sub> (cm <sup>4</sup> )	A <sub>v3</sub> (cm <sup>2</sup> )	A <sub>v2</sub> (cm <sup>2</sup> )
5.2	25.8	12.9	12.9	2.6	2.6

### Design Properties

S <sub>33</sub> (cm <sup>3</sup> )	S <sub>22</sub> (cm <sup>3</sup> )	Z <sub>33</sub> (cm <sup>3</sup> )	Z <sub>22</sub> (cm <sup>3</sup> )	r <sub>33</sub> (mm)	r <sub>22</sub> (mm)	C <sub>w</sub> (cm <sup>6</sup> )
5.3	5.3	7.3	7.3	15.8	15.8	Not required

### Material Properties

E (MPa)	f <sub>y</sub> (MPa)	R <sub>y</sub>	C <sub>pr</sub>	$\alpha$
193000	205	1	1.4	NA

### HSS Section Parameters

HSS Welding	Reduce HSS Thickness?
ERW	No

### Stress Check forces and Moments

Location (mm)	P <sub>u</sub> (kN)	M <sub>u33</sub> (kN-m)	M <sub>u22</sub> (kN-m)	V <sub>u2</sub> (kN)	V <sub>u3</sub> (kN)	T <sub>u</sub> (kN-m)
984.3	8.3445	0.0013	-0.0058	0.0067	0.0099	-0.0001

**Axial Force & Biaxial Moment Design Factors (H1.2,H1-1b)**

	<b>L Factor</b>	<b>K<sub>1</sub></b>	<b>K<sub>2</sub></b>	<b>B<sub>1</sub></b>	<b>B<sub>2</sub></b>	<b>C<sub>m</sub></b>
Major Bending	2	1	1	1	1	1
Minor Bending	2	1	1	1	1	1

**Parameters for Lateral Torsion Buckling**

<b>L<sub>ltb</sub></b>	<b>K<sub>ltb</sub></b>	<b>C<sub>b</sub></b>
2	1	1.78

**Demand/Capacity (D/C) Ratio**

<b>D/C Ratio =</b>	<b><math>(P_r / 2P_c) + (M_{r33} / M_{c33}) + (M_{r22} / M_{c22})</math></b>
0.048 =	0.044 + 0.001 + 0.004

**Axial Force and Capacities**

<b>P<sub>u</sub> Force (kN)</b>	<b>φP<sub>nc</sub> Capacity (kN)</b>	<b>φP<sub>nt</sub> Capacity (kN)</b>
8.3445	47.3521	95.161

**Moments and Capacities**

	<b>M<sub>u</sub> Moment (kN-m)</b>	<b>φM<sub>n</sub> Capacity (kN-m)</b>	<b>φM<sub>n</sub> No LTB (kN-m)</b>	<b>φM<sub>n</sub> Cb=1 (kN-m)</b>
Major Bending	0.0013	1.3533	1.3533	1.3533
Minor Bending	0.0058	1.3533		

**Torsion Moment and Capacities**

<b>T<sub>u</sub> Moment (kN-m)</b>	<b>T<sub>n</sub> Capacity (kN-m)</b>	<b>φT<sub>n</sub> Capacity (kN-m)</b>
-0.0001	1.414	1.2726

**Shear Design**

	<b>V<sub>u</sub> Force (kN)</b>	<b>φV<sub>n</sub> Capacity (kN)</b>	<b>Stress Ratio</b>
Major Shear	0.0148	28.5483	0.001
Minor Shear	0.0099	28.5483	3.471E-04

**End Reaction Axial Forces**

<b>Left End Reaction (kN)</b>	<b>Load Combo</b>	<b>Right End Reaction (kN)</b>	<b>Load Combo</b>
8.3445	Comb1	8.3445	Comb1

**Element Details**

<b>Level</b>	<b>Element</b>	<b>Unique Name</b>	<b>Element Type</b>	<b>Section</b>
Story2	D7	7	Special Moment Frame	SCH 40 1.5"

**DEFLECTION DESIGN**

<b>Deflection Type</b>	<b>L mm</b>	<b>Deflection Value mm</b>	<b>Deflection Limit mm</b>	<b>Deflection Ratio</b>	<b>Load Combo</b>	<b>Station Location mm</b>	<b>Check Status</b>
Dead Load	984.3	0	8.2	0	Comb1	984.3	OK
Super DL + Live Load	984.3	0	8.2	0	Comb1	984.3	OK
Live Load	984.3	0	2.7	0	Comb1	984.3	OK

**DEFLECTION DESIGN (continued)**

<b>Deflection Type</b>	<b>L mm</b>	<b>Deflection Value mm</b>	<b>Deflection Limit mm</b>	<b>Deflection Ratio</b>	<b>Load Combo</b>	<b>Station Location mm</b>	<b>Check Status</b>
Total Load	984.3	0	4.1	0	Comb1	984.3	OK
Total - Camber	984.3	0	4.1	0	Comb1	984.3	OK

## ETABS Steel Frame Design

AISC 360-16 Steel Section Check (Envelope Details)

### Element Details

Level	Element	Unique Name	Section	Combo	Location	Frame Type	Classification
Story1	D8	8	SCH 40 1.5"	Comb1	983.9	Special Moment Frame	Compact

### LLRF and Demand/Capacity Ratio

L (mm)	LLRF	Stress Ratio Limit
983.9	1	0.95

### Analysis and Design Parameters

Provision	Analysis	2nd Order	Reduction
LRFD	Direct Analysis	General 2nd Order	Tau-b Fixed

### Stiffness Reduction Factors

$\alpha P_r / P_y$	$\alpha P_r / P_e$	$\tau_b$	EA factor	EI factor
0.329	0.548	1	0.8	0.8

### Design Code Parameters

$\phi_b$	$\phi_b$	$\phi_{TY}$	$\phi_{TF}$	$\phi_V$	$\phi_{V-RI}$	$\phi_{VT}$
0.9	0.9	0.9	0.75	0.9	1	1

### Section Properties

A (cm <sup>2</sup> )	J (cm <sup>4</sup> )	I <sub>33</sub> (cm <sup>4</sup> )	I <sub>22</sub> (cm <sup>4</sup> )	A <sub>v3</sub> (cm <sup>2</sup> )	A <sub>v2</sub> (cm <sup>2</sup> )
5.2	25.8	12.9	12.9	2.6	2.6

### Design Properties

S <sub>33</sub> (cm <sup>3</sup> )	S <sub>22</sub> (cm <sup>3</sup> )	Z <sub>33</sub> (cm <sup>3</sup> )	Z <sub>22</sub> (cm <sup>3</sup> )	r <sub>33</sub> (mm)	r <sub>22</sub> (mm)	C <sub>w</sub> (cm <sup>6</sup> )
5.3	5.3	7.3	7.3	15.8	15.8	Not required

### Material Properties

E (MPa)	f <sub>y</sub> (MPa)	R <sub>y</sub>	C <sub>pr</sub>	$\alpha$
193000	205	1	1.4	NA

### HSS Section Parameters

HSS Welding	Reduce HSS Thickness?
ERW	No

### Stress Check forces and Moments

Location (mm)	P <sub>u</sub> (kN)	M <sub>u33</sub> (kN-m)	M <sub>u22</sub> (kN-m)	V <sub>u2</sub> (kN)	V <sub>u3</sub> (kN)	T <sub>u</sub> (kN-m)
983.9	-34.7635	0.0084	0.002	0.0022	-0.0021	0



**Axial Force & Biaxial Moment Design Factors (H1-1a)**

	<b>L Factor</b>	<b>K<sub>1</sub></b>	<b>K<sub>2</sub></b>	<b>B<sub>1</sub></b>	<b>B<sub>2</sub></b>	<b>C<sub>m</sub></b>
Major Bending	2	1	1	1	1	1
Minor Bending	2	1	1	1	1	1

**Parameters for Lateral Torsion Buckling**

<b>L<sub>ltb</sub></b>	<b>K<sub>ltb</sub></b>	<b>C<sub>b</sub></b>
2	1	1.289

**Demand/Capacity (D/C) Ratio**

<b>D/C Ratio =</b>	<b><math>(P_r/P_c) + (8/9)(M_{r33}/M_{c33}) + (8/9)(M_{r22}/M_{c22})</math></b>
0.739 =	0.734 + 0.006 + 0.001

**Axial Force and Capacities**

<b>P<sub>u</sub> Force (kN)</b>	<b>φP<sub>nc</sub> Capacity (kN)</b>	<b>φP<sub>nt</sub> Capacity (kN)</b>
34.7635	47.3734	95.161

**Moments and Capacities**

	<b>M<sub>u</sub> Moment (kN-m)</b>	<b>φM<sub>n</sub> Capacity (kN-m)</b>	<b>φM<sub>n</sub> No LTB (kN-m)</b>	<b>φM<sub>n</sub> Cb=1 (kN-m)</b>
Major Bending	0.0084	1.3533	1.3533	1.3533
Minor Bending	0.002	1.3533		

**Torsion Moment and Capacities**

<b>T<sub>u</sub> Moment (kN-m)</b>	<b>T<sub>n</sub> Capacity (kN-m)</b>	<b>φT<sub>n</sub> Capacity (kN-m)</b>
0	1.414	1.2726

**Shear Design**

	<b>V<sub>u</sub> Force (kN)</b>	<b>φV<sub>n</sub> Capacity (kN)</b>	<b>Stress Ratio</b>
Major Shear	0.0193	28.5483	0.001
Minor Shear	0.0021	28.5483	7.198E-05

**End Reaction Axial Forces**

<b>Left End Reaction (kN)</b>	<b>Load Combo</b>	<b>Right End Reaction (kN)</b>	<b>Load Combo</b>
-34.8052	Comb1	-34.8052	Comb1

**Element Details**

<b>Level</b>	<b>Element</b>	<b>Unique Name</b>	<b>Element Type</b>	<b>Section</b>
Story1	D8	8	Special Moment Frame	SCH 40 1.5"

**DEFLECTION DESIGN**

<b>Deflection Type</b>	<b>L mm</b>	<b>Deflection Value mm</b>	<b>Deflection Limit mm</b>	<b>Deflection Ratio</b>	<b>Load Combo</b>	<b>Station Location mm</b>	<b>Check Status</b>
Dead Load	983.9	0	8.2	0	Comb1	983.9	OK
Super DL + Live Load	983.9	0	8.2	0	Comb1	983.9	OK
Live Load	983.9	0	2.7	0	Comb1	983.9	OK
Total Load	983.9	0	4.1	0	Comb1	983.9	OK
Total - Camber	983.9	0	4.1	0	Comb1	983.9	OK

## ETABS Steel Frame Design

AISC 360-16 Steel Section Check (Envelope Details)

### Element Details

Level	Element	Unique Name	Section	Combo	Location	Frame Type	Classification
Story2	D9	9	SCH 40 1.5"	Comb1	0	Special Moment Frame	Compact

### LLRF and Demand/Capacity Ratio

L (mm)	LLRF	Stress Ratio Limit
983.9	1	0.95

### Analysis and Design Parameters

Provision	Analysis	2nd Order	Reduction
LRFD	Direct Analysis	General 2nd Order	Tau-b Fixed

### Stiffness Reduction Factors

$\alpha P_r / P_y$	$\alpha P_r / P_e$	$\tau_b$	EA factor	EI factor
0.329	0.548	1	0.8	0.8

### Design Code Parameters

$\phi_b$	$\phi_b$	$\phi_{TY}$	$\phi_{TF}$	$\phi_V$	$\phi_{V-RI}$	$\phi_{VT}$
0.9	0.9	0.9	0.75	0.9	1	1

### Section Properties

A (cm <sup>2</sup> )	J (cm <sup>4</sup> )	I <sub>33</sub> (cm <sup>4</sup> )	I <sub>22</sub> (cm <sup>4</sup> )	A <sub>v3</sub> (cm <sup>2</sup> )	A <sub>v2</sub> (cm <sup>2</sup> )
5.2	25.8	12.9	12.9	2.6	2.6

### Design Properties

S <sub>33</sub> (cm <sup>3</sup> )	S <sub>22</sub> (cm <sup>3</sup> )	Z <sub>33</sub> (cm <sup>3</sup> )	Z <sub>22</sub> (cm <sup>3</sup> )	r <sub>33</sub> (mm)	r <sub>22</sub> (mm)	C <sub>w</sub> (cm <sup>6</sup> )
5.3	5.3	7.3	7.3	15.8	15.8	Not required

### Material Properties

E (MPa)	f <sub>y</sub> (MPa)	R <sub>y</sub>	C <sub>pr</sub>	$\alpha$
193000	205	1	1.4	NA

### HSS Section Parameters

HSS Welding	Reduce HSS Thickness?
ERW	No

### Stress Check forces and Moments

Location (mm)	P <sub>u</sub> (kN)	M <sub>u33</sub> (kN-m)	M <sub>u22</sub> (kN-m)	V <sub>u2</sub> (kN)	V <sub>u3</sub> (kN)	T <sub>u</sub> (kN-m)
0	-34.7635	0.0084	0.002	0.0022	-0.0021	0

**Axial Force & Biaxial Moment Design Factors (H1-1a)**

	<b>L Factor</b>	<b>K<sub>1</sub></b>	<b>K<sub>2</sub></b>	<b>B<sub>1</sub></b>	<b>B<sub>2</sub></b>	<b>C<sub>m</sub></b>
Major Bending	2	1	1	1	1	1
Minor Bending	2	1	1	1	1	1

**Parameters for Lateral Torsion Buckling**

<b>L<sub>ltb</sub></b>	<b>K<sub>ltb</sub></b>	<b>C<sub>b</sub></b>
2	1	1.749

**Demand/Capacity (D/C) Ratio**

<b>D/C Ratio =</b>	<b><math>(P_r/P_c) + (8/9)(M_{r33}/M_{c33}) + (8/9)(M_{r22}/M_{c22})</math></b>
0.739 =	0.734 + 0.006 + 0.001

**Axial Force and Capacities**

<b>P<sub>u</sub> Force (kN)</b>	<b>φP<sub>nc</sub> Capacity (kN)</b>	<b>φP<sub>nt</sub> Capacity (kN)</b>
34.7635	47.3734	95.161

**Moments and Capacities**

	<b>M<sub>u</sub> Moment (kN-m)</b>	<b>φM<sub>n</sub> Capacity (kN-m)</b>	<b>φM<sub>n</sub> No LTB (kN-m)</b>	<b>φM<sub>n</sub> Cb=1 (kN-m)</b>
Major Bending	0.0084	1.3533	1.3533	1.3533
Minor Bending	0.002	1.3533		

**Torsion Moment and Capacities**

<b>T<sub>u</sub> Moment (kN-m)</b>	<b>T<sub>n</sub> Capacity (kN-m)</b>	<b>φT<sub>n</sub> Capacity (kN-m)</b>
0	1.414	1.2726

**Shear Design**

	<b>V<sub>u</sub> Force (kN)</b>	<b>φV<sub>n</sub> Capacity (kN)</b>	<b>Stress Ratio</b>
Major Shear	0.0236	28.5483	0.001
Minor Shear	0.0021	28.5483	7.198E-05

**End Reaction Axial Forces**

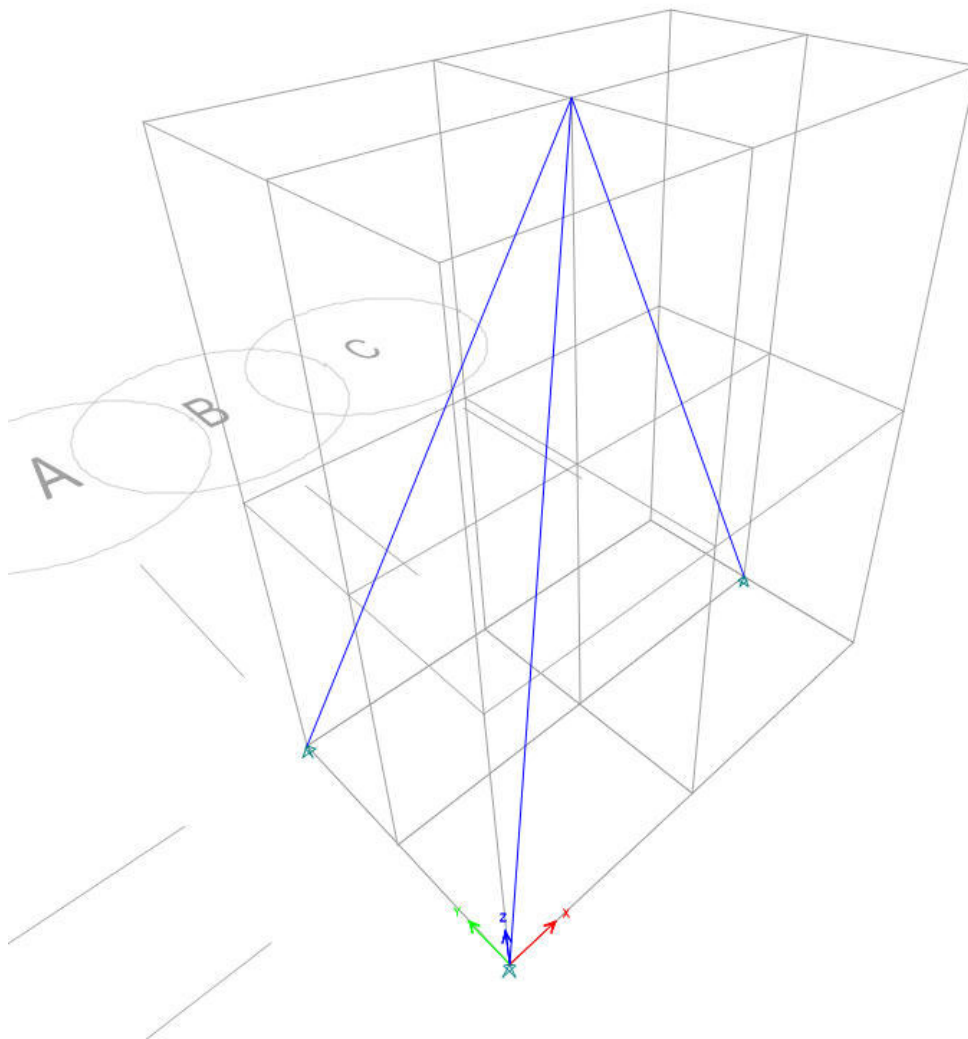
<b>Left End Reaction (kN)</b>	<b>Load Combo</b>	<b>Right End Reaction (kN)</b>	<b>Load Combo</b>
-34.7635	Comb1	-34.7635	Comb1

**Element Details**

<b>Level</b>	<b>Element</b>	<b>Unique Name</b>	<b>Element Type</b>	<b>Section</b>
Story2	D9	9	Special Moment Frame	SCH 40 1.5"

**DEFLECTION DESIGN**

<b>Deflection Type</b>	<b>L mm</b>	<b>Deflection Value mm</b>	<b>Deflection Limit mm</b>	<b>Deflection Ratio</b>	<b>Load Combo</b>	<b>Station Location mm</b>	<b>Check Status</b>
Dead Load	983.9	0	8.2	0	Comb1	983.9	OK
Super DL + Live Load	983.9	0	8.2	0	Comb1	983.9	OK
Live Load	983.9	0	2.7	0	Comb1	983.9	OK
Total Load	983.9	0	4.1	0	Comb1	983.9	OK
Total - Camber	983.9	0	4.1	0	Comb1	983.9	OK



## Reporte de Analisis y Diseño de Mastil - 2 m

Model File: MASTIL 1, Revision 0  
22/05/2024

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# 1 Structure Data

This chapter provides model geometry information, including items such as story levels, point coordinates, and element connectivity.

## 1.1 Story Data

Table 1.1 - Story Definitions

Tower	Name	Height m	Master Story	Similar To	Splice Story	Color
T1	Story2	1	Yes	None	No	Yellow
T1	Story1	1	No	Story2	No	Gray8Dark

## 1.2 Grid Data

Table 1.2 - Grid Definitions - General

Tower	Name	Type	Ux m	Uy m	Rz deg	Story Range	Bubble Size mm	Color
T1	G1	Cartesian	0	0	0	Default	1250	Gray6

Table 1.3 - Grid Definitions - Grid Lines

Name	Grid Line Type	ID	Ordinate m	Bubble Location	Visible
G1	X (Cartesian)	A	0	End	Yes
G1	X (Cartesian)	B	0.75	End	Yes
G1	X (Cartesian)	C	1.65	End	Yes
G1	Y (Cartesian)	1	0	Start	Yes
G1	Y (Cartesian)	2	0.5	Start	Yes
G1	Y (Cartesian)	3	1	Start	Yes

## 1.3 Point Coordinates

Table 1.4 - Point Bays

Label	Is Auto Point	X m	Y m	DZBelow m
1	No	0	0	0
2	No	0.75	0.5	0
3	No	0	1	0
8	No	1.65	0.5	0

## 1.4 Line Connectivity

Table 1.5 - Brace Bays

Label	PointBayI	PointBayJ	IEndStory
D1	3	2	Same
D2	1	2	Same
D3	8	2	Same

## 1.5 Mass

Table 1.6 - Mass Source Definition

Name	Is Default	Include Lateral Mass?	Include Vertical Mass?	Lump Mass?	Source Self Mass?	Source Added Mass?	Source Load Patterns?	Move Mass Centroid?
MsSrc1	Yes	Yes	No	Yes	Yes	Yes	No	No

Table 1.7 - Mass Summary by Story

Story	UX kg	UY kg	UZ kg
Story2	13.32	13.32	0
Story1	0	0	0
Base	13.32	13.32	0

Table 1.8 - Mass Summary by Group

Group	Self Mass kg	Self Weight kN	Mass X kg	Mass Y kg	Mass Z kg
All	26.64	0	26.64	26.64	0

1.6 Groups

Table 1.9 - Group Definitions

Name	Color	Steel Design?	Concrete Design?	Composite Design?
All	Yellow	No	No	No

## 2 Properties

This chapter provides property information for materials, frame sections, shell sections, and links.

### 2.1 Materials

**Table 2.1 - Material Properties - General**

Material	Type	SymType	Grade	Color	Notes
4000Psi	Concrete	Isotropic	fc 4000 psi	Gray8Dark	
A36	Steel	Isotropic	Grade 36	Green	
A416Gr270	Tendon	Uniaxial	Grade 270	Green	
A500GrB46	Steel	Isotropic	Grade B, Fy 46 (HSS Rect.)	Magenta	
A53GrB	Steel	Isotropic	Grade B	Yellow	
A615Gr60	Rebar	Uniaxial	Grade 60	Blue	
A992Fy50	Steel	Isotropic	Grade 50	Yellow	
Acero Inoxidable A304	Steel	Isotropic	A304	Cyan	

**Table 2.2 - Material Properties - Steel Data (Part 1 of 2)**

Material	Fy MPa	Fu MPa	Fye MPa	Fue MPa	SSCurveOpt	SSHysType	SHard mm/mm	SMax mm/mm	SRup mm/mm
A36	248.21	399.9	372.32	439.89	Simple	Kinematic	0.02	0.14	0.2
A500GrB46	317.16	399.9	348.87	439.89	Simple	Kinematic	0.018	0.12	0.18
A53GrB	241.32	413.69	265.45	455.05	Simple	Kinematic	0.02	0.14	0.2
A992Fy50	344.74	448.16	379.21	492.98	Simple	Kinematic	0.015	0.11	0.17
Acero Inoxidable A304	205	515	205	515	Simple	Kinematic	0.015	0.11	0.17

**Table 2.2 - Material Properties - Steel Data (Part 2 of 2)**

Material	FinalSlope
A36	-0.1
A500GrB46	-0.1
A53GrB	-0.1
A992Fy50	-0.1
Acero Inoxidable A304	-0.1

**Table 2.3 - Material Properties - Concrete Data**

Material	Fc MPa	LtWtConc	IsUserFr	SSCurveOpt	SSHysType	SFc mm/mm	SCap mm/mm	FinalSlope	FAngle deg	DAngle deg
4000Psi	27.58	No	No	Mander	Concrete	0.002219	0.005	-0.1	0	0

**Table 2.4 - Material Properties - Rebar Data**

Material	Fy MPa	Fu MPa	Fye MPa	Fue MPa	SSCurveOpt	SSHysType	SHard mm/mm	SCap mm/mm	FinalSlope
A615Gr60	413.69	620.53	455.05	682.58	Simple	Kinematic	0.01	0.09	-0.1

**Table 2.5 - Material Properties - Tendon Data**

Material	Fy MPa	Fu MPa	SSCurveOpt	SSHysType	FinalSlope
A416Gr270	1689.91	1861.58	270 ksi	Kinematic	-0.1

## 2.2 Frame Sections

Table 2.6 - Frame Section Property Definitions - Summary (Part 1 of 4)

Name	Material	Shape	Color	Area cm <sup>2</sup>	J cm <sup>4</sup>	I33 cm <sup>4</sup>	I22 cm <sup>4</sup>	I23 cm <sup>4</sup>	IMajor cm <sup>4</sup>
L1.5x1.5x1/8	A36	Steel Angle	Gray8Dark	2.3	0.1	3.1	3.1	1.8	4.9
PL 2"x1/4"	Acero Inoxidable A304	Steel Plate	Red	3.2	0.4	0.1	6.9		
PTE 2X2X2.5	A500GrB46	Steel Tube	Red	4.7	28.2	17.8	17.8		
PTE 3X3X2.5	A500GrB46	Steel Tube	Cyan	7.2	100.1	64.4	64.4		
PTE2X2X2	A500GrB46	Steel Tube	Magenta	3.8	23.2	14.9	14.9		
SCH 40 1.5"	Acero Inoxidable A304	Steel Pipe	Magenta	5.2	25.8	12.9	12.9		

Table 2.6 - Frame Section Property Definitions - Summary (Part 2 of 4)

Name	IMinor cm <sup>4</sup>	MajorAngle deg	As2 cm <sup>2</sup>	As3 cm <sup>2</sup>	S33Pos cm <sup>3</sup>	S33Neg cm <sup>3</sup>	S22Pos cm <sup>3</sup>	S22Neg cm <sup>3</sup>	Z33 cm <sup>3</sup>	Z22 cm <sup>3</sup>	R33 mm
L1.5x1.5x1/8	1.3	-45	1.1	1.1	1.1	3	3	1.1	2	2	11.7
PL 2"x1/4"			2.7	2.7	0.3	0.3	2.7	2.7	0.5	4.1	1.8
PTE 2X2X2.5			2.4	2.4	7	7	7	7	8.3	8.3	19.5
PTE 3X3X2.5			3.7	3.7	16.9	16.9	16.9	16.9	19.7	19.7	29.9
PTE2X2X2			2	1.9	5.8	5.8	5.8	5.8	6.9	6.9	19.8
SCH 40 1.5"			2.6	2.6	5.3	5.3	5.3	5.3	7.3	7.3	15.8

Table 2.6 - Frame Section Property Definitions - Summary (Part 3 of 4)

Name	Cw cm <sup>6</sup>	Fillet Radius mm	CG Offset 3 mm	CG Offset 2 mm	PNA Offset 3 mm	PNA Offset 2 mm	SC Offset 3 mm	SC Offset 2 mm	Area Modifier	As2 Modifier	As3 Modifier
L1.5x1.5x1/8	0.1	6	8.7	-8.7	16.1	-16.1	17.4	-17.4	1	1	1
PL 2"x1/4"			0	0	0	0			1	1	1
PTE 2X2X2.5		5	0	0	0	0			1	1	1
PTE 3X3X2.5		5	0	0	0	0			1	1	1
PTE2X2X2		4	0	0	0	0			1	1	1
SCH 40 1.5"			0	0	0	0			1	1	1

Table 2.6 - Frame Section Property Definitions - Summary (Part 4 of 4)

Name	I33 Modifier	I22 Modifier	Mass Modifier	Weight Modifier
L1.5x1.5x1/8	1	1	1	1
PL 2"x1/4"	1	1	1	1
PTE 2X2X2.5	1	1	1	1
PTE 3X3X2.5	1	1	1	1
PTE2X2X2	1	1	1	1
SCH 40 1.5"	1	1	1	1

Table 2.7 - Frame Section Property Definitions - Steel Angle (Part 1 of 2)

Name	Material	From File?	Total Depth mm	Total Width mm	Horizontal Leg Thickness mm	Vertical Leg Thickness mm	Fillet Radius mm	Mirror About 2-axis	Mirror About 3-axis	Area Modifier
L1.5x1.5x1/8	A36	No	38.1	38.1	3	3	6	No	No	1

Table 2.7 - Frame Section Property Definitions - Steel Angle (Part 2 of 2)

Name	As2 Modifier	As3 Modifier	J Modifier	I22 Modifier	I33 Modifier	Mass Modifier	Weight Modifier	Color	Notes
L1.5x1.5x1/8	1	1	1	1	1	1	1	Gray8Dark	

Table 2.8 - Frame Section Property Definitions - Steel Pipe (Part 1 of 2)

Name	Material	From File?	Outside Diameter mm	Wall Thickness mm	Area Modifier	As2 Modifier	As3 Modifier	J Modifier
SCH 40 1.5"	Acero Inoxidable A304	No	48.3	3.7	1	1	1	1

Table 2.8 - Frame Section Property Definitions - Steel Pipe (Part 2 of 2)

Name	I22 Modifier	I33 Modifier	Mass Modifier	Weight Modifier	Color	Notes
SCH 40 1.5"	1	1	1	1	Magenta	

Table 2.9 - Frame Section Property Definitions - Steel Plate (Part 1 of 2)

Name	Material	Depth mm	Width mm	Area Modifier	As2 Modifier	As3 Modifier	J Modifier	I22 Modifier	I33 Modifier
PL 2"X1/4"	Acero Inoxidable A304	6.4	50.8	1	1	1	1	1	1

Table 2.9 - Frame Section Property Definitions - Steel Plate (Part 2 of 2)

Name	Mass Modifier	Weight Modifier	Color	Notes
PL 2"X1/4"	1	1	Red	

Table 2.10 - Frame Section Property Definitions - Steel Tube (Part 1 of 2)

Name	Material	From File?	Total Depth mm	Total Width mm	Flange Thickness mm	Web Thickness mm	Corner Radius mm	Area Modifier	As2 Modifier
PTE 2X2X2.5	A500GrB46	No	50.8	50.8	2.5	2.5	5	1	1
PTE 3X3X2.5	A500GrB46	No	76.2	76.2	2.5	2.5	5	1	1
PTE2X2X2	A500GrB46	No	50.8	50.8	2	2	4	1	1

Table 2.10 - Frame Section Property Definitions - Steel Tube (Part 2 of 2)

Name	As3 Modifier	J Modifier	I22 Modifier	I33 Modifier	Mass Modifier	Weight Modifier	Color	Notes
PTE 2X2X2.5	1	1	1	1	1	1	Red	
PTE 3X3X2.5	1	1	1	1	1	1	Cyan	
PTE2X2X2	1	1	1	1	1	1	Magenta	

### 3 Assignments

This chapter provides a listing of the assignments applied to the model.

#### 3.1 Joint Assignments

**Table 3.1 - Joint Assignments - Summary**

Story	Label	UniqueName	Diaphragm	Restraints
Story2	2	2	From Area	
Base	1	3	From Area	UX; UY; UZ
Base	3	1	From Area	UX; UY; UZ
Base	8	4	From Area	UX; UY; UZ

**Table 3.2 - Joint Assignments - Restraints**

Story	Label	UniqueName	UX	UY	UZ	RX	RY	RZ
Base	1	3	Yes	Yes	Yes	No	No	No
Base	3	1	Yes	Yes	Yes	No	No	No
Base	8	4	Yes	Yes	Yes	No	No	No

#### 3.2 Frame Assignments

**Table 3.3 - Frame Assignments - Summary**

Story	Label	UniqueName	Design Type	Length m	Analysis Section	Design Section	Min Number Stations
Story2	D1	1	Brace	2.1937	SCH 40 1.5"	SCH 40 1.5"	3
Story2	D2	2	Brace	2.1937	SCH 40 1.5"	SCH 40 1.5"	3
Story2	D3	3	Brace	2.1932	SCH 40 1.5"	SCH 40 1.5"	3

**Table 3.4 - Frame Assignments - Section Properties**

Story	Label	UniqueName	Shape	Auto Select List	Section Property
Story2	D1	1	Steel Pipe	N.A.	SCH 40 1.5"
Story2	D2	2	Steel Pipe	N.A.	SCH 40 1.5"
Story2	D3	3	Steel Pipe	N.A.	SCH 40 1.5"

## 4 Loads

This chapter provides loading information as applied to the model.

### 4.1 Load Patterns

**Table 4.1 - Load Pattern Definitions**

Name	Is Auto Load	Type	Self Weight Multiplier
~LLRF	Yes	Other	0
Dead	No	Dead	1
Live	No	Live	0

### 4.2 Applied Loads

#### 4.2.1 Point Loads

**Table 4.2 - Joint Loads Assignments - Force**

Story	Label	UniqueName	Load Pattern	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X Dimension mm	Y Dimension mm
Story2	2	2	Live	22.2411	0	-16.0136	0	0	0	0	0

### 4.3 Load Cases

**Table 4.3 - Load Case Definitions - Summary**

Name	Type
Dead	Linear Static
Live	Linear Static
Modal	Modal - Eigen

### 4.4 Load Combinations

**Table 4.4 - Load Combination Definitions**

Name	Type	Is Auto	Load Name	SF	Notes
Comb1	Linear Add	No	Dead	1.2	
Comb1			Live	1	

## 5 Analysis Results

This chapter provides analysis results.

### 5.1 Structure Results

**Table 5.1 - Base Reactions**

Output Case	Case Type	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X m	Y m	Z m
Dead	LinStatic	0	0	0.2613	0.1306	-0.1698	0	0	0	0
Live	LinStatic	-22.2411	0	16.0136	8.0068	-56.4924	11.1206	0	0	0
Comb1	Combination	-22.2411	0	16.3271	8.1636	-56.6962	11.1206	0	0	0

### 5.2 Story Results

**Table 5.2 - Story Drifts**

Story	Output Case	Case Type	Direction	Drift	Label	X m	Y m	Z m
Story2	Dead	LinStatic	X	4.915E-07	2	0.75	0.5	2
Story2	Live	LinStatic	X	0.00087	2	0.75	0.5	2
Story2	Comb1	Combination	X	0.000871	2	0.75	0.5	2

### 5.3 Point Results

**Table 5.3 - Joint Reactions**

Story	Label	Unique Name	Output Case	Case Type	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Base	1	3	Dead	LinStatic	0.0164	0.0115	0.0792	0	0	0
Base	1	3	Live	LinStatic	-3.4178	-2.2777	-9.1121	0	0	0
Base	1	3	Comb1	Combination	-3.3981	-2.2639	-9.0171	0	0	0
Base	3	1	Dead	LinStatic	0.0164	-0.0115	0.0792	0	0	0
Base	3	1	Live	LinStatic	-3.4178	2.2777	-9.1121	0	0	0
Base	3	1	Comb1	Combination	-3.3981	2.2639	-9.0171	0	0	0
Base	8	4	Dead	LinStatic	-0.0327	0	0.1029	0	0	0
Base	8	4	Live	LinStatic	-15.4056	0	34.2378	0	0	0
Base	8	4	Comb1	Combination	-15.4449	0	34.3613	0	0	0

**Table 5.4 - Joint Displacements**

Story	Label	Unique Name	Output Case	Case Type	Ux mm	Uy mm	Uz mm	Rx rad	Ry rad	Rz rad
Story2	2	2	Dead	LinStatic	0.001	0	-0.002	0	-8.2E-05	0
Story2	2	2	Live	LinStatic	1.74	0	-0.351	0	0.000764	0
Story2	2	2	Comb1	Combination	1.742	0	-0.353	0	0.000666	0
Base	1	3	Dead	LinStatic	0	0	0	-0.00011	0.000186	-2.6E-05
Base	1	3	Live	LinStatic	0	0	0	3.5E-05	0.000844	-3.3E-05
Base	1	3	Comb1	Combination	0	0	0	-9.7E-05	0.001067	-6.4E-05
Base	3	1	Dead	LinStatic	0	0	0	0.00011	0.000186	2.6E-05
Base	3	1	Live	LinStatic	0	0	0	-3.5E-05	0.000844	3.3E-05
Base	3	1	Comb1	Combination	0	0	0	9.7E-05	0.001067	6.4E-05
Base	8	4	Dead	LinStatic	0	0	0	0	-0.000139	0
Base	8	4	Live	LinStatic	0	0	0	0	0.000605	0
Base	8	4	Comb1	Combination	0	0	0	0	0.000438	0



## 5.4 Line Results

Table 5.5 - Element Forces - Braces (Part 1 of 2)

Story	Brace	Unique Name	Station m	Output Case	Case Type	P kN	V2 kN	V3 kN	T kN-m	M2 kN-m	M3 kN-m
Story2	D1	1	0	Dead	LinStatic	-0.0804	-0.0143	-0.0005	0	0	0
Story2	D1	1	1.0969	Dead	LinStatic	-0.0407	0.0036	-0.0005	0	0.0006	0.0059
Story2	D1	1	2.1937	Dead	LinStatic	-0.001	0.0215	-0.0005	0	0.0011	-0.0079
Story2	D1	1	0	Live	LinStatic	9.995	-0.0004	-0.0007	0	0	0
Story2	D1	1	1.0969	Live	LinStatic	9.995	-0.0004	-0.0007	0	0.0007	0.0004
Story2	D1	1	2.1937	Live	LinStatic	9.995	-0.0004	-0.0007	0	0.0015	0.0009
Story2	D1	1	0	Comb1	Combination	9.8985	-0.0175	-0.0013	0	0	0
Story2	D1	1	1.0969	Comb1	Combination	9.9461	0.0039	-0.0013	0	0.0014	0.0074
Story2	D1	1	2.1937	Comb1	Combination	9.9938	0.0254	-0.0013	0	0.0028	-0.0087
Story2	D2	2	0	Dead	LinStatic	-0.0804	-0.0143	0.0005	0	0	0
Story2	D2	2	1.0969	Dead	LinStatic	-0.0407	0.0036	0.0005	0	-0.0006	0.0059
Story2	D2	2	2.1937	Dead	LinStatic	-0.001	0.0215	0.0005	0	-0.0011	-0.0079
Story2	D2	2	0	Live	LinStatic	9.995	-0.0004	0.0007	0	0	0
Story2	D2	2	1.0969	Live	LinStatic	9.995	-0.0004	0.0007	0	-0.0007	0.0004
Story2	D2	2	2.1937	Live	LinStatic	9.995	-0.0004	0.0007	0	-0.0015	0.0009
Story2	D2	2	0	Comb1	Combination	9.8985	-0.0175	0.0013	0	0	0
Story2	D2	2	1.0969	Comb1	Combination	9.9461	0.0039	0.0013	0	-0.0014	0.0074
Story2	D2	2	2.1937	Comb1	Combination	9.9938	0.0254	0.0013	0	-0.0028	-0.0087
Story2	D3	3	0	Dead	LinStatic	-0.1073	-0.0124	0	0	0	0
Story2	D3	3	1.0966	Dead	LinStatic	-0.0676	0.0055	0	0	0	0.0038
Story2	D3	3	2.1932	Dead	LinStatic	-0.0279	0.0234	0	0	0	-0.012
Story2	D3	3	0	Live	LinStatic	-37.5441	-0.0013	0	0	0	0
Story2	D3	3	1.0966	Live	LinStatic	-37.5441	-0.0013	0	0	0	0.0014
Story2	D3	3	2.1932	Live	LinStatic	-37.5441	-0.0013	0	0	0	0.0029
Story2	D3	3	0	Comb1	Combination	-37.6729	-0.0162	0	0	0	0
Story2	D3	3	1.0966	Comb1	Combination	-37.6252	0.0053	0	0	0	0.006
Story2	D3	3	2.1932	Comb1	Combination	-37.5776	0.0267	0	0	0	-0.0115

Table 5.5 - Element Forces - Braces (Part 2 of 2)

Story	Brace	Unique Name	Station m	Element	Elem Station m	Location
Story2	D1	1	0	1	0	
Story2	D1	1	1.0969	1	1.0969	
Story2	D1	1	2.1937	1	2.1937	
Story2	D1	1	0	1	0	
Story2	D1	1	1.0969	1	1.0969	
Story2	D1	1	2.1937	1	2.1937	
Story2	D1	1	0	1	0	
Story2	D1	1	1.0969	1	1.0969	
Story2	D1	1	2.1937	1	2.1937	
Story2	D2	2	0	2	0	
Story2	D2	2	1.0969	2	1.0969	
Story2	D2	2	2.1937	2	2.1937	
Story2	D2	2	0	2	0	
Story2	D2	2	1.0969	2	1.0969	
Story2	D2	2	2.1937	2	2.1937	
Story2	D2	2	0	2	0	

Table 5.5 - Element Forces - Braces (Part 2 of 2, continued)

Story	Brace	Unique Name	Station m	Element	Elem Station m	Location
Story2	D2	2	1.0969	2	1.0969	
Story2	D2	2	2.1937	2	2.1937	
Story2	D3	3	0	3	0	
Story2	D3	3	1.0966	3	1.0966	
Story2	D3	3	2.1932	3	2.1932	
Story2	D3	3	0	3	0	
Story2	D3	3	1.0966	3	1.0966	
Story2	D3	3	2.1932	3	2.1932	
Story2	D3	3	0	3	0	
Story2	D3	3	1.0966	3	1.0966	
Story2	D3	3	2.1932	3	2.1932	

Table 5.6 - Element Joint Forces - Frame

Story	Frame	Unique Name	Frame Element	Joint	Output Case	Case Type	F1 kN	F2 kN	F3 kN	M1 kN-m	M2 kN-m	M3 kN-m
Story2	D1	1	1	1	Dead	LinStatic	0.0164	-0.0115	0.0792	0	0	0
Story2	D1	1	1	2	Dead	LinStatic	-0.0164	0.0115	0.0079	0.0053	0.006	-0.0005
Story2	D1	1	1	1	Live	LinStatic	-3.4178	2.2777	-9.1121	0	0	0
Story2	D1	1	1	2	Live	LinStatic	3.4178	-2.2777	9.1121	0.0006	-0.0014	-0.0006
Story2	D1	1	1	1	Comb1	Combination	-3.3981	2.2639	-9.0171	0	0	0
Story2	D1	1	1	2	Comb1	Combination	3.3981	-2.2639	9.1216	0.0069	0.0058	-0.0012
Story2	D2	2	2	3	Dead	LinStatic	0.0164	0.0115	0.0792	0	0	0
Story2	D2	2	2	2	Dead	LinStatic	-0.0164	-0.0115	0.0079	-0.0053	0.006	0.0005
Story2	D2	2	2	3	Live	LinStatic	-3.4178	-2.2777	-9.1121	0	0	0
Story2	D2	2	2	2	Live	LinStatic	3.4178	2.2777	9.1121	-0.0006	-0.0014	0.0006
Story2	D2	2	2	3	Comb1	Combination	-3.3981	-2.2639	-9.0171	0	0	0
Story2	D2	2	2	2	Comb1	Combination	3.3981	2.2639	9.1216	-0.0069	0.0058	0.0012
Story2	D3	3	3	4	Dead	LinStatic	-0.0327	0	0.1029	0	0	0
Story2	D3	3	3	2	Dead	LinStatic	0.0327	0	-0.0158	0	-0.012	0
Story2	D3	3	3	4	Live	LinStatic	-15.4056	0	34.2378	0	0	0
Story2	D3	3	3	2	Live	LinStatic	15.4056	0	-34.2378	0	0.0029	0
Story2	D3	3	3	4	Comb1	Combination	-15.4449	0	34.3613	0	0	0
Story2	D3	3	3	2	Comb1	Combination	15.4449	0	-34.2568	0	-0.0115	0

## 5.5 Modal Results

Table 5.7 - Modal Load Participation Ratios

Case	ItemType	Item	Static %	Dynamic %
Modal	Acceleration	UX	100	100
Modal	Acceleration	UY	100	100
Modal	Acceleration	UZ	0	0

Table 5.8 - Modal Direction Factors

Case	Mode	Period sec	UX	UY	UZ	RZ
Modal	1	0.012	0	1	0	0
Modal	2	0.006	1	0	0	0

## 6 Design Data

This chapter provides design data and results.

### 6.1 Steel Frame Design

**Table 6.1 - Steel Frame Design Preferences - AISC 360-16**

Item	Value
Multi-Response Design	Step-by-Step - All
Frame Type	SMF
Seismic Design Category	D
Importance Factor	1
Design System Rho	1
Design System Sds	0.5
Design System R	8
Design System Omega0	3
Design System Cd	5.5
Design Provision	LRFD
Analysis Method	Direct Analysis
Second Order Method	General 2nd Order
Stiffness Reduction Method	Tau-b Fixed
Add Notional Load Case	No
Beta Factor	1.3
Beta Omega Factor	1.6
Phi (Bending)	0.9
Phi (Compression)	0.9
Phi (Tension-Yielding)	0.9
Phi (Tension-Fracture)	0.75
Phi (Shear)	0.9
Phi (Shear-Short Webbed Rolled I)	1
Phi (Torsion)	0.9
Ignore Seismic Code?	No
Ignore Special Seismic Load?	No
Doubler Plate Plug-Welded?	Yes
HSS Welding Type	ERW
Reduced HSS Thickness	No
Consider Deflection?	Yes
DL Ratio	120
SDL+LL Ratio	120
LL Ratio	360
Total Ratio	240
Total Camber Limit	240
Pattern Live Load Factor	0.75
D/C Ratio Limit	0.95
Maximum Iterations	1

**Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 1 of 6)**

Story	Label	Unique Name	Design Type	Design Section	Frame Type	Omega0	Connection Type
Story2	D1	1	Brace	Program Determined	Program Determined	0	Program Determined
Story2	D2	2	Brace	Program Determined	Program Determined	0	Program Determined
Story2	D3	3	Brace	Program Determined	Program Determined	0	Program Determined

Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 2 of 6)

Relative Hinge Distance Sh/L Left	Yield Line Yc/h Parameter	Relative Hinge Distance Sh/L Right	BRB Beta Factor	BRB Beta*Omega Factor	Perform RBS Capacity Design	Check Deflection?
0	0	0	0	0	Program Determined	Program Determined
0	0	0	0	0	Program Determined	Program Determined
0	0	0	0	0	Program Determined	Program Determined

Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 3 of 6)

DL Ratio	SDL+LL Ratio	LL Ratio	Total Ratio	Camber Ratio	Specified Camber mm	Net Area Ratio	LLRF	Unbraced Length Ratio Major	Unbraced Length Ratio Minor	Unbraced Length Ratio (LTB)
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0

Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 4 of 6)

Effective Length Factor 1 Minor	Effective Length Factor 2 Major	Effective Length Factor 2 Minor	Effective Length Factor (KLTB)	Moment Coefficient (Cm Major)	Moment Coefficient (Cm Minor)	Bending Coefficient (Cb)	Nonsway Moment Factor (B1 Major)	Nonsway Moment Factor (B1 Minor)	Sway Moment Factor (B2 Major)
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 5 of 6)

Reduce HSS Thickness?	HSS Welding Type?	Yield stress, Fy MPa	Expected to specified Fy ratio, Ry	Compressive Capacity, Pnc kN	Tensile Capacity, Pnt kN	Major Bending Capacity, Mn3 kN-m	Minor Bending Capacity, Mn2 kN-m
Program Determined	Program Determined	0	0	0	0	0	0
Program Determined	Program Determined	0	0	0	0	0	0
Program Determined	Program Determined	0	0	0	0	0	0

Table 6.2 - Steel Frame Design Overwrites - AISC 360-16 (Part 6 of 6)

Minor Shear Capacity, Vn3 kN	D/C Ratio Limit
0	0
0	0
0	0

Table 6.3 - Steel Brace Envelope - AISC 360-16 (Part 1 of 2)

UniqueName	Story	Label	Design Section	Moment Interaction Check	PMM Combo	V22 Ratio	V33 Ratio	Section Class
1	Story2	D1	SCH 40 1.5"	$0.059 = 0.053 + 0.006 + 0.002$	Comb1	0.001	0	Seismic HD
2	Story2	D2	SCH 40 1.5"	$0.059 = 0.053 + 0.006 + 0.002$	Comb1	0.001	0	Seismic HD
3	Story2	D3	SCH 40 1.5"	$0.947 = 0.939 + 0.008 + 0$	Comb1	0.001	0	Seismic HD

Table 6.3 - Steel Brace Envelope - AISC 360-16 (Part 2 of 2)

UniqueName	Conn. P I-End kN	Conn. P J-End kN
1	9.9938	9.9938
2	9.9938	9.9938
3	-37.6729	-37.6729

Table 6.4 - Steel Frame Design Summary - AISC 360-16 (Part 1 of 2)

UniqueName	Story	Label	Design Type	Design Section	Status	PMM Combo	PMM Ratio	P Ratio	M Major Ratio	M Minor Ratio
1	Story2	D1	Brace	SCH 40 1.5"	No Message	(T)	0.059	0.053	0.006	0.002
2	Story2	D2	Brace	SCH 40 1.5"	No Message	(T)	0.059	0.053	0.006	0.002
3	Story2	D3	Brace	SCH 40 1.5"	No Message	Comb1(C)	0.947	0.939	0.008	0

Table 6.4 - Steel Frame Design Summary - AISC 360-16 (Part 2 of 2)

UniqueName	V Major Combo	V Major Ratio	V Minor Combo	V Minor Ratio
1	Comb1	0.001	Comb1	0
2	Comb1	0.001	Comb1	0
3	Comb1	0.001	Comb1	0

## ETABS Steel Frame Design

AISC 360-16 Steel Section Check (Envelope Details)

### Element Details

Level	Element	Unique Name	Section	Combo	Location	Frame Type	Classification
Story2	D1	1	SCH 40 1.5"	Comb1	2193.7	Special Moment Frame	Compact

### LLRF and Demand/Capacity Ratio

L (mm)	LLRF	Stress Ratio Limit
2193.7	1	0.95

### Analysis and Design Parameters

Provision	Analysis	2nd Order	Reduction
LRFD	Direct Analysis	General 2nd Order	Tau-b Fixed

### Stiffness Reduction Factors

$\alpha P_r / P_y$	$\alpha P_r / P_e$	$\tau_b$	EA factor	EI factor
-0.095	-0.196	1	0.8	0.8

### Design Code Parameters

$\phi_b$	$\phi_b$	$\phi_{TY}$	$\phi_{TF}$	$\phi_V$	$\phi_{V-RI}$	$\phi_{VT}$
0.9	0.9	0.9	0.75	0.9	1	1

### Section Properties

A (cm <sup>2</sup> )	J (cm <sup>4</sup> )	I <sub>33</sub> (cm <sup>4</sup> )	I <sub>22</sub> (cm <sup>4</sup> )	A <sub>v3</sub> (cm <sup>2</sup> )	A <sub>v2</sub> (cm <sup>2</sup> )
5.2	25.8	12.9	12.9	2.6	2.6

### Design Properties

S <sub>33</sub> (cm <sup>3</sup> )	S <sub>22</sub> (cm <sup>3</sup> )	Z <sub>33</sub> (cm <sup>3</sup> )	Z <sub>22</sub> (cm <sup>3</sup> )	r <sub>33</sub> (mm)	r <sub>22</sub> (mm)	C <sub>w</sub> (cm <sup>6</sup> )
5.3	5.3	7.3	7.3	15.8	15.8	Not required

### Material Properties

E (MPa)	f <sub>y</sub> (MPa)	R <sub>y</sub>	C <sub>pr</sub>	$\alpha$
193000	205	1	1.4	NA

### HSS Section Parameters

HSS Welding	Reduce HSS Thickness?
ERW	No

### Stress Check forces and Moments

Location (mm)	P <sub>u</sub> (kN)	M <sub>u33</sub> (kN-m)	M <sub>u22</sub> (kN-m)	V <sub>u2</sub> (kN)	V <sub>u3</sub> (kN)	T <sub>u</sub> (kN-m)
2193.7	9.9938	-0.0087	0.0028	0.0254	-0.0013	0

### Axial Force & Biaxial Moment Design Factors (H1.2,H1-1b)

	L Factor	K <sub>1</sub>	K <sub>2</sub>	B <sub>1</sub>	B <sub>2</sub>	C <sub>m</sub>
Major Bending	1	1	1	1	1	1
Minor Bending	1	1	1	1	1	1

## Parameters for Lateral Torsion Buckling

$L_{ltb}$	$K_{ltb}$	$C_b$
1	1	1.835

## Demand/Capacity (D/C) Ratio

D/C Ratio =	$(P_r / 2P_c) + (M_{r33} / M_{c33}) + (M_{r22} / M_{c22})$
0.059 =	0.053 + 0.006 + 0.002

## Axial Force and Capacities

$P_u$ Force (kN)	$\phi P_{nc}$ Capacity (kN)	$\phi P_{nt}$ Capacity (kN)
9.9938	39.9948	95.161

## Moments and Capacities

	$M_u$ Moment (kN-m)	$\phi M_n$ Capacity (kN-m)	$\phi M_n$ No LTB (kN-m)	$\phi M_n C_b=1$ (kN-m)
Major Bending	0.0087	1.3533	1.3533	1.3533
Minor Bending	0.0028	1.3533		

## Torsion Moment and Capacities

$T_u$ Moment (kN-m)	$T_n$ Capacity (kN-m)	$\phi T_n$ Capacity (kN-m)
0	1.414	1.2726

## Shear Design

	$V_u$ Force (kN)	$\phi V_n$ Capacity (kN)	Stress Ratio
Major Shear	0.0254	28.5483	0.001
Minor Shear	0.0013	28.5483	4.509E-05

## End Reaction Axial Forces

Left End Reaction (kN)	Load Combo	Right End Reaction (kN)	Load Combo
9.9938	Comb1	9.9938	Comb1

## Element Details

Level	Element	Unique Name	Element Type	Section
Story2	D1	1	Special Moment Frame	SCH 40 1.5"

## DEFLECTION DESIGN

Deflection Type	L mm	Deflection Value mm	Deflection Limit mm	Deflection Ratio	Load Combo	Station Location mm	Check Status
Dead Load	2193.7	0	18.3	0	Comb1	2193.7	OK
Super DL + Live Load	2193.7	0	18.3	0	Comb1	2193.7	OK
Live Load	2193.7	0	6.1	0	Comb1	2193.7	OK
Total Load	2193.7	0	9.1	0	Comb1	2193.7	OK
Total - Camber	2193.7	0	9.1	0	Comb1	2193.7	OK

## ETABS Steel Frame Design

AISC 360-16 Steel Section Check (Envelope Details)

### Element Details

Level	Element	Unique Name	Section	Combo	Location	Frame Type	Classification
Story2	D2	2	SCH 40 1.5"	Comb1	2193.7	Special Moment Frame	Compact

### LLRF and Demand/Capacity Ratio

L (mm)	LLRF	Stress Ratio Limit
2193.7	1	0.95

### Analysis and Design Parameters

Provision	Analysis	2nd Order	Reduction
LRFD	Direct Analysis	General 2nd Order	Tau-b Fixed

### Stiffness Reduction Factors

$\alpha P_r / P_y$	$\alpha P_r / P_e$	$\tau_b$	EA factor	EI factor
-0.095	-0.196	1	0.8	0.8

### Design Code Parameters

$\phi_b$	$\phi_b$	$\phi_{TY}$	$\phi_{TF}$	$\phi_V$	$\phi_{V-RI}$	$\phi_{VT}$
0.9	0.9	0.9	0.75	0.9	1	1

### Section Properties

A (cm <sup>2</sup> )	J (cm <sup>4</sup> )	I <sub>33</sub> (cm <sup>4</sup> )	I <sub>22</sub> (cm <sup>4</sup> )	A <sub>v3</sub> (cm <sup>2</sup> )	A <sub>v2</sub> (cm <sup>2</sup> )
5.2	25.8	12.9	12.9	2.6	2.6

### Design Properties

S <sub>33</sub> (cm <sup>3</sup> )	S <sub>22</sub> (cm <sup>3</sup> )	Z <sub>33</sub> (cm <sup>3</sup> )	Z <sub>22</sub> (cm <sup>3</sup> )	r <sub>33</sub> (mm)	r <sub>22</sub> (mm)	C <sub>w</sub> (cm <sup>6</sup> )
5.3	5.3	7.3	7.3	15.8	15.8	Not required

### Material Properties

E (MPa)	f <sub>y</sub> (MPa)	R <sub>y</sub>	C <sub>pr</sub>	$\alpha$
193000	205	1	1.4	NA

### HSS Section Parameters

HSS Welding	Reduce HSS Thickness?
ERW	No

### Stress Check forces and Moments

Location (mm)	P <sub>u</sub> (kN)	M <sub>u33</sub> (kN-m)	M <sub>u22</sub> (kN-m)	V <sub>u2</sub> (kN)	V <sub>u3</sub> (kN)	T <sub>u</sub> (kN-m)
2193.7	9.9938	-0.0087	-0.0028	0.0254	0.0013	0

### Axial Force & Biaxial Moment Design Factors (H1.2,H1-1b)

	L Factor	K <sub>1</sub>	K <sub>2</sub>	B <sub>1</sub>	B <sub>2</sub>	C <sub>m</sub>
Major Bending	1	1	1	1	1	1
Minor Bending	1	1	1	1	1	1



## Parameters for Lateral Torsion Buckling

$L_{ltb}$	$K_{ltb}$	$C_b$
1	1	1.835

## Demand/Capacity (D/C) Ratio

D/C Ratio =	$(P_r / 2P_c) + (M_{r33} / M_{c33}) + (M_{r22} / M_{c22})$
0.059 =	0.053 + 0.006 + 0.002

## Axial Force and Capacities

$P_u$ Force (kN)	$\phi P_{nc}$ Capacity (kN)	$\phi P_{nt}$ Capacity (kN)
9.9938	39.9948	95.161

## Moments and Capacities

	$M_u$ Moment (kN-m)	$\phi M_n$ Capacity (kN-m)	$\phi M_n$ No LTB (kN-m)	$\phi M_n C_b=1$ (kN-m)
Major Bending	0.0087	1.3533	1.3533	1.3533
Minor Bending	0.0028	1.3533		

## Torsion Moment and Capacities

$T_u$ Moment (kN-m)	$T_n$ Capacity (kN-m)	$\phi T_n$ Capacity (kN-m)
0	1.414	1.2726

## Shear Design

	$V_u$ Force (kN)	$\phi V_n$ Capacity (kN)	Stress Ratio
Major Shear	0.0254	28.5483	0.001
Minor Shear	0.0013	28.5483	4.509E-05

## End Reaction Axial Forces

Left End Reaction (kN)	Load Combo	Right End Reaction (kN)	Load Combo
9.9938	Comb1	9.9938	Comb1

## Element Details

Level	Element	Unique Name	Element Type	Section
Story2	D2	2	Special Moment Frame	SCH 40 1.5"

## DEFLECTION DESIGN

Deflection Type	L mm	Deflection Value mm	Deflection Limit mm	Deflection Ratio	Load Combo	Station Location mm	Check Status
Dead Load	2193.7	0	18.3	0	Comb1	2193.7	OK
Super DL + Live Load	2193.7	0	18.3	0	Comb1	2193.7	OK
Live Load	2193.7	0	6.1	0	Comb1	2193.7	OK
Total Load	2193.7	0	9.1	0	Comb1	2193.7	OK
Total - Camber	2193.7	0	9.1	0	Comb1	2193.7	OK

## ETABS Steel Frame Design

AISC 360-16 Steel Section Check (Envelope Details)

### Element Details

Level	Element	Unique Name	Section	Combo	Location	Frame Type	Classification
Story2	D3	3	SCH 40 1.5"	Comb1	2193.2	Special Moment Frame	Compact

### LLRF and Demand/Capacity Ratio

L (mm)	LLRF	Stress Ratio Limit
2193.2	1	0.95

### Analysis and Design Parameters

Provision	Analysis	2nd Order	Reduction
LRFD	Direct Analysis	General 2nd Order	Tau-b Fixed

### Stiffness Reduction Factors

$\alpha P_r / P_y$	$\alpha P_r / P_e$	$\tau_b$	EA factor	EI factor
0.355	0.736	1	0.8	0.8

### Design Code Parameters

$\phi_b$	$\phi_b$	$\phi_{TY}$	$\phi_{TF}$	$\phi_V$	$\phi_{V-RI}$	$\phi_{VT}$
0.9	0.9	0.9	0.75	0.9	1	1

### Section Properties

A (cm <sup>2</sup> )	J (cm <sup>4</sup> )	I <sub>33</sub> (cm <sup>4</sup> )	I <sub>22</sub> (cm <sup>4</sup> )	A <sub>v3</sub> (cm <sup>2</sup> )	A <sub>v2</sub> (cm <sup>2</sup> )
5.2	25.8	12.9	12.9	2.6	2.6

### Design Properties

S <sub>33</sub> (cm <sup>3</sup> )	S <sub>22</sub> (cm <sup>3</sup> )	Z <sub>33</sub> (cm <sup>3</sup> )	Z <sub>22</sub> (cm <sup>3</sup> )	r <sub>33</sub> (mm)	r <sub>22</sub> (mm)	C <sub>w</sub> (cm <sup>6</sup> )
5.3	5.3	7.3	7.3	15.8	15.8	Not required

### Material Properties

E (MPa)	f <sub>y</sub> (MPa)	R <sub>y</sub>	C <sub>pr</sub>	$\alpha$
193000	205	1	1.4	NA

### HSS Section Parameters

HSS Welding	Reduce HSS Thickness?
ERW	No

### Stress Check forces and Moments

Location (mm)	P <sub>u</sub> (kN)	M <sub>u33</sub> (kN-m)	M <sub>u22</sub> (kN-m)	V <sub>u2</sub> (kN)	V <sub>u3</sub> (kN)	T <sub>u</sub> (kN-m)
2193.2	-37.5776	-0.0115	0	0.0267	0	0

### Axial Force & Biaxial Moment Design Factors (H1-1a)

	L Factor	K <sub>1</sub>	K <sub>2</sub>	B <sub>1</sub>	B <sub>2</sub>	C <sub>m</sub>
Major Bending	1	1	1	1	1	1
Minor Bending	1	1	1	1	1	1

## Parameters for Lateral Torsion Buckling

$L_{ltb}$	$K_{ltb}$	$C_b$
1	1	2.058

## Demand/Capacity (D/C) Ratio

D/C Ratio =	$(P_r/P_c) + (8/9)(M_{r33}/M_{c33}) + (8/9)(M_{r22}/M_{c22})$
0.947 =	0.939 + 0.008 + 0

## Axial Force and Capacities

$P_u$ Force (kN)	$\phi P_{nc}$ Capacity (kN)	$\phi P_{nt}$ Capacity (kN)
37.5776	40.0128	95.161

## Moments and Capacities

	$M_u$ Moment (kN-m)	$\phi M_n$ Capacity (kN-m)	$\phi M_n$ No LTB (kN-m)	$\phi M_n C_b=1$ (kN-m)
Major Bending	0.0115	1.3533	1.3533	1.3533
Minor Bending	0	1.3533		

## Torsion Moment and Capacities

$T_u$ Moment (kN-m)	$T_n$ Capacity (kN-m)	$\phi T_n$ Capacity (kN-m)
0	1.414	1.2726

## Shear Design

	$V_u$ Force (kN)	$\phi V_n$ Capacity (kN)	Stress Ratio
Major Shear	0.0267	28.5483	0.001
Minor Shear	0	28.5483	0

## End Reaction Axial Forces

Left End Reaction (kN)	Load Combo	Right End Reaction (kN)	Load Combo
-37.6729	Comb1	-37.6729	Comb1

## Element Details

Level	Element	Unique Name	Element Type	Section
Story2	D3	3	Special Moment Frame	SCH 40 1.5"

## DEFLECTION DESIGN

Deflection Type	L mm	Deflection Value mm	Deflection Limit mm	Deflection Ratio	Load Combo	Station Location mm	Check Status
Dead Load	2193.2	0	18.3	0	Comb1	2193.2	OK
Super DL + Live Load	2193.2	0	18.3	0	Comb1	2193.2	OK
Live Load	2193.2	0	6.1	0	Comb1	2193.2	OK
Total Load	2193.2	0	9.1	0	Comb1	2193.2	OK
Total - Camber	2193.2	0	9.1	0	Comb1	2193.2	OK

## Cálculo de anclaje AnchorFix-3001 - Acero inoxidable A4-70 M10

**El anclaje seleccionado es aplicable**

### Información sobre el producto

#### AnchorFix-3001 - Acero inoxidable A4-70

Material	Acero inoxidable A4-70
Método de perforación	
Tipo	Anclaje químico
Homologación	
Profundidad del taladro	64.0 mm
Diámetro nominal de broca	12 mm
Profundidad efectiva del anclaje	64.0 mm



### Material

#### Hormigón (peso normal)

Resistencia a compresión del hormigón	2500 psi (17.2 N/mm²)
Zona	Hormigón fisurado (Zona de tracción)

#### Hormigón armado

Armadura para fuerzas de tracción	No
Armadura para fuerzas de cortadura	No
Refuerzo para controlar la fisura	Sí
No evaluar rotura de hormigón a tracción	No
No evaluar rotura de hormigón a cortadura	No

#### Condiciones

Temperatura máxima a corto plazo	55 °C
Temperatura máxima a largo plazo	43 °C
Inspección	Periodico
Condiciones de instalación	Seco
Dirección de instalación	Hacia abajo

### Geometría

#### Anclaje

Configuración de los anclajes	Grupo de cuatro con agujeros ranurados
Rotación	0 °

#### Excentricidad

Sika Services AG

(P) +41 58 436 6800  
www.sika.com

(F) +41 58 436 6850  
info@sika.com

## Cálculo de anclaje AnchorFix-3001 - Acero inoxidable A4-70 M10

### Excentricidad

Desplazamientos	$y$	0.0 mm
Desplazamientos	$z$	0.0 mm

### Distancia entre anclajes

Distancia entre anclajes	$y_1$	100.0 mm
Distancia entre anclajes	$z_1$	100.0 mm

### Distancias de bordes / Espesor del hormigón

Espesor del hormigón	$h$	100.0 mm
----------------------	-----	----------

### Dimensiones de la placa de anclaje

Forma de placa de anclaje		Rectángulo
Anchura de la placa de anclaje	$y$	150.0 mm
Longitud de la placa de anclaje	$z$	150.0 mm
Espesor de la placa de anclaje		9.0 mm

### Perfil conectado - Excentricidad

Desplazamientos	$y$	0.0 mm
Desplazamientos	$z$	0.0 mm

## Carga

### Carga

Tracción	$N_u$	18.13 kN
Cortadura	$V_{uy}$	6.80 kN
Cortadura	$V_{uz}$	4.53 kN
Momento flector	$M_{uy}$	0.00 kNm
Momento flector	$M_{uz}$	0.00 kNm

### Condiciones de carga de tracción

Tracción permanente	No
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### Condiciones de carga a cortante

Usar anclajes con capa de mortero inyectada	No
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### Combinación de carga

Factor de carga	ACI 318 capítulo 5.3
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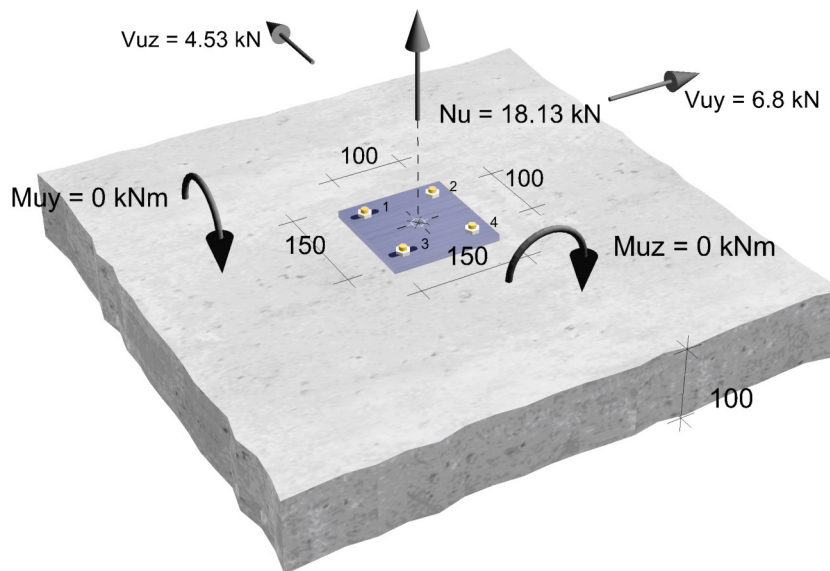
### Sísmico

Categoría sísmica C, D, E o F	No
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## Cálculo de anclaje AnchorFix-3001 - Acero inoxidable A4-70 M10

### Fuerzas de sección

Anclaje Nr.	Tracción [kN]	Cortadura [kN]
1	4.53 kN	1.13 kN
2	4.53 kN	3.58 kN
3	4.53 kN	1.13 kN
4	4.53 kN	3.58 kN



### Verificaciones ACI 318-14 (IBC 2015)

## Cálculo de anclaje AnchorFix-3001 - Acero inoxidable A4-70 M10

### Capacidad total por fallo del acero

$$\beta_N = \frac{N_{ua}}{\Phi N_{sa}} = \frac{4.53 \text{ kN}}{26.39 \text{ kN}}$$

	$N_{ua}$ [kN]	$\Phi$	$N_{sa}$ [kN]	$\Phi N_{sa}$ [kN]	$\beta_N$ [%]
	4.53	0.65	40.60	26.39	17.18

### Capacidad total por cono del hormigón (Anclajes de control: 1, 2, 3, 4)

$$N_b = k_c \cdot \lambda_a \cdot \sqrt{f'_c} \cdot h_{ef}^{1.5}$$

	$k_c$	$\lambda_a$	$f'_c$ [N/mm <sup>2</sup> ]	$h_{ef}$ [mm]	$N_b$ [kN]
	7	1.00	17.24	64.0	15.09

$$N_{cb} = \frac{A_{Nc}}{A_{Nc0}} \cdot \psi_{ec,N} \cdot \psi_{ed,N} \cdot \psi_{c,N} \cdot \psi_{cp,N} \cdot N_b$$

	$A_{Nc}$ [mm <sup>2</sup> ]	$A_{Nc0}$ [mm <sup>2</sup> ]	$\psi_{ec,N}$	$\psi_{ed,N}$	$\psi_{c,N}$	$\psi_{cp,N}$
	85264	36864	1.000	1.000	1.000	1.000
	$N_b$ [kN]	$N_{cb}$ [kN]				
	15.09	34.91				

$$\beta_N = \frac{N_{ua}}{\Phi N_{cb}} = \frac{18.13 \text{ kN}}{22.69 \text{ kN}}$$

	$N_{ua}$ [kN]	$\Phi$	$N_{cb}$ [kN]	$\Phi N_{cb}$ [kN]	$\beta_N$ [%]
	18.13	0.65	34.91	22.69	79.90

## Cálculo de anclaje AnchorFix-3001 - Acero inoxidable A4-70 M10

### Fallo de adhesión - Tracción (Anclajes de control: 1, 2, 3, 4)

$$N_{ba} = \lambda_a \cdot k_{sust} \cdot \tau_{k,cr} \cdot \pi \cdot d \cdot h_{ef}$$

	$\lambda_a$	$k_{sust}$	$\tau_{k,cr}$ [N/mm <sup>2</sup> ]	$d$ [mm]	$h_{ef}$ [mm]
	1.00	1.00	7.9	10.0	64.0
	$N_{ba}$ [kN]				
	15.88				

$$N_a = \frac{A_{Na}}{A_{Na0}} \cdot \psi_{ed,Na} \cdot \psi_{ec,Na} \cdot \psi_{cp,Na} \cdot N_{ba}$$

	$A_{Na}$ [mm <sup>2</sup> ]	$A_{Na0}$ [mm <sup>2</sup> ]	$\psi_{ed,Na}$	$\psi_{ec,Na}$	$\psi_{cp,Na}$
	103195	48947	1.000	1.000	1.000
	$N_{ba}$ [kN]		$N_a$ [kN]		
	15.88		33.49		

$$\beta_N = \frac{N_{ua}}{\Phi N_a} = \frac{18.13 \text{ kN}}{21.77 \text{ kN}}$$

	$N_{ua}$ [kN]	$\Phi$	$N_a$ [kN]	$\Phi N_a$ [kN]	$\beta_N$ [%]
	18.13	0.65	33.49	21.77	83.29

### Capacidad total por fallo del acero en la fuerza cortante

$$\beta_V = \frac{V_{ua}}{\Phi V_{sa}} = \frac{3.58 \text{ kN}}{14.64 \text{ kN}}$$

	$V_{ua}$ [kN]	$\Phi$	$V_{sa}$ [kN]	$\Phi V_{sa}$ [kN]	$\beta_V$ [%]
	3.58	0.60	24.40	14.64	24.48



## Cálculo de anclaje AnchorFix-3001 - Acero inoxidable A4-70 M10

### Fallo de ruptura del hormigón - Cortante - Grupo de anclajes (Anclajes de control: 1, 2, 3, 4)

$$N_b = k_c \cdot \lambda_a \cdot \sqrt{f'_c} \cdot h_{ef}^{1.5}$$

	$k_c$	$\lambda_a$	$f'_c$ [N/mm <sup>2</sup> ]	$h_{ef}$ [mm]	$N_b$ [kN]
	7	1.00	17.24	64.0	15.09

$$N_{cbg} = \frac{A_{Nc}}{A_{Nc0}} \cdot \psi_{ec,N} \cdot \psi_{ed,N} \cdot \psi_{c,N} \cdot \psi_{cp,N} \cdot N_b$$

	$A_{Nc}$ [mm <sup>2</sup> ]	$A_{Nc0}$ [mm <sup>2</sup> ]	$\psi_{ec,N}$	$\psi_{ed,N}$	$\psi_{c,N}$	$\psi_{cp,N}$
	85264	36864	1.000	1.000	1.000	1.000
	$N_b$ [kN]	$N_{cbg}$ [kN]				
	15.09	34.91				

$$N_{ba} = \lambda_a \cdot \tau_{k,cr} \cdot \pi \cdot d \cdot h_{ef}$$

	$\lambda_a$	$\tau_{k,cr}$ [N/mm <sup>2</sup> ]	$d$ [mm]	$h_{ef}$ [mm]	$N_{ba}$ [kN]
	1.00	7.9	10.0	64.0	15.88

$$N_{ag} = \frac{A_{Na}}{A_{N0}} \cdot \psi_{ed,Na} \cdot \psi_{ec,Na} \cdot \psi_{p,Na} \cdot N_{ba}$$

	$A_{Na}$ [mm <sup>2</sup> ]	$A_{N0}$ [mm <sup>2</sup> ]	$\psi_{ed,Na}$	$\psi_{ec,Na}$	$\psi_{p,Na}$
	103195	48947	1.000	1.000	1.000
	$N_{ba}$ [kN]	$N_{ag}$ [kN]			
	15.88	33.49			

$$V_{cpg} = k_{cp} \cdot \min(N_{cbg}; N_{ag})$$

	$k_{cp}$	$N_{cbg}$ [kN]	$N_{ag}$ [kN]	$V_{cpg}$ [kN]
	2	34.91	33.49	66.98

$$\beta_N = \frac{V_{ua}}{\Phi V_{cpg}} = \frac{8.17 \text{ kN}}{46.88 \text{ kN}}$$

	$V_{ua}$ [kN]	$\Phi$	$V_{cpg}$ [kN]	$\Phi V_{cpg}$ [kN]	$\beta_N$ [%]
	8.17	0.70	66.98	46.88	17.43

### Capacidad total por interacción de cargas combinadas a tracción y cortante

$$\beta = \frac{\beta_{N,max} + \beta_{V,max}}{1.2}$$

	$\beta_{N,max}$ [%]	$\beta_{V,max}$ [%]	$\beta$ [%]
	83.29	24.48	89.81

## Cálculo de anclaje AnchorFix-3001 - Acero inoxidable A4-70 M10

El anclaje seleccionado es aplicable

## Cálculo de anclaje AnchorFix-3001 - Acero inoxidable A4-70 M10

### Sugerencias

Notas sobre los cálculos:

Comprobar la capacidad de carga de los anclajes consulte los siguientes documentos:

- Evaluación u homologación del anclaje

Se han realizado las siguientes hipótesis para el cálculo:

- Se ha comprobado la calidad del material de construcción elegido
- Todos los anclajes de un grupo son del mismo tipo y tamaño
- La placa de anclaje permanece rígida durante la carga

Se comprobó la transferencia local de cargas al material base, debiendo comprobarse por separado la transferencia de estas cargas al resto de la estructura.

El cálculo se basa en numerosos valores específicos del anclaje. Si se sustituye un anclaje o se modifican los valores de entrada, se requiere un nuevo cálculo. Deben respetarse las exigencias o disposiciones de la homologación técnica de los anclajes, especialmente si los anclajes están sometidos a cargas dinámicas.

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## **Cálculo de anclaje AnchorFix-3001 - Acero inoxidable A4-70 M10**

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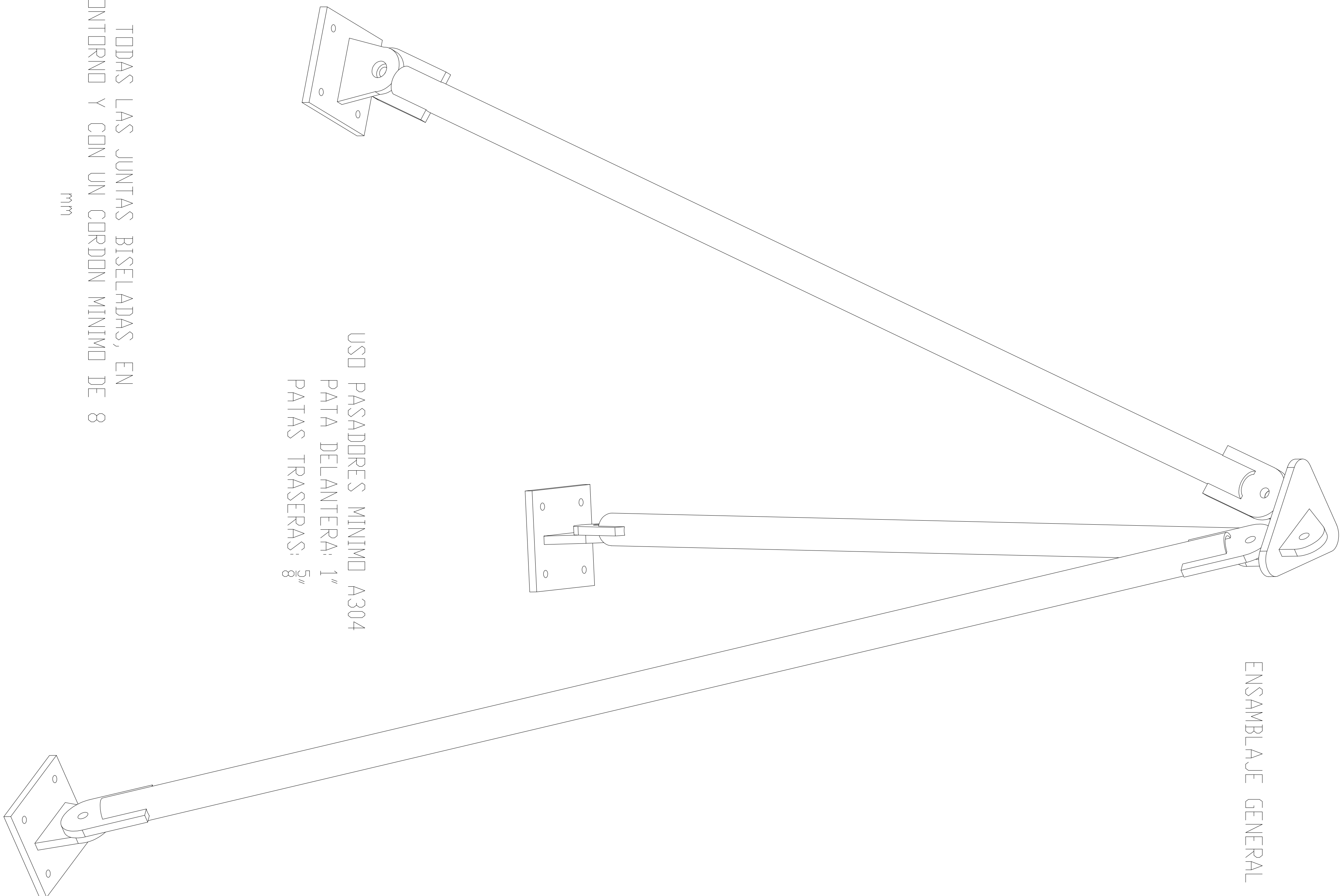
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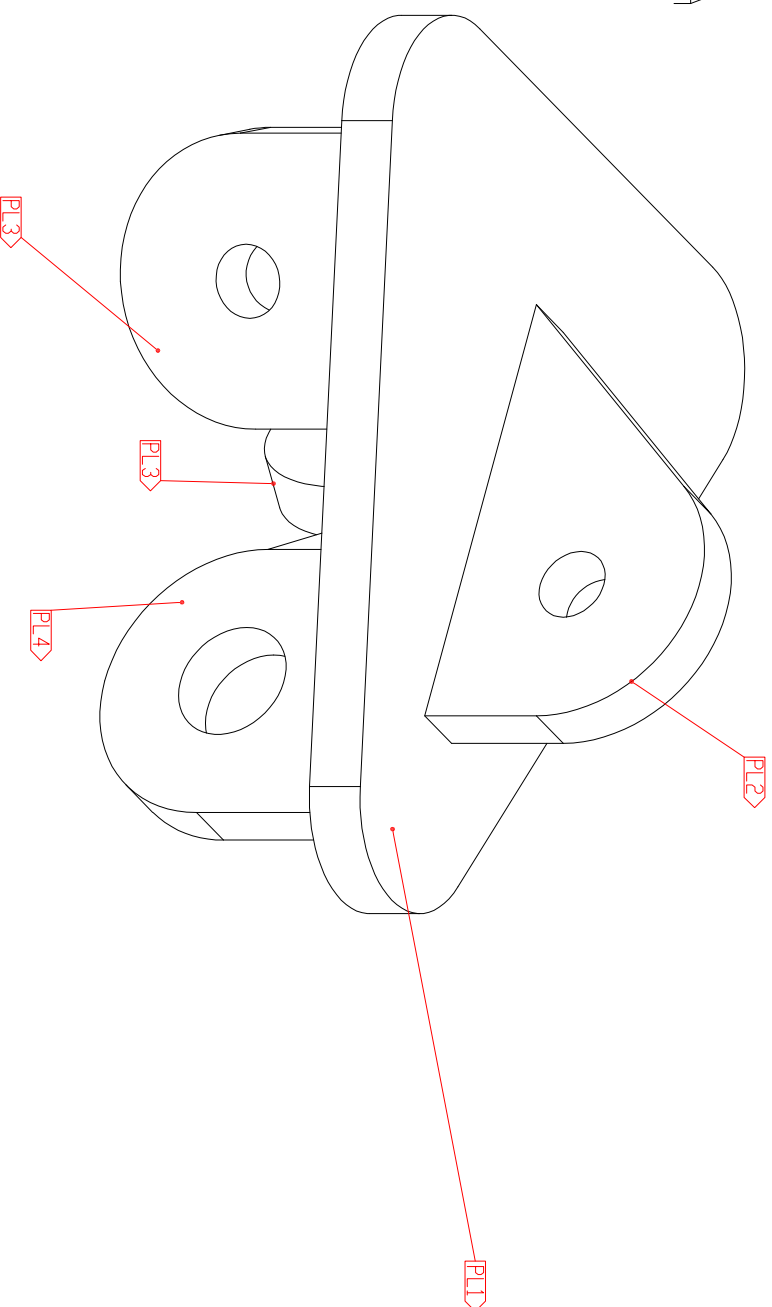
ENSAMBLAJE GENERAL



USO PASADDORES MINIMO A304  
PATA DELANTERA: 1"  
PATAS TRASERAS: 5/8"

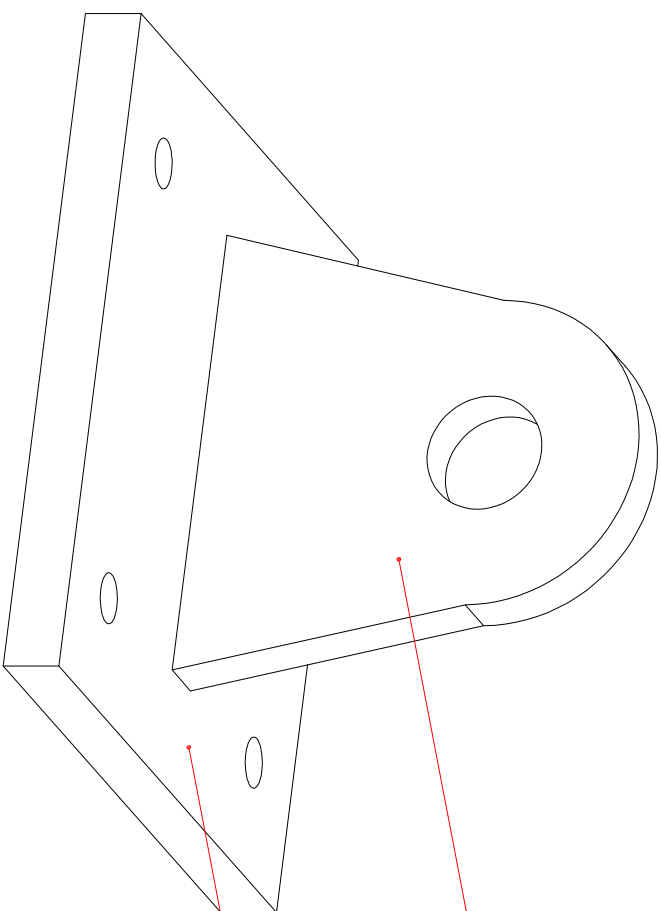
TODAS LAS JUNTAS BISELADAS, EN  
CONTORNO Y CON UN CORDON MINIMO DE 8  
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ISOMETRICO CABEZA

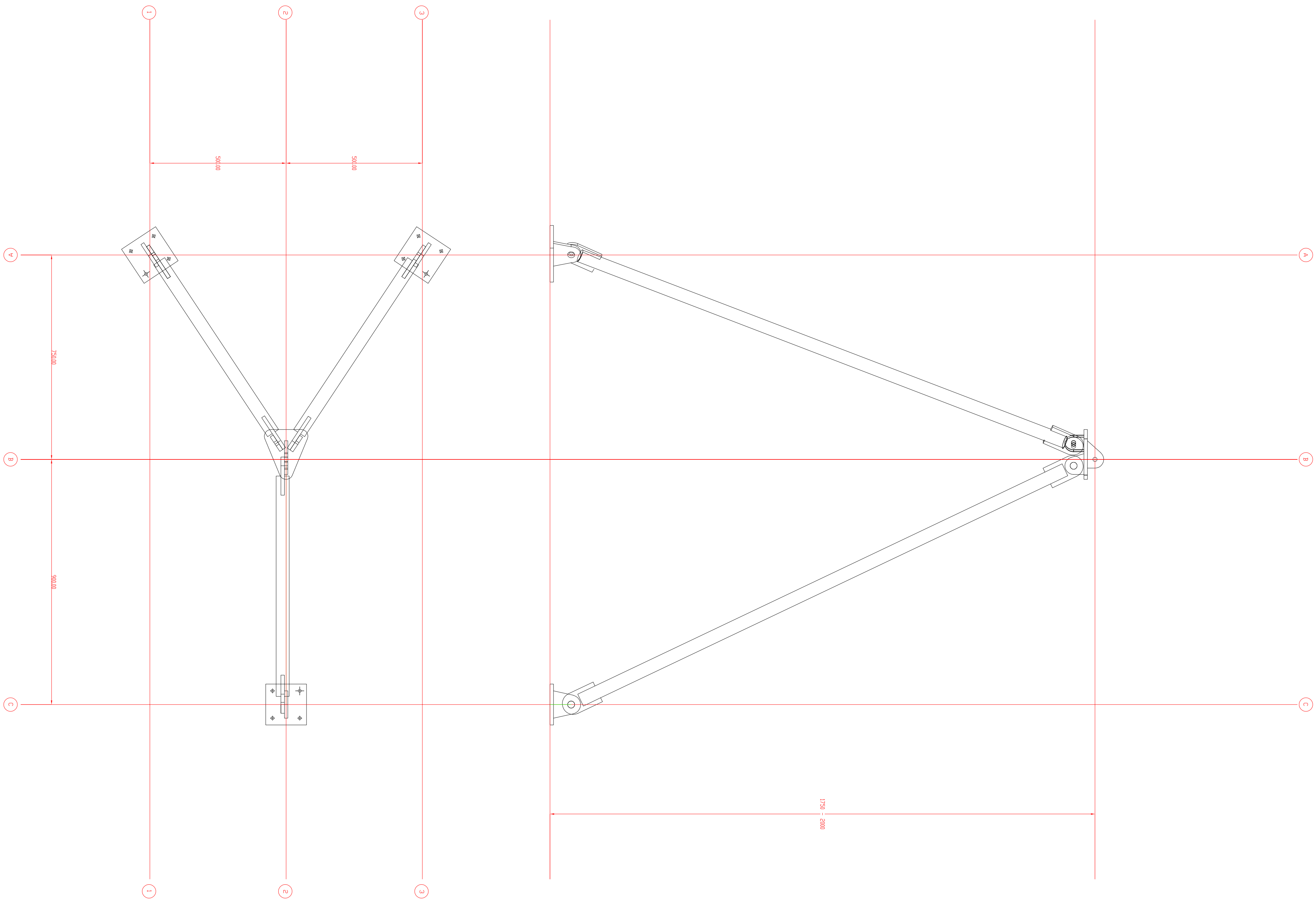


USO PASADDORES MINIMO A304  
PATA DELANTERA: 1"  
PATAS TRASERAS: 5/8"

ISOMETRICO BESE



USO PASADDORES MINIMO A304  
PATA DELANTERA: 1"  
PATAS TRASERAS: 5/8"



SI NO SE INDICA LA CANTIDAD, SE ADOPTA SIN PREJUDICIO				REVISAR Y VALIDAR		NO CAMBIA LA ESCALA		REVISAR Y VALIDAR	
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AUTOR				AUTOR		AUTOR		AUTOR	
FECHA				FECHA		FECHA		FECHA	
MATERIAL				MATERIAL		MATERIAL		MATERIAL	
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# VISTA ISOMETRIC TRIPPLE

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