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Memoria de Cálculo

POLMIR Plaza

Ubicación: Cumbayá, Ecuador
Fecha: domingo, 21 de marzo de 2021
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Contenidos

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1. Descripción

Se describe el análisis y diseño estructural del proyecto "POLMIR Plaza". Dicho proyecto contempla dos bloques estructurales de dos plantas altas con uno o dos subsuelos.

1.1. Uso

El proyecto es de uso comercial. La primera planta es de uso de locales comerciales y parqueaderos, las demás plantas altas son de uso de locales comerciales, oficinas y áreas comunales iluminadas, el subsuelo para parqueaderos.

1.2. Materiales

- **Cimentación:** **hormigón armado $f'_c = 280\,kg/cm^2$ y $f_y = 4200\,kg/cm^2$**
- **Vigas:** **Acero estructural ASTM A36**
- **Columnas:** **Acero estructural ASTM A36**
- **Vigas secundarias:** **Acero estructural ASTM A36**
- **Losa:** **Placa colaborante tipo "Deck" ASTM A653 y hormigón armado $f'_c = 210\,kg/cm^2$ y $f_y = 4200\,kg/cm^2$**

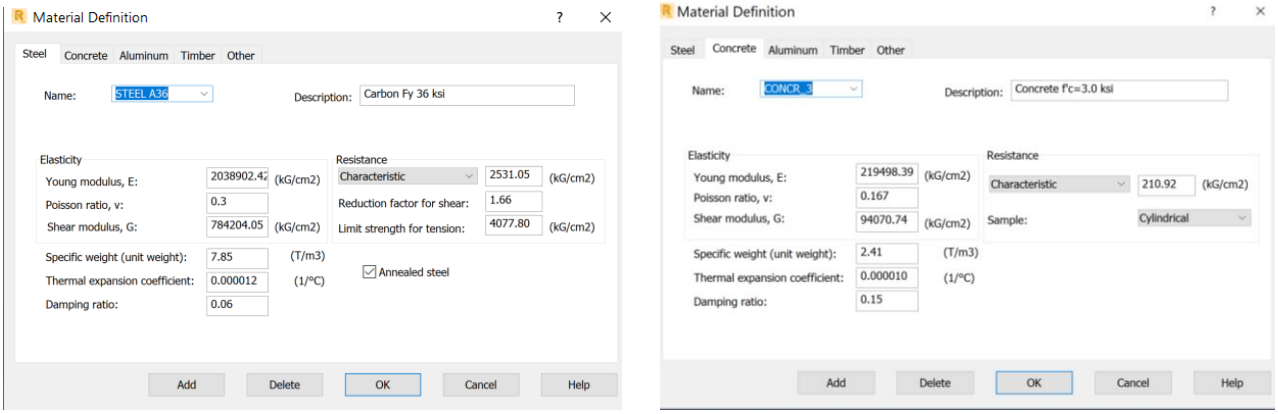

Ilustración 1 Definición de materiales en el software de cálculo

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1.3.Sistemas estructurales

Los sistemas estructurales se distinguen en dos categorías: Sistemas de cargas verticales o gravitatorias y sistemas de cargas laterales, y se los describe según el flujo de la carga respectiva.

- Sistema de carga vertical: Sistema de losa tipo deck, vigas secundarias, vigas principales, columna compuesta, plinto o zapata combinada.
- Sistema de carga lateral. Diafragma de piso (losa tipo deck), conectores de corte, pórticos especiales resistente a momento con columna compuesta, placas base y plinto o zapata combinada. Se excluyen ciertos elementos tipo viga y columna del sistema de resistencia lateral con conexiones simples a corte para controlar torsión en planta.

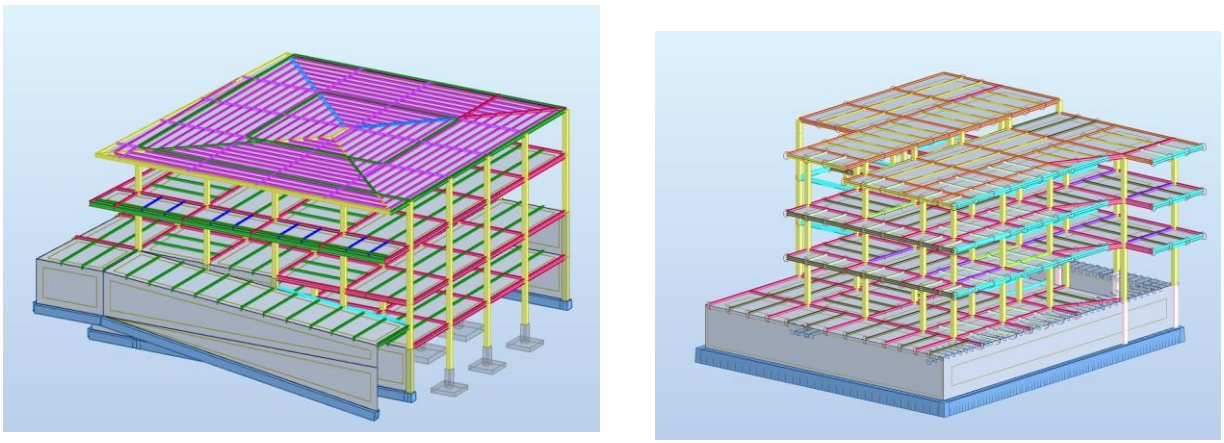

Ilustración 2 Captura de los modelos estructurales en el software de cálculo

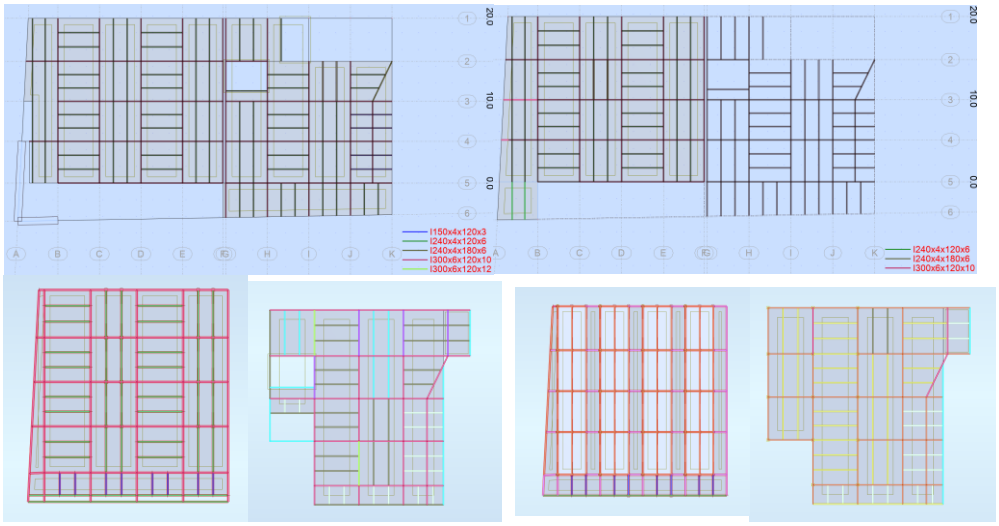

Ilustración 3 Captura del modelo, configuración de entrepisos y cubierta

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2. Cálculo de Cargas Verticales

Se detalla el cálculo de cargas verticales, distinto para cubiertas y losas de entre piso.

2.1. Cubiertas

Carga Muerta	
Peso Propio de la estructura[1]	$50\,kg/m^2$
Peso propio de losa tipo "deck"	$200\,kg/m^2$
Pesos acabados	$60\,kg/m^2$
Total	$310\,kg/m^2$
Carga Viva (Tabla 4.2 NEC-15)	
Granizo, ceniza volcánica	$100\,kg/m^2$
Total	$100\,kg/m^2$

2.2. Entrepisos o terrazas accesibles

Carga Muerta	
Peso Propio de la estructura	$50\,kg/m^2$
Peso propio de losa tipo "deck"	$200\,kg/m^2$
Pesos acabados	$60\,kg/m^2$
Total	$310\,kg/m^2$
Carga Viva (Tabla 4.2 NEC-15)	
Almacenes Planta baja y lugares de reunión	$480\,kg/m^2$
Almacenes y Oficinas Planta alta	$240\,kg/m^2$

[1] Valor aproximado, generado automáticamente por el software de cálculo. Considerando 2.40 t/m³ para el peso volumétrico del hormigón armado, 7.85 t/m³ para el peso volumétrico del acero, 0.50 t/m³ para el peso volumétrico de la madera.

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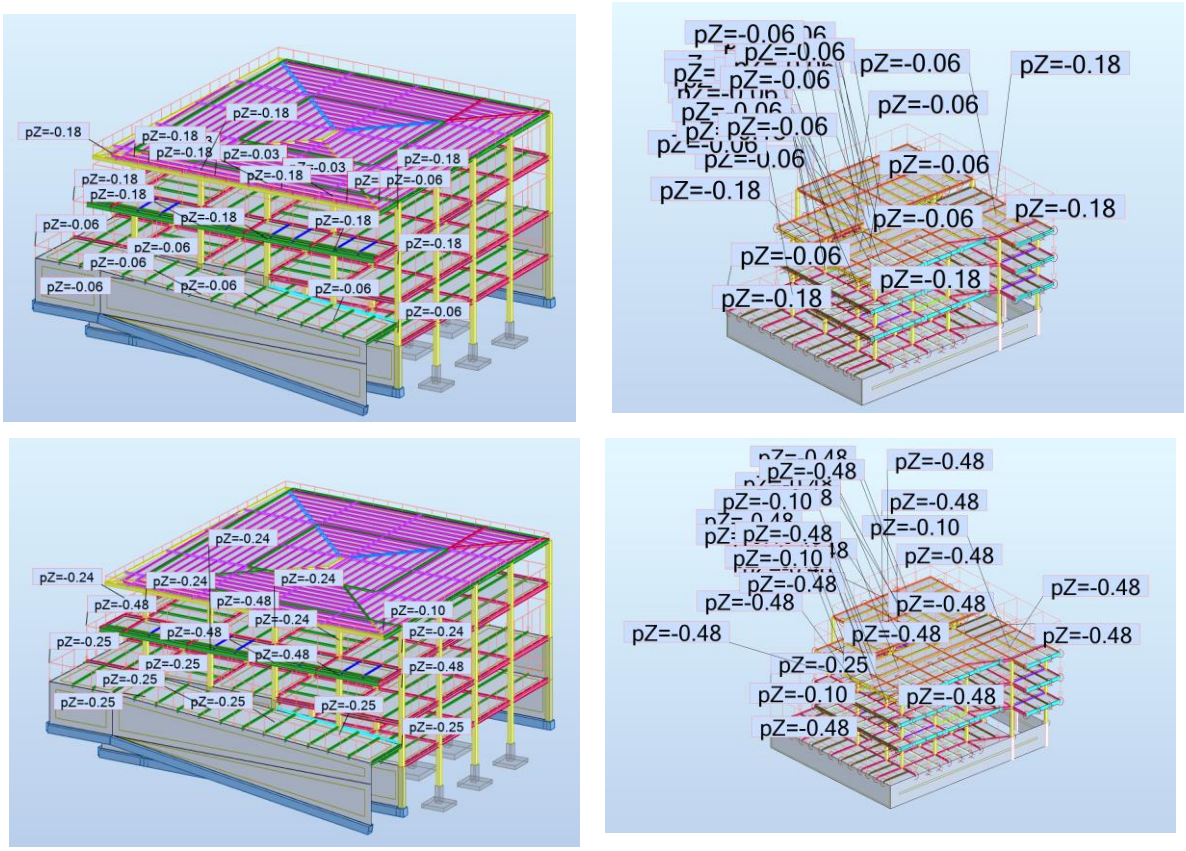

Ilustración 4 Captura de pantalla, Carga Muerta y Carga Viva

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3. Cálculo de Cargas Laterales

Se detalla el cálculo de cargas laterales para el proyecto.

3.1. Cargas de Viento

No se considera la carga de viento debido a su baja incidencia con relación al sismo.

3.2. Cargas sísmicas

Se realiza un análisis Modal Espectral de la estructura en conformidad a la NEC-15 y ASCE7-16 para el dimensionamiento y el diseño de la estructura. Se muestra el cálculo de la fuerza estática equivalente horizontal como parámetro de referencia en el diseño. Esto se lo realiza para cada uno de los dos bloques estructurales.

- **El peso sísmico utilizado para el cálculo en los parámetros sísmico para el bloque 1 es** $W = 730.10\ ton$

	FX (T)	FY (T)	FZ (T)	MX (Tm)	MY (Tm)	MZ (Tm)
Case 1	Peso Propio					
Sum of val.	0.02	-0.02	516.00	1.73	2.18	0.22
Sum of reac.	-0.00	-0.00	517.64	4138.14	-5943.32	0.00
Sum of forc.	0.00	-0.00	-517.64	-4138.14	5943.32	0.00
Check val.	-0.00	-0.00	-0.00	-0.00	-0.00	0.00
Precision	4.74311e-06	6.78006e-16				
Case 2	Carga Muerta					
Sum of val.	0.03	-0.03	211.92	1.68	1.20	0.08
Sum of reac.	-0.00	-0.00	212.44	1824.64	-2655.77	0.00
Sum of forc.	0.0	0.0	-212.44	-1824.64	2655.77	0.0
Check val.	-0.00	-0.00	-0.00	-0.00	-0.00	0.00
Precision	2.80783e-06	1.47645e-15				

- **El peso sísmico utilizado para el cálculo en los parámetros sísmico para el bloque 2 es** $W = 734.10\ ton$

	FX (T)	FY (T)	FZ (T)	MX (Tm)	MY (Tm)	MZ (Tm)
Case 1	Peso Propio					
Sum of val.	-0.08	0.05	529.08	1.99	-1.12	-0.11
Sum of reac.	0.00	-0.00	530.78	4857.60	-19097.38	-0.15
Sum of forc.	0.00	-0.00	-531.63	-4868.88	19119.93	-0.00
Check val.	0.00	-0.00	-0.85	-11.28	22.55	-0.15
Precision	3.05028e-02	2.57102e-06				
Case 2	Carga Muerta					
Sum of val.	-0.02	0.01	201.67	1.79	-0.72	-0.04
Sum of reac.	0.00	-0.00	202.18	1791.23	-7372.07	-0.05
Sum of forc.	0.0	0.0	-202.45	-1794.73	7379.08	0.0
Check val.	0.00	-0.00	-0.26	-3.50	7.00	-0.05
Precision	1.89354e-02	1.70925e-06				

Ilustración 5 Captura de pantalla, reacciones de Peso Propio y Carga Muerta

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- **Se define el espectro de respuesta en conformidad con la NEC-15**

Zona Sísmica	Aceleración	Región	N
V	0.4	Sierra	2.48

Tipo de Suelo	Fa	Fd	Fs	r
D	1.2	1.19	1.28	1

Sa	para	0 <= T <= Tc	1.190
Sa	para	T > Tc	0.291
Sa	para	T <= Tc	0.480

To (seg)	0.127
Tc (seg)	0.698
TL (seg)	2.856

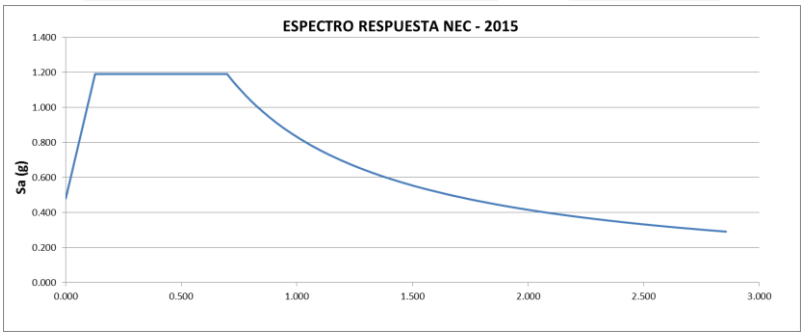

Ilustración 6 Parámetros sísmicos y Espectro, NEC-15

- **Se define el factor de reducción sísmica $R = 8$ para sistemas con pórticos especiales.**
- **Se define el factor de importancia $I = 1$ para estructuras de ocupación normal.**
- **Se realiza el cálculo del porcentaje de W para aplicar el cortante basal V, el coeficiente es $C = 0.15$**

DATOS Y CALCULOS			
Categoria de Ocupación	I	1	
	W (ton)	456.72	
	Sa	1.190	
	R	8	Tabla 2.14
	ΦPA	1	Tablas 2.10 y 2.12
	ΦPB	1	Tablas 2.10 y 2.12
	ΦP	1	
	ΦEA	1	Tablas 2.10 y 2.13
	ΦEB	1	Tablas 2.10 y 2.13
	ΦE	1	
	V (ton)	**67.960**	
	n (#pisos)	3	
	hi (m)	3.3	
	hn (m)	9.9	
	Tipo	3	Tabla Tipo de Estructura
	Ct	0.055	
	α	0.9	
	T (seg)	**0.433**	
	K	**1.000**	

DATOS Y CALCULOS			
Categoria de Ocupación	I	1	
	W (ton)	460.72	
	Sa	1.190	
	R	8	Tabla 2.14
	ΦPA	1	Tablas 2.10 y 2.12
	ΦPB	1	Tablas 2.10 y 2.12
	ΦP	1	
	ΦEA	1	Tablas 2.10 y 2.13
	ΦEB	1	Tablas 2.10 y 2.13
	ΦE	1	
	V (ton)	**68.555**	
	n (#pisos)	3	
	hi (m)	3.3	
	hn (m)	9.9	
	Tipo	3	Tabla Tipo de Estructura
	Ct	0.055	
	α	0.9	
	T (seg)	**0.433**	
	K	**1.000**	

Ilustración 7 Parámetros y cálculo del corte basal V, NEC-15

- **El cortante basal de referencia utilizado es $V_1 = 67.96\ ton$ y $V_2 = 68.55\ ton$**
- **A continuación, se definen los parámetros sísmicos en el software de cálculo para la aplicación del espectro de diseño con los parámetros del IBC y ASCE7 que generalmente generan fuerzas un poco mayores a NEC-15.**

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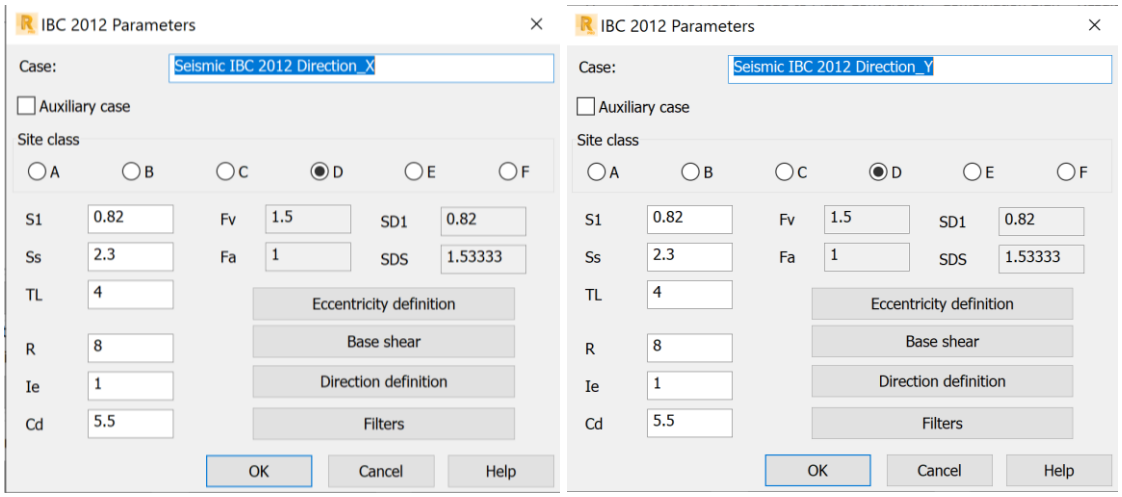

Ilustración 8 Captura de pantalla ingreso de parámetros sísmicos

- **Las fuerzas sísmicas aplicadas en el modelo son** $V1x = 72.00\ ton$ **y** $V1y = 72.00\ ton$
- **Las fuerzas sísmicas aplicadas en el modelo son** $V2x = 78.71\ ton$ **y** $V2y = 78.71\ ton$

Case 5 : Seismic IBC 2012 Direction_X
Analysis type: Dynamics - Seismic

Base shear value 72.000 (T)
Base shear coefficient for the combination SRSS : 1.051
Base shear coefficient for the combination CQC : 1.038
Base shear coefficient for the combination 10% : 1.025
Base shear coefficient for the combination 2S : 1.024

Case 5 : Seismic IBC 2012 Direction_X
Analysis type: Dynamics - Seismic

Base shear value 78.705 (T)
Base shear coefficient for the combination SRSS : 1.134
Base shear coefficient for the combination CQC : 1.113
Base shear coefficient for the combination 10% : 1.106
Base shear coefficient for the combination 2S : 1.103

Case 6 : Seismic IBC 2012 Direction_Y
Analysis type: Dynamics - Seismic

Base shear value 72.000 (T)
Base shear coefficient for the combination SRSS : 1.033
Base shear coefficient for the combination CQC : 1.003
Base shear coefficient for the combination 10% : 1.019
Base shear coefficient for the combination 2S : 0.986

Case 6 : Seismic IBC 2012 Direction_Y
Analysis type: Dynamics - Seismic

Base shear value 78.705 (T)
Base shear coefficient for the combination SRSS : 1.323
Base shear coefficient for the combination CQC : 1.292
Base shear coefficient for the combination 10% : 1.286
Base shear coefficient for the combination 2S : 1.273

Ilustración 9 Captura de pantalla resumen de fuerzas sísmicas aplicadas

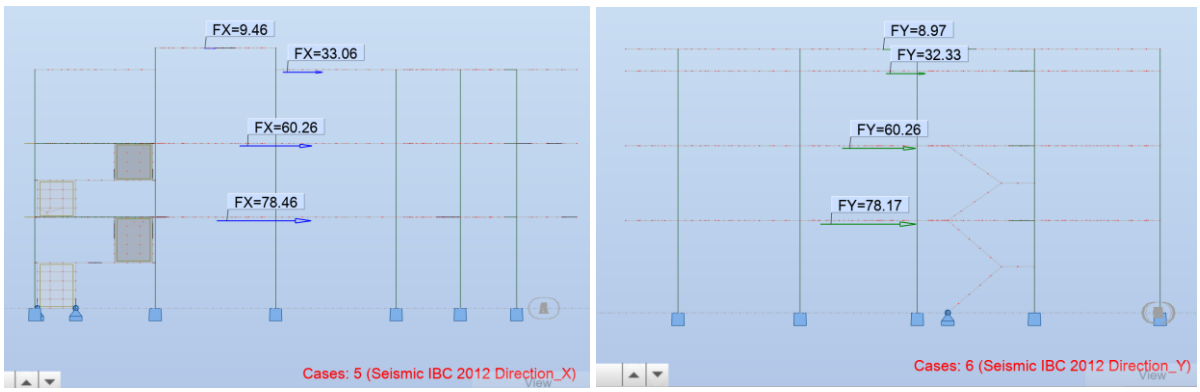

Ilustración 10 Captura de pantalla de fuerzas sísmicas aplicadas

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- **El valor del cortante basal aplicado en el modelo de cálculo debe ser igual o mayor al valor estimado por medio de la NEC-15.**

$$Vx = 78.71 > 68.55\ ton \ \rightarrow OK$$

$$Vy = 78.71 > 68.55\ ton \ \rightarrow OK$$

- **El cálculo del sismo vertical Ev se realiza en conformidad con la ASCE7-16 y se aplica a las combinaciones de cargas como un porcentaje adicional a la carga muerta.**

$$Ev = 0.408D$$

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4. Combinaciones de Cargas

4.1. Combinaciones de Cargas de Servicio

Se detalla el resumen de las combinaciones de carga de servicio utilizadas para la revisión de deformaciones verticales y esfuerzos en el suelo, no se considera el sismo vertical ascendente Ev para el cálculo de los esfuerzos en el suelo.

Combinación (ASCE7)	Nombre
2	D+L
8.1	D+0.7Ev+0.7Eh
8.2	D+0.7Ev+0.7Eh
8.3	D+0.7Ev+0.7Eh
8.4	D+0.7Ev+0.7Eh
8.5	D+0.7Ev+0.7Eh
8.6	D+0.7Ev+0.7Eh
8.7	D+0.7Ev+0.7Eh
8.8	D+0.7Ev+0.7Eh
9.1	D+0.525Ev+0.525Eh+0.75L
9.2	D+0.525Ev+0.525Eh+0.75L
9.3	D+0.525Ev+0.525Eh+0.75L
9.4	D+0.525Ev+0.525Eh+0.75L
9.5	D+0.525Ev+0.525Eh+0.75L
9.6	D+0.525Ev+0.525Eh+0.75L
9.7	D+0.525Ev+0.525Eh+0.75L
9.8	D+0.525Ev+0.525Eh+0.75L
10.1	0.6D-0.7Ev+0.7Eh
10.2	0.6D-0.7Ev+0.7Eh
10.3	0.6D-0.7Ev+0.7Eh
10.4	0.6D-0.7Ev+0.7Eh
10.5	0.6D-0.7Ev+0.7Eh
10.6	0.6D-0.7Ev+0.7Eh
10.7	0.6D-0.7Ev+0.7Eh
10.8	0.6D-0.7Ev+0.7Eh

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4.2.Combinaciones de Cargas Últimas

Se detalla el resumen de las combinaciones de carga últimas utilizadas para el diseño de los elementos estructurales.

Combinación (ASCE7)	Nombre
1	1.4D
2	1.2D+1.6L
6.1	1.2D+Ev+Eh+L(1 ó 0.5)
6.2	1.2D+Ev+Eh+L(1 ó 0.5)
6.3	1.2D+Ev+Eh+L(1 ó 0.5)
6.4	1.2D+Ev+Eh+L(1 ó 0.5)
6.5	1.2D+Ev+Eh+L(1 ó 0.5)
6.6	1.2D+Ev+Eh+L(1 ó 0.5)
6.7	1.2D+Ev+Eh+L(1 ó 0.5)
6.8	1.2D+Ev+Eh+L(1 ó 0.5)
7.1	0.9D-Ev+Eh
7.2	0.9D-Ev+Eh
7.3	0.9D-Ev+Eh
7.4	0.9D-Ev+Eh
7.5	0.9D-Ev+Eh
7.6	0.9D-Ev+Eh
7.7	0.9D-Ev+Eh
7.8	0.9D-Ev+Eh

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5. Resultados Análisis

5.1. Análisis modal

De los resultados del análisis modal se puede observar que el primer modo tiene alta participación modal en el sentido "Y". El segundo modo tiene una alta participación modal en el sentido "X". Por lo que se consideran fundamentales de la estructura del Bloque 1.

De los resultados del análisis modal se puede observar que el primer modo tiene alta participación modal en el sentido "Y". El tercer modo tiene una alta participación modal en el sentido "X". Por lo que se consideran fundamentales de la estructura del Bloque 2.

Case/Mode	Frequency (Hz)	Period (sec)	Rel.mas.UX (%)	Rel.mas.UY (%)	Rel.mas.UZ (%)	Cur.mas.UX (%)	Cur.mas.UY (%)	Cur.mas.UZ (%)
4/ 1	2.103	0.475	0.000	89.148	0.0	0.000	89.148	0.0
4/ 2	2.151	0.465	91.610	89.245	0.0	91.610	0.097	0.0
4/ 3	2.310	0.433	93.623	93.308	0.0	2.013	4.063	0.0
4/ 4	7.000	0.143	94.848	98.686	0.0	1.225	5.378	0.0
4/ 5	7.016	0.143	99.551	99.996	0.0	4.703	1.310	0.0
4/ 6	7.702	0.130	100.000	100.000	0.0	0.449	0.003	0.0
4/ 7	13.103	0.076	100.000	100.000	0.0	0.000	0.000	0.0
4/ 8	30.038	0.033	100.000	100.000	0.0	0.000	0.000	0.0
4/ 9	35.983	0.028	100.000	100.000	0.0	0.000	0.000	0.0
4/ 10	37.842	0.026	100.000	100.000	0.0	0.000	0.000	0.0
Case/Mode	**Frequency (Hz)**	**Period (sec)**	**Rel.mas.UX (%)**	**Rel.mas.UY (%)**	**Rel.mas.UZ (%)**	**Cur.mas.UX (%)**	**Cur.mas.UY (%)**	**Cur.mas.UZ (%)**
4/ 1	1.464	0.683	0.933	84.914	0.0	0.933	84.914	0.0
4/ 2	1.618	0.618	2.911	88.771	0.0	1.978	3.856	0.0
4/ 3	1.716	0.583	87.847	89.163	0.0	84.937	0.392	0.0
4/ 4	4.623	0.216	87.900	97.510	0.0	0.053	8.348	0.0
4/ 5	5.021	0.199	96.776	97.669	0.0	8.875	0.158	0.0
4/ 6	5.209	0.192	97.367	97.758	0.0	0.591	0.089	0.0
4/ 7	9.581	0.104	97.427	99.010	0.0	0.060	1.252	0.0
4/ 8	10.129	0.099	99.088	99.070	0.0	1.661	0.060	0.0
4/ 9	11.223	0.089	99.115	99.339	0.0	0.028	0.269	0.0
4/ 10	14.404	0.069	99.115	99.341	0.0	0.000	0.002	0.0

Ilustración 11 Participación Modal

5.2. Derivas de entrepiso

Se revisa que los valores de derivas de entrepiso sean menores que los límites establecidos por los códigos, en este caso $\Delta_{\max} = 0.02\ h_{piso}$

$$\Delta_{\max x} = 6.60 > 4.20\ cm \rightarrow OK$$

$$\Delta_{\max y} = 6.60 > 5.20\ cm \rightarrow OK$$

En la Ilustración 12 se muestran los desplazamientos y derivas últimas del software de cálculo.

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Case/Story	UX (cm)	UY (cm)	dr UX (cm)	dr UY (cm)	d UX	d UY
5/ 1	0.002	0.002	0.002	0.002	0.000	0.000
5/ 2	4.208	0.606	4.206	0.605	0.011	0.002
5/ 3	7.635	1.097	3.427	0.491	0.011	0.002
5/ 4	10.395	1.580	2.761	0.482	0.009	0.002
5/ 5	11.163	1.170	0.768	-0.409	0.009	-0.005
Case/Story	**UX (cm)**	**UY (cm)**	**dr UX (cm)**	**dr UY (cm)**	**d UX**	**d UY**
6/ 1	0.000	0.001	0.000	0.001	0.000	0.000
6/ 2	0.982	5.202	0.981	5.201	0.003	0.014
6/ 3	1.500	8.990	0.518	3.788	0.002	0.012
6/ 4	1.842	12.005	0.342	3.015	0.001	0.010
6/ 5	1.802	12.008	-0.041	0.003	-0.000	0.000

Ilustración 12 Derivas de entrepiso, Sismo en X y Y

5.3.Torsión en planta

Se realizó la revisión de torsión en planta con los limites recomendados por la ASCE7. Se puede observar que los valores de desplazamiento torsional son inferiores a los considerados como torsión en planta.

- **Bloque 1**

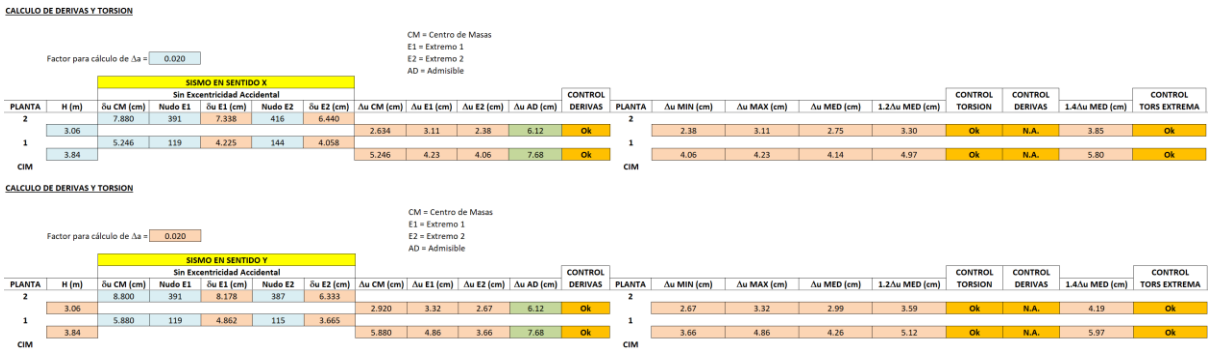
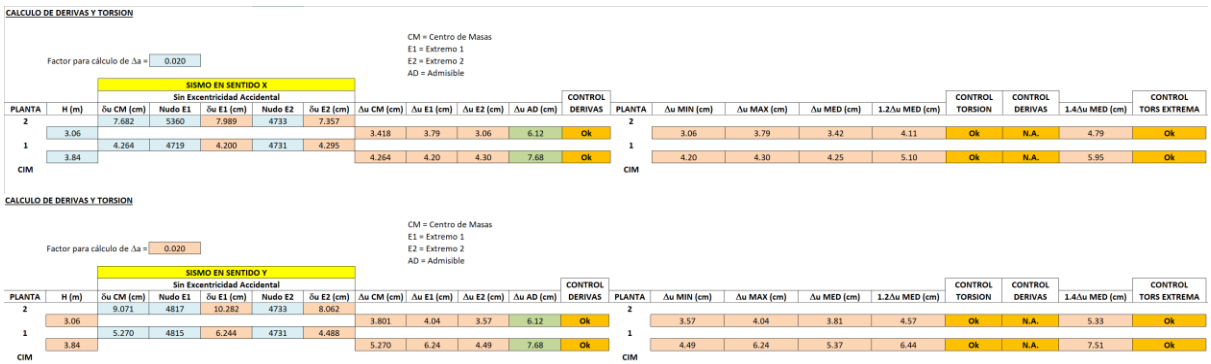


Ilustración 13 Limites de derivas y torsión en planta, Sismo en X y Y Bloque 1

- **Bloque 2**



- *Ilustración 14 Limites de derivas y torsión en planta, Sismo X y Y Bloque 2*

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5.4.Deformaciones verticales

Se realiza un control de deformaciones para condiciones de servicio utilizando los limites recomendados por la normativa.

- **Para losas de entrepiso con elementos no estructurales sensibles a grandes deformaciones** $\Delta_{max}=\frac{L}{360}$
- **Para cubiertas planas sin elementos no estructurales sensibles a grandes deformaciones** $\Delta_{max}=\frac{L}{180}$

Se muestra la deformación vertical de la estructura.

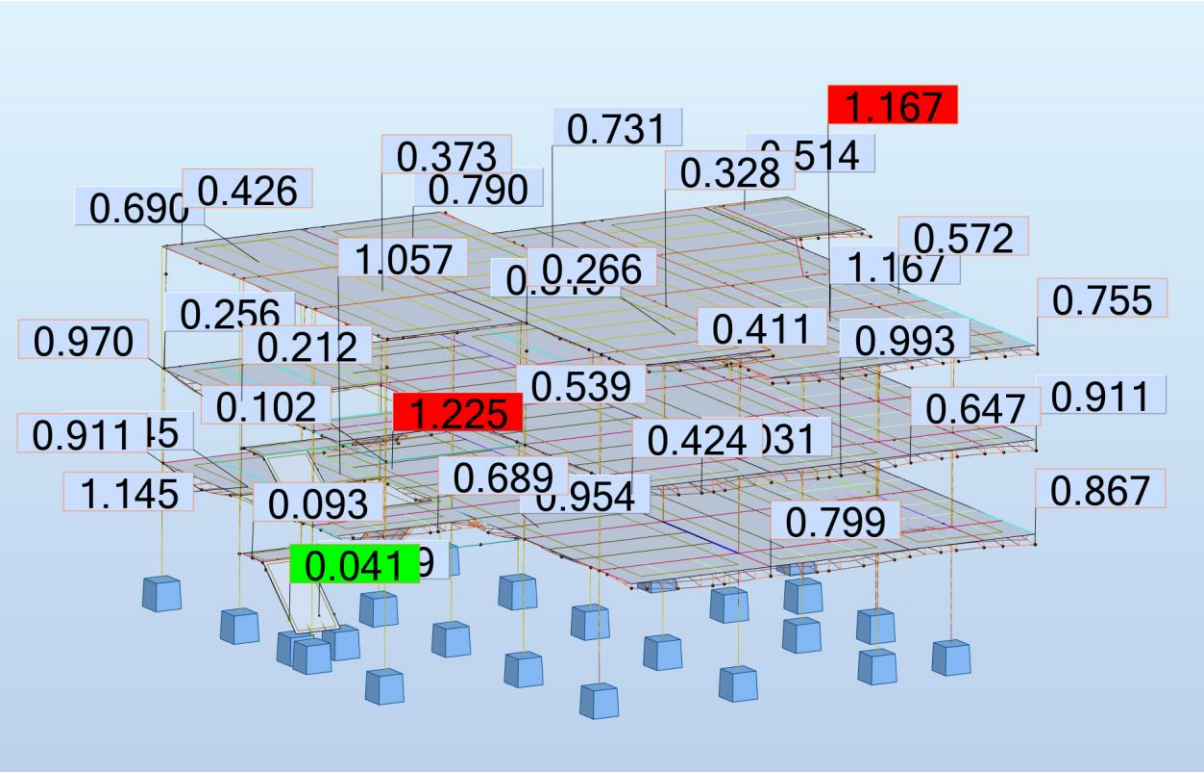

Ilustración 15 Resumen deformaciones verticales, Combinación D+L

Se considera que la estructura cumple con los requisitos de servicio para cargas verticales.

$$\Delta_{max}=\frac{515}{360}=1.43>1.23\ cm\ \rightarrow OK$$

$$\Delta_{max}=\frac{500}{180}=2.78>1.17\ cm\ \rightarrow OK$$

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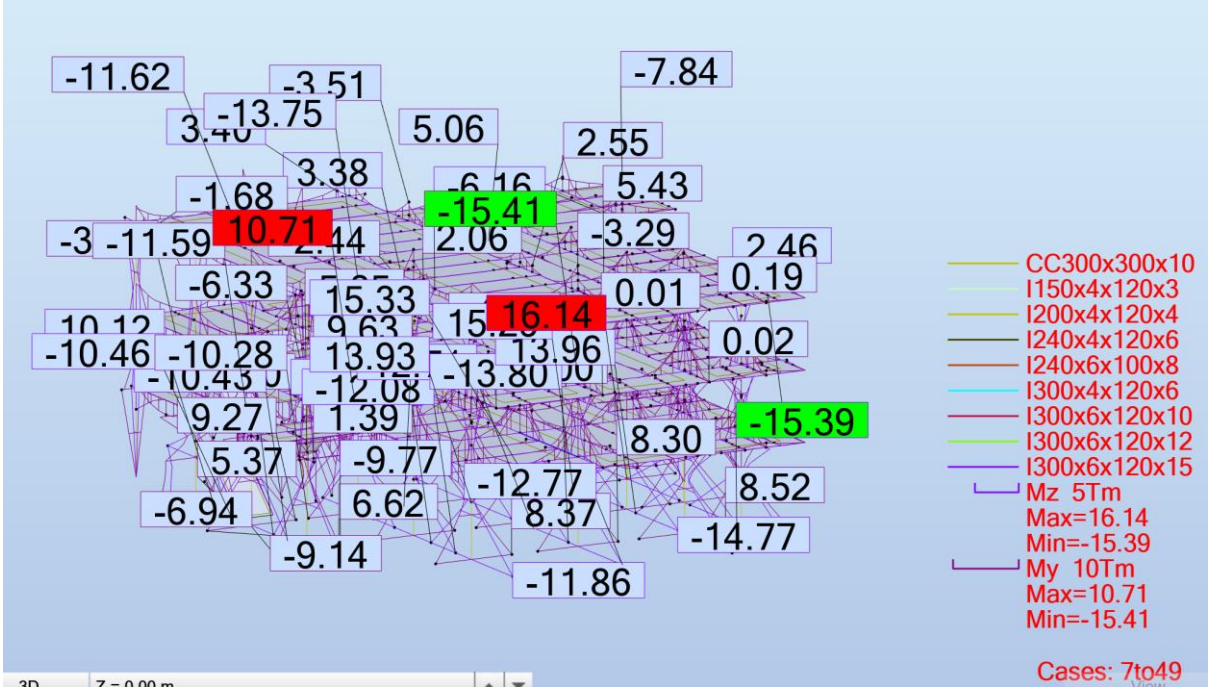
5.5.Reacciones



Se muestra la envolvente de diseño de flexión como ejemplo de las reacciones internas de los elementos estructurales con las cuales se procede al diseño estructural.

Ilustración 16 Diagrama de Momentos Y, Envolvente de diseño

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6. Diseño Estructural

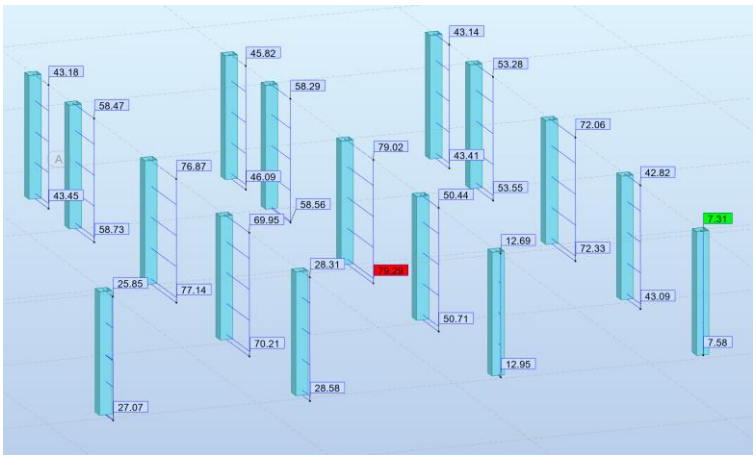
Los elementos estructurales se diseñan en conformidad con la normativa NEC-15 y las normativas internacionales vigentes.

- **Cimentación:** **ACI-318**
- **Vigas:** **AISC-360 /AISC341**
- **Columnas:** **AISC-360/AISC 341**
- **Conexiones:** **AISC-360/AISC 358 BC4-2015**
- **Losas:** **Tipo Deck, Catalogo producto.**

6.1. Cimentación

Se diseña la cimentación superficial para el proyecto con un valor de esfuerzo admisible del suelo de $q_{adm} = 10\, t/m^2$ cómo se recomienda en el estudio de suelo.

- **Descarga columnas en la base, combinación D+L**



- **Resumen del diseño del plinto combinado más crítico**

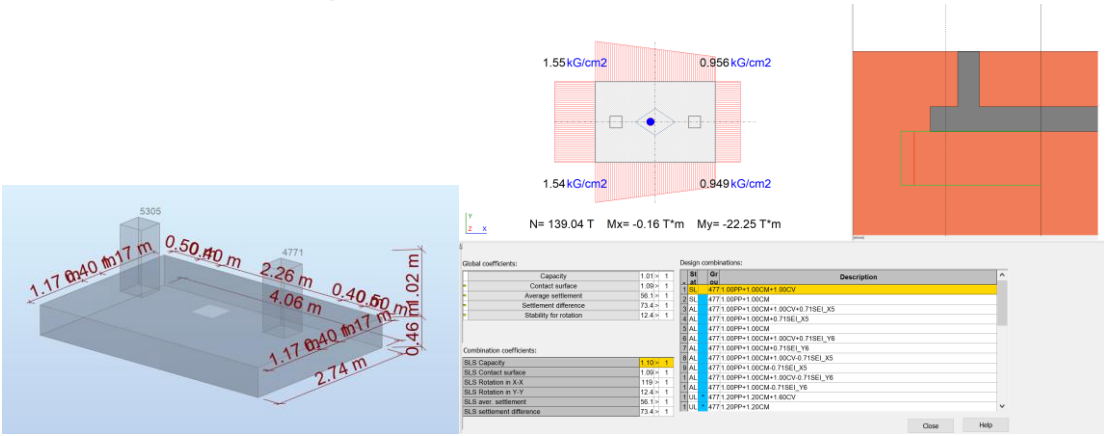


Ilustración 17 Dimensiones y reacciones en plintos

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Stress calculations

Take account of plastic redistribution of allowable stresses
Soil type under foundation: not layered
Design combination **ALS : 1.00PP+1.00CM+1.00CV+0.71SEI_X5**
Load factors: **1.00** * Foundation weight
1.00 * Soil weight
Calculation results: On the foundation level
Weight of foundation and soil over it: Gr = 37.72 (T)
Design load:
Nr = 153.13 (T) Mx = 0.13 (T*m) My = -22.46 (T*m)
Stress in soil: 1.48 (kG/cm2)
Design soil pressure 1.50 (kG/cm2)
Safety factor: 1.013 > 1

Uplift

Uplift in SLS
Design combination: **SLS : 1.00PP+1.00CM+1.00CV**
Load factors: **1.00** * Foundation weight
1.00 * Soil weight
Contact area: s = 1.098
s_{lim} = 1.000

Average settlement

Soil type under foundation: not layered
Design combination **SLS : 1.00PP+1.00CM+1.00CV**
Load factors: **1.00** * Foundation weight
1.00 * Soil weight
Weight of foundation and soil over it: Gr = 37.72 (T)
Average stress caused by design load: q = 1.25 (kG/cm2)
Thickness of the actively settling soil: z = 4.11 (m)
Stress on the level z:
- Additional: σzd = 0.24 (kG/cm2)
- Caused by soil weight: σzγ = 1.25 (kG/cm2)
Settlement:
- Original s' = 0.09 (cm)
- Secondary s'' = 0.00 (cm)
- TOTAL S = 0.09 (cm) < Sadm = 5.08 (cm)
Safety factor: 56.1 > 1

Settlement difference

Design combination **SLS : 1.00PP+1.00CM+1.00CV**
Load factors: **1.00** * Foundation weight
1.00 * Soil weight
Settlement difference: S = 0.07 (cm) < Sadm = 5.08 (cm)
Safety factor: 73.48 > 1

Rotation

About OX axis
Design combination **SLS : 1.00PP+1.00CM+1.00CV**
Load factors: **1.00** * Foundation weight
1.00 * Soil weight
Weight of foundation and soil over it: Gr = 37.72 (T)
Design load:
Nr = 139.04 (T) Mx = -0.16 (T*m) My = -22.25 (T*m)
Stability moment: M_{stab} = 190.71 (T*m)
Rotation moment: M_{renv} = 0.16 (T*m)
Stability for rotation: 1199 > 1

About OY axis
Design combination: **SLS : 1.00PP+1.00CM+1.00CV**
Load factors: **1.00** * Foundation weight
1.00 * Soil weight
Weight of foundation and soil over it: Gr = 37.72 (T)
Design load:
Nr = 139.04 (T) Mx = -0.16 (T*m) My = -22.25 (T*m)
Stability moment: M_{stab} = 282.97 (T*m)
Rotation moment: M_{renv} = 22.69 (T*m)
Stability for rotation: 12.47 > 1

1.3 RC design

1.3.1 Assumptions

- Concrete exposed to earth and weather : no

1.3.2 Analysis of punching and shear

Punching

Design combination **ULS : 1.20PP+1.20CM+1.60CV**
Load factors: **0.90** * Foundation weight
0.90 * Soil weight
Design load:
Nr = 175.17 (T) Mx = -0.22 (T*m) My = -31.26 (T*m)
Length of critical circumference: 3.09 (m)
Punching force: 73.41 (T)
Section effective height h_{eff} = 0.37 (m)
Shear stress: 6.37 (kG/cm2)
Admissible shear stress: 7.29 (kG/cm2)
Safety factor: 1.144 > 1

1.3.3 Required reinforcement

Spread footing:

bottom:

ULS : 1.20PP+1.20CM+1.60CV
My = 5.69 (T*m) A_{sx} = 8.11 (cm2/m)

ULS : 1.20PP+1.20CM+1.60CV
Mx = 35.43 (T*m) A_{sy} = 8.11 (cm2/m)

$A_{s\ min}$ = 8.11 (cm2/m)

top:

ULS : 1.20PP+1.20CM+1.60CV
My = -21.30 (T*m) A'_{sx} = 8.11 (cm2/m)
A'_{sy} = 0.00 (cm2/m)

$A_{s\ min}$ = 8.11 (cm2/m)

Column pier: 1
Longitudinal reinforcement A = 16.00 (cm2) A_{min} = 16.00 (cm2)
A = 2 * (Asx1 + Asy1)
Asx1 = 3.00 (cm2) Asy1 = 5.00 (cm2)
Column pier: 2
Longitudinal reinforcement A = 16.00 (cm2) A_{min} = 16.00 (cm2)
A = 2 * (Asx2 + Asy2)
Asx2 = 3.00 (cm2) Asy2 = 5.00 (cm2)

Ilustración 18 Resumen estados límites y diseño de plinto

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6.2.Vigas

Se muestra el diseño de una la viga crítica y el resumen de diseño de todos los elementos tipo viga. Las vigas 27 988 999 1224 1413 1420 1434 1447 exceden la capacidad de diseño a flexión, pero se consideran aceptables debido a que se tiene un $\phi_f = 0.9$, y para generarse la rótula plástica se tiene que exceder este factor de seguridad.

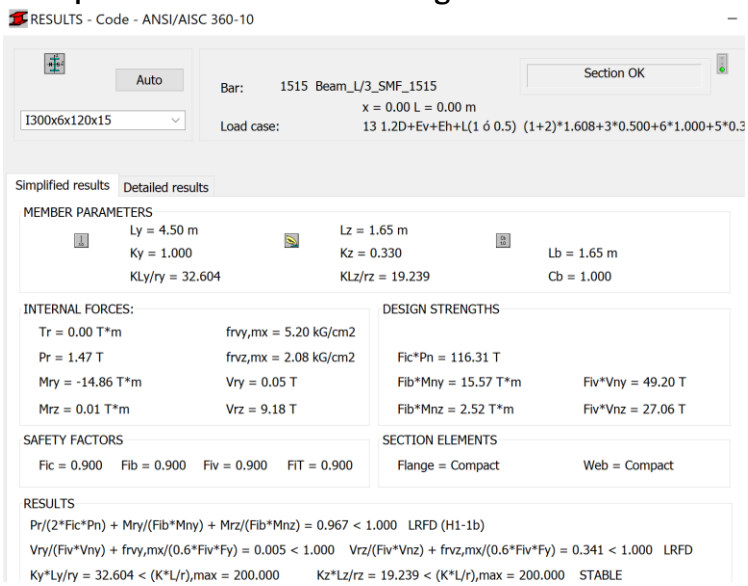

Ilustración 19 Estados límites y diseño de viga

Elemento	Sección	Material	Rel.
1	I300x6x120x10	STEEL A36	0.408
2	I300x6x120x10	STEEL A36	0.264
6	I300x6x120x10	STEEL A36	0.778
7	I300x6x120x10	STEEL A36	0.441
8	I300x6x120x10	STEEL A36	0.299
9	I300x6x120x10	STEEL A36	0.411
10	I300x6x120x10	STEEL A36	0.259
12 Beam_L/3_SMF_12	I300x6x120x15	STEEL A36	0.947
13 Beam_L/3_SMF_13	I300x6x120x15	STEEL A36	0.967
14 Beam_L/3_SMF_14	I300x6x120x10	STEEL A36	0.441
25 Beam_L/3_SMF_25	I300x6x120x10	STEEL A36	0.364
26 Beam_L/3_SMF_26	I300x6x120x10	STEEL A36	0.427
27 Beam_L/3_SMF_27	I300x6x120x10	STEEL A36	1.143
28 Beam_L/3_SMF_28	I300x6x120x10	STEEL A36	0.409
29	I300x6x120x10	STEEL A36	0.505
35	I150x4x120x3	STEEL A36	0.19
40	I150x4x120x3	STEEL A36	0.178
45 Beam_L/3_45	I300x4x120x6	STEEL A36	0.225

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50 Beam_L/3_50	I300x6x120x12	STEEL A36	0.855
55 Beam_L/3_55	I240x4x120x6	STEEL A36	0.625
70	I150x4x120x3	STEEL A36	0.184
80	I150x4x120x3	STEEL A36	0.19
81 Beam_L/3_81	I300x4x120x6	STEEL A36	0.23
83 Beam_L/3_83	I240x4x120x6	STEEL A36	0.169
84 Beam_L/3_84	I240x4x120x6	STEEL A36	0.637
87	I150x4x120x3	STEEL A36	0.2
99	I150x4x120x3	STEEL A36	0.195
105	I150x4x120x3	STEEL A36	0.191
111 Beam_L/3_SMF_111	I240x6x100x8	STEEL A36	0.668
117 Beam_L/3_117	I200x4x120x4	STEEL A36	0.318
118 Beam_L/3_SMF_118	I240x6x100x8	STEEL A36	0.632
120	I150x4x120x3	STEEL A36	0.193
121	I240x4x120x6	STEEL A36	0.201
123	I300x6x120x10	STEEL A36	0.627
125	I300x6x120x10	STEEL A36	0.467
170	I300x6x120x10	STEEL A36	0.59
171	I300x6x120x10	STEEL A36	0.521
175	I300x6x120x10	STEEL A36	0.639
177	I300x6x120x10	STEEL A36	0.361
179	I300x6x120x10	STEEL A36	0.794
180	I300x6x120x10	STEEL A36	0.478
181	I240x4x120x6	STEEL A36	0.114
263	I300x6x120x10	STEEL A36	0.893
264	I300x6x120x10	STEEL A36	0.419
265	I240x4x120x6	STEEL A36	0.111
289	I240x4x120x6	STEEL A36	0.203
322	I150x4x120x3	STEEL A36	0.151
396	I150x4x120x3	STEEL A36	0.146
519	I150x4x120x3	STEEL A36	0.159
523	I150x4x120x3	STEEL A36	0.159
559	I150x4x120x3	STEEL A36	0.162
560	I150x4x120x3	STEEL A36	0.158
561	I150x4x120x3	STEEL A36	0.156
566	I150x4x120x3	STEEL A36	0.159
583	I240x6x100x8	STEEL A36	0.451
588	I240x6x100x8	STEEL A36	0.408
593	I240x6x100x8	STEEL A36	0.426
598	I240x6x100x8	STEEL A36	0.427

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603	I240x6x100x8	STEEL A36	0.469
604	I240x6x100x8	STEEL A36	0.301
627	I200x4x120x4	STEEL A36	0.103
640	I200x4x120x4	STEEL A36	0.151
663	I150x4x120x3	STEEL A36	0.113
667	I150x4x120x3	STEEL A36	0.092
674	I150x4x120x3	STEEL A36	0.12
675	I150x4x120x3	STEEL A36	0.111
676	I150x4x120x3	STEEL A36	0.121
677	I150x4x120x3	STEEL A36	0.108
678	I150x4x120x3	STEEL A36	0.13
679	I150x4x120x3	STEEL A36	0.113
940 Beam_L/3_SMF_940	I300x6x120x10	STEEL A36	0.846
941 Beam_L/3_SMF_941	I300x6x120x10	STEEL A36	0.775
942 Beam_L/3_SMF_942	I300x6x120x10	STEEL A36	0.763
943 Beam_L/3_SMF_943	I300x6x120x10	STEEL A36	0.791
950 Beam_L/3_SMF_950	I300x6x120x10	STEEL A36	0.409
951 Beam_L/3_SMF_951	I300x6x120x10	STEEL A36	0.921
952 Beam_L/3_952	I300x4x120x6	STEEL A36	0.691
953 Beam_L/3_953	I300x6x120x12	STEEL A36	0.972
954 Beam_L/3_954	I300x6x120x12	STEEL A36	0.836
957 Beam_L/3_SMF_957	I300x6x120x10	STEEL A36	0.719
958 Beam_L/3_SMF_958	I300x6x120x10	STEEL A36	0.714
959 Beam_L/3_SMF_959	I300x6x120x15	STEEL A36	0.875
960 Beam_L/3_SMF_960	I300x6x120x12	STEEL A36	0.919
967 Beam_L/3_SMF_967	I240x6x100x8	STEEL A36	0.63
969 Beam_L/3_969	I200x4x120x4	STEEL A36	0.254
970 Beam_L/3_970	I240x4x120x6	STEEL A36	0.354
977 Beam_L/3_SMF_977	I300x6x120x10	STEEL A36	0.918
978 Beam_L/3_SMF_978	I300x6x120x10	STEEL A36	0.862
979 Beam_L/3_SMF_979	I300x6x120x10	STEEL A36	0.792

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987 Beam_L/3_SMF_987	I300x6x120x10	STEEL A36	0.949
988 Beam_L/3_SMF_988	I300x6x120x15	STEEL A36	1.046
989 Beam_L/3_SMF_989	I300x6x120x12	STEEL A36	1.039
990 Beam_L/3_SMF_990	I300x6x120x12	STEEL A36	0.988
994 Beam_L/3_SMF_994	I300x6x120x12	STEEL A36	0.973
995 Beam_L/3_SMF_995	I300x6x120x10	STEEL A36	0.991
996 Beam_L/3_SMF_996	I300x6x120x10	STEEL A36	0.953
997 Beam_L/3_SMF_997	I300x6x120x15	STEEL A36	0.913
1004 Beam_L/3_1004	I200x4x120x4	STEEL A36	0.458
1005 Beam_L/3_1005	I200x4x120x4	STEEL A36	0.358
1006 Beam_L/3_1006	I200x4x120x4	STEEL A36	0.349
1007 Beam_L/3_1007	I240x4x120x6	STEEL A36	0.298
1014 Beam_L/3_SMF_1014	I300x6x120x10	STEEL A36	0.821
1015 Beam_L/3_SMF_1015	I300x6x120x10	STEEL A36	0.793
1016 Beam_L/3_SMF_1016	I300x6x120x10	STEEL A36	0.747
1024 Beam_L/3_SMF_1024	I300x6x120x10	STEEL A36	0.69
1025 Beam_L/3_SMF_1025	I300x6x120x15	STEEL A36	0.965
1026 Beam_L/3_SMF_1026	I300x6x120x12	STEEL A36	0.929
1027 Beam_L/3_SMF_1027	I300x6x120x15	STEEL A36	0.864
1031 Beam_L/3_SMF_1031	I300x6x120x10	STEEL A36	0.893
1032 Beam_L/3_SMF_1032	I300x6x120x10	STEEL A36	0.849
1033 Beam_L/3_SMF_1033	I300x6x120x10	STEEL A36	0.889
1034 Beam_L/3_SMF_1034	I300x6x120x15	STEEL A36	0.903
1041 Beam_L/3_SMF_1041	I240x6x100x8	STEEL A36	0.784
1042 Beam_L/3_SMF_1042	I240x6x100x8	STEEL A36	0.747
1043 Beam_L/3_SMF_1043	I240x6x100x8	STEEL A36	0.79

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1044 Beam_L/3_SMF_1044	I240x6x100x8	STEEL A36	1
1061 Beam_L/3_SMF_1061	I300x4x120x6	STEEL A36	0.093
1062 Beam_L/3_SMF_1062	I300x4x120x6	STEEL A36	0.191
1063 Beam_L/3_SMF_1063	I300x4x120x6	STEEL A36	0.192
1064 Beam_L/3_SMF_1064	I300x4x120x6	STEEL A36	0.094
1068 Beam_L/3_SMF_1068	I300x4x120x6	STEEL A36	0.185
1069 Beam_L/3_SMF_1069	I300x4x120x6	STEEL A36	0.179
1070 Beam_L/3_SMF_1070	I300x4x120x6	STEEL A36	0.063
1071 Beam_L/3_SMF_1071	I300x6x120x15	STEEL A36	1.001
1078 Beam_L/3_SMF_1078	I300x4x120x6	STEEL A36	0.106
1079 Beam_L/3_SMF_1079	I300x4x120x6	STEEL A36	0.109
1080 Beam_L/3_SMF_1080	I300x4x120x6	STEEL A36	0.059
1081 Beam_L/3_SMF_1081	I300x6x120x10	STEEL A36	0.764
1094 Beam_L/3_SMF_1094	I300x6x120x10	STEEL A36	0.517
1095 Beam_L/3_SMF_1095	I300x6x120x10	STEEL A36	0.55
1096 Beam_L/3_1096	I240x4x120x6	STEEL A36	0.147
1097 Beam_L/3_1097	I240x4x120x6	STEEL A36	0.148
1098 Beam_L/3_SMF_1098	I300x6x120x10	STEEL A36	0.502
1099 Beam_L/3_SMF_1099	I300x6x120x10	STEEL A36	0.584
1100 Beam_L/3_1100	I240x4x120x6	STEEL A36	0.138
1101 Beam_L/3_1101	I240x4x120x6	STEEL A36	0.138
1102 Beam_L/3_SMF_1102	I300x6x120x10	STEEL A36	0.477
1104 Beam_L/3_1104	I240x4x120x6	STEEL A36	0.154
1105 Beam_L/3_1105	I240x4x120x6	STEEL A36	0.153
1106 Beam_L/3_SMF_1106	I300x6x120x10	STEEL A36	0.165
1107 Beam_L/3_SMF_1107	I300x6x120x10	STEEL A36	0.52
1108 Beam_L/3_1108	I240x4x120x6	STEEL A36	0.148
1109 Beam_L/3_1109	I240x4x120x6	STEEL A36	0.139

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1114 Beam_L/3_SMF_1114	I300x6x120x10	STEEL A36	0.935
1115 Beam_L/3_SMF_1115	I300x6x120x10	STEEL A36	0.923
1116 Beam_L/3_SMF_1116	I300x6x120x10	STEEL A36	0.927
1117 Beam_L/3_SMF_1117	I300x6x120x10	STEEL A36	0.942
1120 Beam_L/3_1120	I240x4x120x6	STEEL A36	0.277
1121 Beam_L/3_1121	I240x4x120x6	STEEL A36	0.276
1122 Beam_L/3_1122	I240x4x120x6	STEEL A36	0.261
1123 Beam_L/3_1123	I240x4x120x6	STEEL A36	0.283
1124 Beam_L/3_1124	I240x4x120x6	STEEL A36	0.349
1125 Beam_L/3_1125	I240x4x120x6	STEEL A36	0.358
1130 Beam_L/3_SMF_1130	I300x6x120x10	STEEL A36	0.823
1141 Beam_L/3_1141	I300x4x120x6	STEEL A36	0.084
1142 Beam_L/3_SMF_1142	I300x6x120x10	STEEL A36	0.921
1143 Beam_L/3_SMF_1143	I300x6x120x10	STEEL A36	0.9
1147 Beam_L/3_1147	I300x4x120x6	STEEL A36	0.774
1151 Beam_L/3_1151	I300x4x120x6	STEEL A36	0.773
1153 Beam_L/3_SMF_1153	I300x6x120x10	STEEL A36	0.863
1154 Beam_L/3_SMF_1154	I300x6x120x10	STEEL A36	0.868
1155 Beam_L/3_SMF_1155	I300x6x120x10	STEEL A36	0.913
1156 Beam_L/3_SMF_1156	I300x6x120x10	STEEL A36	0.904
1157 Beam_L/3_1157	I240x4x120x6	STEEL A36	0.485
1158 Beam_L/3_1158	I240x4x120x6	STEEL A36	0.241
1159 Beam_L/3_1159	I300x4x120x6	STEEL A36	0.226
1161 Beam_L/3_1161	I240x4x120x6	STEEL A36	0.415
1162 Beam_L/3_1162	I240x4x120x6	STEEL A36	0.268
1163 Beam_L/3_1163	I300x4x120x6	STEEL A36	0.24
1168 Beam_L/3_1168	I240x4x120x6	STEEL A36	0.272
1169 Beam_L/3_SMF_1169	I300x6x120x10	STEEL A36	0.566
1170 Beam_L/3_SMF_1170	I300x6x120x10	STEEL A36	0.635
1173 Beam_L/3_1173	I240x4x120x6	STEEL A36	0.318
1174 Beam_L/3_1174	I240x4x120x6	STEEL A36	0.28
1175 Beam_L/3_1175	I240x4x120x6	STEEL A36	0.243

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1176 Beam_L/3_1176	I240x4x120x6	STEEL A36	0.255
1177 Beam_L/3_1177	I240x4x120x6	STEEL A36	0.265
1178 Beam_L/3_1178	I240x4x120x6	STEEL A36	0.268
1190 Beam_L/3_SMF_1190	I300x6x120x10	STEEL A36	0.606
1191 Beam_L/3_SMF_1191	I300x6x120x10	STEEL A36	0.625
1192 Beam_L/3_SMF_1192	I300x6x120x10	STEEL A36	0.509
1193 Beam_L/3_1193	I240x4x120x6	STEEL A36	0.319
1194 Beam_L/3_1194	I240x4x120x6	STEEL A36	0.302
1196 Beam_L/3_1196	I240x4x120x6	STEEL A36	0.487
1197 Beam_L/3_1197	I240x4x120x6	STEEL A36	0.311
1198 Beam_L/3_1198	I240x4x120x6	STEEL A36	0.28
1200 Beam_L/3_1200	I240x4x120x6	STEEL A36	0.501
1202 Beam_L/3_SMF_1202	I300x6x120x10	STEEL A36	0.659
1203 Beam_L/3_SMF_1203	I300x6x120x10	STEEL A36	0.692
1205 Beam_L/3_1205	I240x4x120x6	STEEL A36	0.332
1206 Beam_L/3_1206	I240x4x120x6	STEEL A36	0.267
1207 Beam_L/3_1207	I300x4x120x6	STEEL A36	0.332
1208 Beam_L/3_1208	I240x4x120x6	STEEL A36	0.339
1209 Beam_L/3_1209	I240x4x120x6	STEEL A36	0.275
1210 Beam_L/3_1210	I300x4x120x6	STEEL A36	0.342
1214 Beam_L/3_SMF_1214	I300x6x120x10	STEEL A36	0.684
1215 Beam_L/3_SMF_1215	I300x6x120x10	STEEL A36	0.737
1216 Beam_L/3_SMF_1216	I300x6x120x10	STEEL A36	0.84
1217 Beam_L/3_SMF_1217	I300x6x120x10	STEEL A36	0.744
1218 Beam_L/3_1218	I300x4x120x6	STEEL A36	0.315
1219 Beam_L/3_1219	I300x4x120x6	STEEL A36	0.343
1220 Beam_L/3_1220	I240x4x120x6	STEEL A36	0.347
1221 Beam_L/3_1221	I240x4x120x6	STEEL A36	0.273
1222 Beam_L/3_1222	I240x4x120x6	STEEL A36	0.615
1223 Beam_L/3_1223	I240x4x120x6	STEEL A36	0.639
1224 Beam_L/3_SMF_1224	I300x6x120x15	STEEL A36	1.105
1226 Beam_L/3_SMF_1226	I300x6x120x10	STEEL A36	0.405
1227 Beam_L/3_SMF_1227	I300x6x120x10	STEEL A36	0.934

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1228 Beam_L/3_SMF_1228	I300x6x120x10	STEEL A36	0.677
1229 Beam_L/3_SMF_1229	I300x4x120x6	STEEL A36	0.075
1231 Beam_L/3_SMF_1231	I240x6x100x8	STEEL A36	0.325
1232 Beam_L/3_SMF_1232	I240x6x100x8	STEEL A36	0.27
1233 Beam_L/3_SMF_1233	I240x6x100x8	STEEL A36	0.518
1234 Beam_L/3_SMF_1234	I300x4x120x6	STEEL A36	0.062
1235 Beam_L/3_1235	I240x4x120x6	STEEL A36	0.294
1236 Beam_L/3_1236	I240x4x120x6	STEEL A36	0.201
1237 Beam_L/3_1237	I240x4x120x6	STEEL A36	0.34
1240 Beam_L/3_SMF_1240	I300x4x120x6	STEEL A36	0.33
1241 Beam_L/3_1241	I300x6x120x10	STEEL A36	0.562
1242 Beam_L/3_1242	I300x6x120x10	STEEL A36	0.542
1243 Beam_L/3_1243	I240x4x120x6	STEEL A36	0.323
1244 Beam_L/3_1244	I240x4x120x6	STEEL A36	0.306
1248 Beam_1248	I150x4x120x3	STEEL A36	0.34
1249 Beam_1249	I150x4x120x3	STEEL A36	0.396
1250 Beam_1250	I150x4x120x3	STEEL A36	0.477
1251 Beam_1251	I150x4x120x3	STEEL A36	0.446
1252 Beam_1252	I150x4x120x3	STEEL A36	0.214
1253 Beam_1253	I150x4x120x3	STEEL A36	0.268
1254 Beam_L/3_SMF_1254	I300x6x120x10	STEEL A36	0.552
1255 Beam_L/3_SMF_1255	I300x6x120x10	STEEL A36	0.574
1256 Beam_L/3_SMF_1256	I300x6x120x10	STEEL A36	0.642
1257 Beam_L/3_SMF_1257	I300x6x120x10	STEEL A36	0.629
1258 Beam_L/3_1258	I300x4x120x6	STEEL A36	0.33
1259 Beam_L/3_1259	I240x4x120x6	STEEL A36	0.291
1260 Beam_L/3_SMF_1260	I300x6x120x10	STEEL A36	0.803
1261 Beam_L/3_SMF_1261	I300x6x120x10	STEEL A36	0.735
1262 Beam_L/3_SMF_1262	I300x6x120x10	STEEL A36	0.736
1263 Beam_L/3_SMF_1263	I300x6x120x10	STEEL A36	0.786
1264 Beam_L/3_1264	I300x4x120x6	STEEL A36	0.344

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1265 Beam_L/3_1265	I240x4x120x6	STEEL A36	0.329
1266 Beam_L/3_1266	I240x4x120x6	STEEL A36	0.349
1267 Beam_L/3_1267	I240x4x120x6	STEEL A36	0.306
1268 Beam_L/3_1268	I240x4x120x6	STEEL A36	0.33
1269 Beam_L/3_1269	I240x4x120x6	STEEL A36	0.371
1270 Beam_L/3_1270	I240x4x120x6	STEEL A36	0.361
1275 Beam_L/3_SMF_1275	I300x6x120x10	STEEL A36	0.741
1284 Beam_L/3_1284	I300x4x120x6	STEEL A36	0.034
1285 Beam_L/3_SMF_1285	I300x6x120x10	STEEL A36	0.637
1286 Beam_L/3_SMF_1286	I300x6x120x10	STEEL A36	0.598
1290 Beam_L/3_1290	I300x4x120x6	STEEL A36	0.704
1294 Beam_L/3_1294	I300x4x120x6	STEEL A36	0.509
1296 Beam_L/3_SMF_1296	I300x6x120x10	STEEL A36	0.81
1297 Beam_L/3_SMF_1297	I300x6x120x10	STEEL A36	0.805
1298 Beam_L/3_SMF_1298	I300x6x120x10	STEEL A36	0.81
1299 Beam_L/3_SMF_1299	I300x6x120x10	STEEL A36	0.856
1300 Beam_L/3_1300	I240x4x120x6	STEEL A36	0.421
1301 Beam_L/3_1301	I240x4x120x6	STEEL A36	0.265
1302 Beam_L/3_1302	I300x4x120x6	STEEL A36	0.25
1303 Beam_L/3_1303	I240x4x120x6	STEEL A36	0.299
1304 Beam_L/3_1304	I240x4x120x6	STEEL A36	0.283
1305 Beam_L/3_1305	I300x4x120x6	STEEL A36	0.272
1307 Beam_L/3_1307	I240x4x120x6	STEEL A36	0.342
1308 Beam_L/3_1308	I240x4x120x6	STEEL A36	0.288
1309 Beam_L/3_1309	I240x4x120x6	STEEL A36	0.58
1310 Beam_L/3_1310	I240x4x120x6	STEEL A36	0.593
1311 Beam_L/3_1311	I240x4x120x6	STEEL A36	0.198
1312 Beam_L/3_1312	I240x4x120x6	STEEL A36	0.337
1314 Beam_L/3_SMF_1314	I300x4x120x6	STEEL A36	0.308
1315 Beam_L/3_1315	I300x6x120x10	STEEL A36	0.551
1316 Beam_L/3_1316	I300x6x120x10	STEEL A36	0.538
1317 Beam_L/3_1317	I240x4x120x6	STEEL A36	0.324
1318 Beam_L/3_1318	I240x4x120x6	STEEL A36	0.301
1322 Beam_1322	I150x4x120x3	STEEL A36	0.356
1323 Beam_1323	I150x4x120x3	STEEL A36	0.393
1324 Beam_1324	I150x4x120x3	STEEL A36	0.439

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1325 Beam_1325	I150x4x120x3	STEEL A36	0.421
1326 Beam_1326	I150x4x120x3	STEEL A36	0.237
1327 Beam_1327	I150x4x120x3	STEEL A36	0.286
1328 Beam_L/3_SMF_1328	I240x6x100x8	STEEL A36	0.549
1329 Beam_L/3_SMF_1329	I240x6x100x8	STEEL A36	0.457
1330 Beam_L/3_SMF_1330	I240x6x100x8	STEEL A36	0.661
1331 Beam_L/3_SMF_1331	I240x6x100x8	STEEL A36	0.584
1332 Beam_L/3_1332	I240x4x120x6	STEEL A36	0.278
1333 Beam_L/3_1333	I200x4x120x4	STEEL A36	0.203
1334 Beam_L/3_SMF_1334	I240x6x100x8	STEEL A36	0.827
1335 Beam_L/3_1335	I200x4x120x4	STEEL A36	0.903
1336 Beam_L/3_SMF_1336	I240x6x100x8	STEEL A36	0.833
1337 Beam_L/3_1337	I200x4x120x4	STEEL A36	0.771
1338 Beam_L/3_1338	I240x4x120x6	STEEL A36	0.262
1339 Beam_L/3_1339	I200x4x120x4	STEEL A36	0.23
1340 Beam_L/3_1340	I200x4x120x4	STEEL A36	0.281
1341 Beam_L/3_1341	I200x4x120x4	STEEL A36	0.226
1342 Beam_L/3_1342	I200x4x120x4	STEEL A36	0.285
1343 Beam_L/3_1343	I200x4x120x4	STEEL A36	0.29
1344 Beam_L/3_1344	I200x4x120x4	STEEL A36	0.226
1349 Beam_L/3_SMF_1349	I240x6x100x8	STEEL A36	0.607
1358 Beam_L/3_SMF_1358	I240x6x100x8	STEEL A36	0.552
1359 Beam_L/3_SMF_1359	I240x6x100x8	STEEL A36	0.976
1360 Beam_L/3_SMF_1360	I240x6x100x8	STEEL A36	1.041
1370 Beam_L/3_SMF_1370	I240x6x100x8	STEEL A36	0.801
1371 Beam_L/3_SMF_1371	I240x6x100x8	STEEL A36	0.841
1372 Beam_L/3_SMF_1372	I240x6x100x8	STEEL A36	0.827
1373 Beam_L/3_SMF_1373	I240x6x100x8	STEEL A36	0.868
1374 Beam_L/3_1374	I200x4x120x4	STEEL A36	0.521
1375 Beam_L/3_1375	I200x4x120x4	STEEL A36	0.216
1376 Beam_L/3_1376	I200x4x120x4	STEEL A36	0.426
1377 Beam_L/3_1377	I200x4x120x4	STEEL A36	0.432

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1378 Beam_L/3_1378	I200x4x120x4	STEEL A36	0.222
1379 Beam_L/3_1379	I200x4x120x4	STEEL A36	0.337
1381 Beam_L/3_1381	I200x4x120x4	STEEL A36	0.288
1382 Beam_L/3_1382	I200x4x120x4	STEEL A36	0.32
1383 Beam_L/3_1383	I200x4x120x4	STEEL A36	0.52
1384 Beam_L/3_1384	I200x4x120x4	STEEL A36	0.532
1385 Beam_L/3_1385	I200x4x120x4	STEEL A36	0.152
1386 Beam_L/3_1386	I200x4x120x4	STEEL A36	0.21
1388 Beam_L/3_SMF_1388	I300x4x120x6	STEEL A36	0.173
1389 Beam_L/3_1389	I240x6x100x8	STEEL A36	0.489
1390 Beam_L/3_1390	I240x6x100x8	STEEL A36	0.49
1391 Beam_L/3_1391	I150x4x120x3	STEEL A36	0.279
1392 Beam_L/3_1392	I150x4x120x3	STEEL A36	0.27
1396 Beam_1396	I150x4x120x3	STEEL A36	0.262
1397 Beam_1397	I150x4x120x3	STEEL A36	0.297
1398 Beam_1398	I150x4x120x3	STEEL A36	0.372
1399 Beam_1399	I150x4x120x3	STEEL A36	0.33
1400 Beam_1400	I150x4x120x3	STEEL A36	0.215
1401 Beam_1401	I150x4x120x3	STEEL A36	0.223
1403 Beam_L/3_SMF_1403	I240x4x120x6	STEEL A36	0.142
1404 Beam_L/3_1404	I150x4x120x3	STEEL A36	0.175
1405 Beam_L/3_1405	I150x4x120x3	STEEL A36	0.139
1406 Beam_L/3_1406	I200x4x120x4	STEEL A36	0.353
1408 Beam_L/3_SMF_1408	I240x4x120x6	STEEL A36	0.14
1409 Beam_L/3_1409	I150x4x120x3	STEEL A36	0.312
1410 Beam_L/3_1410	I150x4x120x3	STEEL A36	0.341
1412 Beam_L/3_SMF_1412	I300x6x120x10	STEEL A36	0.588
1413 Beam_L/3_SMF_1413	I300x4x120x6	STEEL A36	1.191
1414 Beam_L/3_SMF_1414	I300x4x120x6	STEEL A36	0.595
1415 Beam_L/3_SMF_1415	I300x6x120x10	STEEL A36	1.008
1416 Beam_L/3_SMF_1416	I240x4x120x6	STEEL A36	0.206
1417 Beam_L/3_SMF_1417	I300x4x120x6	STEEL A36	0.873
1418 Beam_L/3_SMF_1418	I300x6x120x10	STEEL A36	0.999
1419 Beam_L/3_SMF_1419	I240x4x120x6	STEEL A36	0.528

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1420 Beam_L/3_SMF_1420	I300x4x120x6	STEEL A36	1.153
1421 Beam_1421	I240x4x120x6	STEEL A36	0.063
1425 Beam_1425	I300x4x120x6	STEEL A36	0.912
1429 Beam_1429	I150x4x120x3	STEEL A36	0.337
1431 Beam_1431	I150x4x120x3	STEEL A36	0.281
1432 Beam_1432	I300x6x120x10	STEEL A36	0.961
1433 Beam_1433	I300x4x120x6	STEEL A36	0.654
1434 Beam_1434	I300x4x120x6	STEEL A36	1.186
1435 Beam_1435	I300x4x120x6	STEEL A36	0.349
1437 Beam_1437	I240x4x120x6	STEEL A36	0.138
1438 Beam_1438	I240x4x120x6	STEEL A36	0.139
1440 Beam_1440	I150x4x120x3	STEEL A36	0.37
1441 Beam_1441	I150x4x120x3	STEEL A36	1.058
1442 Beam_1442	I240x4x120x6	STEEL A36	0.169
1443 Beam_1443	I300x6x120x12	STEEL A36	0.887
1444 Beam_1444	I300x4x120x6	STEEL A36	0.83
1445 Beam_1445	I240x4x120x6	STEEL A36	0.235
1446 Beam_1446	I240x4x120x6	STEEL A36	0.17
1447 Beam_1447	I300x6x120x12	STEEL A36	1.134
1448 Beam_1448	I300x4x120x6	STEEL A36	1.064
1449 Beam_1449	I300x4x120x6	STEEL A36	0.589
1450 Beam_1450	I300x4x120x6	STEEL A36	0.468
1463 Beam_L/3_SMF_1463	I240x6x100x8	STEEL A36	0.639
1477 Beam_L/3_SMF_1477	I240x6x100x8	STEEL A36	0.568
1478 Beam_L/3_SMF_1478	I240x6x100x8	STEEL A36	0.686
1481 Beam_L/3_1481	I200x4x120x4	STEEL A36	0.267
1482 Beam_L/3_1482	I200x4x120x4	STEEL A36	0.33
1487 Beam_L/3_1487	I200x4x120x4	STEEL A36	0.226
1488 Beam_L/3_1488	I200x4x120x4	STEEL A36	0.304
1489 Beam_L/3_1489	I200x4x120x4	STEEL A36	0.464
1490 Beam_L/3_1490	I200x4x120x4	STEEL A36	0.344
1509 Beam_L/3_SMF_1509	I300x6x120x10	STEEL A36	0.667
1510 Beam_L/3_SMF_1510	I300x6x120x10	STEEL A36	0.676
1514 Beam_L/3_SMF_1514	I240x6x100x8	STEEL A36	0.498
1515 Beam_L/3_SMF_1515	I300x6x120x15	STEEL A36	0.967

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1516 Beam_L/3_SMF_1516	I300x6x120x12	STEEL A36	0.965
1517 Beam_L/3_SMF_1517	I300x6x120x10	STEEL A36	0.859
1518 Beam_L/3_SMF_1518	I300x6x120x10	STEEL A36	0.834
1519 Beam_L/3_SMF_1519	I240x6x100x8	STEEL A36	0.728
1520 Beam_L/3_SMF_1520	I240x6x100x8	STEEL A36	0.708
1521 Beam_L/3_SMF_1521	I300x6x120x10	STEEL A36	0.516
1522 Beam_L/3_SMF_1522	I300x6x120x10	STEEL A36	0.786
1523 Beam_L/3_SMF_1523	I300x6x120x10	STEEL A36	0.92
1531 Beam_L/3_SMF_1531	I300x6x120x10	STEEL A36	0.664
1532 Beam_L/3_SMF_1532	I300x6x120x10	STEEL A36	0.677
1533 Beam_L/3_SMF_1533	I300x6x120x10	STEEL A36	0.581
1534 Beam_L/3_1534	I150x4x120x3	STEEL A36	0.117
1535 Beam_L/3_1535	I150x4x120x3	STEEL A36	0.104
1536 Beam_L/3_1536	I150x4x120x3	STEEL A36	0.131
1537 Beam_L/3_1537	I150x4x120x3	STEEL A36	0.097
1538 Beam_L/3_1538	I150x4x120x3	STEEL A36	0.109
1539 Beam_L/3_1539	I150x4x120x3	STEEL A36	0.105
1540 Beam_L/3_1540	I150x4x120x3	STEEL A36	0.123
1541 Beam_L/3_1541	I150x4x120x3	STEEL A36	0.108
1542	I240x4x120x6	STEEL A36	0.164
1543	I240x4x120x6	STEEL A36	0.187
1546 Beam_L/3_SMF_1546	I240x6x100x8	STEEL A36	0.584
1547 Beam_L/3_SMF_1547	I240x6x100x8	STEEL A36	0.329
1548 Beam_L/3_SMF_1548	I240x6x100x8	STEEL A36	0.595
1551 Beam_L/3_SMF_1551	I240x6x100x8	STEEL A36	0.557
1552 Beam_L/3_SMF_1552	I240x6x100x8	STEEL A36	0.676
1564 Beam_1564	I300x6x120x10	STEEL A36	0.74

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6.3.Columnas

Se muestra el diseño de la columna crítica y el resumen de diseño de todos los elementos. Las columnas se diseñan como elementos compuestos que cumplen compacidad sísmica y tiene mayor capacidad que la calculada por el software de análisis. Se muestra también el cálculo de estas propiedades.

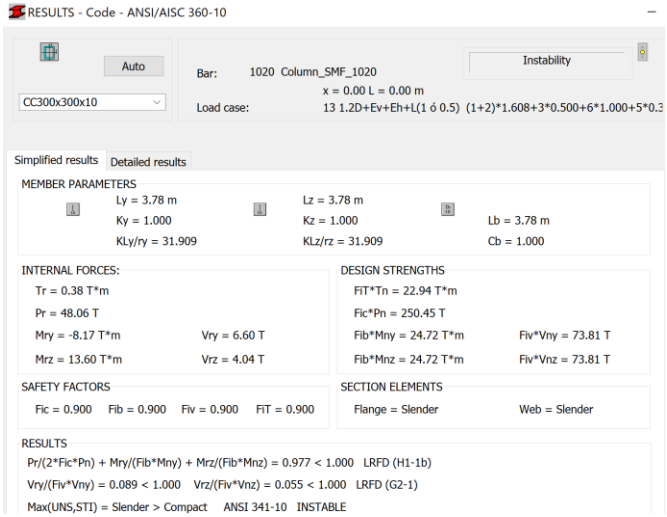

Ilustración 20 Estados límites y diseño de columna

- **Cálculo sección compuesta**

$$\phi Mn_z = 36.80\ Tm$$
$$\phi Mn_y = 36.80\ Tm$$
$$\phi Pn = 79.29\ T$$

DISEÑO DE COLUMNAS CAJON RELLENAS DE HORMIGON

C-HSS AISC 360-10 (SIN ARMADURA DE REFUERZO INTERNA)

H (mm)	300	Dimensión exterior			H (cm)	30.00
B (mm)	300	Dimensión exterior			B (cm)	30.00
th (mm)	10				th (cm)	1.00
tb (mm)	10				tb (cm)	1.00
					H' (cm)	28.00
Fy (Ksi)	36	2,531	(Kg/cm^2)		B' (cm)	28.00
Es (Ksi)	29,000	2,038,903	(Kg/cm^2)			
Ry	1.5					
H' (mm)	280.00			Maximo 1.48(E/RyFy)$^{0.5}$	34.30	[Tabla D1.1 341-16]
B' (mm)	280.00					
COMPACIDAD (H'/th)	28.00	Ok				
COMPACIDAD (B'/tb)	28.00	Ok				

f'c (Kg/cm^2)	210	Ec (Kg/cm^2)	166,651	Altura de columna, L (cm)	295	Modulo d
				K	1.20	Modulo d

	ACERO	HORMIG				
Area (cm^2)	116.00	784.00	E.Ieff	C_2	0.85	[Sec. I2 2 2b]
Inercia X (cm^4)	16,278.67	51,221.33	4.05E+10	C_3	0.86	[I2-13]
Inercia Y (cm^4)	16,278.67	51,221.33	4.05E+10			

PA, Pno (t)	433.55	[I2-9B]	ϕc	0.75	ϕb	0.90	
Pe (t)	3,190.69	[I2-5]	**PA', Pnmax (t)**	**409.58**	**MB", MuHmax (t.m)**	**31.70**	
Pno/Pe	0.14		**PA", Pumax (t)**	**307.18**	**MB", MuBmax (t.m)**	**31.70**	λ 0.945

DIAGRAMAS DE INTERACCION

SENTIDO DE H				
Mn	Pn	Pn.λ	Mu (t.m)	Pu (t)
0.00	-293.60	-293.60	0.00	-264.24
22.02	-141.74	-141.74	19.82	-127.57
26.57	-106.30	-106.30	23.91	-95.67
30.28	-70.87	-70.87	27.25	-63.78
33.17	-35.43	-35.43	29.85	-31.89
35.22	0.00	0.00	31.70	0.00
35.97	18.78	17.74	32.38	13.31
36.49	37.56	35.48	32.84	26.61
36.78	56.34	53.22	33.10	39.92
36.83	75.12	70.96	33.15	53.22
36.65	93.89	88.70	32.99	66.53
36.24	112.67	106.44	32.61	79.83
35.59	131.45	124.18	32.03	93.14
34.71	150.23	141.93	31.24	106.44
33.60	169.01	159.67	30.24	119.75
32.25	187.79	177.41	29.03	133.06
30.67	206.57	195.15	27.60	146.36
28.86	225.35	212.89	25.97	159.67
26.81	244.13	230.63	24.13	172.97
24.53	262.90	248.37	22.08	186.28
22.02	281.68	266.11	19.82	199.58
0.00	433.55	409.58	0.00	307.18

SENTIDO DE B				
Mn	Pn	Pn.λ	Mu (t.m)	Pu (t)
0.00	-293.60	-293.60	0.00	-264.24
22.02	-141.74	-141.74	19.82	-127.57
26.57	-106.30	-106.30	23.91	-95.67
30.28	-70.87	-70.87	27.25	-63.78
33.17	-35.43	-35.43	29.85	-31.89
35.22	0.00	0.00	31.70	0.00
35.97	18.78	17.74	32.38	13.31
36.49	37.56	35.48	32.84	26.61
36.78	56.34	53.22	33.10	39.92
36.83	75.12	70.96	33.15	53.22
36.65	93.89	88.70	32.99	66.53
36.24	112.67	106.44	32.61	79.83
35.59	131.45	124.18	32.03	93.14
34.71	150.23	141.93	31.24	106.44
33.60	169.01	159.67	30.24	119.75
32.25	187.79	177.41	29.03	133.06
30.67	206.57	195.15	27.60	146.36
28.86	225.35	212.89	25.97	159.67
26.81	244.13	230.63	24.13	172.97
24.53	262.90	248.37	22.08	186.28
22.02	281.68	266.11	19.82	199.58
0.00	433.55	409.58	0.00	307.18

Ilustración 21 Resumen y captura de pantalla del cálculo de capacidad de columna compuesta.

Elemento	Sección	Material	Rel.
1	I300x6x120x10	STEEL A36	0.408
2	I300x6x120x10	STEEL A36	0.264
6	I300x6x120x10	STEEL A36	0.778
7	I300x6x120x10	STEEL A36	0.441
8	I300x6x120x10	STEEL A36	0.299
9	I300x6x120x10	STEEL A36	0.411
10	I300x6x120x10	STEEL A36	0.259
12 Beam_L/3_SMF_12	I300x6x120x15	STEEL A36	0.947
13 Beam_L/3_SMF_13	I300x6x120x15	STEEL A36	0.967
14 Beam_L/3_SMF_14	I300x6x120x10	STEEL A36	0.441
25 Beam_L/3_SMF_25	I300x6x120x10	STEEL A36	0.364
26 Beam_L/3_SMF_26	I300x6x120x10	STEEL A36	0.427
27 Beam_L/3_SMF_27	I300x6x120x10	STEEL A36	1.143
28 Beam_L/3_SMF_28	I300x6x120x10	STEEL A36	0.409
29	I300x6x120x10	STEEL A36	0.505
35	I150x4x120x3	STEEL A36	0.19
40	I150x4x120x3	STEEL A36	0.178

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45 Beam_L/3_45	I300x4x120x6	STEEL A36	0.225
50 Beam_L/3_50	I300x6x120x12	STEEL A36	0.855
55 Beam_L/3_55	I240x4x120x6	STEEL A36	0.625
70	I150x4x120x3	STEEL A36	0.184
80	I150x4x120x3	STEEL A36	0.19
81 Beam_L/3_81	I300x4x120x6	STEEL A36	0.23
83 Beam_L/3_83	I240x4x120x6	STEEL A36	0.169
84 Beam_L/3_84	I240x4x120x6	STEEL A36	0.637
87	I150x4x120x3	STEEL A36	0.2
99	I150x4x120x3	STEEL A36	0.195
105	I150x4x120x3	STEEL A36	0.191
111 Beam_L/3_SMF_111	I240x6x100x8	STEEL A36	0.668
117 Beam_L/3_117	I200x4x120x4	STEEL A36	0.318
118 Beam_L/3_SMF_118	I240x6x100x8	STEEL A36	0.632
120	I150x4x120x3	STEEL A36	0.193
121	I240x4x120x6	STEEL A36	0.201
123	I300x6x120x10	STEEL A36	0.627
125	I300x6x120x10	STEEL A36	0.467
170	I300x6x120x10	STEEL A36	0.59
171	I300x6x120x10	STEEL A36	0.521
175	I300x6x120x10	STEEL A36	0.639
177	I300x6x120x10	STEEL A36	0.361
179	I300x6x120x10	STEEL A36	0.794
180	I300x6x120x10	STEEL A36	0.478
181	I240x4x120x6	STEEL A36	0.114
263	I300x6x120x10	STEEL A36	0.893
264	I300x6x120x10	STEEL A36	0.419
265	I240x4x120x6	STEEL A36	0.111
289	I240x4x120x6	STEEL A36	0.203
322	I150x4x120x3	STEEL A36	0.151
396	I150x4x120x3	STEEL A36	0.146
519	I150x4x120x3	STEEL A36	0.159
523	I150x4x120x3	STEEL A36	0.159
559	I150x4x120x3	STEEL A36	0.162
560	I150x4x120x3	STEEL A36	0.158
561	I150x4x120x3	STEEL A36	0.156
566	I150x4x120x3	STEEL A36	0.159
583	I240x6x100x8	STEEL A36	0.451
588	I240x6x100x8	STEEL A36	0.408
593	I240x6x100x8	STEEL A36	0.426

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598	I240x6x100x8	STEEL A36	0.427
603	I240x6x100x8	STEEL A36	0.469
604	I240x6x100x8	STEEL A36	0.301
627	I200x4x120x4	STEEL A36	0.103
640	I200x4x120x4	STEEL A36	0.151
663	I150x4x120x3	STEEL A36	0.113
667	I150x4x120x3	STEEL A36	0.092
674	I150x4x120x3	STEEL A36	0.12
675	I150x4x120x3	STEEL A36	0.111
676	I150x4x120x3	STEEL A36	0.121
677	I150x4x120x3	STEEL A36	0.108
678	I150x4x120x3	STEEL A36	0.13
679	I150x4x120x3	STEEL A36	0.113
940 Beam_L/3_SMF_940	I300x6x120x10	STEEL A36	0.846
941 Beam_L/3_SMF_941	I300x6x120x10	STEEL A36	0.775
942 Beam_L/3_SMF_942	I300x6x120x10	STEEL A36	0.763
943 Beam_L/3_SMF_943	I300x6x120x10	STEEL A36	0.791
950 Beam_L/3_SMF_950	I300x6x120x10	STEEL A36	0.409
951 Beam_L/3_SMF_951	I300x6x120x10	STEEL A36	0.921
952 Beam_L/3_952	I300x4x120x6	STEEL A36	0.691
953 Beam_L/3_953	I300x6x120x12	STEEL A36	0.972
954 Beam_L/3_954	I300x6x120x12	STEEL A36	0.836
957 Beam_L/3_SMF_957	I300x6x120x10	STEEL A36	0.719
958 Beam_L/3_SMF_958	I300x6x120x10	STEEL A36	0.714
959 Beam_L/3_SMF_959	I300x6x120x15	STEEL A36	0.875
960 Beam_L/3_SMF_960	I300x6x120x12	STEEL A36	0.919
967 Beam_L/3_SMF_967	I240x6x100x8	STEEL A36	0.63
969 Beam_L/3_969	I200x4x120x4	STEEL A36	0.254
970 Beam_L/3_970	I240x4x120x6	STEEL A36	0.354
977 Beam_L/3_SMF_977	I300x6x120x10	STEEL A36	0.918
978 Beam_L/3_SMF_978	I300x6x120x10	STEEL A36	0.862
979 Beam_L/3_SMF_979	I300x6x120x10	STEEL A36	0.792

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987 Beam_L/3_SMF_987	I300x6x120x10	STEEL A36	0.949
988 Beam_L/3_SMF_988	I300x6x120x15	STEEL A36	1.046
989 Beam_L/3_SMF_989	I300x6x120x12	STEEL A36	1.039
990 Beam_L/3_SMF_990	I300x6x120x12	STEEL A36	0.988
994 Beam_L/3_SMF_994	I300x6x120x12	STEEL A36	0.973
995 Beam_L/3_SMF_995	I300x6x120x10	STEEL A36	0.991
996 Beam_L/3_SMF_996	I300x6x120x10	STEEL A36	0.953
997 Beam_L/3_SMF_997	I300x6x120x15	STEEL A36	0.913
1004 Beam_L/3_1004	I200x4x120x4	STEEL A36	0.458
1005 Beam_L/3_1005	I200x4x120x4	STEEL A36	0.358
1006 Beam_L/3_1006	I200x4x120x4	STEEL A36	0.349
1007 Beam_L/3_1007	I240x4x120x6	STEEL A36	0.298
1014 Beam_L/3_SMF_1014	I300x6x120x10	STEEL A36	0.821
1015 Beam_L/3_SMF_1015	I300x6x120x10	STEEL A36	0.793
1016 Beam_L/3_SMF_1016	I300x6x120x10	STEEL A36	0.747
1024 Beam_L/3_SMF_1024	I300x6x120x10	STEEL A36	0.69
1025 Beam_L/3_SMF_1025	I300x6x120x15	STEEL A36	0.965
1026 Beam_L/3_SMF_1026	I300x6x120x12	STEEL A36	0.929
1027 Beam_L/3_SMF_1027	I300x6x120x15	STEEL A36	0.864
1031 Beam_L/3_SMF_1031	I300x6x120x10	STEEL A36	0.893
1032 Beam_L/3_SMF_1032	I300x6x120x10	STEEL A36	0.849
1033 Beam_L/3_SMF_1033	I300x6x120x10	STEEL A36	0.889
1034 Beam_L/3_SMF_1034	I300x6x120x15	STEEL A36	0.903
1041 Beam_L/3_SMF_1041	I240x6x100x8	STEEL A36	0.784
1042 Beam_L/3_SMF_1042	I240x6x100x8	STEEL A36	0.747
1043 Beam_L/3_SMF_1043	I240x6x100x8	STEEL A36	0.79

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1044 Beam_L/3_SMF_1044	I240x6x100x8	STEEL A36	1
1061 Beam_L/3_SMF_1061	I300x4x120x6	STEEL A36	0.093
1062 Beam_L/3_SMF_1062	I300x4x120x6	STEEL A36	0.191
1063 Beam_L/3_SMF_1063	I300x4x120x6	STEEL A36	0.192
1064 Beam_L/3_SMF_1064	I300x4x120x6	STEEL A36	0.094
1068 Beam_L/3_SMF_1068	I300x4x120x6	STEEL A36	0.185
1069 Beam_L/3_SMF_1069	I300x4x120x6	STEEL A36	0.179
1070 Beam_L/3_SMF_1070	I300x4x120x6	STEEL A36	0.063
1071 Beam_L/3_SMF_1071	I300x6x120x15	STEEL A36	1.001
1078 Beam_L/3_SMF_1078	I300x4x120x6	STEEL A36	0.106
1079 Beam_L/3_SMF_1079	I300x4x120x6	STEEL A36	0.109
1080 Beam_L/3_SMF_1080	I300x4x120x6	STEEL A36	0.059
1081 Beam_L/3_SMF_1081	I300x6x120x10	STEEL A36	0.764
1094 Beam_L/3_SMF_1094	I300x6x120x10	STEEL A36	0.517
1095 Beam_L/3_SMF_1095	I300x6x120x10	STEEL A36	0.55
1096 Beam_L/3_1096	I240x4x120x6	STEEL A36	0.147
1097 Beam_L/3_1097	I240x4x120x6	STEEL A36	0.148
1098 Beam_L/3_SMF_1098	I300x6x120x10	STEEL A36	0.502
1099 Beam_L/3_SMF_1099	I300x6x120x10	STEEL A36	0.584
1100 Beam_L/3_1100	I240x4x120x6	STEEL A36	0.138
1101 Beam_L/3_1101	I240x4x120x6	STEEL A36	0.138
1102 Beam_L/3_SMF_1102	I300x6x120x10	STEEL A36	0.477
1104 Beam_L/3_1104	I240x4x120x6	STEEL A36	0.154
1105 Beam_L/3_1105	I240x4x120x6	STEEL A36	0.153
1106 Beam_L/3_SMF_1106	I300x6x120x10	STEEL A36	0.165
1107 Beam_L/3_SMF_1107	I300x6x120x10	STEEL A36	0.52
1108 Beam_L/3_1108	I240x4x120x6	STEEL A36	0.148
1109 Beam_L/3_1109	I240x4x120x6	STEEL A36	0.139

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1114 Beam_L/3_SMF_1114	I300x6x120x10	STEEL A36	0.935
1115 Beam_L/3_SMF_1115	I300x6x120x10	STEEL A36	0.923
1116 Beam_L/3_SMF_1116	I300x6x120x10	STEEL A36	0.927
1117 Beam_L/3_SMF_1117	I300x6x120x10	STEEL A36	0.942
1120 Beam_L/3_1120	I240x4x120x6	STEEL A36	0.277
1121 Beam_L/3_1121	I240x4x120x6	STEEL A36	0.276
1122 Beam_L/3_1122	I240x4x120x6	STEEL A36	0.261
1123 Beam_L/3_1123	I240x4x120x6	STEEL A36	0.283
1124 Beam_L/3_1124	I240x4x120x6	STEEL A36	0.349
1125 Beam_L/3_1125	I240x4x120x6	STEEL A36	0.358
1130 Beam_L/3_SMF_1130	I300x6x120x10	STEEL A36	0.823
1141 Beam_L/3_1141	I300x4x120x6	STEEL A36	0.084
1142 Beam_L/3_SMF_1142	I300x6x120x10	STEEL A36	0.921
1143 Beam_L/3_SMF_1143	I300x6x120x10	STEEL A36	0.9
1147 Beam_L/3_1147	I300x4x120x6	STEEL A36	0.774
1151 Beam_L/3_1151	I300x4x120x6	STEEL A36	0.773
1153 Beam_L/3_SMF_1153	I300x6x120x10	STEEL A36	0.863
1154 Beam_L/3_SMF_1154	I300x6x120x10	STEEL A36	0.868
1155 Beam_L/3_SMF_1155	I300x6x120x10	STEEL A36	0.913
1156 Beam_L/3_SMF_1156	I300x6x120x10	STEEL A36	0.904
1157 Beam_L/3_1157	I240x4x120x6	STEEL A36	0.485
1158 Beam_L/3_1158	I240x4x120x6	STEEL A36	0.241
1159 Beam_L/3_1159	I300x4x120x6	STEEL A36	0.226
1161 Beam_L/3_1161	I240x4x120x6	STEEL A36	0.415
1162 Beam_L/3_1162	I240x4x120x6	STEEL A36	0.268
1163 Beam_L/3_1163	I300x4x120x6	STEEL A36	0.24
1168 Beam_L/3_1168	I240x4x120x6	STEEL A36	0.272
1169 Beam_L/3_SMF_1169	I300x6x120x10	STEEL A36	0.566
1170 Beam_L/3_SMF_1170	I300x6x120x10	STEEL A36	0.635
1173 Beam_L/3_1173	I240x4x120x6	STEEL A36	0.318
1174 Beam_L/3_1174	I240x4x120x6	STEEL A36	0.28
1175 Beam_L/3_1175	I240x4x120x6	STEEL A36	0.243

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1176 Beam_L/3_1176	I240x4x120x6	STEEL A36	0.255
1177 Beam_L/3_1177	I240x4x120x6	STEEL A36	0.265
1178 Beam_L/3_1178	I240x4x120x6	STEEL A36	0.268
1190 Beam_L/3_SMF_1190	I300x6x120x10	STEEL A36	0.606
1191 Beam_L/3_SMF_1191	I300x6x120x10	STEEL A36	0.625
1192 Beam_L/3_SMF_1192	I300x6x120x10	STEEL A36	0.509
1193 Beam_L/3_1193	I240x4x120x6	STEEL A36	0.319
1194 Beam_L/3_1194	I240x4x120x6	STEEL A36	0.302
1196 Beam_L/3_1196	I240x4x120x6	STEEL A36	0.487
1197 Beam_L/3_1197	I240x4x120x6	STEEL A36	0.311
1198 Beam_L/3_1198	I240x4x120x6	STEEL A36	0.28
1200 Beam_L/3_1200	I240x4x120x6	STEEL A36	0.501
1202 Beam_L/3_SMF_1202	I300x6x120x10	STEEL A36	0.659
1203 Beam_L/3_SMF_1203	I300x6x120x10	STEEL A36	0.692
1205 Beam_L/3_1205	I240x4x120x6	STEEL A36	0.332
1206 Beam_L/3_1206	I240x4x120x6	STEEL A36	0.267
1207 Beam_L/3_1207	I300x4x120x6	STEEL A36	0.332
1208 Beam_L/3_1208	I240x4x120x6	STEEL A36	0.339
1209 Beam_L/3_1209	I240x4x120x6	STEEL A36	0.275
1210 Beam_L/3_1210	I300x4x120x6	STEEL A36	0.342
1214 Beam_L/3_SMF_1214	I300x6x120x10	STEEL A36	0.684
1215 Beam_L/3_SMF_1215	I300x6x120x10	STEEL A36	0.737
1216 Beam_L/3_SMF_1216	I300x6x120x10	STEEL A36	0.84
1217 Beam_L/3_SMF_1217	I300x6x120x10	STEEL A36	0.744
1218 Beam_L/3_1218	I300x4x120x6	STEEL A36	0.315
1219 Beam_L/3_1219	I300x4x120x6	STEEL A36	0.343
1220 Beam_L/3_1220	I240x4x120x6	STEEL A36	0.347
1221 Beam_L/3_1221	I240x4x120x6	STEEL A36	0.273
1222 Beam_L/3_1222	I240x4x120x6	STEEL A36	0.615
1223 Beam_L/3_1223	I240x4x120x6	STEEL A36	0.639
1224 Beam_L/3_SMF_1224	I300x6x120x15	STEEL A36	1.105
1226 Beam_L/3_SMF_1226	I300x6x120x10	STEEL A36	0.405
1227 Beam_L/3_SMF_1227	I300x6x120x10	STEEL A36	0.934

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1228 Beam_L/3_SMF_1228	I300x6x120x10	STEEL A36	0.677
1229 Beam_L/3_SMF_1229	I300x4x120x6	STEEL A36	0.075
1231 Beam_L/3_SMF_1231	I240x6x100x8	STEEL A36	0.325
1232 Beam_L/3_SMF_1232	I240x6x100x8	STEEL A36	0.27
1233 Beam_L/3_SMF_1233	I240x6x100x8	STEEL A36	0.518
1234 Beam_L/3_SMF_1234	I300x4x120x6	STEEL A36	0.062
1235 Beam_L/3_1235	I240x4x120x6	STEEL A36	0.294
1236 Beam_L/3_1236	I240x4x120x6	STEEL A36	0.201
1237 Beam_L/3_1237	I240x4x120x6	STEEL A36	0.34
1240 Beam_L/3_SMF_1240	I300x4x120x6	STEEL A36	0.33
1241 Beam_L/3_1241	I300x6x120x10	STEEL A36	0.562
1242 Beam_L/3_1242	I300x6x120x10	STEEL A36	0.542
1243 Beam_L/3_1243	I240x4x120x6	STEEL A36	0.323
1244 Beam_L/3_1244	I240x4x120x6	STEEL A36	0.306
1248 Beam_1248	I150x4x120x3	STEEL A36	0.34
1249 Beam_1249	I150x4x120x3	STEEL A36	0.396
1250 Beam_1250	I150x4x120x3	STEEL A36	0.477
1251 Beam_1251	I150x4x120x3	STEEL A36	0.446
1252 Beam_1252	I150x4x120x3	STEEL A36	0.214
1253 Beam_1253	I150x4x120x3	STEEL A36	0.268
1254 Beam_L/3_SMF_1254	I300x6x120x10	STEEL A36	0.552
1255 Beam_L/3_SMF_1255	I300x6x120x10	STEEL A36	0.574
1256 Beam_L/3_SMF_1256	I300x6x120x10	STEEL A36	0.642
1257 Beam_L/3_SMF_1257	I300x6x120x10	STEEL A36	0.629
1258 Beam_L/3_1258	I300x4x120x6	STEEL A36	0.33
1259 Beam_L/3_1259	I240x4x120x6	STEEL A36	0.291
1260 Beam_L/3_SMF_1260	I300x6x120x10	STEEL A36	0.803
1261 Beam_L/3_SMF_1261	I300x6x120x10	STEEL A36	0.735
1262 Beam_L/3_SMF_1262	I300x6x120x10	STEEL A36	0.736
1263 Beam_L/3_SMF_1263	I300x6x120x10	STEEL A36	0.786
1264 Beam_L/3_1264	I300x4x120x6	STEEL A36	0.344

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1265 Beam_L/3_1265	I240x4x120x6	STEEL A36	0.329
1266 Beam_L/3_1266	I240x4x120x6	STEEL A36	0.349
1267 Beam_L/3_1267	I240x4x120x6	STEEL A36	0.306
1268 Beam_L/3_1268	I240x4x120x6	STEEL A36	0.33
1269 Beam_L/3_1269	I240x4x120x6	STEEL A36	0.371
1270 Beam_L/3_1270	I240x4x120x6	STEEL A36	0.361
1275 Beam_L/3_SMF_1275	I300x6x120x10	STEEL A36	0.741
1284 Beam_L/3_1284	I300x4x120x6	STEEL A36	0.034
1285 Beam_L/3_SMF_1285	I300x6x120x10	STEEL A36	0.637
1286 Beam_L/3_SMF_1286	I300x6x120x10	STEEL A36	0.598
1290 Beam_L/3_1290	I300x4x120x6	STEEL A36	0.704
1294 Beam_L/3_1294	I300x4x120x6	STEEL A36	0.509
1296 Beam_L/3_SMF_1296	I300x6x120x10	STEEL A36	0.81
1297 Beam_L/3_SMF_1297	I300x6x120x10	STEEL A36	0.805
1298 Beam_L/3_SMF_1298	I300x6x120x10	STEEL A36	0.81
1299 Beam_L/3_SMF_1299	I300x6x120x10	STEEL A36	0.856
1300 Beam_L/3_1300	I240x4x120x6	STEEL A36	0.421
1301 Beam_L/3_1301	I240x4x120x6	STEEL A36	0.265
1302 Beam_L/3_1302	I300x4x120x6	STEEL A36	0.25
1303 Beam_L/3_1303	I240x4x120x6	STEEL A36	0.299
1304 Beam_L/3_1304	I240x4x120x6	STEEL A36	0.283
1305 Beam_L/3_1305	I300x4x120x6	STEEL A36	0.272
1307 Beam_L/3_1307	I240x4x120x6	STEEL A36	0.342
1308 Beam_L/3_1308	I240x4x120x6	STEEL A36	0.288
1309 Beam_L/3_1309	I240x4x120x6	STEEL A36	0.58
1310 Beam_L/3_1310	I240x4x120x6	STEEL A36	0.593
1311 Beam_L/3_1311	I240x4x120x6	STEEL A36	0.198
1312 Beam_L/3_1312	I240x4x120x6	STEEL A36	0.337
1314 Beam_L/3_SMF_1314	I300x4x120x6	STEEL A36	0.308
1315 Beam_L/3_1315	I300x6x120x10	STEEL A36	0.551
1316 Beam_L/3_1316	I300x6x120x10	STEEL A36	0.538
1317 Beam_L/3_1317	I240x4x120x6	STEEL A36	0.324
1318 Beam_L/3_1318	I240x4x120x6	STEEL A36	0.301
1322 Beam_1322	I150x4x120x3	STEEL A36	0.356
1323 Beam_1323	I150x4x120x3	STEEL A36	0.393
1324 Beam_1324	I150x4x120x3	STEEL A36	0.439

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1325 Beam_1325	I150x4x120x3	STEEL A36	0.421
1326 Beam_1326	I150x4x120x3	STEEL A36	0.237
1327 Beam_1327	I150x4x120x3	STEEL A36	0.286
1328 Beam_L/3_SMF_1328	I240x6x100x8	STEEL A36	0.549
1329 Beam_L/3_SMF_1329	I240x6x100x8	STEEL A36	0.457
1330 Beam_L/3_SMF_1330	I240x6x100x8	STEEL A36	0.661
1331 Beam_L/3_SMF_1331	I240x6x100x8	STEEL A36	0.584
1332 Beam_L/3_1332	I240x4x120x6	STEEL A36	0.278
1333 Beam_L/3_1333	I200x4x120x4	STEEL A36	0.203
1334 Beam_L/3_SMF_1334	I240x6x100x8	STEEL A36	0.827
1335 Beam_L/3_1335	I200x4x120x4	STEEL A36	0.903
1336 Beam_L/3_SMF_1336	I240x6x100x8	STEEL A36	0.833
1337 Beam_L/3_1337	I200x4x120x4	STEEL A36	0.771
1338 Beam_L/3_1338	I240x4x120x6	STEEL A36	0.262
1339 Beam_L/3_1339	I200x4x120x4	STEEL A36	0.23
1340 Beam_L/3_1340	I200x4x120x4	STEEL A36	0.281
1341 Beam_L/3_1341	I200x4x120x4	STEEL A36	0.226
1342 Beam_L/3_1342	I200x4x120x4	STEEL A36	0.285
1343 Beam_L/3_1343	I200x4x120x4	STEEL A36	0.29
1344 Beam_L/3_1344	I200x4x120x4	STEEL A36	0.226
1349 Beam_L/3_SMF_1349	I240x6x100x8	STEEL A36	0.607
1358 Beam_L/3_SMF_1358	I240x6x100x8	STEEL A36	0.552
1359 Beam_L/3_SMF_1359	I240x6x100x8	STEEL A36	0.976
1360 Beam_L/3_SMF_1360	I240x6x100x8	STEEL A36	1.041
1370 Beam_L/3_SMF_1370	I240x6x100x8	STEEL A36	0.801
1371 Beam_L/3_SMF_1371	I240x6x100x8	STEEL A36	0.841
1372 Beam_L/3_SMF_1372	I240x6x100x8	STEEL A36	0.827
1373 Beam_L/3_SMF_1373	I240x6x100x8	STEEL A36	0.868
1374 Beam_L/3_1374	I200x4x120x4	STEEL A36	0.521
1375 Beam_L/3_1375	I200x4x120x4	STEEL A36	0.216
1376 Beam_L/3_1376	I200x4x120x4	STEEL A36	0.426
1377 Beam_L/3_1377	I200x4x120x4	STEEL A36	0.432

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1378 Beam_L/3_1378	I200x4x120x4	STEEL A36	0.222
1379 Beam_L/3_1379	I200x4x120x4	STEEL A36	0.337
1381 Beam_L/3_1381	I200x4x120x4	STEEL A36	0.288
1382 Beam_L/3_1382	I200x4x120x4	STEEL A36	0.32
1383 Beam_L/3_1383	I200x4x120x4	STEEL A36	0.52
1384 Beam_L/3_1384	I200x4x120x4	STEEL A36	0.532
1385 Beam_L/3_1385	I200x4x120x4	STEEL A36	0.152
1386 Beam_L/3_1386	I200x4x120x4	STEEL A36	0.21
1388 Beam_L/3_SMF_1388	I300x4x120x6	STEEL A36	0.173
1389 Beam_L/3_1389	I240x6x100x8	STEEL A36	0.489
1390 Beam_L/3_1390	I240x6x100x8	STEEL A36	0.49
1391 Beam_L/3_1391	I150x4x120x3	STEEL A36	0.279
1392 Beam_L/3_1392	I150x4x120x3	STEEL A36	0.27
1396 Beam_1396	I150x4x120x3	STEEL A36	0.262
1397 Beam_1397	I150x4x120x3	STEEL A36	0.297
1398 Beam_1398	I150x4x120x3	STEEL A36	0.372
1399 Beam_1399	I150x4x120x3	STEEL A36	0.33
1400 Beam_1400	I150x4x120x3	STEEL A36	0.215
1401 Beam_1401	I150x4x120x3	STEEL A36	0.223
1403 Beam_L/3_SMF_1403	I240x4x120x6	STEEL A36	0.142
1404 Beam_L/3_1404	I150x4x120x3	STEEL A36	0.175
1405 Beam_L/3_1405	I150x4x120x3	STEEL A36	0.139
1406 Beam_L/3_1406	I200x4x120x4	STEEL A36	0.353
1408 Beam_L/3_SMF_1408	I240x4x120x6	STEEL A36	0.14
1409 Beam_L/3_1409	I150x4x120x3	STEEL A36	0.312
1410 Beam_L/3_1410	I150x4x120x3	STEEL A36	0.341
1412 Beam_L/3_SMF_1412	I300x6x120x10	STEEL A36	0.588
1413 Beam_L/3_SMF_1413	I300x4x120x6	STEEL A36	1.191
1414 Beam_L/3_SMF_1414	I300x4x120x6	STEEL A36	0.595
1415 Beam_L/3_SMF_1415	I300x6x120x10	STEEL A36	1.008
1416 Beam_L/3_SMF_1416	I240x4x120x6	STEEL A36	0.206
1417 Beam_L/3_SMF_1417	I300x4x120x6	STEEL A36	0.873
1418 Beam_L/3_SMF_1418	I300x6x120x10	STEEL A36	0.999
1419 Beam_L/3_SMF_1419	I240x4x120x6	STEEL A36	0.528

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1420 Beam_L/3_SMF_1420	I300x4x120x6	STEEL A36	1.153
1421 Beam_1421	I240x4x120x6	STEEL A36	0.063
1425 Beam_1425	I300x4x120x6	STEEL A36	0.912
1429 Beam_1429	I150x4x120x3	STEEL A36	0.337
1431 Beam_1431	I150x4x120x3	STEEL A36	0.281
1432 Beam_1432	I300x6x120x10	STEEL A36	0.961
1433 Beam_1433	I300x4x120x6	STEEL A36	0.654
1434 Beam_1434	I300x4x120x6	STEEL A36	1.186
1435 Beam_1435	I300x4x120x6	STEEL A36	0.349
1437 Beam_1437	I240x4x120x6	STEEL A36	0.138
1438 Beam_1438	I240x4x120x6	STEEL A36	0.139
1440 Beam_1440	I150x4x120x3	STEEL A36	0.37
1441 Beam_1441	I150x4x120x3	STEEL A36	1.058
1442 Beam_1442	I240x4x120x6	STEEL A36	0.169
1443 Beam_1443	I300x6x120x12	STEEL A36	0.887
1444 Beam_1444	I300x4x120x6	STEEL A36	0.83
1445 Beam_1445	I240x4x120x6	STEEL A36	0.235
1446 Beam_1446	I240x4x120x6	STEEL A36	0.17
1447 Beam_1447	I300x6x120x12	STEEL A36	1.134
1448 Beam_1448	I300x4x120x6	STEEL A36	1.064
1449 Beam_1449	I300x4x120x6	STEEL A36	0.589
1450 Beam_1450	I300x4x120x6	STEEL A36	0.468
1463 Beam_L/3_SMF_1463	I240x6x100x8	STEEL A36	0.639
1477 Beam_L/3_SMF_1477	I240x6x100x8	STEEL A36	0.568
1478 Beam_L/3_SMF_1478	I240x6x100x8	STEEL A36	0.686
1481 Beam_L/3_1481	I200x4x120x4	STEEL A36	0.267
1482 Beam_L/3_1482	I200x4x120x4	STEEL A36	0.33
1487 Beam_L/3_1487	I200x4x120x4	STEEL A36	0.226
1488 Beam_L/3_1488	I200x4x120x4	STEEL A36	0.304
1489 Beam_L/3_1489	I200x4x120x4	STEEL A36	0.464
1490 Beam_L/3_1490	I200x4x120x4	STEEL A36	0.344
1509 Beam_L/3_SMF_1509	I300x6x120x10	STEEL A36	0.667
1510 Beam_L/3_SMF_1510	I300x6x120x10	STEEL A36	0.676
1514 Beam_L/3_SMF_1514	I240x6x100x8	STEEL A36	0.498
1515 Beam_L/3_SMF_1515	I300x6x120x15	STEEL A36	0.967

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1516 Beam_L/3_SMF_1516	I300x6x120x12	STEEL A36	0.965
1517 Beam_L/3_SMF_1517	I300x6x120x10	STEEL A36	0.859
1518 Beam_L/3_SMF_1518	I300x6x120x10	STEEL A36	0.834
1519 Beam_L/3_SMF_1519	I240x6x100x8	STEEL A36	0.728
1520 Beam_L/3_SMF_1520	I240x6x100x8	STEEL A36	0.708
1521 Beam_L/3_SMF_1521	I300x6x120x10	STEEL A36	0.516
1522 Beam_L/3_SMF_1522	I300x6x120x10	STEEL A36	0.786
1523 Beam_L/3_SMF_1523	I300x6x120x10	STEEL A36	0.92
1531 Beam_L/3_SMF_1531	I300x6x120x10	STEEL A36	0.664
1532 Beam_L/3_SMF_1532	I300x6x120x10	STEEL A36	0.677
1533 Beam_L/3_SMF_1533	I300x6x120x10	STEEL A36	0.581
1534 Beam_L/3_1534	I150x4x120x3	STEEL A36	0.117
1535 Beam_L/3_1535	I150x4x120x3	STEEL A36	0.104
1536 Beam_L/3_1536	I150x4x120x3	STEEL A36	0.131
1537 Beam_L/3_1537	I150x4x120x3	STEEL A36	0.097
1538 Beam_L/3_1538	I150x4x120x3	STEEL A36	0.109
1539 Beam_L/3_1539	I150x4x120x3	STEEL A36	0.105
1540 Beam_L/3_1540	I150x4x120x3	STEEL A36	0.123
1541 Beam_L/3_1541	I150x4x120x3	STEEL A36	0.108
1542	I240x4x120x6	STEEL A36	0.164
1543	I240x4x120x6	STEEL A36	0.187
1546 Beam_L/3_SMF_1546	I240x6x100x8	STEEL A36	0.584
1547 Beam_L/3_SMF_1547	I240x6x100x8	STEEL A36	0.329
1548 Beam_L/3_SMF_1548	I240x6x100x8	STEEL A36	0.595
1551 Beam_L/3_SMF_1551	I240x6x100x8	STEEL A36	0.557
1552 Beam_L/3_SMF_1552	I240x6x100x8	STEEL A36	0.676
1564 Beam_1564	I300x6x120x10	STEEL A36	0.74

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6.4.Conexiones/Nodo

Para estructuras especiales se requiere revisar la conexión y que se garantice que la rótula plástica se genere en la viga y no en la columna. Se muestra el cálculo con las recomendaciones de AISC 358 y un resumen de los nudos.

MOMENT RATIO REQUIREMENT _ WUF-W

COLUMNA

$$\sum M^*_{pc} = \sum Z_c (F_{yc} - \alpha_s P_r / A_g)$$

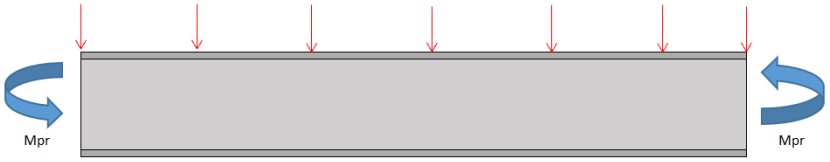
α_s =	1					→ Factor para ajustar la magnitud de fuerza (1.0 LRFD, 1.5 ASSD).
Z_c =	1455	cm^3	=	88.79	in^3	→ Módulo plástico de la sección de la columna respecto al eje de flexión.
F_{yc} =	2530	kg/cm^2	=	35.99	ksi	→ Esfuerzo mínimo de fluencia de la columna.
Ag=	900	cm^2	=	139.50	in^2	→ Área bruta de la columna.
Pr =	79.29	T	=	174.80	kips	→ Carga axial.
	2					→ 1 Cubierta, 2 Entrepiso
Mpc =	***3083.90***	*kip.in*	=	***35.53***	*T.m*	
∑Mpc =	***6167.79***	*kip.in*	=	*71.06*	*T.m*	

VIGA

$$\sum M^*_{pb} = \sum (M_{pr} + \alpha_s M_v)$$

$$M_{pr} = C_{pr} R_y F_y Z_e$$

α_s =	1					→ Factor para ajustar la magnitud de fuerza (1.0 LRFD, 1.5 ASSD).
C_{pr} =	1.20	$C_{pr} = \frac{F_y + F_u}{2F_y} \le 1.2$				→ Factor para considerar la resistencia máxima de la conexión.
R_y =	1.5					→ Relación entre esfuerzo de fluencia esperado y mínimo esfuerzo de fluencia.
F_y =	2530	kg/cm^2	=	35.99	ksi	→ Esfuerzo mínimo de fluencia.
F_u =	4080	kg/cm^3	=	58.03		→ Esfuerzo de fluencia esperado.
Z_e = Zx =	507	cm^3	=	30.94	in^3	→ Módulo plástico efectivo de la sección.
Mpr=	***2004.05***	*kip.in*	=	**23.09**	T.m	
		ln=		500	cm	→ 196.85 *in*
		l'n=		500	cm	→ 196.85 *in*
Sh=	0	cm	=	0.00	*in*	
dc→	15	*cm*	=	5.91	*in*	→ Lado de la columna (depth)



Vh = (+/-)

Vg = 6.61 T / 2 = 14.57 kips

Vh1=	34.93	kip	=	15.85	T	Muv1=	103.15	kip.in	=	1.19 T.m
Vh2=	13.75	kip	=	6.24	T	Muv2=	40.60	kip.in	=	0.47 T.m
	2	→	1 viga en un solo lado, 2 viga en los dos lados							
						∑Mpr=	***4151.86***	*kip.in*	=	***47.83*** T.m

$$\frac{\sum M^*_{pc}}{\sum M^*_{pb}} > 1.0$$

$$\frac{71.06}{47.83} > 1$$

1.49 > 1 → ok!

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Tipo	Viga 1	Vg	Columna	Pg	Viga 2	Vg	RATIO	Ubicación
0	300x6-120x10	2.74	300x10	27.11	300x6-120x10	4.61	1.46	G2-1 enY
0	300x6-120x10	4.61	300x10	29.37	300x6-120x10	1.46	1.46	G3-2 enY
0	300x6-120x10	1.46	300x10	12.94	300x6-120x10	1.75	1.47	G4-3 enY
0	300x6-120x10	1.75	300x10	7.6	300x6-120x10	1.23	1.47	G5-4 en Y
1			300x10	26.65	300x6-120x10	6.15	2.94	I2 en Y
0	300x6-120x10	6.15	300x10	76.72	300x6-120x10	6.12	1.49	I3-2 en Y
0	300x6-120x10	6.12	300x10	79.28	300x6-120x10	6.61	1.49	I4-3 en Y
0	300x6-120x10	6.61	300x10	72.19	300x6-120x10	2.57	1.49	I5-4 en Y
1			300x10	7.6	300x6-120x10	4.82	2.91	5G en X
0	300x6-120x10	4.82	300x10	43.13	300x6-120x10	3.3	1.5	5H en X
0	300x6-120x10	3.3	300x10	72.45	300x6-120x10	3.89	1.48	5I en X
0	300x6-120x10	3.89	300x10	53.52	300x6-120x10	1.22	1.5	5J en X
0	300x6-120x10	1.22	300x10	43.45	300x6-120x10	0.71	1.48	5J-K en X
1			300x10	29.37	300x6-120x10	4.01	2.95	3G en X
0	300x6-120x10	4.01	300x10	69.96	300x6-120x10	3.81	1.49	3H en X
0	300x6-120x10	3.81	300x10	76.98	300x6-120x10	5.04	1.49	3I en X
0	300x6-120x10	5.04	300x10	58.72	300x6-120x10	1.29	1.49	3J en X
0	300x6-120x10	1.29	300x10	43.35	300x6-120x10	0.4	1.49	3J-K en X
1			300x10	3.17	300x4-120x6	0.05	4.9	4G en X
0	300x6-120x10	0.05	300x10	18.07	300x6-120x10	4.87	2.95	4H en X
0	300x6-120x10	4.87	300x10	32.96	300x6-120x10	5.34	2.93	4I en X
0	300x6-120x10	5.34	300x10	23.95	300x6-120x10	1.38	2.93	4J en X
0	300x6-120x10	1.38	300x10	21.67	300x6-120x10	3.43	2.93	4J-K en X
1			300x10	16.33	300x6-120x12	7.62	2.57	G1 en Y
0	300x6-120x12	7.62	300x10	30.78	300x6-120x15	7.95	1.24	G2-1 enY
0	300x6-120x15	7.95	300x10	30.32	300x6-120x10	4.41	1.35	G3-2 enY
0	300x6-120x10	4.41	300x10	18.07	300x6-120x10	2.57	1.48	G4-3 enY
0	300x6-120x10	2.57	300x10	15.29	300x6-120x10	1.88	1.48	G5-4 en Y
1			300x10	27.78	300x6-120x15	8.25	2.12	I1 en Y
0	300x6-120x15	8.25	300x10	58.49	300x6-120x12	6.45	1.18	I2-1 enY
0	300x6-120x12	6.45	300x10	54.61	300x6-120x12	6.63	1.3	I3-2 enY
0	300x6-120x12	6.63	300x10	56.47	300x6-150x15	7.2	1.18	I4-3 enY
0	300x6-150x15	7.2	300x10	55	300x6-120x10	5.87	1.26	I5-4 en Y
1			300x10	10.51	240x6-100x8	2.25	2.59	J2 en Y
0	240x6-100x8	2.25	300x10	7.76	240x6-100x8	1.78	1.36	J2-3 en Y
0	240x6-100x8	1.78	300x10	7.74	240x6-100x8	1.9	1.36	J3-4 en Y
0	240x6-100x8	1.9	300x10	7.52	240x6-100x8	2.2	1.36	J4-5 en Y

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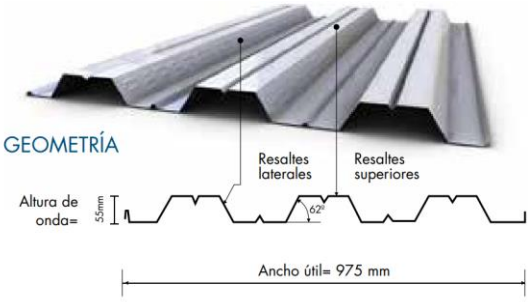
6.5.Losas

Se utilizan las recomendaciones del fabricante de placa colaborante tipo "Deck" para el diseño del sistema de piso. Se especifican vigas secundarias con una separación máxima de 1.5m.



PROPIEDADES DE LA SECCIÓN SIMPLE					
Espesor (mm)	Peso (kg/m²)	I+ (cm⁴/m)	S+ (cm³/m)	S- (cm³/m)	As (cm²/m)
0.65	6.38	31.56	9.66	10.41	8.13
0.76	7.47	39.37	12.43	13.29	9.51
1.00	9.82	55.99	18.43	19.34	12.51

CUADRO DE CAPACIDADES DE CARGA NOVALOSA 55												
Espesor de losa (cm)	Volúmen de hormigón (m³/m²)	Espesor Novalosa (mm)	Máxima luz sin apuntular (m)		Carga total sobreimpuesta (kg/m²)							
			Condición de apoyo		Separación entre apoyos (m)							
			1 vano	2 o más vanos	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00
5	0.075	0.65	1.46	1.94	1418	1030	861	656	500	378	282	204
		0.76	1.73	2.31	1531	1301	980	742	638	498	486	296
		1.00	2.23	2.96	2000	1638	1225	920	880	699	556	440

Ilustración 22 Recomendaciones fabricante de Novalosa

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7. Conclusiones y recomendaciones

La presente memoria de cálculo describe la metodología utilizada para el cálculo y diseño estructural. Se considera un diseño seguro y eficiente, que a su vez cumple con los requisitos mínimos exigidos por las normativas vigentes. Se recomienda al constructor y propietarios del proyecto que sigan las metodologías descritas en la normativa vigente para la construcción y mantenimiento de la estructura respectivamente para su adecuado desempeño en el tiempo de vida de la estructura.

Firma de responsabilidad

JOSE DANIEL POVEDA HINOJOSA

Firmado digitalmente por JOSE DANIEL POVEDA HINOJOSA
Fecha: 2022.07.30 21:20:53 -05'00'

Ing. José D. Poveda H.
Reg. No. 1027-13-1188-607