


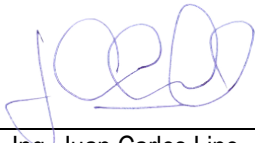




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|  | TIPO DE DOCUMENTO:<br><b>MEMORIA DE CÁLCULO</b>  | CÓDIGO DEL DOCUMENTO.:<br><b>IPE-2025-2977-S-MC-011</b> |
|   | PROYECTO:<br><b>INGENIERÍA BÁSICA Y DE DETALLE PARA LA IMPLEMENTACIÓN DE LA 4TA Y 5TA UCG EN LA E°C° COLPA</b> | HOJA:<br><br>1 de 140                                   |
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## ÍNDICE DE REVISIONES


| Fecha      | Revisión | Observaciones             |
|------------|----------|---------------------------|
| 10-11-2025 | A        | Para Revisión del Cliente |

|   |   |   |
|---|---|---|
|    |  |  |
| Ing. Victor H. Perez<br><b>Ingeniero de Proyecto</b><br><b>ELABORADO POR</b>  | Ing. Juan Carlos Lino<br><b>Especialista Civil</b><br><b>REVISADO POR</b>           | Ing. Andrés Aguilar Ll.<br><b>Gerente de Proyecto</b><br><b>APROBADO POR</b>          |
| <small>ESTE DOCUMENTO ES PROPIEDAD DE YPFB TRANSPORTE S.A. Y NO PODRÁ SER REPRODUCIDO O UTILIZADO PARA CUALQUIER FINALIDAD DIFERENTE DE AQUELLA PARA LA QUE HA SIDO SUMINISTRADO.</small> |   |   |


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## 1. OBJETIVO

Realizar el análisis, cálculo estructural y la verificación de la fundación y estructura de postes de luminarias, de tal forma que sea capaz de soportar los esfuerzos y demás cargas sobre la estructura para el proyecto "INGENIERÍA BÁSICA Y DE DETALLE PARA LA IMPLEMENTACIÓN DE LA 4TA Y 5TA UCG EN LA E°C° COLPA".

## 2. ALCANCE

El alcance del presente documento se limita al análisis, cálculo estructural y la verificación de las fundaciones, estructura metálica y de hormigón del almacén y taller, que será construido en Estación de Compresión Colpa, para YPFB Transporte S.A.

## 3. DOCUMENTACIÓN DE REFERENCIA, NORMAS Y ABREVIATURAS


### 3.1. DOCUMENTOS DE REFERENCIA

A continuación, se detalla la documentación de referencia asociada a este documento:

|           |                           |  |
|-----------|---------------------------|--|
| [Ref. 1.] | IPE-2025-2977-G-MD-003    | Bases de Diseño  |
| [Ref. 2.] | SC-E30-CI-00-05-01 de 01  | Plan General de Ubicación de Obras Civiles - Área Instalación 4ta y 5ta UCG  |
| [Ref. 3.] | SC-E30-TO-00-05-01 de 01  | Planos Topográficos  |
| [Ref. 4.] | IPE-2025-2977-S-EG-001    | Informe de Estudio Geotécnico y Ensayos realizados (SPT)   |
| [Ref. 5.] | SC-E30-AR-00-05-01 de 02  | Almacén Lubricantes, Taller y Baño Vista en Planta y Vistas.   |
| [Ref. 6.] | SC-E30-CI-00-08-16 de 40  | Replanteo de Fundaciones y vigas de Encadenados H°A° Inferior y superior Almacenes, Taller y Baño Vista en Planta, Cortes y Detalles |
| [Ref. 7.] | SC-E30-CI-00-08-17 de 40  | Vigas de Encadenados H°A° Almacenes, Taller y Baño Vista en Planta, Cortes y Detalles  |
| [Ref. 8.] | SC-E30-CI-00-08-18 de 40  | Fundaciones y Columnas H°A° Almacenes, Taller y Baño Vista en Planta, Cortes y Detalles  |
| [Ref. 9.] | -SC-E30-CI-00-08-19 de 40 | Estructura Metálica de Cubiertas y Portón Área Almacenes, Taller y Baño Vista en Planta, Cortes y Detalles                           |

### 3.2. NORMAS DE REFERENCIA

A continuación, se detallan las normas de referencia asociadas a este documento:

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|------------|-------------------|--|
| [Ref. 10.] | NB 1225001        | Norma Boliviana de Hormigón Estructural            |
| [Ref. 11.] | NBDS-2023         | Norma Boliviana de Diseño Sísmico 2023             |
| [Ref. 12.] | ACI 318-19        | Requisitos de Reglamento para Concreto Estructural |
| [Ref. 13.] | AISC 360-16       | Especificación para Construcciones de Acero        |
| [Ref. 14.] | ASCE 7-16         | Sociedad Americana de Ingenieros Civiles           |
| [Ref. 15.] | AWS-D1.1-C1M-2020 | American welding society                           |

## 4. PARAMETROS DE DISEÑO


### 4.1. HORMIGÓN

**Tabla 1.** Características del hormigón.

| Características Hormigón                        | Valores         |
|---|-----------------|
| Coeficiente de Poisson                          | 0.2             |
| Peso Unitario                                   | 2400.0 kg/m³    |
| Coeficiente de Dilatación Térmica               | 9.90E-06 1/C    |
| Módulo de Elasticidad (Es)                      | 2.14E+05 kg/cm² |
| Tensión de Fluencia del Acero Longitudinal (Fy) | 4200.0 kg/cm²   |
| Tensión de Fluencia del Acero Transversal (Fy)  | 4200.0 kg/cm²   |
| Factor Cte. Torsión J (0.05)                    | 0.05            |
| Tensión de Rotura del Hormigón (f'c)            | 210.0 kg/cm²    |
| Módulo de Elasticidad del Acero (Es)            | 2.04E+06 kg/cm² |

### 4.2. RECUBRIMIENTO

Los recubrimientos para la armadura serán los especificados en la norma ACI 318-19, y se listan en la siguiente tabla:

|   |   |                               |
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**Tabla 2.** Recubrimiento mecánico.

| 7.7.1 concreto construido en sitio (no preesforzado)                            |                          |
|---|--------------------------|
| Estado  | Recubrimiento mínimo, mm |
| a) Concreto colocado contra el suelo y expuesto permanentemente a él            | 75                       |
| b) Concreto expuesto a suelo o a la intemperie:                                 |                          |
| Barras 19 mm (3/4") a 57 mm (2-1/4")  | 50                       |
| Barras 16 mm (5/8"), alambre MW200 ó MD200 (16 mm (5/8") de diámetro) y menores | 40                       |
| c) Concreto no expuesto a la intemperie ni en contacto con el suelo:            |                          |
| * Losas, muros, viguetas:   |                          |
| Barras 43 mm (1-3/4") y 57 mm (2-1/4")  | 40                       |
| Barras 36 mm (1-5/16") y menores  | 20                       |
| * Vigas, columnas:  |                          |
| Armadura principal, estribos, espirales   | 40                       |
| * Cáscaras y placas plegadas:   |                          |
| Barra 19 mm (3/4") y mayores  | 20                       |
| Barras 16 mm (5/8"), alambre MW200 ó MD200 (16 mm (5/8") de diámetro) y menores | 15                       |

Se asumirán los siguientes recubrimientos:


- 75 mm en Hormigón colocado contra el suelo y permanentemente en él.
- 50 mm en Hormigón colocado en suelo o a la intemperie.
- 25 mm en Hormigón no expuesto a la intemperie ni en contacto con el suelo.

### 4.3. PARÁMETROS DEL SUELO DEL SUELO

Para realizar el cálculo de la fundación y comprender mejor el comportamiento de las propiedades físicas y mecánicas del suelo se realizaron estudios geotécnicos en puntos establecidos, con la finalidad de obtener parámetros referidos especialmente a la resistencia al corte y presión admisible del suelo de fundación, las siguientes características fueron obtenidas de los SPT1 Y SPT2 del estudio de suelos IPE-2025-2977-S-EG-001.

**Tabla 3.** Características del Suelo.

| Características Suelo de Fundación | Valores                 |
|------------------------------------|-------------------------|
| Ángulo de Fricción                 | 20 (º)                  |
| Densidad Natural                   | 1860 kg/m <sup>3</sup>  |
| Coeficiente de Balasto (K30)       | 3.15 kg/cm <sup>3</sup> |
| Tensión Admisible (qadm)           | 1.50 kg/cm <sup>2</sup> |

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La viga de arriostre se idealizará sobre apoyos elásticos, para ello se adoptó en función a las características del suelo el coeficiente de balasto K30 el cual está indicado en el informe geotécnico.

Para el cálculo del coeficiente de balasto se usará el procedimiento de Terzaghi para una fundación de área rectangular.

Ancho B = 3.75 m

Largo L = 17.35 m

$$K_{S(rectangular)} = \frac{2}{3} K_{S(cuadrado)} \left( 1 + \frac{B}{2L} \right)$$

$$K_{S(cuadrado)} = K_{S(30)} * \left[ \frac{(b+0,30)}{2b} \right]^2$$

..... Para suelos arenosos (KN/m3)

Dónde:

$K_{S(cuadrado)}$  = Valor del módulo de balasto para una sección cuadrada en kg/cm<sup>3</sup>.

$$K_{S(30)} = 3150000 \text{ [ kg/m}^3\text{]}$$

- Para calcular el valor  $K_{S(cuadrado)}$ , se usará expresión para suelos arenosos:

- Entonces el valor de Ty que usaremos en el programa de cálculo estructural RAM Elements será:


Área Apoyo Elástico 0.20 m x 0.20 m para vigas con sección de 20x40 cm

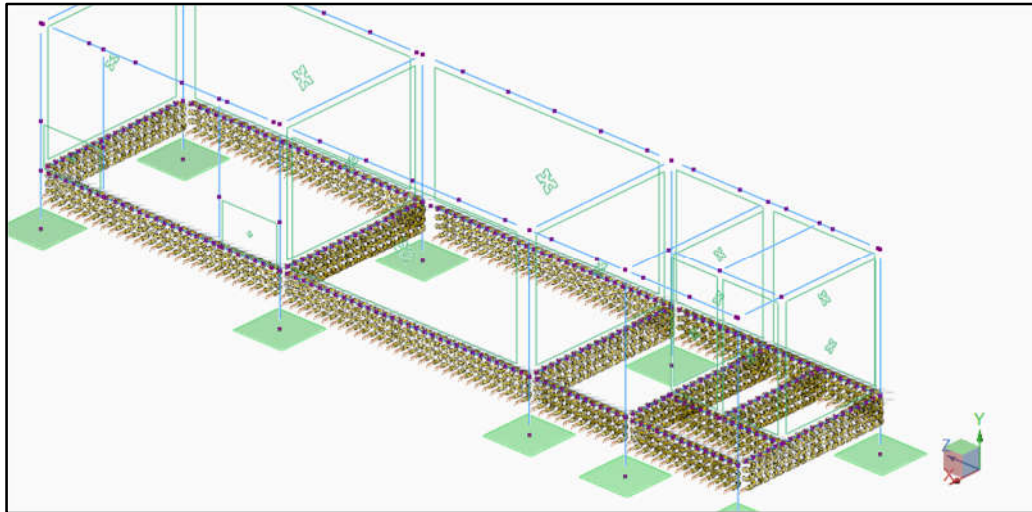
Área Apoyo Elástico 0.15 m x 0.20 m para vigas con sección de 15x40 cm

Ty1= 27123.833 kg/m

Ty2= 20342.875 kg/m

**Figura 1.** Apoyos Elásticos en Vigas de Arriostre.

|   |   |                               |
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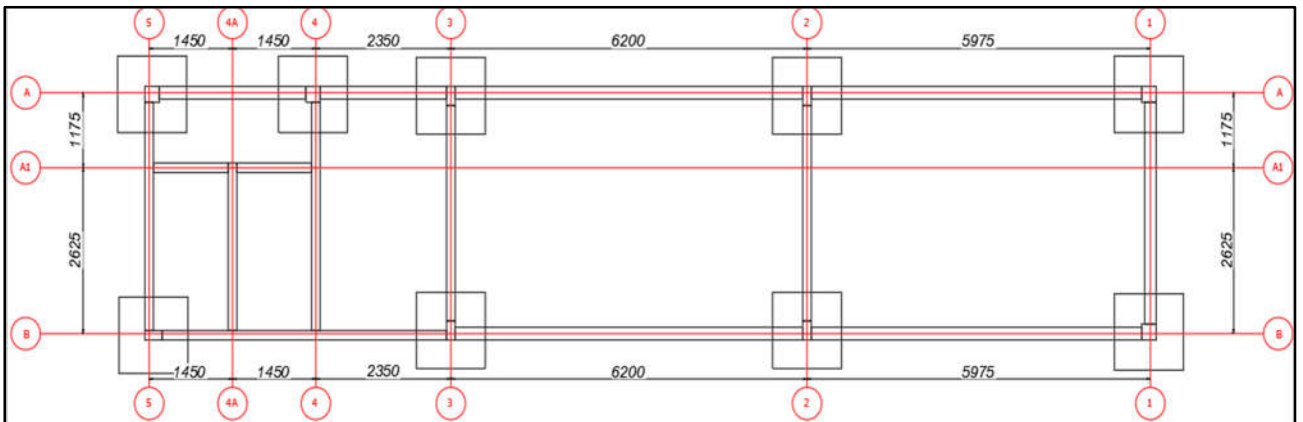


## 5. ANÁLISIS DE CARGA


Para el análisis de carga y los efectos que producen las mismas, se analizaron con la ayuda del Software Ram Elements v23.

### 5.1.GEOMETRÍA

**Figura 2.** Vista en planta de Almacén de lubricantes.






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## 5.2. COMBINACIONES DE CARGA


**Tabla 4.** Estados de carga.

| Condición   | Descripción           | Comb. | Categoría |
|-------------|-----------------------|-------|-----------|
| CM          | Carga Muerta          | No    | DL        |
| CV          | Carga Viva de Techo   | No    | LL        |
| VxCASOA...  | Viento en X CASO A+   | No    | WIND      |
| VxCASOA...  | Viento en X CASO A-   | No    | WIND      |
| VzCASOA...  | Viento en Z CASO A+   | No    | WIND      |
| VzCASOA...  | Viento en Z CASO A-   | No    | WIND      |
| VzCASOBP... | Viento en Z CASO B+   | No    | WIND      |
| VzCASOB...  | Viento en Z CASO B-   | No    | WIND      |
| EQx         | Sismo en X            | No    | EQ        |
| EQz         | Sismo en Z            | No    | EQ        |
| EQxCUB      | Sismo en X (cubierta) | No    | EQ        |
| EQzCUB      | Sismo en Z (cubierta) | No    | EQ        |

|   |   |                               |
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**Tabla 5.** Combinaciones de diseño.

| Condición | Descripción         | Comb. | Categoría |
|-----------|---------------------|-------|-----------|
| D1        | 1.4CM               | Si    |           |
| D2        | 1.2CM+0.5VxCASOAPOS | Si    |           |
| D3        | 1.2CM+0.5VxCASOANEG | Si    |           |
| D4        | 1.2CM+0.5VzCASOAPOS | Si    |           |
| D5        | 1.2CM+0.5VzCASOANEG | Si    |           |
| D6        | 1.2CM+VxCASOAPOS    | Si    |           |
| D7        | 1.2CM+VxCASOANEG    | Si    |           |
| D8        | 1.2CM+VzCASOAPOS    | Si    |           |
| D9        | 1.2CM+VzCASOANEG    | Si    |           |
| D10       | 0.9CM+VxCASOAPOS    | Si    |           |
| D11       | 0.9CM+VxCASOANEG    | Si    |           |
| D12       | 0.9CM+VzCASOAPOS    | Si    |           |
| D13       | 0.9CM+VzCASOANEG    | Si    |           |
| D14       | 1.2CM+EQx           | Si    |           |
| D15       | 1.2CM+EQz           | Si    |           |
| D16       | 0.9CM+EQx           | Si    |           |
| D17       | 0.9CM+EQz           | Si    |           |
| D18       | 1.2CM+1.6CV         | Si    |           |
| D19       | 1.2CM+0.5VzCASOBPOS | Si    |           |
| D20       | 1.2CM+0.5VzCASOBNEG | Si    |           |
| D21       | 1.2CM+VzCASOBPOS    | Si    |           |
| D22       | 1.2CM+VzCASOBNEG    | Si    |           |
| D23       | 1.2CM+VxCASOAPOS+CV | Si    |           |
| D24       | 1.2CM+VxCASOANEG+CV | Si    |           |
| D25       | 1.2CM+VzCASOAPOS+CV | Si    |           |
| D26       | 1.2CM+VzCASOANEG+CV | Si    |           |
| D27       | 1.2CM+VzCASOBPOS+CV | Si    |           |
| D28       | 1.2CM+VzCASOBNEG+CV | Si    |           |
| D29       | 0.9CM+VzCASOBPOS    | Si    |           |
| D30       | 0.9CM+VzCASOBNEG    | Si    |           |
| D31       | 1.2CM+EQxCUB        | Si    |           |
| D32       | 1.2CM+EQzCUB        | Si    |           |
| D33       | 1.2CM+EQx+CV        | Si    |           |
| D34       | 1.2CM+EQz+CV        | Si    |           |
| D35       | 1.2CM+EQxCUB+CV     | Si    |           |
| D36       | 1.2CM+EQzCUB+CV     | Si    |           |
| D37       | 0.9CM+EQxCUB        | Si    |           |
| D38       | 0.9CM+EQzCUB        | Si    |           |

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**Tabla 6.**Combinaciones de servicio.

| Condición | Descripción              | Comb. | Categoría |
|-----------|--------------------------|-------|-----------|
| S1        | CM                       | Si    |           |
| S2        | CM+0.6VxCASOAPOS         | Si    |           |
| S3        | CM+0.6VxCASOANEG         | Si    |           |
| S4        | CM+0.6VzCASOAPOS         | Si    |           |
| S5        | CM+0.6VzCASOANEG         | Si    |           |
| S6        | CM+0.7EQx                | Si    |           |
| S7        | CM+0.7EQz                | Si    |           |
| S8        | 0.6CM+0.6VxCASOAPOS      | Si    |           |
| S9        | 0.6CM+0.6VxCASOANEG      | Si    |           |
| S10       | 0.6CM+0.6VzCASOAPOS      | Si    |           |
| S11       | 0.6CM+0.6VzCASOANEG      | Si    |           |
| S12       | CM+EQx                   | Si    |           |
| S13       | CM+EQz                   | Si    |           |
| S14       | CM+0.525EQx              | Si    |           |
| S15       | CM+0.525EQz              | Si    |           |
| S16       | 0.6CM+0.7EQx             | Si    |           |
| S17       | 0.6CM+0.7EQz             | Si    |           |
| S18       | CM+CV                    | Si    |           |
| S19       | CM+0.75CV                | Si    |           |
| S20       | CM+0.6VzCASOBPOS         | Si    |           |
| S21       | CM+0.6VzCASOBNEG         | Si    |           |
| S22       | CM+0.7EQxCUB             | Si    |           |
| S23       | CM+0.7EQzCUB             | Si    |           |
| S24       | CM+0.75CV+0.45VxCASOAPOS | Si    |           |
| S25       | CM+0.75CV+0.45VxCASOANEG | Si    |           |
| S26       | CM+0.75CV+0.45VzCASOAPOS | Si    |           |
| S27       | CM+0.75CV+0.45VzCASOANEG | Si    |           |
| S28       | CM+0.75CV+0.45VzCASOBPOS | Si    |           |
| S29       | CM+0.75CV+0.45VzCASOBNEG | Si    |           |
| S30       | 0.6CM+0.6VzCASOBPOS      | Si    |           |
| S31       | 0.6CM+0.6VzCASOBNEG      | Si    |           |
| S32       | CM+EQxCUB                | Si    |           |
| S33       | CM+EQzCUB                | Si    |           |
| S34       | CM+0.75CV+0.525EQx       | Si    |           |
| S35       | CM+0.75CV+0.525EQz       | Si    |           |
| S36       | CM+0.75CV+0.525EQxCUB    | Si    |           |
| S37       | CM+0.75CV+0.525EQzCUB    | Si    |           |
| S38       | CM+0.525EQxCUB           | Si    |           |
| S39       | CM+0.525EQzCUB           | Si    |           |
| S40       | 0.6CM+0.7EQxCUB          | Si    |           |
| S41       | 0.6CM+0.7EQzCUB          | Si    |           |

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### 5.3. CARGA MUERTA

Se consideran cargas muertas a todas aquellas fuerzas que actúan sobre la estructura de manera permanente.

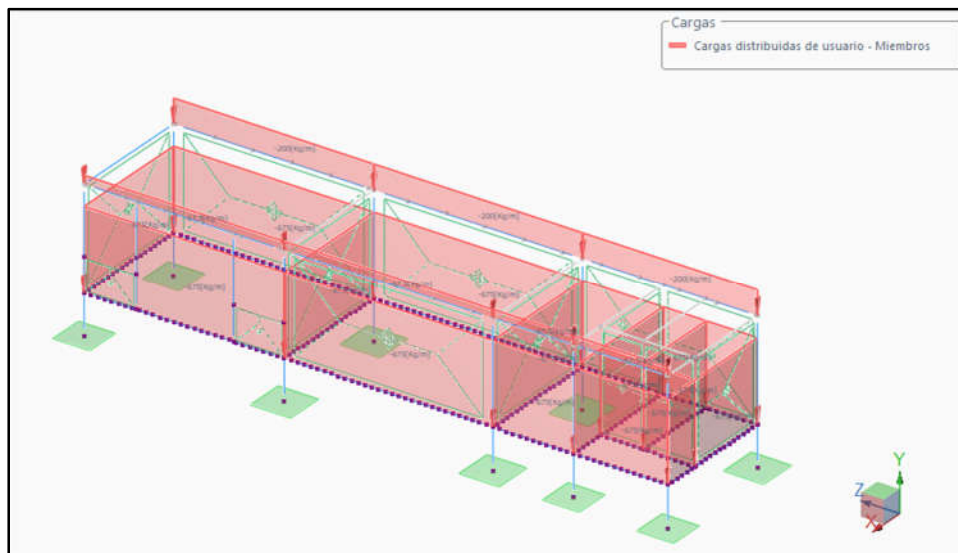
El peso propio es calculado por el software con las características de la sección y material que conforma la estructura.


- Sección columna HºAº 25x25 cm
- Sección columna HºAº 15x30 cm
- Sección viga encadenado superior HºAº 15x40 cm
- Sección viga encadenado superior HºAº 20x40 cm
- Sección viga encadenado inferior HºAº 15x40 cm
- Sección viga encadenado inferior HºAº 20x40 cm

Carga muerta en muros

- Carga de muro simple (ladrillo adobito) = 250 kg/m<sup>2</sup>

**Figura 3.** Carga muerta en Muro de ladrillo.



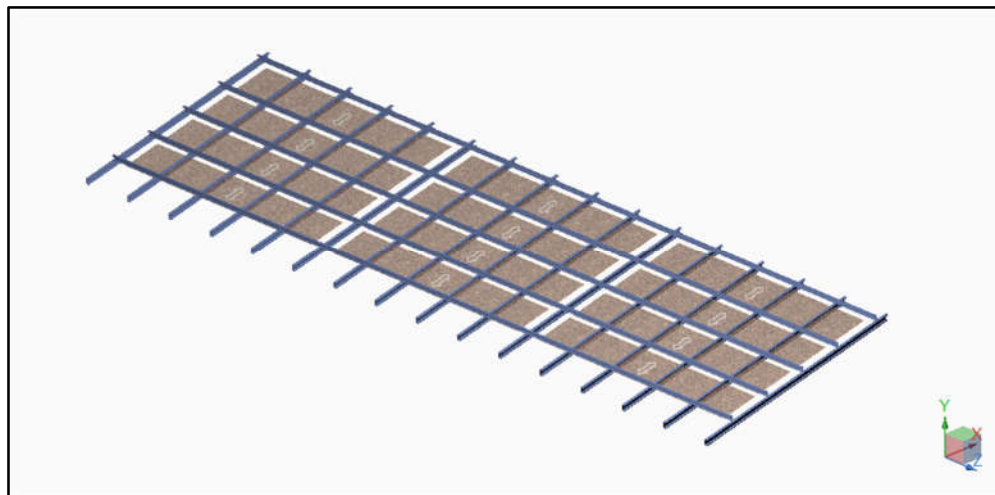
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Carga muerta de cubierta metálica

El peso propio es calculado por el software con las características de la sección y material que conforma la estructura


- Perfil C150x60x20x2.66 mm ASTM A36.
- Perfil C100x50x17x2.66 mm ASTM A36.
- Calamina Trapezoidal Calibre #26 = 5 kg/m<sup>2</sup>.

**Figura 4.** Carga muerta (Cubierta Metálica).

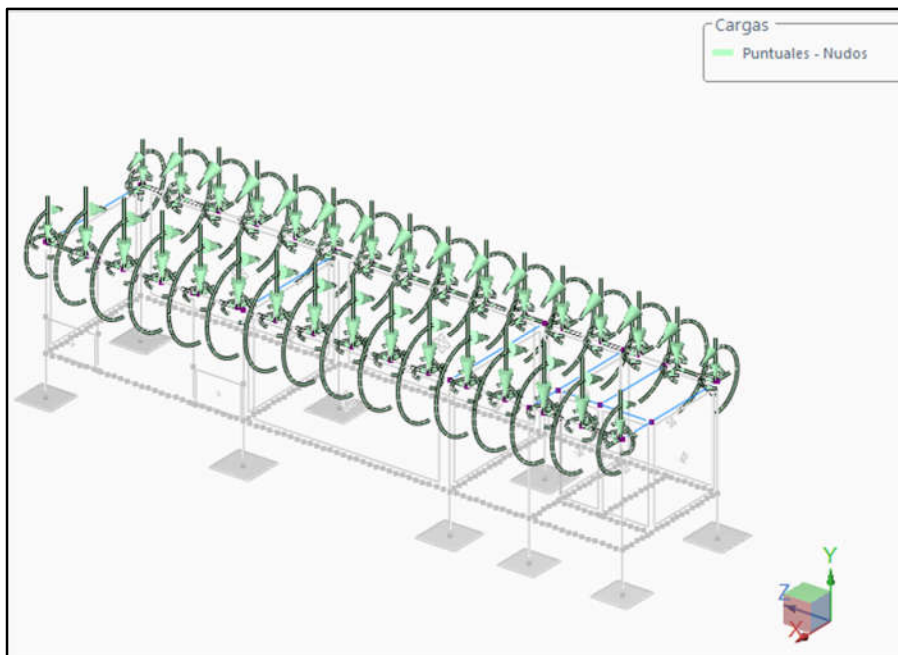


#### 5.4. CARGA VIVA

Se consideran cargas vivas a todas aquellas fuerzas que actúan sobre la estructura de manera variable, para el caso se procedió a realizar en partes separadas la cubierta metálica y la estructura de hormigón armado, por lo tanto, la única carga viva en la estructura de hormigón armado son las reacciones del estado de carga viva de la estructura metálica.

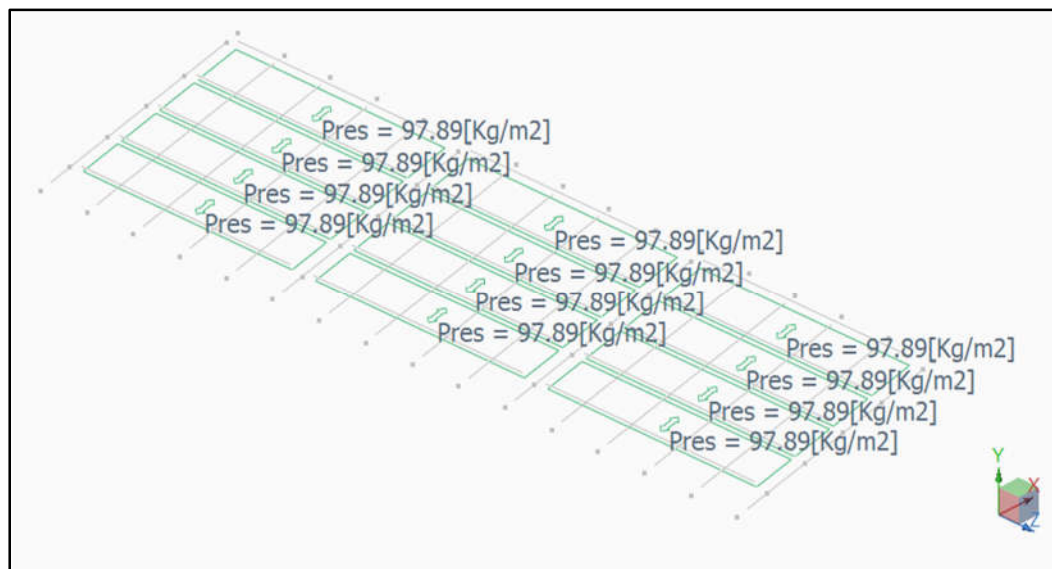
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**Figura 5.** Carga viva (reacciones de carga viva cubierta metálica).




Carga viva para cubierta metálica = 97.89 kg/m<sup>2</sup>

**Figura 6.** Carga viva de cubierta metálica.





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## 5.5. CARGA DE VIENTO

Para la obtención de la presión del viento ( $q_z$ ) se utilizará la siguiente ecuación de acuerdo a la ASCE 7-16 (Eq 26. 10-1):

$$q_z = 0.613 * K_z * K_{zt} * K_d * K_e * V^2 \quad [N/m^2]$$

### Velocidad básica del viento

El efecto del viento se considera en general en los ejes principales de una construcción.

La velocidad básica del viento según la Norma Boliviana APNB 1225003-1 para Santa Cruz es:

$$V = 42.60 \text{ m/s}$$


### Determinación del factor direccional $K_d$

**Tabla 7.** Factor de direccionalidad del viento,  $K_d$  (ASCE 7-16, tabla 26.6-1).

| Structure Type  | Directionality Factor $K_d$ |
|---|-----------------------------|
| <b>Buildings</b>  |                             |
| Main Wind Force Resisting System  | 0.85                        |
| Components and Cladding   | 0.85                        |
| Arched Roofs  | 0.85                        |
| Circular Domes  | 1.0 <sup>a</sup>            |
| Chimneys, Tanks, and Similar Structures   |                             |
| Square  | 0.90                        |
| Hexagonal   | 0.95                        |
| Octagonal   | 1.0 <sup>a</sup>            |
| Round   | 1.0 <sup>a</sup>            |
| Solid Freestanding Walls, Roof Top Equipment, and Solid Freestanding and Attached Signs | 0.85                        |
| Open Signs and Single-Plane Open Frames   | 0.85                        |
| Trussed Towers  |                             |
| Triangular, square, or rectangular  | 0.85                        |
| All other cross sections  | 0.95                        |

<sup>a</sup>Directionality factor  $K_d=0.95$  shall be permitted for round or octagonal structures with nonaxisymmetric structural systems.

$$K_d = 0.85$$

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## Determinación del factor de elevación del terreno $K_e$

**Tabla 8.** Factor elevación del terreno,  $K_e$  (ASCE 7-16, tabla 26.9-1).


| Table 26.9-1 Ground Elevation Factor, $K_e$ |        |                                  |
|---|--------|----------------------------------|
| Ground Elevation above Sea Level            |        | Ground Elevation Factor<br>$K_e$ |
| ft  | m      |                                  |
| <0  | <0     | See note 2                       |
| 0   | 0      | 1.00                             |
| 1,000                                       | 305    | 0.96                             |
| 2,000                                       | 610    | 0.93                             |
| 3,000                                       | 914    | 0.90                             |
| 4,000                                       | 1,219  | 0.86                             |
| 5,000                                       | 1,524  | 0.83                             |
| 6,000                                       | 1,829  | 0.80                             |
| >6,000                                      | >1,829 | See note 2                       |

*Notes*

- The conservative approximation  $K_e = 1.00$  is permitted in all cases.
- The factor  $K_e$  shall be determined from the above table using interpolation or from the following formula for all elevations:  
 $K_e = e^{-0.0000962z_g}$  ( $z_g$  = ground elevation above sea level in ft).  
 $K_e = e^{-0.000119z_g}$  ( $z_g$  = ground elevation above sea level in m).
- $K_e$  is permitted to be take as 1.00 in all cases.

$$K_e = 1$$



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### Determinación de categoría de exposición K<sub>z</sub>

**Exposición C.** Terrenos abiertos con obstrucciones dispersas, con alturas generalmente menores que 10.00 m. Esta categoría incluye campo abierto plano y terrenos agrícolas.

**Tabla 9.** Coeficientes de exposición de presión de la velocidad, K<sub>h</sub> y K<sub>z</sub> (ASCE 7-16, tabla 26.10-1).


| Height above Ground Level, z |       | Exposure                 |      |      |
|------------------------------|-------|--------------------------|------|------|
| ft                           | m     | B                        | C    | D    |
| 0-15                         | 0-4.6 | 0.57 (0.70) <sup>a</sup> | 0.85 | 1.03 |
| 20                           | 6.1   | 0.62 (0.70) <sup>a</sup> | 0.90 | 1.08 |
| 25                           | 7.6   | 0.66 (0.70) <sup>a</sup> | 0.94 | 1.12 |
| 30                           | 9.1   | 0.70                     | 0.98 | 1.16 |
| 40                           | 12.2  | 0.76                     | 1.04 | 1.22 |
| 50                           | 15.2  | 0.81                     | 1.09 | 1.27 |
| 60                           | 18.0  | 0.85                     | 1.13 | 1.31 |
| 70                           | 21.3  | 0.89                     | 1.17 | 1.34 |
| 80                           | 24.4  | 0.93                     | 1.21 | 1.38 |
| 90                           | 27.4  | 0.96                     | 1.24 | 1.40 |
| 100                          | 30.5  | 0.99                     | 1.26 | 1.43 |
| 120                          | 36.6  | 1.04                     | 1.31 | 1.48 |
| 140                          | 42.7  | 1.09                     | 1.36 | 1.52 |
| 160                          | 48.8  | 1.13                     | 1.39 | 1.55 |
| 180                          | 54.9  | 1.17                     | 1.43 | 1.58 |
| 200                          | 61.0  | 1.20                     | 1.46 | 1.61 |
| 250                          | 76.2  | 1.28                     | 1.53 | 1.68 |
| 300                          | 91.4  | 1.35                     | 1.59 | 1.73 |
| 350                          | 106.7 | 1.41                     | 1.64 | 1.78 |
| 400                          | 121.9 | 1.47                     | 1.69 | 1.82 |
| 450                          | 137.2 | 1.52                     | 1.73 | 1.86 |
| 500                          | 152.4 | 1.56                     | 1.77 | 1.89 |

<sup>a</sup>Use 0.70 in Chapter 28, Exposure B, when z < 30 ft (9.1 m).

**Notes**

- The velocity pressure exposure coefficient K<sub>z</sub> may be determined from the following formula:  
For 15 ft (4.6 m) ≤ z ≤ z<sub>g</sub>    K<sub>z</sub> = 2.01(z/z<sub>g</sub>)<sup>2/α</sup>  
For z < 15 ft (4.6 m)    K<sub>z</sub> = 2.01(15/z<sub>g</sub>)<sup>2/α</sup>
- α and z<sub>g</sub> are tabulated in Table 26.11-1.
- Linear interpolation for intermediate values of height z is acceptable.
- Exposure categories are defined in Section 26.7.

$$K_z = 0.85$$

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### Determinación de efecto topográfico Kzt

Los efectos del aumento de la velocidad del viento sobre lomas, escarpas y colinas aisladas que constituyen cambios abruptos en la topografía general en cualquier categoría de exposición, se consideraron para el caso específico de nuestro proyecto un terreno plano con un valor de:

$$K_{ZT} = 1 \text{ Terreno plano}$$

### Presión dinámica

La presión dinámica  $q_z$ , evaluada a la altura  $z$ , se debe calcular mediante la siguiente ecuación:

$$q_z = 0.613 * K_z * K_{ZT} * K_d * K_e * V^2 \quad [N/m^2]$$

Donde:

$$K_d = 0.85$$

$$K_z = 0.85$$

$$K_{zt} = 1.00$$


$$V = 42.60 \text{ m/s}$$

$$K_e = 1.00$$

$$q_z = 0.613 * 0.85 * 1 * 0.85 * 1 * (42.60)^2 = 803.744 \text{ N/m}^2 = 81.960 \text{ kg/m}^2$$

Se adopta:  $q_z = 81.960 \text{ kg/m}^2$

Para la cubierta metálica una vez calculada la presión de viento debemos calcular la fuerza de viento actuante para el caso de nuestra cubierta a un agua según nota 4 el efecto de viento actuante en este tipo de cubiertas solo actúa el sotavento. Para nuestro ángulo de inclinación de  $11.31^\circ$  interpolando en la tabla 27.3-1 de ASCE 7-16 de coeficiente de presión obtenemos el CP para el viento en dirección X y para el eje Z los obtenemos de la tabla 27.3-7.

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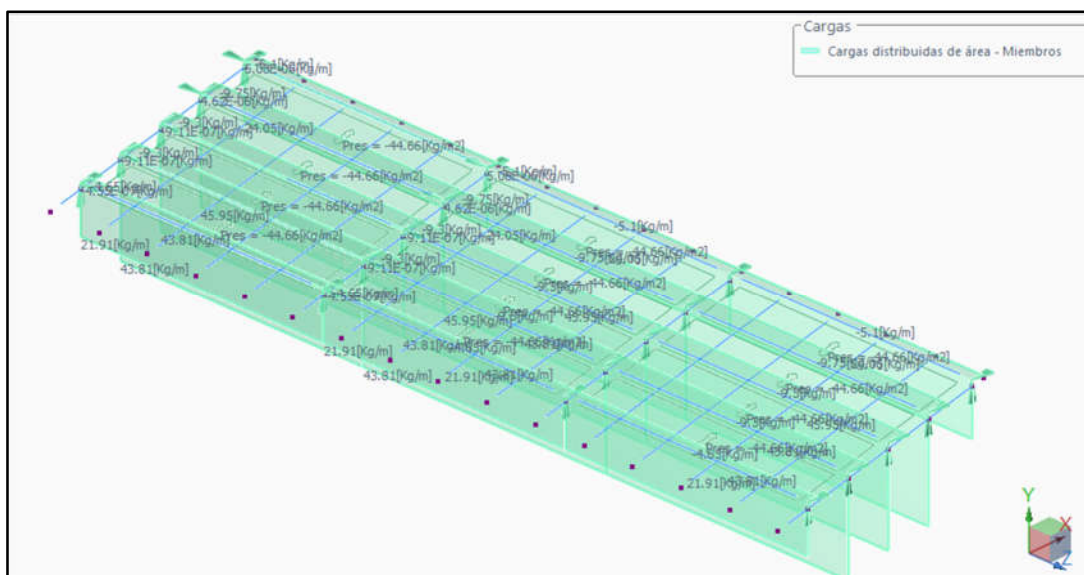
**Tabla 10.** Tabla Carga de viento en X (Cubierta Metálica).


| Load Case |    | G    | CP          | Cpi   | Carga de viento (kg/m <sup>2</sup> ) |
|-----------|----|------|-------------|-------|--------------------------------------|
| Sotavento | A+ | 0.85 | -0.57417434 | 0.18  | -44.659                              |
| Sotavento | A- | 0.85 | -0.57417434 | -0.18 | -23.342                              |

**Tabla 11.** Tabla Carga de viento en Z (Cubierta Metálica).

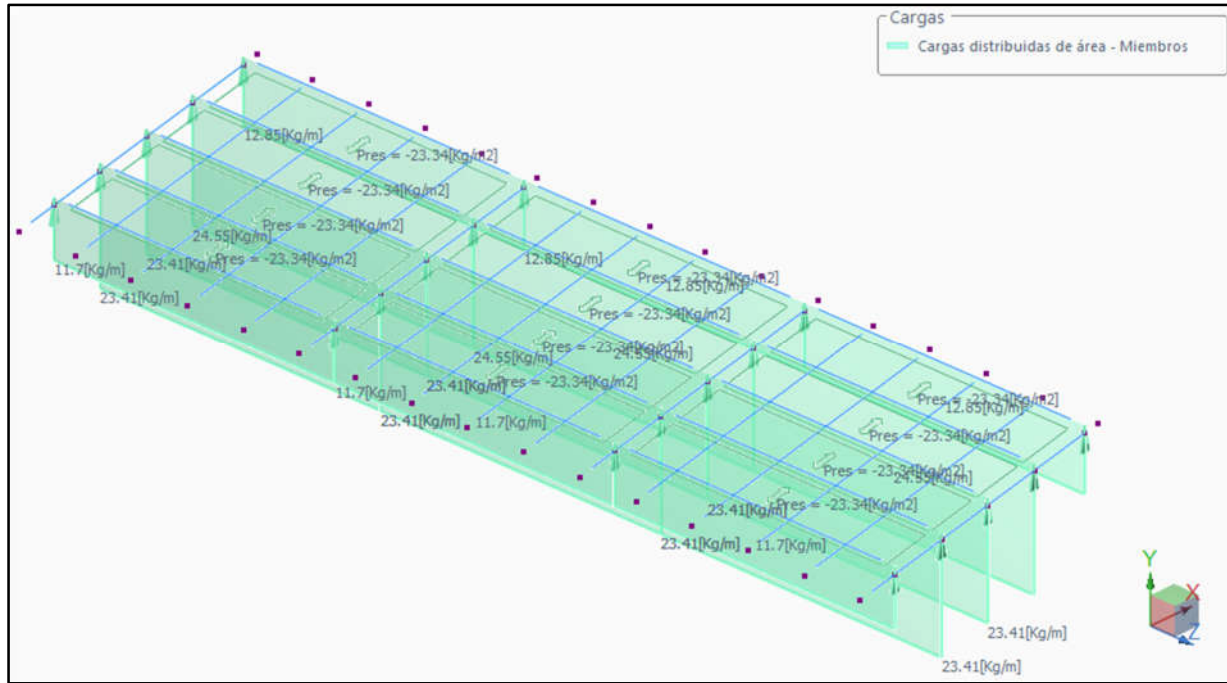
| Distancia        | Load Case | cp    | C <sub>N</sub> | Carga de viento (kg/m <sup>2</sup> ) |
|------------------|-----------|-------|----------------|--------------------------------------|
| 0 a 1.84875      | A         | -0.9  | 0.18           | -63.9526368                          |
|                  | B         | -0.18 | 0.18           | -21.3175456                          |
|                  | A-        | -0.9  | -0.18          | -42.6350912                          |
|                  | B-        | -0.18 | -0.18          | 0                                    |
| 1.84875 a 3.6975 | A         | -0.9  | 0.18           | -63.9526368                          |
|                  | B         | -0.18 | 0.18           | -21.3175456                          |
|                  | A-        | -0.9  | -0.18          | -42.6350912                          |
|                  | B-        | -0.18 | -0.18          | 0                                    |
| 3.6975 a 7.395   | A         | -0.5  | 0.18           | -40.266475                           |
|                  | B         | -0.18 | 0.18           | -21.3175456                          |
|                  | A-        | -0.5  | -0.18          | -18.9489294                          |
|                  | B-        | -0.18 | -0.18          | 0                                    |
| > 7.395          | A         | -0.3  | 0.18           | -28.4233941                          |
|                  | B         | -0.18 | 0.18           | -21.3175456                          |
|                  | A-        | -0.3  | -0.18          | -7.10584854                          |
|                  | B-        | -0.18 | -0.18          | 0                                    |

**Figura 7.** Carga de viento en X Caso A+ (Cubierta Metálica).

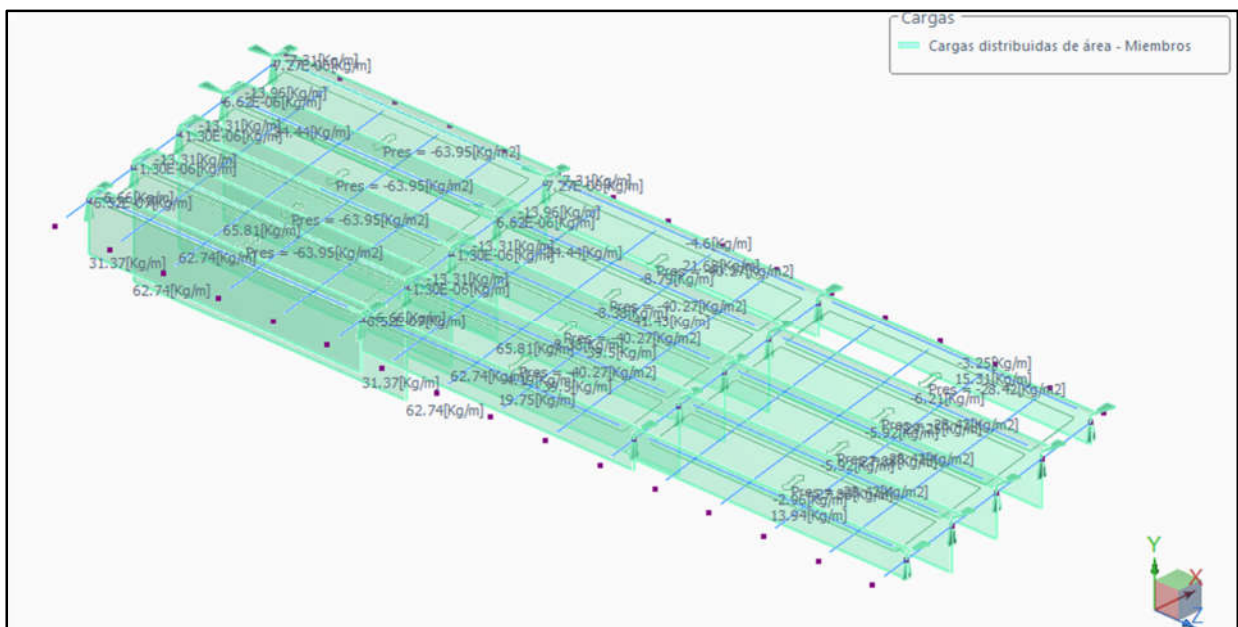



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**Figura 8. Carga de viento en X Caso A- (Cubierta Metálica).**

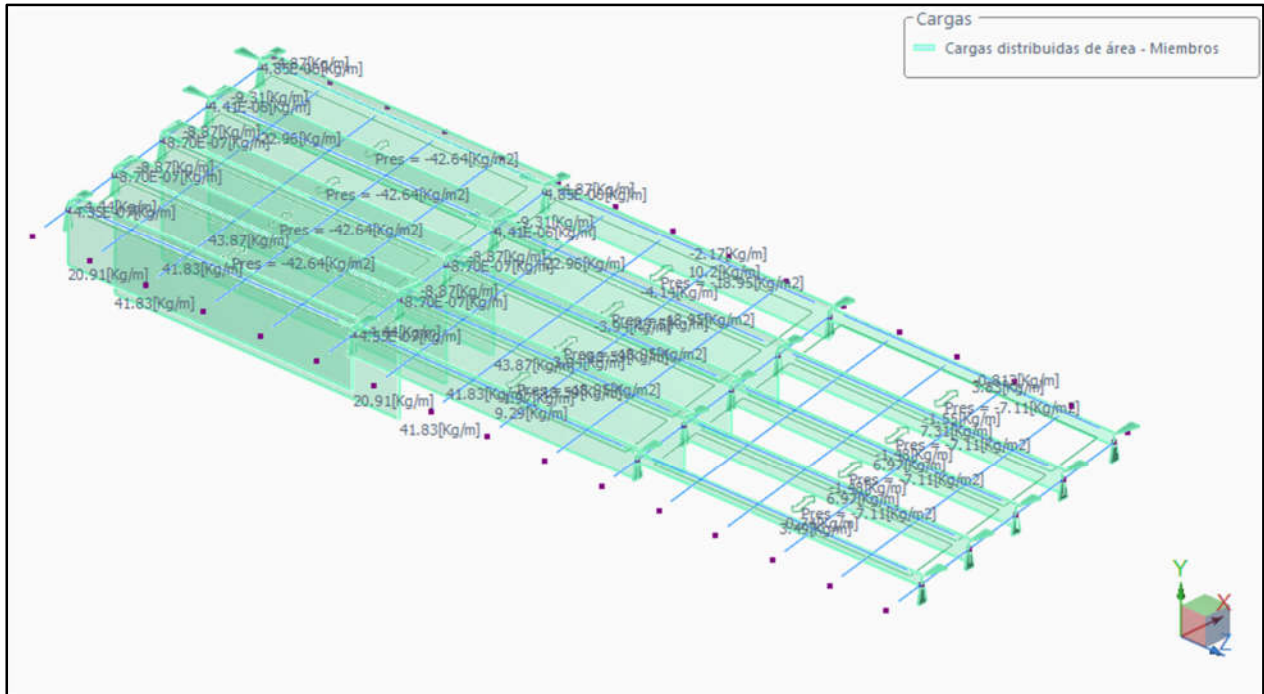


**Figura 9. Carga de viento en Z Caso A+ (Cubierta Metálica).**

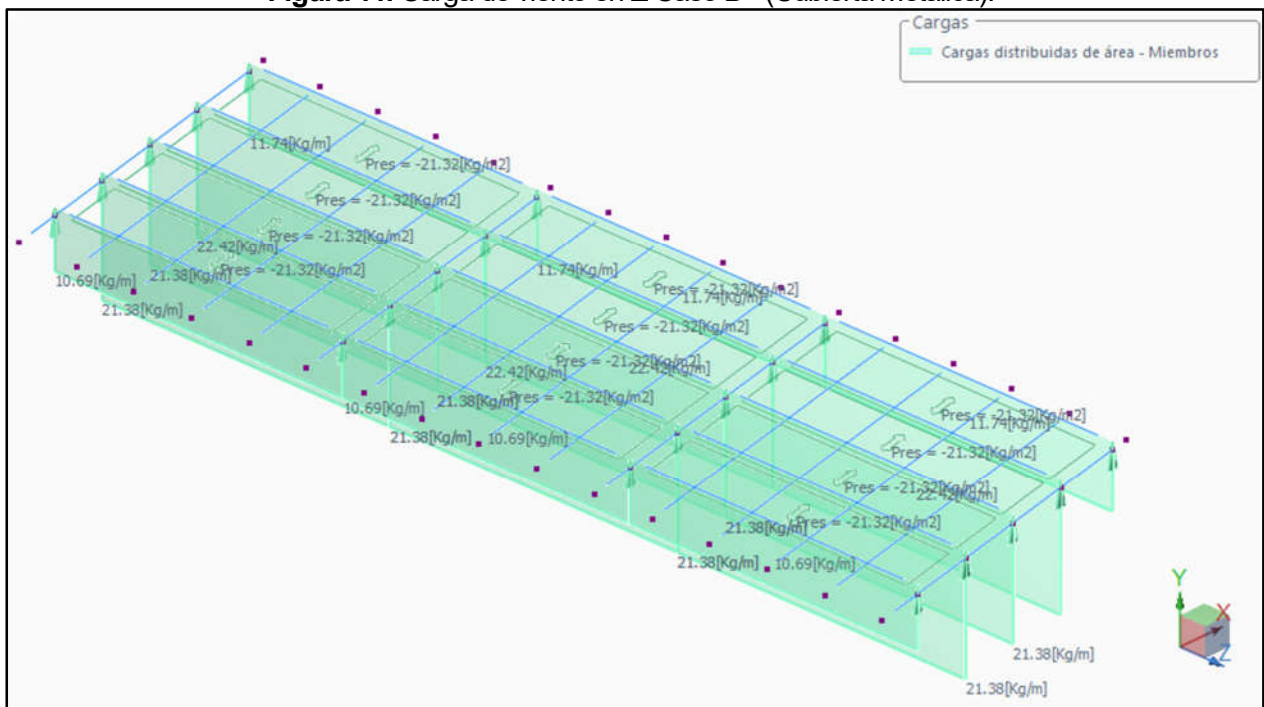


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**Figura 10. Carga de viento en Z Caso A- (Cubierta Metálica).**




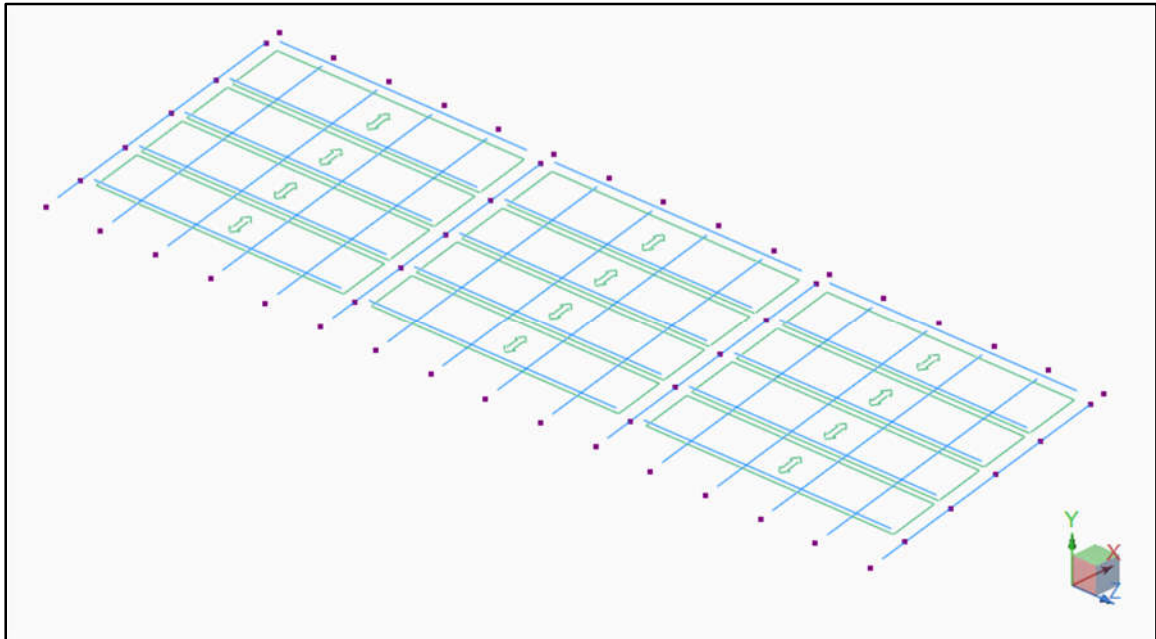
**Figura 11. Carga de viento en Z Caso B+ (Cubierta Metálica).**



**Figura 12. Carga de viento en Z Caso B- (Cubierta Metálica).**



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Para el cálculo de viento en la estructura de HºAº se tomaron las reacciones de la cubierta en los casos de viento y se colocaron en el punto de apoyo de la estructura además se añadieron las cargas de viento en los muros.

**Tabla 12.** Tabla Carga de viento en X (Muros).

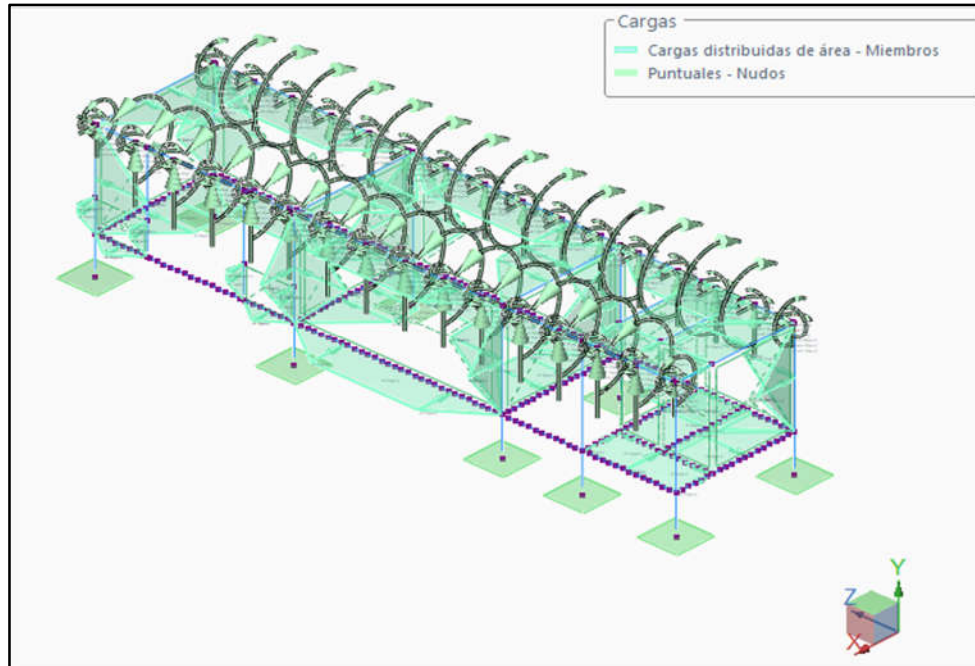
| Load Case  |    | CP   | CPI   | Carga de viento (kg/m²) |
|------------|----|------|-------|-------------------------|
| Barlovento | A+ | 0.8  | 0.18  | 36.714                  |
|            | A- | 0.8  | -0.18 | 58.031                  |
| Sotavento  | A+ | -0.5 | 0.18  | -40.266                 |
|            | A- | -0.5 | -0.18 | -18.949                 |
| Costado    | A+ | -0.7 | 0.18  | -52.110                 |
|            | A- | -0.7 | -0.18 | -30.792                 |

**Tabla 13.** Tabla Carga de viento en Z (Muros).

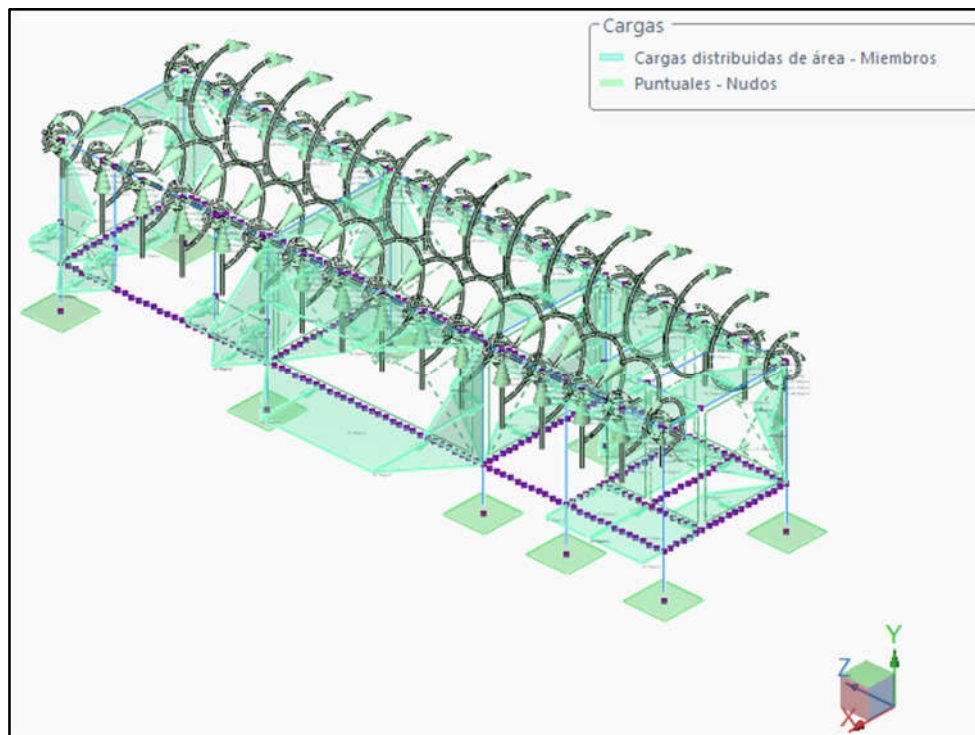
| Load Case  |    | CP     | CPI   | kg/m2   |
|------------|----|--------|-------|---------|
| Barlovento | A+ | 0.8    | 0.18  | 36.714  |
|            | A- | 0.8    | -0.18 | 58.031  |
| Sotavento  | A+ | -0.098 | 0.18  | -16.462 |
|            | A- | -0.098 | -0.18 | 4.856   |
| Costado    | A+ | -0.7   | 0.18  | -52.110 |
|            | A- | -0.7   | -0.18 | -30.792 |


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**Figura 13.** Carga de viento en X Caso A+ ((Muros)).

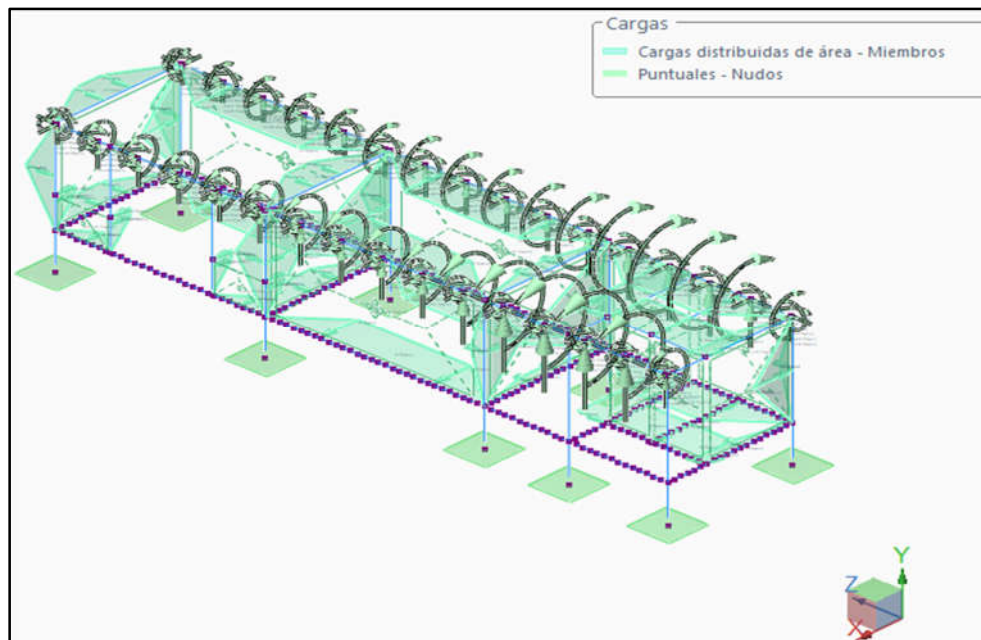


**Figura 14.** Carga de viento en X Caso A- (Muros).

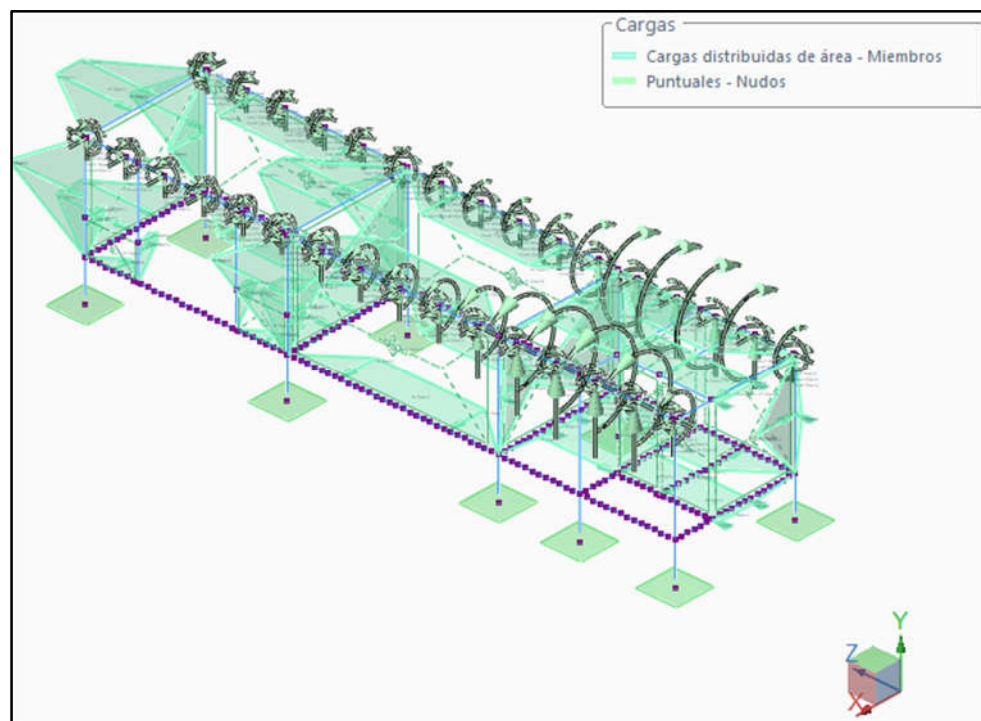


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**Figura 15.** Carga de viento en Z Caso A+ (Muros).



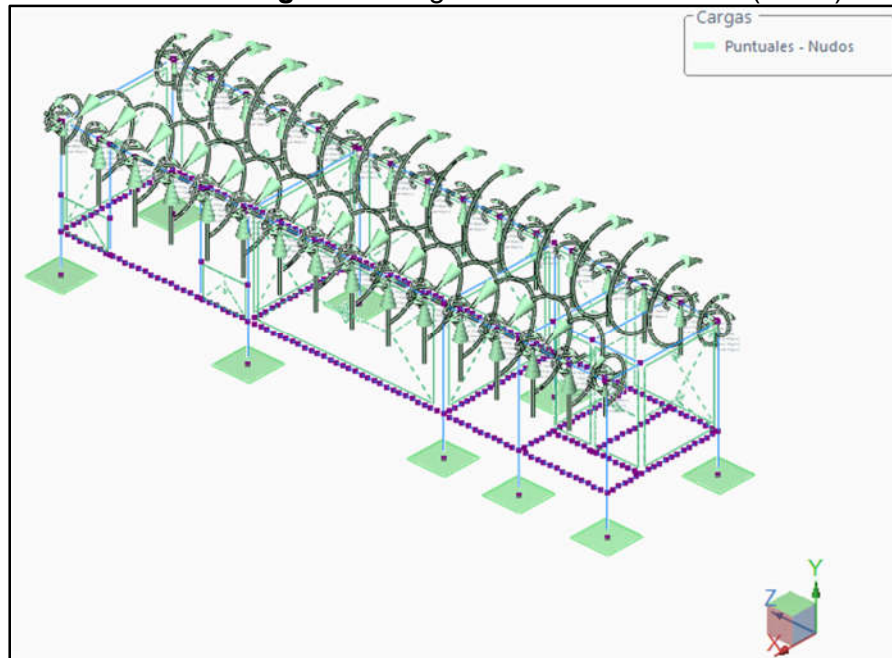
**Figura 16.** Carga de viento en Z Caso A- (Muros).



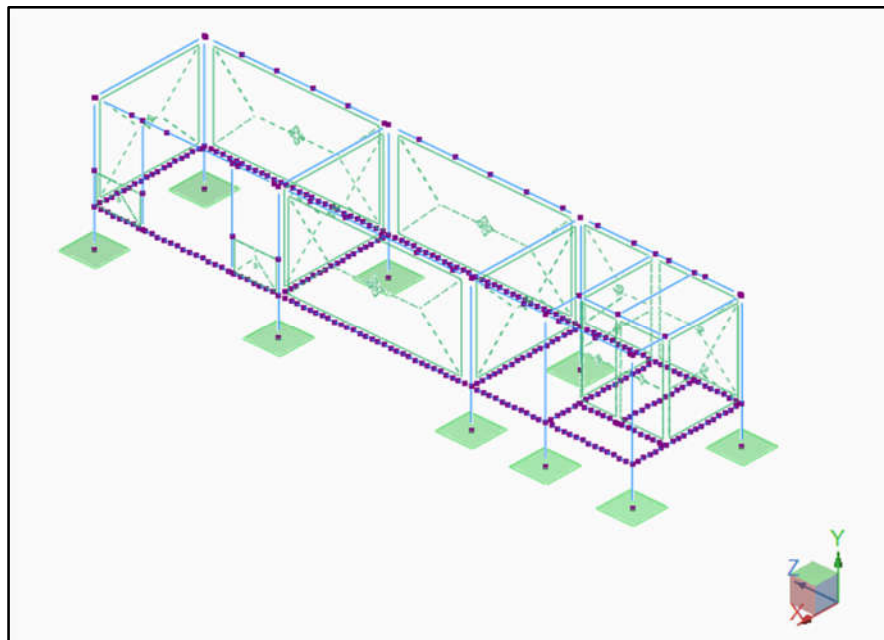



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**Figura 17. Carga de viento en Z Caso B+ (Muros).**



**Figura 18. Carga de viento en Z Caso B- (Muros).**



|   |   |                               |
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## 6. CARGAS SÍSMICAS (S)

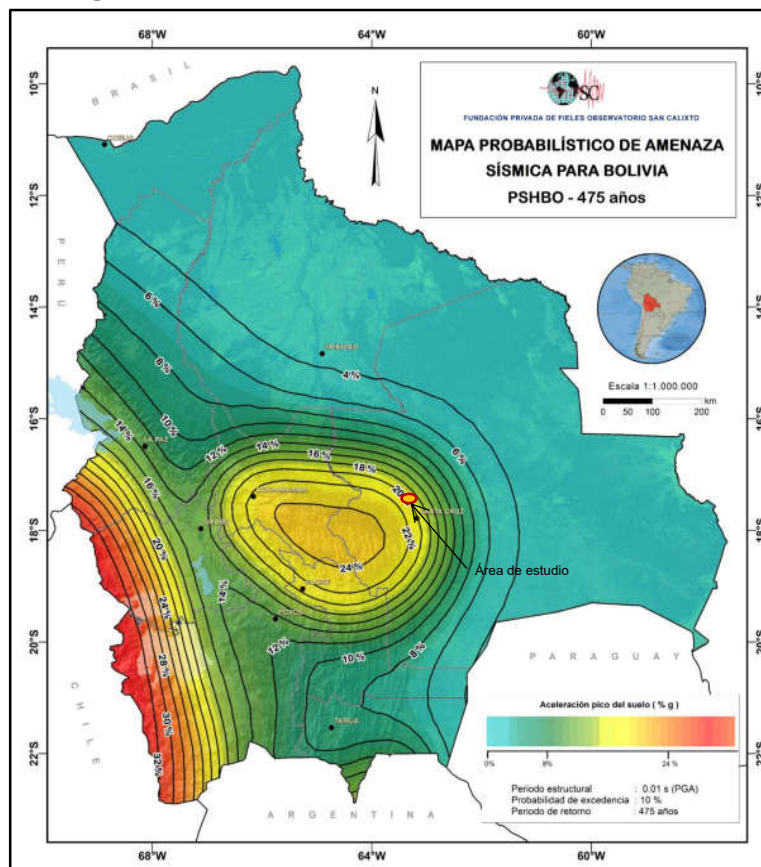
De acuerdo con la Norma Boliviana de diseño sísmico 2023, la solicitación sísmica se determina mediante el método de análisis estático o modal espectral según conveniencia en función al tipo de estructura.

El lugar donde se encuentra el proyecto la actividad sísmica en estas regiones es moderado-alto en comparación en otras zonas morfotectónicas.

Para la determinación Peak Ground Aceleración – PGA, se usó el registro histórico y el mapa probabilístico de amenazas sísmicas, para un periodo de retorno de 475 años, con 10% de probabilidad de excedencia en 10 años.


Para el punto del proyecto fue considerado el rango de excedencia desfavorable de  $PGA=20\%$ .

**Figura 19.** Mapa probabilístico de amenaza sísmica.



Para determinar los espectros de diseño aceleración se determinan los siguientes valores:

- Factor de Importancia  $I_e$

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**Tabla 14.** Factor de Importancia,  $I_e$ .

| Tipo | $I_e$             |
|------|-------------------|
| IV   | 1.5               |
| III  | 1.3               |
| II   | 1.0               |
| I    | Nota <sup>1</sup> |

*Nota<sup>1</sup>:* Edificaciones cuya resistencia y rigidez sean adecuadas para resistir acciones laterales a criterio del proyectista.

➤ Clasificación de suelo de fundación

**Tabla 15.** Tipo de Suelo.

| Suelo | Descripción                                |
|-------|--|
| S0    | Roca dura                                  |
| S1    | Roca                                       |
| S2    | Suelo muy rígido - roca blanda             |
| S3    | Suelo rígido                               |
| S4    | Suelo blando                               |
| S5    | Requiere un análisis de respuesta de sitio |


➤ Coeficiente,  $F_a$  y  $F_v$

Los efectos del tipo de suelo en la acción sísmica se pueden considerar a partir de la aplicación de los factores,  $F_a$  y  $F_v$ , en función de la aceleración máxima del suelo,  $S_0$ , (PGA).

**Tabla 16.** Coeficiente de sitio de periodo corto,  $F_a$ .

| Tipo de suelo | $S_0$   |       |       |       |       |         |
|---------------|---------|-------|-------|-------|-------|---------|
|               | < 0.067 | 0.133 | 0.200 | 0.267 | 0.333 | > 0.400 |
| S0            | 0.8     | 0.8   | 0.8   | 0.8   | 0.8   | 0.8     |
| S1            | 0.9     | 0.9   | 0.9   | 0.9   | 0.9   | 0.9     |
| S2            | 1.3     | 1.3   | 1.2   | 1.1   | 1.1   | 1.1     |
| S3            | 1.6     | 1.4   | 1.2   | 1.1   | 1.1   | 1.1     |
| S4            | 2.4     | 1.7   | 1.3   | 1.2   | 1.2   | 1.2     |

*Nota:* Se permite interpolación lineal para valores intermedios.

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**Tabla 17.** Coeficiente de sitio de periodo largo  $F_v$

| Tipo de suelo | $S_0$   |       |       |       |       |         |
|---------------|---------|-------|-------|-------|-------|---------|
|               | < 0.053 | 0.107 | 0.160 | 0.213 | 0.267 | > 0.320 |
| S0            | 0.64    | 0.7   | 0.8   | 0.8   | 0.8   | 0.8     |
| S1            | 0.64    | 0.7   | 0.8   | 0.8   | 0.8   | 0.8     |
| S2            | 1.2     | 1.3   | 1.5   | 1.5   | 1.5   | 1.4     |
| S3            | 2.0     | 2.0   | 2.0   | 1.9   | 1.8   | 1.7     |
| S4            | 3.5     | 3.0   | 2.8   | 2.4   | 2.4   | 2.4     |

*Nota:* Se permite interpolación lineal para valores intermedios.

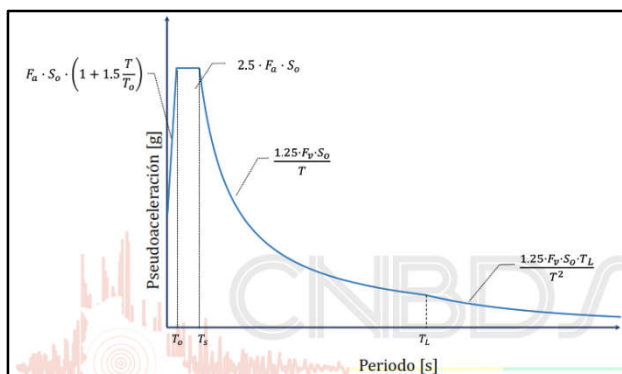
- Efecto de topografía y pendientes

Se considera la ubicación topográfica >D, donde el factor será  $\tau = 1$

- Espectros de respuestas


La parametrización del espectro elástico,  $S_{ae}$  (Figura 3) se realizará mediante las ecuaciones de las tablas (Tabla 13 y Tabla 14), ramas y periodos de regiones, respectivamente.

**Figura 20.** Espectro elástico de pseudoaceleración en unidades de, g.



**Tabla 18.** Parametrización del espectro elástico de pseudoaceleración.

| Rama                  | Pseudoaceleración ( $S_{ae}$ )                                 |
|-----------------------|--|
| $T < T_0$             | $F_a \cdot S_0 \cdot \left(1 + 1.5 \cdot \frac{T}{T_0}\right)$ |
| $T_0 \leq T \leq T_s$ | $2.5 \cdot F_a \cdot S_0$                                      |
| $T_s < T \leq T_L$    | $\frac{1.25 \cdot F_v \cdot S_0}{T}$                           |
| $T_L < T$             | $\frac{1.25 \cdot F_v \cdot S_0 \cdot T_L}{T^2}$               |

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**Tabla 19.** Periodo límite inicial, corto y largo.

| $T_0$                        | $T_s$                       | $T_L$                     |
|------------------------------|-----------------------------|---------------------------|
| $0.15 \cdot \frac{F_v}{F_a}$ | $0.5 \cdot \frac{F_v}{F_a}$ | $4 \cdot \frac{F_v}{F_a}$ |

➤ Espectro de diseño


El espectro de diseño  $S_a$ , es el espectro elástico afectado por los factores, de reducción  $R$  de importancia  $I_e$  y topografía  $\tau$ , definido por:

$$S_a = \frac{S_{ae} \cdot I_e \cdot \tau}{R}$$

$S_{ae}$ = Espectro elástico de Pseudoaceleración definido.

**Tabla 20.** Coeficientes de reducción,  $R$ , amplificación,  $C_d$  y valores de distorsión  $\Delta^1$ .

| Sistema Estructural  | $R$  | $C_d$ | $\Delta^1$ |
|--|------|-------|------------|
| <b>Hormigón<sup>2</sup></b>  |      |       |            |
| <b>Sistema de Pórticos</b>   |      |       |            |
| Pórticos Especiales Resistentes a Momentos   | 8    | 5.5   | 0.012      |
| Pórticos Intermedios Resistentes a Momentos  | 5    | 4.5   | 0.011      |
| Pórticos Ordinarios Resistentes a Momentos   | 3    | 2.5   | 0.010      |
| <b>Sistema de Entrepiso sin Viga</b>   |      |       |            |
| Entrepisos planos compuestos por losas macizas o nervadas bidireccionales con ábacos, apoyados en columnas con o sin capiteles. Altura máxima, 30 m.   | 2.5  | 1.8   | 0.007      |
| Entrepisos planos compuestos por losas macizas o nervadas bidireccionales con ábacos, apoyados en columnas con o sin capiteles y muros de corte ordinarios. Altura máxima, 30 m.                               | 4    | 3.6   | 0.008      |
| <b>Sistema de Entrepiso con Vigas Planas</b>   |      |       |            |
| Entrepisos planos apoyados en vigas planas y columnas. Altura máxima, 30 m.  | 2.5  | 1.8   | 0.007      |
| Entrepisos planos apoyados en vigas planas ( $b \geq 400$ mm) y columnas. Altura máxima, 30 m.   | 4    | 3.6   | 0.008      |
| Entrepisos planos de losas macizas o nervadas bidireccionales con ábacos apoyados en un sistema dual de columnas especiales con o sin capiteles y muros de corte especiales y vigas planas ( $b \geq 400$ mm). | 5.5  | 4.5   | 0.009      |
| <b>Sistema de Muros</b>  |      |       |            |
| Muros estructurales Especiales   | 6    | 5     | 0.009      |
| Muros estructurales Ordinarios   | 5    | 4.5   | 0.008      |
| <b>Sistemas Duales</b>   |      |       |            |
| Pórticos Especiales con Muros Especiales   | 7    | 5.5   | 0.010      |
| Pórticos Especiales con Muros Especiales acoplados   | 8    | 8     | 0.010      |
| Pórticos Especiales con Muros Ordinarios   | 6    | 5     | 0.009      |
| Pórticos Intermedios con Muros Especiales  | 6.5  | 5     | 0.009      |
| Pórticos Intermedios con Muros Ordinarios  | 5.5  | 4.5   | 0.008      |
| Pórticos Ordinarios con Muros Ordinarios   | 4.5  | 4     | 0.007      |
| Sistemas de muros de ductilidad limitada   | 4    | 3.6   | 0.006      |
| <b>Acero</b>   |      |       |            |
| Pórticos Especiales Resistentes a Momentos   | 8    | 5.5   | 0.010      |
| Pórticos Intermedios Resistentes a Momentos  | 4.5  | 4     | 0.009      |
| Pórticos Ordinarios Resistentes a Momentos   | 3.5  | 3     | 0.008      |
| Pórticos Especiales Concéntricamente Arriostrados  | 6    | 5     | 0.009      |
| Pórticos Ordinarios Concéntricamente Arriostrados  | 3.25 | 3.25  | 0.008      |
| Pórticos Excéntricamente Arriostrados  | 8    | 4     | 0.010      |


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**Tabla 21.** Coeficientes de reducción, R, amplificación, Cd y valores de distorsión  $\Delta^1$  (Cubierta Metálica).

| DATOS                                      | PARÁMETROS |
|--|------------|
| PGA (So) (%g)                              | 20         |
| Tipo de suelo                              | S4         |
| Tipo de edificación                        | IV         |
| Coeficiente de sitio de periodo corto "Fa" | 1.300      |
| Coeficiente de sitio de periodo largo "Fv" | 2.498      |
| Periodo limite inicial "To" (Seg)          | 0.288      |
| Periodo limite corto "Ts" (Seg)            | 0.961      |
| Periodo limite largo "TL" (Seg)            | 7.686      |
| Factor de importancia "Ie"                 | 1.500      |
| Topografía "τ"                             | 1.000      |
| Factor de Reducción "R"                    | 3.500      |

**Tabla 22.** Coeficientes de reducción, R, amplificación, Cd y valores de distorsión  $\Delta^1$  (Cubierta Metálica).


| DATOS                                      | PARÁMETROS |
|--|------------|
| PGA (So) (%g)                              | 20.00      |
| Tipo de suelo                              | S4         |
| Tipo de edificación                        | IV         |
| Coeficiente de sitio de periodo corto "Fa" | 1.300      |
| Coeficiente de sitio de periodo largo "Fv" | 2.498      |
| Periodo limite inicial "To" (Seg)          | 0.288      |
| Periodo limite corto "Ts" (Seg)            | 0.961      |
| Periodo limite largo "TL" (Seg)            | 7.686      |
| Factor de importancia "Ie"                 | 1.500      |
| Topografía "τ"                             | 1.000      |
| Factor de Reducción "R"                    | 4.500      |

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**Tabla 23.** Coeficientes de reducción, R, amplificación, Cd y valores de distorsión  $\Delta^1$ .

| PUNTOS | PERIODO | ESPECTRO DE DISEÑO ACCELERACIÓN |
|--------|---------|---------------------------------|
|        | seg     | Sa [g]                          |
| 1      | 0       | 0.1114                          |
| 2      | 0.05    | 0.1404                          |
| 3      | 0.1     | 0.1694                          |
| 4      | 0.15    | 0.1984                          |
| 5      | 0.2     | 0.2274                          |
| 6      | 0.25    | 0.2564                          |
| 7      | 0.3     | 0.2786                          |
| 8      | 0.4     | 0.2786                          |
| 9      | 0.45    | 0.2786                          |
| 10     | 0.6     | 0.2786                          |
| 11     | 0.7     | 0.2786                          |
| 12     | 0.8     | 0.2786                          |
| 13     | 1       | 0.2677                          |
| 14     | 1.2     | 0.223                           |
| 15     | 1.5     | 0.1784                          |
| 16     | 2       | 0.1338                          |
| 17     | 2.5     | 0.1071                          |
| 18     | 3       | 0.0892                          |
| 19     | 3.5     | 0.0765                          |
| 20     | 4       | 0.0669                          |
| 21     | 4.5     | 0.0595                          |
| 22     | 5       | 0.0535                          |
| 23     | 5.5     | 0.0487                          |
| 24     | 6       | 0.0446                          |
| 25     | 6.5     | 0.0412                          |
| 26     | 7       | 0.0382                          |
| 27     | 7.5     | 0.0357                          |
| 28     | 8       | 0.0321                          |
| 29     | 8.5     | 0.0285                          |
| 30     | 9       | 0.0254                          |
| 31     | 9.5     | 0.0228                          |
| 32     | 10      | 0.0206                          |




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**Tabla 24.** Coeficientes de reducción, R, amplificación, Cd y valores de distorsión  $\Delta^1$ .

| PUNTOS | PERIODO | ESPECTRO DE DISEÑO ACCELERACIÓN |
|--------|---------|---------------------------------|
|        | seg     | Sa [g]                          |
| 1      | 0       | 0.0867                          |
| 2      | 0.05    | 0.1092                          |
| 3      | 0.1     | 0.1318                          |
| 4      | 0.15    | 0.1543                          |
| 5      | 0.2     | 0.1769                          |
| 6      | 0.25    | 0.1994                          |
| 7      | 0.3     | 0.2167                          |
| 8      | 0.4     | 0.2167                          |
| 9      | 0.45    | 0.2167                          |
| 10     | 0.6     | 0.2167                          |
| 11     | 0.7     | 0.2167                          |
| 12     | 0.8     | 0.2167                          |
| 13     | 1       | 0.2082                          |
| 14     | 1.2     | 0.1735                          |
| 15     | 1.5     | 0.1388                          |
| 16     | 2       | 0.1041                          |
| 17     | 2.5     | 0.0833                          |
| 18     | 3       | 0.0694                          |
| 19     | 3.5     | 0.0595                          |
| 20     | 4       | 0.0520                          |
| 21     | 4.5     | 0.0463                          |
| 22     | 5       | 0.0416                          |
| 23     | 5.5     | 0.0379                          |
| 24     | 6       | 0.0347                          |
| 25     | 6.5     | 0.0320                          |
| 26     | 7       | 0.0297                          |
| 27     | 7.5     | 0.0278                          |
| 28     | 8       | 0.0250                          |
| 29     | 8.5     | 0.0221                          |
| 30     | 9       | 0.0198                          |
| 31     | 9.5     | 0.0177                          |
| 32     | 10      | 0.0160                          |




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## 7. RESULTADOS DE ANALISIS

### 7.1. VERIFICACIÓN DE PARTICIPACIÓN DE MASAS


**Tabla 25.** Porcentaje de participación de masas (Cubierta Metálica).

| Participación Modal |        |        |        |       |       |       |
|---------------------|--------|--------|--------|-------|-------|-------|
| MODO                | Part.X | Part.Y | Part.Z | Rot.X | Rot.Y | Rot.Z |
| 1                   | 0.26   | 5.85   | 67.63  | 0     | 0     | 0     |
| 2                   | 0      | 0      | 0      | 0     | 0     | 0     |
| 3                   | 0.65   | 14.26  | 1.49   | 0     | 0     | 0     |
| 4                   | 1.74   | 38.43  | 3.81   | 0     | 0     | 0     |
| 5                   | 0.01   | 0.25   | 0.03   | 0     | 0     | 0     |
| 6                   | 0.43   | 9.55   | 0.8    | 0     | 0     | 0     |
| 7                   | 0      | 0.02   | 0      | 0     | 0     | 0     |
| 8                   | 0.04   | 0.85   | 0.05   | 0     | 0     | 0     |
| 9                   | 0      | 0      | 0      | 0     | 0     | 0     |
| 10                  | 0      | 0      | 0.3    | 0     | 0     | 0     |
| 11                  | 0      | 0.03   | 0      | 0     | 0     | 0     |
| 12                  | 0      | 0      | 0      | 0     | 0     | 0     |
| 13                  | 0      | 0      | 0      | 0     | 0     | 0     |
| 14                  | 0.02   | 0.44   | 7.65   | 0     | 0     | 0     |
| 15                  | 0      | 0      | 0      | 0     | 0     | 0     |
| 16                  | 0      | 0.05   | 0.02   | 0     | 0     | 0     |
| 17                  | 0      | 0.01   | 0      | 0     | 0     | 0     |
| 18                  | 0      | 0      | 0.01   | 0     | 0     | 0     |
| 19                  | 0      | 0.11   | 2.66   | 0     | 0     | 0     |
| 20                  | 0      | 0      | 0.01   | 0     | 0     | 0     |
| 21                  | 0.36   | 8.53   | 0.33   | 0     | 0     | 0     |
| 22                  | 0.09   | 1.32   | 0.14   | 0     | 0     | 0     |
| 23                  | 0.01   | 1.32   | 0.1    | 0     | 0     | 0     |
| 24                  | 0.01   | 0.02   | 12.84  | 0     | 0     | 0     |
| 25                  | 75.39  | 2.42   | 0.01   | 0     | 0     | 0     |
| 26                  | 1.9    | 12.37  | 0.12   | 0     | 0     | 0     |
| 27                  | 10.88  | 0.31   | 0.08   | 0     | 0     | 0     |
| TOTAL:              | 91.8   | 96.13  | 98.09  | 0     | 0     | 0     |

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**Tabla 26.** Porcentaje de participación de masas (Estructura de HºAº).

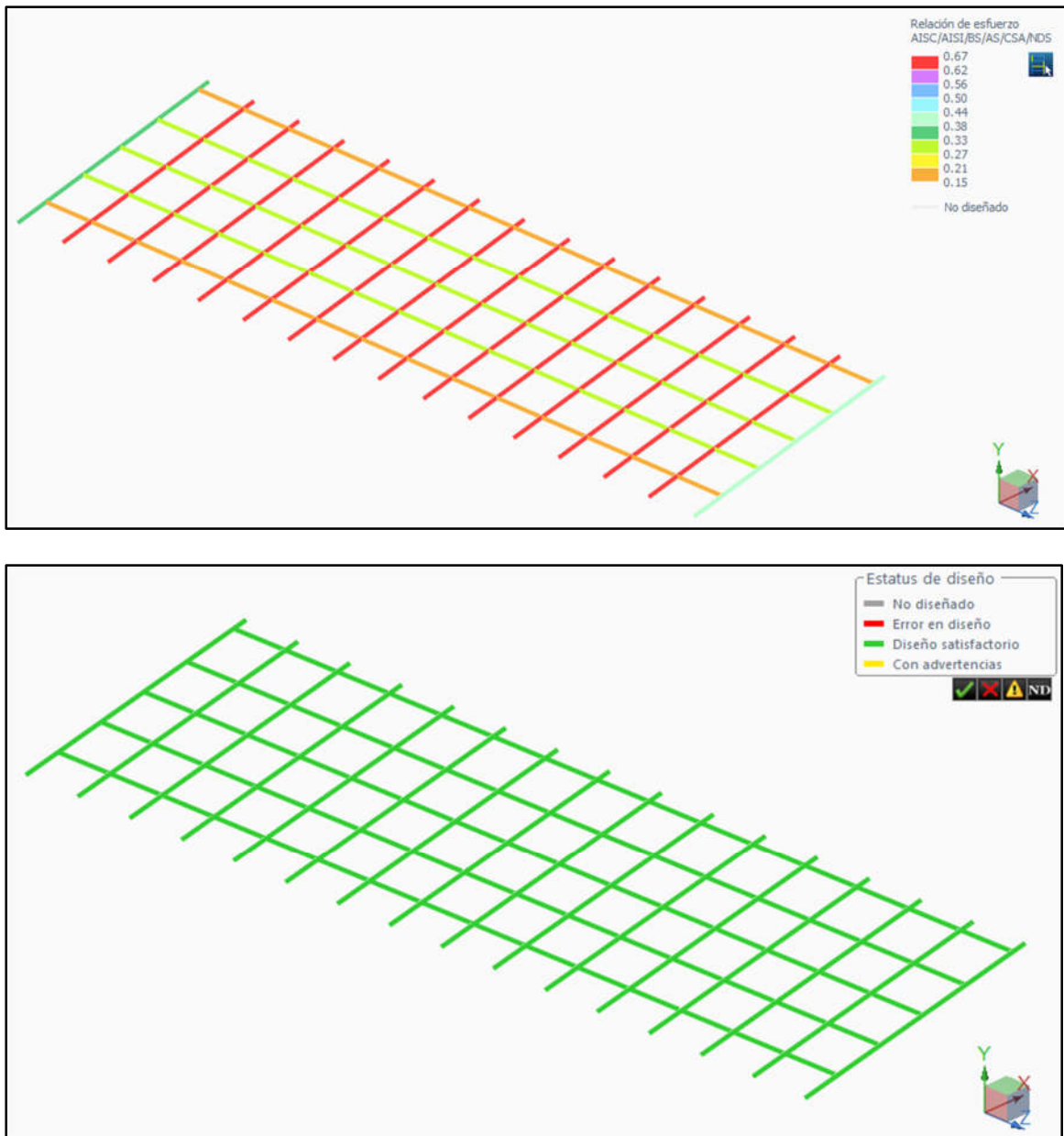
| Participación Modal |              |              |              |          |          |          |
|---------------------|--------------|--------------|--------------|----------|----------|----------|
| MODO                | Part.X       | Part.Y       | Part.Z       | Rot.X    | Rot.Y    | Rot.Z    |
| 1                   | 3.51         | 0.02         | 40.81        | 0        | 0        | 0        |
| 2                   | 49.15        | 0.04         | 3.78         | 0        | 0        | 0        |
| 3                   | 2.21         | 0.03         | 2.53         | 0        | 0        | 0        |
| 4                   | 2.83         | 0            | 5.76         | 0        | 0        | 0        |
| 5                   | 1.98         | 0            | 6.44         | 0        | 0        | 0        |
| 6                   | 0.03         | 0            | 0.01         | 0        | 0        | 0        |
| 7                   | 0            | 0            | 0            | 0        | 0        | 0        |
| 8                   | 0.66         | 0            | 0.14         | 0        | 0        | 0        |
| 9                   | 0.25         | 0            | 0            | 0        | 0        | 0        |
| 10                  | 0.06         | 0            | 0.03         | 0        | 0        | 0        |
| 11                  | 1.33         | 0            | 0.03         | 0        | 0        | 0        |
| 12                  | 0.83         | 0            | 0            | 0        | 0        | 0        |
| 13                  | 8.92         | 0            | 0.01         | 0        | 0        | 0        |
| 14                  | 0.03         | 0.09         | 0            | 0        | 0        | 0        |
| 15                  | 0.16         | 0.14         | 0            | 0        | 0        | 0        |
| 16                  | 0.17         | 0.03         | 16.59        | 0        | 0        | 0        |
| 17                  | 1.26         | 0.08         | 3.2          | 0        | 0        | 0        |
| 18                  | 3.78         | 1.42         | 0.79         | 0        | 0        | 0        |
| 19                  | 2.38         | 4.42         | 0.24         | 0        | 0        | 0        |
| 20                  | 0.08         | 17.66        | 0.19         | 0        | 0        | 0        |
| 21                  | 0.25         | 5.66         | 2.03         | 0        | 0        | 0        |
| 22                  | 0.17         | 0.02         | 9.05         | 0        | 0        | 0        |
| 23                  | 11.76        | 0.15         | 0.04         | 0        | 0        | 0        |
| 24                  | 0.03         | 6.73         | 0.11         | 0        | 0        | 0        |
| 25                  | 0.06         | 20.74        | 0            | 0        | 0        | 0        |
| 26                  | 0.02         | 25.39        | 0.02         | 0        | 0        | 0        |
| <b>TOTAL:</b>       | <b>91.93</b> | <b>82.62</b> | <b>91.78</b> | <b>0</b> | <b>0</b> | <b>0</b> |

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## 7.2. VERIFICACIÓN ESTRUCTURA METALICA

El diseño y verificación de todos los elementos se realiza mediante el software RAM Elements, Norma de diseño AISC 360 LRFD a continuación, se muestra el estatus de diseño y la relación de esfuerzos para la cubierta Metálica.

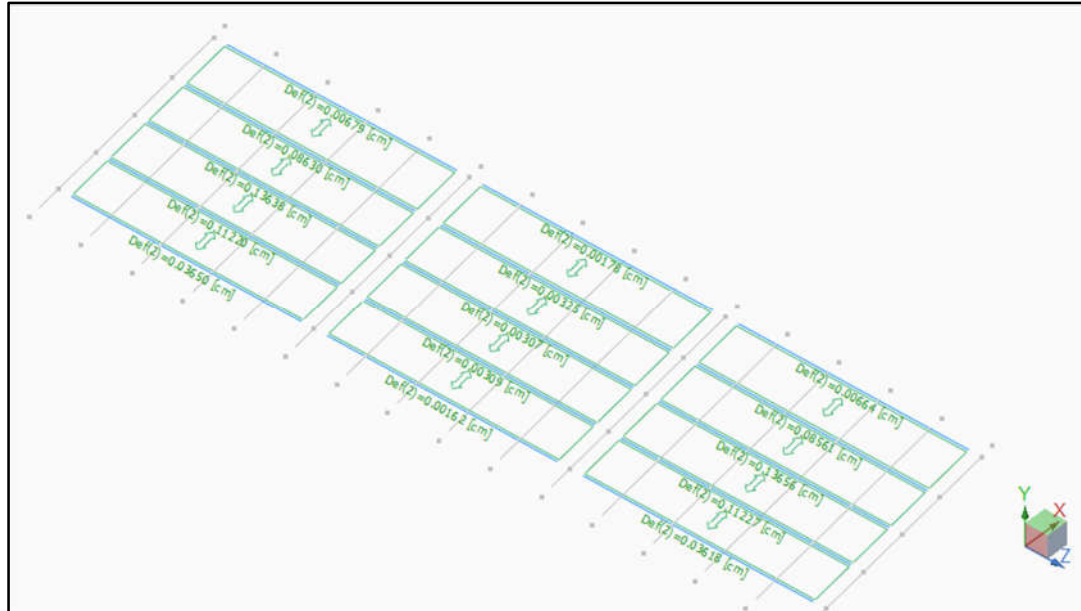
**Figura 21.** Estatus de diseño y relación de esfuerzos.





|   |   |                               |
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**Figura 23.** Deformación en Vigas Correas.



La máxima deformación vertical en la viga principal mas critica es de 0.13656 cm


Las deformaciones máximas establecidas de acuerdo a la norma AISC 360-16 es de L/240.

Se tiene una longitud entre apoyos  $H = 5.75 \text{ m} = 575 \text{ cm}$ .

Deformación máxima  $\Delta = H/240$ .

$$\Delta = 575 \text{ cm} / 240 = 2.40 \text{ cm}.$$

$0.13656 \text{ cm} \leq 2.40 \text{ cm}$  Cumple con la verificación!!

|   |   |                               |
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## 8. DISEÑO DE ESTRUCTURA DE HORMIGÓN ARMADO

### 8.1. DISEÑO DE COLUMNAS

#### 8.1.1. COLUMNA C-01


## Resultados de Diseño Columnas de Hormigón Armado

### Datos Generales

Código de diseño : ACI 318-2019

#### Estados de carga considerados en el diseño:

|     |   |                     |
|-----|---|---------------------|
| D1  | : | 1.4CM               |
| D2  | : | 1.2CM+0.5VxCASOAPOS |
| D3  | : | 1.2CM+0.5VxCASOANEG |
| D4  | : | 1.2CM+0.5VzCASOAPOS |
| D5  | : | 1.2CM+0.5VzCASOANEG |
| D6  | : | 1.2CM+VxCASOAPOS    |
| D7  | : | 1.2CM+VxCASOANEG    |
| D8  | : | 1.2CM+VzCASOAPOS    |
| D9  | : | 1.2CM+VzCASOANEG    |
| D10 | : | 0.9CM+VxCASOAPOS    |
| D11 | : | 0.9CM+VxCASOANEG    |
| D12 | : | 0.9CM+VzCASOAPOS    |
| D13 | : | 0.9CM+VzCASOANEG    |
| D14 | : | 1.2CM+EQx           |
| D15 | : | 1.2CM+EQz           |
| D16 | : | 0.9CM+EQx           |
| D17 | : | 0.9CM+EQz           |
| D18 | : | 1.2CM+1.6CV         |
| D19 | : | 1.2CM+0.5VzCASOBPOS |
| D20 | : | 1.2CM+0.5VzCASOBNEG |
| D21 | : | 1.2CM+VzCASOBPOS    |
| D22 | : | 1.2CM+VzCASOBNEG    |
| D23 | : | 1.2CM+VxCASOAPOS+CV |
| D24 | : | 1.2CM+VxCASOANEG+CV |
| D25 | : | 1.2CM+VzCASOAPOS+CV |
| D26 | : | 1.2CM+VzCASOANEG+CV |
| D27 | : | 1.2CM+VzCASOBPOS+CV |
| D28 | : | 1.2CM+VzCASOBNEG+CV |
| D29 | : | 0.9CM+VzCASOBPOS    |
| D30 | : | 0.9CM+VzCASOBNEG    |
| D31 | : | 1.2CM+EQxCUB        |
| D32 | : | 1.2CM+EQzCUB        |
| D33 | : | 1.2CM+EQx+CV        |
| D34 | : | 1.2CM+EQz+CV        |
| D35 | : | 1.2CM+EQxCUB+CV     |
| D36 | : | 1.2CM+EQzCUB+CV     |
| D37 | : | 0.9CM+EQxCUB        |
| D38 | : | 0.9CM+EQzCUB        |

|   |   |                               |
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#### **Materiales**

|                         |                      |                         |                  |
|-------------------------|----------------------|-------------------------|------------------|
| Hormigón, $f_c$         | : 2100000.00 [Kg...] | Acero, $f_y$            | : 4.2E07 [Kg/m2] |
| Tipo de concreto        | : Normal             | Acero, $f_{yt}$         | : 4.2E07 [Kg/m2] |
| Módulo de elasticidad   | : 2.14E09 [Kg/m2]    | Tipo de empalmes        | : Tangencial     |
| Peso unitario           | : 2400.00 [Kg/m3]    | Cuantía mínima adoptada | : 0.010          |
| Cuantía máxima adoptada | : 0.080              |                         |                  |

Estatus general : **Bien**

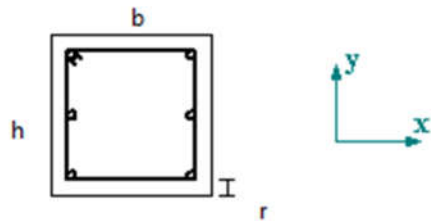
## Columna 1

### Datos

#### **Geometría**

|                           |               |
|---------------------------|---------------|
| Tipo de sección           | : Rectangular |
| Posición de la columna    | : Centro      |
| Distancia entre niveles   | : 4.20 [m]    |
| Ancho $b$ (// a eje $x$ ) | : 25.00 [cm]  |
| Alto $h$ (// a eje $y$ )  | : 25.00 [cm]  |


#### **Armadura**



|                                   |                     |
|-----------------------------------|---------------------|
| Longitudinal                      | : 6-12mm            |
| Recubrimiento libre               | : 2.50 [cm]         |
| As provista                       | : 6.78 [cm2]        |
| Cuantía provista                  | : 0.011             |
| Número de barras // a la cara $x$ | : 2                 |
| Con una separación entre barras   | : 16.00 [cm]        |
| Número de barras // a la cara $y$ | : 3                 |
| Con una separación entre barras   | : 7.40 [cm]         |
| Transversal                       | : 21 8mm c/ 18.00cm |
| Número de ramas // a eje $x$      | : 2                 |
| Número de ramas // a eje $y$      | : 2                 |
| Separación inicial (Sini)         | : 0.00 [cm]         |

#### **Parámetros de diseño**

| <b>Esbeltez</b> | <b>Eje yy</b> | <b>Eje xx</b> |
|-----------------|---------------|---------------|
| Lu[cm]          | 420.00        | 420.00        |
| K               | 1.00          | 1.00          |
| Pc[Kg]          | 97439.21      | 97439.21      |


|   |   |                               |
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### Solicitaciones

| <u>transversal</u> | Estado | Posición | Pu       | Muxx    | Muyy    | Vx     | Vy      | <u>Carga</u> |
|--------------------|--------|----------|----------|---------|---------|--------|---------|--------------|
|                    |        |          | [Kg]     | [Kg*m]  | [Kg*m]  | [Kg]   | [Kg]    | xx           |
|                    | yy     |          |          |         |         |        |         |              |
|                    | D1     | Sup.     | -1163.78 | 98.48   | -179.23 | 130.61 | 129.67  | No           |
|                    | No     | Inferior | -6578.14 | 125.91  | 141.86  | 422.11 | 821.37  | No           |
|                    | No     | Sup.     | -860.35  | -76.04  | -108.51 | 85.00  | 11.68   | No           |
|                    | D2     | Inferior | -5387.34 | 268.08  | 91.77   | 331.92 | 558.63  | No           |
|                    | No     | Sup.     | -908.49  | -34.25  | -126.20 | 95.34  | 35.63   | No           |
|                    | D3     | Inferior | -5461.74 | 242.44  | 102.46  | 342.46 | 578.77  | No           |
|                    | No     | Sup.     | -931.29  | -4.66   | -199.79 | 145.27 | 64.52   | No           |
|                    | D4     | Inferior | -5601.11 | 152.56  | 192.97  | 444.65 | 668.24  | No           |
|                    | No     | Sup.     | -979.82  | 33.15   | -219.75 | 157.08 | 85.76   | No           |
|                    | D5     | Inferior | -5676.32 | 129.00  | 205.39  | 456.90 | 687.49  | No           |
|                    | No     | Sup.     | -723.04  | -236.94 | -63.44  | 58.08  | -87.99  | No           |
|                    | D6     | Inferior | -5135.83 | 428.81  | 61.97   | 302.06 | 413.08  | No           |
|                    | No     | Sup.     | -819.28  | -153.39 | -98.79  | 78.74  | -40.08  | No           |
|                    | D7     | Inferior | -5284.56 | 377.55  | 83.35   | 323.13 | 453.37  | No           |
|                    | No     | Sup.     | -864.81  | -94.24  | -245.89 | 178.57 | 17.74   | No           |
|                    | D8     | Inferior | -5563.17 | 197.79  | 264.35  | 527.51 | 632.34  | No           |
|                    | No     | Sup.     | -961.88  | -18.63  | -285.83 | 202.19 | 60.21   | No           |
|                    | D9     | Inferior | -5713.61 | 150.68  | 289.18  | 552.01 | 670.83  | No           |
|                    | No     | Sup.     | -474.10  | -257.09 | -25.15  | 30.13  | -115.42 | No           |
|                    | D10    | Inferior | -3727.41 | 400.71  | 31.66   | 211.62 | 237.41  | No           |
|                    | No     | Sup.     | -570.28  | -173.61 | -60.46  | 50.78  | -67.55  | No           |
|                    | D11    | Inferior | -3876.00 | 349.54  | 53.00   | 232.69 | 277.66  | No           |
|                    | No     | Sup.     | -615.42  | -114.95 | -207.22 | 150.49 | -9.97   | No           |
|                    | D12    | Inferior | -4153.69 | 170.23  | 233.73  | 436.95 | 456.43  | No           |
|                    | No     |          |          |         |         |        |         |              |



|   |  |  |  |  |  |                        |  |  |
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|     |          |          |         |         |        |        |    |
|-----|----------|----------|---------|---------|--------|--------|----|
| D13 | Sup.     | -712.43  | -39.40  | -247.11 | 174.08 | 32.48  | No |
| No  | Inferior | -4303.99 | 123.21  | 258.52  | 461.42 | 494.87 | No |
| No  | Sup.     | -1131.91 | -330.20 | -306.24 | 213.61 | 401.42 | No |
| D14 | Inferior | -5928.74 | -282.76 | 18.36   | 460.00 | 989.78 | No |
| No  | Sup.     | -1131.91 | -330.20 | -306.24 | 213.61 | 401.42 | No |
| D15 | Inferior | -5928.74 | -282.76 | 18.36   | 460.00 | 989.78 | No |
| No  | Sup.     | -882.71  | -350.85 | -267.83 | 185.61 | 373.78 | No |
| D16 | Inferior | -4519.65 | -310.28 | -12.05  | 369.52 | 813.87 | No |
| No  | Sup.     | -882.71  | -350.85 | -267.83 | 185.61 | 373.78 | No |
| D17 | Inferior | -4519.65 | -310.28 | -12.05  | 369.52 | 813.87 | No |
| No  | Sup.     | -1465.59 | 245.43  | -265.90 | 166.41 | 141.66 | No |
| D18 | Inferior | -6073.00 | 163.32  | 119.81  | 339.65 | 654.64 | No |
| No  | Sup.     | -965.89  | 73.99   | -145.98 | 108.24 | 109.25 | No |
| D19 | Inferior | -5609.45 | 103.50  | 121.70  | 363.29 | 707.52 | No |
| No  | Sup.     | -997.73  | 84.94   | -153.62 | 111.94 | 111.32 | No |
| D20 | Inferior | -5639.00 | 107.30  | 121.58  | 361.79 | 704.15 | No |
| No  | Sup.     | -934.05  | 63.03   | -138.33 | 104.53 | 107.17 | No |
| D21 | Inferior | -5579.89 | 99.69   | 121.81  | 364.79 | 710.90 | No |
| No  | Sup.     | -997.73  | 84.94   | -153.62 | 111.94 | 111.32 | No |
| D22 | Inferior | -5639.00 | 107.30  | 121.58  | 361.79 | 704.15 | No |
| No  | Sup.     | -1015.19 | -136.95 | -133.40 | 92.01  | -69.20 | No |
| D23 | Inferior | -5406.49 | 464.08  | 60.78   | 288.19 | 382.03 | No |
| No  | Sup.     | -1111.50 | -53.34  | -168.82 | 112.71 | -21.25 | No |
| D24 | Inferior | -5555.36 | 412.76  | 82.19   | 309.28 | 422.35 | No |
| No  | Sup.     | -1157.44 | 6.25    | -316.35 | 212.74 | 36.79  | No |
| D25 | Inferior | -5834.88 | 232.73  | 263.33  | 513.69 | 601.42 | No |
| No  | Sup.     | -1254.59 | 81.90   | -356.37 | 236.39 | 79.30  | No |
| D26 | Inferior | -5985.46 | 185.58  | 288.18  | 538.18 | 639.94 | No |
| No  | Sup.     | -1226.49 | 163.53  | -208.48 | 138.56 | 126.19 | No |
| D27 |          |          |         |         |        |        | No |
| No  |          |          |         |         |        |        | No |

|   |  |  |  |  |  |                        |  |  |
|---|--|--|--|--|--|------------------------|--|--|
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|        |          |          |         |         |        |        |    |
|--------|----------|----------|---------|---------|--------|--------|----|
|        | Inferior | -5851.24 | 134.64  | 120.70  | 350.95 | 679.95 | No |
| No D28 | Sup.     | -1290.16 | 185.35  | -223.78 | 145.98 | 130.32 | No |
| No     | Inferior | -5910.30 | 142.27  | 120.47  | 347.95 | 673.20 | No |
| No D29 | Sup.     | -684.82  | 42.31   | -99.92  | 76.54  | 79.51  | No |
| No     | Inferior | -4170.75 | 72.21   | 91.40   | 274.31 | 534.99 | No |
| No D30 | Sup.     | -748.53  | 64.30   | -115.21 | 83.95  | 83.68  | No |
| No     | Inferior | -4229.91 | 79.78   | 91.17   | 271.31 | 528.24 | No |
| No D31 | Sup.     | -1010.85 | 85.80   | -169.47 | 122.48 | 112.09 | No |
| No     | Inferior | -5664.16 | 106.23  | 131.22  | 370.38 | 704.96 | No |
| No D32 | Sup.     | -1010.85 | 85.80   | -169.47 | 122.48 | 112.09 | No |
| No     | Inferior | -5664.16 | 106.23  | 131.22  | 370.38 | 704.96 | No |
| No D33 | Sup.     | -1424.34 | -229.79 | -376.40 | 247.64 | 420.42 | No |
| No     | Inferior | -6200.04 | -247.79 | 17.25   | 446.16 | 958.83 | No |
| No D34 | Sup.     | -1424.34 | -229.79 | -376.40 | 247.64 | 420.42 | No |
| No     | Inferior | -6200.04 | -247.79 | 17.25   | 446.16 | 958.83 | No |
| No D35 | Sup.     | -1303.31 | 186.22  | -239.67 | 156.53 | 131.10 | No |
| No     | Inferior | -5935.52 | 141.20  | 130.11  | 356.54 | 674.02 | No |
| No D36 | Sup.     | -1303.31 | 186.22  | -239.67 | 156.53 | 131.10 | No |
| No     | Inferior | -5935.52 | 141.20  | 130.11  | 356.54 | 674.02 | No |
| No D37 | Sup.     | -761.62  | 65.14   | -131.03 | 94.48  | 84.44  | No |
| No     | Inferior | -4255.02 | 78.72   | 100.79  | 279.90 | 529.05 | No |
| No D38 | Sup.     | -761.62  | 65.14   | -131.03 | 94.48  | 84.44  | No |
| No     | Inferior | -4255.02 | 78.72   | 100.79  | 279.90 | 529.05 | No |
| No     |          |          |         |         |        |        |    |

## Diseño

Estatus de la columna : Bien


### Compresión biaxial

Estado gobernante : D14  
 Esfuerzos en barras :  $f_s > 0.5f_y$   
 Longitud de empalme : 69.00 [cm]







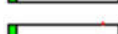









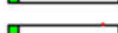



|   |  |  |                        |
|---|--|--|------------------------|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |
|   | MEMORIA DE CÁLCULO   |  | IFE-2025-2977-S-MC-011 |
|   | TÍTULO:  |  | HOJA:                  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 43 de 140              |
|   |  |  | REV:                   |
|   |  |  | A                      |


Separación libre en empalme : 6.20 [cm]

| Estado | Pos. | Pu<br>[Kg] | Mcxx<br>[Kg*m] | Mcyy<br>[Kg*m] | δnsxx | δnsyy | Cmxx  | Cmyy  |
|--------|------|------------|----------------|----------------|-------|-------|-------|-------|
| D1     | Sup. | -1163.78   | 98.48          | -179.23        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -6578.14   | 125.91         | 141.86         | 1.00  | 1.00  | 1.000 | 1.000 |
| D2     | Sup. | -860.35    | -76.04         | -108.51        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5387.34   | 268.08         | 91.77          | 1.00  | 1.00  | 1.000 | 1.000 |
| D3     | Sup. | -908.49    | -34.25         | -126.20        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5461.74   | 242.44         | 102.46         | 1.00  | 1.00  | 1.000 | 1.000 |
| D4     | Sup. | -931.29    | -4.66          | -199.79        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5601.11   | 152.56         | 192.97         | 1.00  | 1.00  | 1.000 | 1.000 |
| D5     | Sup. | -979.82    | 33.15          | -219.75        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5676.32   | 129.00         | 205.39         | 1.00  | 1.00  | 1.000 | 1.000 |
| D6     | Sup. | -723.04    | -236.94        | -63.44         | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5135.83   | 428.81         | 61.97          | 1.00  | 1.00  | 1.000 | 1.000 |
| D7     | Sup. | -819.28    | -153.39        | -98.79         | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5284.56   | 377.55         | 83.35          | 1.00  | 1.00  | 1.000 | 1.000 |
| D8     | Sup. | -864.81    | -94.24         | -245.89        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5563.17   | 197.79         | 264.35         | 1.00  | 1.00  | 1.000 | 1.000 |
| D9     | Sup. | -961.88    | -18.63         | -285.83        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5713.61   | 150.68         | 289.18         | 1.00  | 1.00  | 1.000 | 1.000 |
| D10    | Sup. | -474.10    | -257.09        | -25.15         | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -3727.41   | 400.71         | 31.66          | 1.00  | 1.00  | 1.000 | 1.000 |
| D11    | Sup. | -570.28    | -173.61        | -60.46         | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -3876.00   | 349.54         | 53.00          | 1.00  | 1.00  | 1.000 | 1.000 |
| D12    | Sup. | -615.42    | -114.95        | -207.22        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -4153.69   | 170.23         | 233.73         | 1.00  | 1.00  | 1.000 | 1.000 |
| D13    | Sup. | -712.43    | -39.40         | -247.11        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -4303.99   | 123.21         | 258.52         | 1.00  | 1.00  | 1.000 | 1.000 |
| D14    | Sup. | -1131.91   | -330.20        | -306.24        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5928.74   | -282.76        | 18.36          | 1.00  | 1.00  | 1.000 | 1.000 |
| D15    | Sup. | -1131.91   | -330.20        | -306.24        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5928.74   | -282.76        | 18.36          | 1.00  | 1.00  | 1.000 | 1.000 |
| D16    | Sup. | -882.71    | -350.85        | -267.83        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -4519.65   | -310.28        | -12.05         | 1.00  | 1.00  | 1.000 | 1.000 |
| D17    | Sup. | -882.71    | -350.85        | -267.83        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -4519.65   | -310.28        | -12.05         | 1.00  | 1.00  | 1.000 | 1.000 |
| D18    | Sup. | -1465.59   | 245.43         | -265.90        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -6073.00   | 163.32         | 119.81         | 1.00  | 1.00  | 1.000 | 1.000 |
| D19    | Sup. | -965.89    | 73.99          | -145.98        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5609.45   | 103.50         | 121.70         | 1.00  | 1.00  | 1.000 | 1.000 |
| D20    | Sup. | -997.73    | 84.94          | -153.62        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5639.00   | 107.30         | 121.58         | 1.00  | 1.00  | 1.000 | 1.000 |
| D21    | Sup. | -934.05    | 63.03          | -138.33        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5579.89   | 99.69          | 121.81         | 1.00  | 1.00  | 1.000 | 1.000 |
| D22    | Sup. | -997.73    | 84.94          | -153.62        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5639.00   | 107.30         | 121.58         | 1.00  | 1.00  | 1.000 | 1.000 |
| D23    | Sup. | -1015.19   | -136.95        | -133.40        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5406.49   | 464.08         | 60.78          | 1.00  | 1.00  | 1.000 | 1.000 |
| D24    | Sup. | -1111.50   | -53.34         | -168.82        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5555.36   | 412.76         | 82.19          | 1.00  | 1.00  | 1.000 | 1.000 |
| D25    | Sup. | -1157.44   | 6.25           | -316.35        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5834.88   | 232.73         | 263.33         | 1.00  | 1.00  | 1.000 | 1.000 |
| D26    | Sup. | -1254.59   | 81.90          | -356.37        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5985.46   | 185.58         | 288.18         | 1.00  | 1.00  | 1.000 | 1.000 |
| D27    | Sup. | -1226.49   | 163.53         | -208.48        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5851.24   | 134.64         | 120.70         | 1.00  | 1.00  | 1.000 | 1.000 |


|   |  |  |                        |  |
|---|--|--|------------------------|--|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |  |
|   | MEMORIA DE CÁLCULO   |  | IPE-2025-2977-S-MC-011 |  |
|   | TÍTULO:  |  | HOJA:                  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 44 de 140              |  |
|   |  |  | REV:                   |  |
|   |  |  | A                      |  |




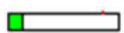






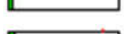


|     |      |          |         |         |      |      |       |       |
|-----|------|----------|---------|---------|------|------|-------|-------|
| D28 | Sup. | -1290.16 | 185.35  | -223.78 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -5910.30 | 142.27  | 120.47  | 1.00 | 1.00 | 1.000 | 1.000 |
| D29 | Sup. | -684.82  | 42.31   | -99.92  | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -4170.75 | 72.21   | 91.40   | 1.00 | 1.00 | 1.000 | 1.000 |
| D30 | Sup. | -748.53  | 64.30   | -115.21 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -4229.91 | 79.78   | 91.17   | 1.00 | 1.00 | 1.000 | 1.000 |
| D31 | Sup. | -1010.85 | 85.80   | -169.47 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -5664.16 | 106.23  | 131.22  | 1.00 | 1.00 | 1.000 | 1.000 |
| D32 | Sup. | -1010.85 | 85.80   | -169.47 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -5664.16 | 106.23  | 131.22  | 1.00 | 1.00 | 1.000 | 1.000 |
| D33 | Sup. | -1424.34 | -229.79 | -376.40 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -6200.04 | -247.79 | 17.25   | 1.00 | 1.00 | 1.000 | 1.000 |
| D34 | Sup. | -1424.34 | -229.79 | -376.40 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -6200.04 | -247.79 | 17.25   | 1.00 | 1.00 | 1.000 | 1.000 |
| D35 | Sup. | -1303.31 | 186.22  | -239.67 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -5935.52 | 141.20  | 130.11  | 1.00 | 1.00 | 1.000 | 1.000 |
| D36 | Sup. | -1303.31 | 186.22  | -239.67 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -5935.52 | 141.20  | 130.11  | 1.00 | 1.00 | 1.000 | 1.000 |
| D37 | Sup. | -761.62  | 65.14   | -131.03 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -4255.02 | 78.72   | 100.79  | 1.00 | 1.00 | 1.000 | 1.000 |
| D38 | Sup. | -761.62  | 65.14   | -131.03 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -4255.02 | 78.72   | 100.79  | 1.00 | 1.00 | 1.000 | 1.000 |

| Estado | Pos. | $\phi^*M_{nxx}$ | $\phi^*M_{nyy}$<br>[Kg*m] | $M_c/(\phi^*M_n)$<br>[Kg*m] | $P_u/(\phi^*P_n)$ | Asreq/Asprov | Relación de resistencia |   |
|--------|------|-----------------|---------------------------|-----------------------------|-------------------|--------------|-------------------------|---|
| D1     | Sup. | 1362.28         | -2479.36                  | 0.07                        | 0.02              | 0.92         | 0.07                    |  |
|        | Inf. | 2002.60         | 2256.25                   | 0.06                        | 0.09              | 0.92         | 0.09                    |  |
| D2     | Sup. | -1605.39        | -2290.83                  | 0.05                        | 0.01              | 0.92         | 0.05                    |  |
|        | Inf. | 2792.80         | 956.02                    | 0.10                        | 0.07              | 0.92         | 0.10                    |  |
| D3     | Sup. | -688.25         | -2536.23                  | 0.05                        | 0.01              | 0.92         | 0.05                    |  |
|        | Inf. | 2718.92         | 1149.11                   | 0.09                        | 0.08              | 0.92         | 0.09                    |  |
| D4     | Sup. | -59.68          | -2556.09                  | 0.08                        | 0.01              | 0.92         | 0.08                    |  |
|        | Inf. | 1904.95         | 2409.62                   | 0.08                        | 0.08              | 0.92         | 0.08                    |  |
| D5     | Sup. | 383.35          | -2541.55                  | 0.09                        | 0.01              | 0.92         | 0.09                    |  |
|        | Inf. | 1663.16         | 2647.99                   | 0.08                        | 0.08              | 0.92         | 0.08                    |  |
| D6     | Sup. | -2528.32        | -676.93                   | 0.09                        | 0.01              | 0.92         | 0.09                    |  |
|        | Inf. | 2915.30         | 421.31                    | 0.15                        | 0.07              | 0.92         | 0.15                    |  |
| D7     | Sup. | -2288.00        | -1473.63                  | 0.07                        | 0.01              | 0.92         | 0.07                    |  |
|        | Inf. | 2923.00         | 645.32                    | 0.13                        | 0.07              | 0.92         | 0.13                    |  |
| D8     | Sup. | -964.88         | -2517.62                  | 0.10                        | 0.01              | 0.92         | 0.10                    |  |
|        | Inf. | 1856.64         | 2481.47                   | 0.11                        | 0.08              | 0.92         | 0.11                    |  |
| D9     | Sup. | -166.17         | -2549.18                  | 0.11                        | 0.01              | 0.92         | 0.11                    |  |
|        | Inf. | 1457.65         | 2797.41                   | 0.10                        | 0.08              | 0.92         | 0.10                    |  |
| D10    | Sup. | -2518.54        | -246.36                   | 0.10                        | 0.01              | 0.92         | 0.10                    |  |
|        | Inf. | 2812.48         | 222.18                    | 0.14                        | 0.05              | 0.92         | 0.14                    |  |
| D11    | Sup. | -2502.35        | -871.48                   | 0.07                        | 0.01              | 0.92         | 0.07                    |  |
|        | Inf. | 2808.87         | 425.93                    | 0.12                        | 0.05              | 0.92         | 0.12                    |  |

|   |  |  |  |  |  |                        |  |
|---|--|--|--|--|--|------------------------|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  | IPE-2025-2977-S-MC-011 |  |
|   | TÍTULO:  |  |  |  |  | HOJA:                  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  | 45 de 140              |  |
|   |  |  |  |  |  | REV:                   |  |
|   |  |  |  |  |  | A                      |  |

|     |      |          |          |      |      |      |      |  |
|-----|------|----------|----------|------|------|------|------|--|
| D12 | Sup. | -1349.41 | -2432.65 | 0.09 | 0.01 | 0.92 | 0.09 |  |
|     | Inf. | 1773.45  | 2435.05  | 0.10 | 0.06 | 0.92 | 0.10 |  |
| D13 | Sup. | -401.30  | -2517.17 | 0.10 | 0.01 | 0.92 | 0.10 |  |
|     | Inf. | 1316.48  | 2762.29  | 0.09 | 0.06 | 0.92 | 0.09 |  |
| D14 | Sup. | -2044.75 | -1896.35 | 0.16 | 0.02 | 0.92 | 0.16 |  |
|     | Inf. | -2997.52 | 194.62   | 0.09 | 0.08 | 0.92 | 0.09 |  |
| D15 | Sup. | -2044.75 | -1896.35 | 0.16 | 0.02 | 0.92 | 0.16 |  |
|     | Inf. | -2997.52 | 194.62   | 0.09 | 0.08 | 0.92 | 0.09 |  |
| D16 | Sup. | -2197.62 | -1677.62 | 0.16 | 0.01 | 0.92 | 0.16 |  |
|     | Inf. | -2886.75 | -112.14  | 0.11 | 0.06 | 0.92 | 0.11 |  |
| D17 | Sup. | -2197.62 | -1677.62 | 0.16 | 0.01 | 0.92 | 0.16 |  |
|     | Inf. | -2886.75 | -112.14  | 0.11 | 0.06 | 0.92 | 0.11 |  |
| D18 | Sup. | 1911.18  | -2070.57 | 0.13 | 0.02 | 0.92 | 0.13 |  |
|     | Inf. | 2348.44  | 1722.79  | 0.07 | 0.08 | 0.92 | 0.08 |  |
| D19 | Sup. | 1259.47  | -2484.91 | 0.06 | 0.01 | 0.92 | 0.06 |  |
|     | Inf. | 1954.89  | 2298.63  | 0.05 | 0.08 | 0.92 | 0.08 |  |
| D20 | Sup. | 1362.27  | -2463.80 | 0.06 | 0.01 | 0.92 | 0.06 |  |
|     | Inf. | 1982.68  | 2246.47  | 0.05 | 0.08 | 0.92 | 0.08 |  |
| D21 | Sup. | 1138.74  | -2499.14 | 0.06 | 0.01 | 0.92 | 0.06 |  |
|     | Inf. | 1927.43  | 2355.07  | 0.05 | 0.08 | 0.92 | 0.08 |  |
| D22 | Sup. | 1362.27  | -2463.80 | 0.06 | 0.01 | 0.92 | 0.06 |  |
|     | Inf. | 1982.68  | 2246.47  | 0.05 | 0.08 | 0.92 | 0.08 |  |
| D23 | Sup. | -1993.70 | -1942.11 | 0.07 | 0.01 | 0.92 | 0.07 |  |
|     | Inf. | 2939.55  | 385.02   | 0.16 | 0.07 | 0.92 | 0.16 |  |
| D24 | Sup. | -805.45  | -2549.10 | 0.07 | 0.02 | 0.92 | 0.07 |  |
|     | Inf. | 2949.06  | 587.21   | 0.14 | 0.08 | 0.92 | 0.14 |  |
| D25 | Sup. | 50.92    | -2577.04 | 0.12 | 0.02 | 0.92 | 0.12 |  |
|     | Inf. | 1986.96  | 2248.19  | 0.12 | 0.08 | 0.92 | 0.12 |  |
| D26 | Sup. | 589.71   | -2565.89 | 0.14 | 0.02 | 0.92 | 0.14 |  |
|     | Inf. | 1702.65  | 2644.00  | 0.11 | 0.08 | 0.92 | 0.11 |  |
| D27 | Sup. | 1735.54  | -2212.68 | 0.09 | 0.02 | 0.92 | 0.09 |  |
|     | Inf. | 2172.65  | 1947.71  | 0.06 | 0.08 | 0.92 | 0.08 |  |
| D28 | Sup. | 1792.96  | -2164.66 | 0.10 | 0.02 | 0.92 | 0.10 |  |
|     | Inf. | 2220.42  | 1880.06  | 0.06 | 0.08 | 0.92 | 0.08 |  |
| D29 | Sup. | 1054.23  | -2489.69 | 0.04 | 0.01 | 0.92 | 0.04 |  |
|     | Inf. | 1860.78  | 2355.26  | 0.04 | 0.06 | 0.92 | 0.06 |  |
| D30 | Sup. | 1362.02  | -2440.47 | 0.05 | 0.01 | 0.92 | 0.05 |  |
|     | Inf. | 1953.60  | 2232.43  | 0.04 | 0.06 | 0.92 | 0.06 |  |
| D31 | Sup. | 1259.94  | -2488.69 | 0.07 | 0.01 | 0.92 | 0.07 |  |
|     | Inf. | 1921.16  | 2373.00  | 0.06 | 0.08 | 0.92 | 0.08 |  |
| D32 | Sup. | 1259.94  | -2488.69 | 0.07 | 0.01 | 0.92 | 0.07 |  |

|   |                    |  |                        |           |
|---|--------------------|--|------------------------|-----------|
|  | TIPO DE DOCUMENTO: |  | CÓDIGO DEL DOCUMENTO:  |           |
|   | MEMORIA DE CÁLCULO |  | IPE-2025-2977-S-MC-011 |           |
|   | TÍTULO:            |  | HOJA:                  |           |
|   |                    | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |                        | 46 de 140 |
|   |                    |  |                        | REV:      |
|   |                    |  |                        | A         |

|     |      |          |          |      |      |      |      |   |
|-----|------|----------|----------|------|------|------|------|---|
| D33 | Inf. | 1921.16  | 2373.00  | 0.06 | 0.08 | 0.92 | 0.08 |  |
|     | Sup. | -1489.73 | -2440.21 | 0.15 | 0.02 | 0.92 | 0.15 |  |
| D34 | Inf. | -3017.88 | 210.04   | 0.08 | 0.09 | 0.92 | 0.09 |  |
|     | Sup. | -1489.73 | -2440.21 | 0.15 | 0.02 | 0.92 | 0.15 |  |
| D35 | Inf. | -3017.88 | 210.04   | 0.08 | 0.09 | 0.92 | 0.09 |  |
|     | Sup. | 1729.17  | -2225.43 | 0.11 | 0.02 | 0.92 | 0.11 |  |
| D36 | Inf. | 2151.58  | 1982.73  | 0.07 | 0.08 | 0.92 | 0.08 |  |
|     | Sup. | 1729.17  | -2225.43 | 0.11 | 0.02 | 0.92 | 0.11 |  |
| D37 | Inf. | 2151.58  | 1982.73  | 0.07 | 0.08 | 0.92 | 0.08 |  |
|     | Sup. | 1228.89  | -2471.74 | 0.05 | 0.01 | 0.92 | 0.05 |  |
| D38 | Inf. | 1851.83  | 2370.98  | 0.04 | 0.06 | 0.92 | 0.06 |  |
|     | Sup. | 1228.89  | -2471.74 | 0.05 | 0.01 | 0.92 | 0.05 |  |
|     | Inf. | 1851.83  | 2370.98  | 0.04 | 0.06 | 0.92 | 0.06 |  |

#### Cortantes

S adoptado : 18.00 [cm] S calculado : 19.20 [cm]

| Dir | Estado Gob. | Pos. | Vu [Kg] | Vc [Kg] | Vs [Kg] | $\phi \cdot Vn$ [Kg] | $Vu/(\phi \cdot Vn)$ |
|-----|-------------|------|---------|---------|---------|----------------------|----------------------|
| 2   | D14         | Sup. | 401.42  | 4213.00 | 4952.87 | 6874.41              | 0.13                 |
|     |             | Inf. | 989.78  | 4887.76 | 4952.87 | 7380.47              | 0.13                 |
| 3   | D9          | Sup. | 202.19  | 4189.08 | 4952.87 | 6856.47              | 0.08                 |
|     |             | Inf. | 552.01  | 4857.49 | 4952.87 | 7357.78              | 0.08                 |

Se utilizo el diseño de la columna más crítica a continuación se mostrará el resumen de diseño de las otras columnas.


**Figura 24.** Resumen de diseño de columnas.

| Columnas |             |            |            |          |                 |              |         |         |                          |            |
|----------|-------------|------------|------------|----------|-----------------|--------------|---------|---------|--------------------------|------------|
| COL ID   | Faxial [Kg] | M33 [Kg*m] | M22 [Kg*m] | Carga ID | A.cálculo [cm2] | Longitud [m] | V3 [Kg] | V2 [Kg] | Sep. Estribos Barra [cm] | B x H [cm] |
| 1        | -676.50     | 519.80     | -32.01     | D18      | 6.25            | 4.20         | 17.00   | 291.50  | T8 19.20                 | 25x25      |
| 2        | -2561.00    | -836.50    | 1391.00    | D18      | 6.25            | 4.20         | 784.40  | 484.50  | T8 19.20                 | 25x25      |
| 4        | -1994.00    | 955.70     | 230.60     | D18      | 6.25            | 4.20         | 134.90  | 526.60  | T8 19.20                 | 25x25      |

Al tener similares carga y armadura de cálculo similar asumiremos la de la más crítica teniendo el siguiente armado:

Columna C-01 (01/02/03/04)

Sección de la columna 25 cm x 25 cm

|   |   |                               |
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Armadura Longitudinal: 6 Ø 12 mm  $A_s = 6.78 \text{ cm}^2$

Armadura Transversal: Ø 8 mm c/15 cm

### 8.1.2. COLUMNA C-02


## Resultados de Diseño Columnas de Hormigón Armado

### Datos Generales

Código de diseño : ACI 318-2019

#### Estados de carga considerados en el diseño:

|     |   |                     |
|-----|---|---------------------|
| D1  | : | 1.4CM               |
| D2  | : | 1.2CM+0.5VxCASOAPOS |
| D3  | : | 1.2CM+0.5VxCASOANEG |
| D4  | : | 1.2CM+0.5VzCASOAPOS |
| D5  | : | 1.2CM+0.5VzCASOANEG |
| D6  | : | 1.2CM+VxCASOAPOS    |
| D7  | : | 1.2CM+VxCASOANEG    |
| D8  | : | 1.2CM+VzCASOAPOS    |
| D9  | : | 1.2CM+VzCASOANEG    |
| D10 | : | 0.9CM+VxCASOAPOS    |
| D11 | : | 0.9CM+VxCASOANEG    |
| D12 | : | 0.9CM+VzCASOAPOS    |
| D13 | : | 0.9CM+VzCASOANEG    |
| D14 | : | 1.2CM+EQx           |
| D15 | : | 1.2CM+EQz           |
| D16 | : | 0.9CM+EQx           |
| D17 | : | 0.9CM+EQz           |
| D18 | : | 1.2CM+1.6CV         |
| D19 | : | 1.2CM+0.5VzCASOBPOS |
| D20 | : | 1.2CM+0.5VzCASOBNEG |
| D21 | : | 1.2CM+VzCASOBPOS    |
| D22 | : | 1.2CM+VzCASOBNEG    |
| D23 | : | 1.2CM+VxCASOAPOS+CV |
| D24 | : | 1.2CM+VxCASOANEG+CV |
| D25 | : | 1.2CM+VzCASOAPOS+CV |
| D26 | : | 1.2CM+VzCASOANEG+CV |
| D27 | : | 1.2CM+VzCASOBPOS+CV |
| D28 | : | 1.2CM+VzCASOBNEG+CV |
| D29 | : | 0.9CM+VzCASOBPOS    |
| D30 | : | 0.9CM+VzCASOBNEG    |
| D31 | : | 1.2CM+EQxCUB        |
| D32 | : | 1.2CM+EQzCUB        |
| D33 | : | 1.2CM+EQx+CV        |
| D34 | : | 1.2CM+EQz+CV        |
| D35 | : | 1.2CM+EQxCUB+CV     |
| D36 | : | 1.2CM+EQzCUB+CV     |
| D37 | : | 0.9CM+EQxCUB        |
| D38 | : | 0.9CM+EQzCUB        |

|   |   |                               |
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#### Materiales

|                         |                     |                         |                  |
|-------------------------|---------------------|-------------------------|------------------|
| Hormigón, $f_c$         | : 2100000.00 [Kg... | Acero, $f_y$            | : 4.2E07 [Kg/m2] |
| Tipo de concreto        | : Normal            | Acero, $f_{yt}$         | : 4.2E07 [Kg/m2] |
| Módulo de elasticidad   | : 2.14E09 [Kg/m2]   | Tipo de empalmes        | : Tangencial     |
| Peso unitario           | : 2400.00 [Kg/m3]   | Cuantía mínima adoptada | : 0.010          |
| Cuantía máxima adoptada | : 0.080             |                         |                  |
| Estatus general         | : Bien              |                         |                  |

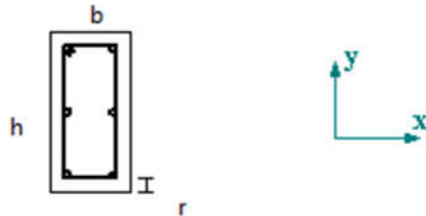
## Columna 1

### Datos

#### **Geometría**

|                           |               |
|---------------------------|---------------|
| Tipo de sección           | : Rectangular |
| Posición de la columna    | : Centro      |
| Distancia entre niveles   | : 4.20 [m]    |
| Ancho $b$ (// a eje $x$ ) | : 15.00 [cm]  |
| Alto $h$ (// a eje $y$ )  | : 30.00 [cm]  |

#### **Armadura**




|                                   |                     |
|-----------------------------------|---------------------|
| Longitudinal                      | : 6-12mm            |
| Recubrimiento libre               | : 2.50 [cm]         |
| As provista                       | : 6.78 [cm2]        |
| Cuantía provista                  | : 0.015             |
| Número de barras // a la cara $x$ | : 2                 |
| Con una separación entre barras   | : 6.00 [cm]         |
| Número de barras // a la cara $y$ | : 3                 |
| Con una separación entre barras   | : 9.90 [cm]         |
| Transversal                       | : 31 8mm c/ 12.00cm |
| Número de ramas // a eje $x$      | : 2                 |
| Número de ramas // a eje $y$      | : 2                 |

#### **Parámetros de diseño**


| Esbeltez | Eje $yy$ | Eje $xx$  |
|----------|----------|-----------|
| Lu[cm]   | 420.00   | 420.00    |
| K        | 1.00     | 1.00      |
| Pc[Kg]   | 25256.24 | 101025.00 |
| Sway     | Si       | Si        |




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### Solicitaciones

| <u>transversal</u> | Estado | Posición | Pu       | Muxx    | Muyy    | Vx      | Vy      | <u>Carga</u> |
|--------------------|--------|----------|----------|---------|---------|---------|---------|--------------|
|                    |        |          | [Kg]     | [Kg*m]  | [Kg*m]  | [Kg]    | [Kg]    | xx           |
|                    | yy     |          |          |         |         |         |         |              |
|                    | D1     | Sup.     | -2182.50 | 1054.50 | -417.78 | 296.79  | 705.81  | No           |
|                    | No     | Inferior | -8503.30 | -562.86 | 546.76  | 1103.49 | 1760.11 | No           |
|                    | No     | Sup.     | -1845.62 | 844.44  | -399.46 | 267.98  | 547.79  | No           |
|                    | D2     | Inferior | -7313.40 | -442.87 | 529.02  | 1030.17 | 1472.22 | No           |
|                    | No     | Sup.     | -1874.58 | 875.36  | -400.21 | 275.23  | 574.85  | No           |
|                    | D3     | Inferior | -7337.49 | -461.26 | 519.11  | 1017.01 | 1488.66 | No           |
|                    | No     | Sup.     | -1800.74 | 935.24  | -340.38 | 227.37  | 632.47  | No           |
|                    | D4     | Inferior | -7289.64 | -610.21 | 486.27  | 970.52  | 1637.98 | No           |
|                    | No     | Sup.     | -1831.76 | 964.19  | -342.86 | 235.75  | 657.88  | No           |
|                    | D5     | Inferior | -7315.57 | -625.42 | 477.32  | 958.64  | 1651.44 | No           |
|                    | No     | Sup.     | -1820.69 | 785.06  | -441.07 | 281.40  | 490.65  | No           |
|                    | D6     | Inferior | -7338.36 | -403.29 | 589.75  | 1114.38 | 1435.89 | No           |
|                    | No     | Sup.     | -1878.63 | 846.88  | -442.57 | 295.89  | 544.76  | No           |
|                    | D7     | Inferior | -7386.56 | -440.05 | 569.95  | 1088.07 | 1468.77 | No           |
|                    | No     | Sup.     | -1730.93 | 966.51  | -322.94 | 200.20  | 659.93  | No           |
|                    | D8     | Inferior | -7290.79 | -737.90 | 504.27  | 995.09  | 1767.39 | No           |
|                    | No     | Sup.     | -1793.01 | 1024.48 | -327.90 | 216.94  | 710.77  | No           |
|                    | D9     | Inferior | -7342.71 | -768.34 | 486.38  | 971.33  | 1794.33 | No           |
|                    | No     | Sup.     | -1352.64 | 559.26  | -351.07 | 218.09  | 339.43  | No           |
|                    | D10    | Inferior | -5515.73 | -282.87 | 472.07  | 878.17  | 1058.65 | No           |
|                    | No     | Sup.     | -1410.59 | 620.97  | -352.61 | 232.57  | 393.51  | No           |
|                    | D11    | Inferior | -5563.96 | -319.54 | 452.30  | 851.83  | 1091.51 | No           |
|                    | No     | Sup.     | -1262.93 | 739.99  | -233.20 | 136.80  | 508.50  | No           |
|                    | D12    | Inferior | -5468.09 | -616.74 | 386.78  | 758.83  | 1389.97 | No           |
|                    | No     | Sup.     | -1325.02 | 797.87  | -238.18 | 153.53  | 559.31  | No           |
|                    | D13    |          |          |         |         |         |         |              |
|                    | No     |          |          |         |         |         |         |              |

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|-----|----------|----------|---------|---------|---------|---------|----|
|     | Inferior | -5520.04 | -647.11 | 368.91  | 735.05  | 1416.90 | No |
| No  | Sup.     | -2133.01 | 673.98  | -594.10 | 406.53  | 767.05  | No |
| D14 |          |          |         |         |         |         |    |
| No  | Inferior | -7829.70 | -687.96 | 306.37  | 1172.68 | 1666.77 | No |
| No  | Sup.     | -2133.01 | 673.98  | -594.10 | 406.53  | 767.05  | No |
| D15 |          |          |         |         |         |         |    |
| No  | Inferior | -7829.70 | -687.96 | 306.37  | 1172.68 | 1666.77 | No |
| No  | Sup.     | -1665.14 | 447.99  | -504.33 | 343.07  | 615.78  | No |
| D16 |          |          |         |         |         |         |    |
| No  | Inferior | -6007.42 | -567.36 | 188.86  | 936.28  | 1289.50 | No |
| No  | Sup.     | -1665.14 | 447.99  | -504.33 | 343.07  | 615.78  | No |
| D17 |          |          |         |         |         |         |    |
| No  | Inferior | -6007.42 | -567.36 | 188.86  | 936.28  | 1289.50 | No |
| No  | Sup.     | -2464.48 | 1161.26 | -529.16 | 349.47  | 727.40  | No |
| D18 |          |          |         |         |         |         |    |
| No  | Inferior | -7946.30 | -444.69 | 473.64  | 933.46  | 1414.40 | No |
| No  | Sup.     | -1830.09 | 886.32  | -346.16 | 248.08  | 596.62  | No |
| D19 |          |          |         |         |         |         |    |
| No  | Inferior | -7243.62 | -485.04 | 467.90  | 946.78  | 1514.95 | No |
| No  | Sup.     | -1870.50 | 903.83  | -357.81 | 254.55  | 604.95  | No |
| D20 |          |          |         |         |         |         |    |
| No  | Inferior | -7288.38 | -482.46 | 468.26  | 945.93  | 1508.55 | No |
| No  | Sup.     | -1789.67 | 868.81  | -334.51 | 241.61  | 588.30  | No |
| D21 |          |          |         |         |         |         |    |
| No  | Inferior | -7198.87 | -487.61 | 467.53  | 947.63  | 1521.36 | No |
| No  | Sup.     | -1870.50 | 903.83  | -357.81 | 254.55  | 604.95  | No |
| D22 |          |          |         |         |         |         |    |
| No  | Inferior | -7288.38 | -482.46 | 468.26  | 945.93  | 1508.55 | No |
| No  | Sup.     | -2192.05 | 945.76  | -548.34 | 340.66  | 567.08  | No |
| D23 |          |          |         |         |         |         |    |
| No  | Inferior | -7749.74 | -379.64 | 593.22  | 1106.64 | 1377.16 | No |
| No  | Sup.     | -2249.98 | 1007.69 | -549.81 | 355.16  | 621.25  | No |
| D24 |          |          |         |         |         |         |    |
| No  | Inferior | -7797.95 | -416.44 | 573.40  | 1080.31 | 1410.01 | No |
| No  | Sup.     | -2102.29 | 1128.01 | -429.98 | 259.50  | 736.74  | No |
| D25 |          |          |         |         |         |         |    |
| No  | Inferior | -7702.31 | -714.62 | 507.61  | 987.25  | 1708.59 | No |
| No  | Sup.     | -2164.35 | 1186.07 | -434.90 | 276.25  | 787.63  | No |
| D26 |          |          |         |         |         |         |    |
| No  | Inferior | -7754.23 | -745.09 | 489.70  | 963.48  | 1735.50 | No |
| No  | Sup.     | -2160.82 | 1029.67 | -441.55 | 300.97  | 664.80  | No |
| D27 |          |          |         |         |         |         |    |
| No  | Inferior | -7609.92 | -464.03 | 470.87  | 939.82  | 1462.56 | No |
| No  |          |          |         |         |         |         |    |

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|     |          |          |         |         |         |         |    |
|-----|----------|----------|---------|---------|---------|---------|----|
| D28 | Sup.     | -2241.69 | 1064.70 | -464.88 | 313.89  | 681.46  | No |
| No  | Inferior | -7699.49 | -458.87 | 471.61  | 938.13  | 1449.73 | No |
| No  | Sup.     | -1321.84 | 642.82  | -244.76 | 178.12  | 437.03  | No |
| D29 | Inferior | -5376.66 | -367.00 | 350.05  | 711.24  | 1144.06 | No |
| No  | Sup.     | -1402.64 | 677.84  | -268.05 | 191.09  | 453.67  | No |
| D30 | Inferior | -5466.10 | -361.87 | 350.76  | 709.54  | 1131.27 | No |
| No  | Sup.     | -1875.99 | 920.41  | -357.23 | 254.14  | 617.23  | No |
| D31 | Inferior | -7301.59 | -496.82 | 467.86  | 945.42  | 1518.14 | No |
| No  | Sup.     | -1875.99 | 920.41  | -357.23 | 254.14  | 617.23  | No |
| D32 | Inferior | -7301.59 | -496.82 | 467.86  | 945.42  | 1518.14 | No |
| No  | Sup.     | -2504.19 | 834.85  | -701.16 | 465.87  | 843.57  | No |
| D33 | Inferior | -8240.81 | -664.36 | 309.71  | 1164.87 | 1607.96 | No |
| No  | Sup.     | -2504.19 | 834.85  | -701.16 | 465.87  | 843.57  | No |
| D34 | Inferior | -8240.81 | -664.36 | 309.71  | 1164.87 | 1607.96 | No |
| No  | Sup.     | -2247.19 | 1081.34 | -464.29 | 313.49  | 693.77  | No |
| D35 | Inferior | -7712.73 | -473.25 | 471.21  | 937.61  | 1459.32 | No |
| No  | Sup.     | -2247.19 | 1081.34 | -464.29 | 313.49  | 693.77  | No |
| D36 | Inferior | -7712.73 | -473.25 | 471.21  | 937.61  | 1459.32 | No |
| No  | Sup.     | -1408.11 | 694.37  | -267.47 | 190.69  | 465.94  | No |
| D37 | Inferior | -5479.28 | -376.19 | 350.37  | 709.03  | 1140.86 | No |
| No  | Sup.     | -1408.11 | 694.37  | -267.47 | 190.69  | 465.94  | No |
| D38 | Inferior | -5479.28 | -376.19 | 350.37  | 709.03  | 1140.86 | No |
| No  |          |          |         |         |         |         |    |
| No  |          |          |         |         |         |         |    |

## Diseño


Estatus de la columna : Bien

### Compresión biaxial

Estado gobernante : D33  
Esfuerzos en barras : fs>0.5fy  
Longitud de empalme : 69.00 [cm]  
Separación libre en empalme : 4.80 [cm]


|   |  |  |                       |
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|   |  |  | A                     |

| Estado | Pos. | Pu<br>[Kg] | Mcxx<br>[Kg*m] | Mcyy<br>[Kg*m] | δnsxx | δnsyy | Cmxx  | Cmyy  |
|--------|------|------------|----------------|----------------|-------|-------|-------|-------|
| D1     | Sup. | -2182.50   | 1054.50        | -417.78        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -8503.30   | -562.86        | 546.76         | 1.00  | 1.00  | 1.000 | 1.000 |
| D2     | Sup. | -1845.62   | 844.44         | -399.46        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7313.40   | -442.87        | 529.02         | 1.00  | 1.00  | 1.000 | 1.000 |
| D3     | Sup. | -1874.58   | 875.36         | -400.21        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7337.49   | -461.26        | 519.11         | 1.00  | 1.00  | 1.000 | 1.000 |
| D4     | Sup. | -1800.74   | 935.24         | -340.38        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7289.64   | -610.21        | 486.27         | 1.00  | 1.00  | 1.000 | 1.000 |
| D5     | Sup. | -1831.76   | 964.19         | -342.86        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7315.57   | -625.42        | 477.32         | 1.00  | 1.00  | 1.000 | 1.000 |
| D6     | Sup. | -1820.69   | 785.06         | -441.07        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7338.36   | -403.29        | 589.75         | 1.00  | 1.00  | 1.000 | 1.000 |
| D7     | Sup. | -1878.63   | 846.88         | -442.57        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7386.56   | -440.05        | 569.95         | 1.00  | 1.00  | 1.000 | 1.000 |
| D8     | Sup. | -1730.93   | 966.51         | -322.94        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7290.79   | -737.90        | 504.27         | 1.00  | 1.00  | 1.000 | 1.000 |
| D9     | Sup. | -1793.01   | 1024.48        | -327.90        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7342.71   | -768.34        | 486.38         | 1.00  | 1.00  | 1.000 | 1.000 |
| D10    | Sup. | -1352.64   | 559.26         | -351.07        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5515.73   | -282.87        | 472.07         | 1.00  | 1.00  | 1.000 | 1.000 |
| D11    | Sup. | -1410.59   | 620.97         | -352.61        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5563.96   | -319.54        | 452.30         | 1.00  | 1.00  | 1.000 | 1.000 |
| D12    | Sup. | -1262.93   | 739.99         | -233.20        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5468.09   | -616.74        | 386.78         | 1.00  | 1.00  | 1.000 | 1.000 |
| D13    | Sup. | -1325.02   | 797.87         | -238.18        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -5520.04   | -647.11        | 368.91         | 1.00  | 1.00  | 1.000 | 1.000 |
| D14    | Sup. | -2133.01   | 673.98         | -594.10        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7829.70   | -687.96        | 306.37         | 1.00  | 1.00  | 1.000 | 1.000 |
| D15    | Sup. | -2133.01   | 673.98         | -594.10        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7829.70   | -687.96        | 306.37         | 1.00  | 1.00  | 1.000 | 1.000 |
| D16    | Sup. | -1665.14   | 447.99         | -504.33        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -6007.42   | -567.36        | 188.86         | 1.00  | 1.00  | 1.000 | 1.000 |
| D17    | Sup. | -1665.14   | 447.99         | -504.33        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -6007.42   | -567.36        | 188.86         | 1.00  | 1.00  | 1.000 | 1.000 |
| D18    | Sup. | -2464.48   | 1161.26        | -529.16        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7946.30   | -444.69        | 473.64         | 1.00  | 1.00  | 1.000 | 1.000 |
| D19    | Sup. | -1830.09   | 886.32         | -346.16        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7243.62   | -485.04        | 467.90         | 1.00  | 1.00  | 1.000 | 1.000 |
| D20    | Sup. | -1870.50   | 903.83         | -357.81        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7288.38   | -482.46        | 468.26         | 1.00  | 1.00  | 1.000 | 1.000 |
| D21    | Sup. | -1789.67   | 868.81         | -334.51        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7198.87   | -487.61        | 467.53         | 1.00  | 1.00  | 1.000 | 1.000 |
| D22    | Sup. | -1870.50   | 903.83         | -357.81        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7288.38   | -482.46        | 468.26         | 1.00  | 1.00  | 1.000 | 1.000 |
| D23    | Sup. | -2192.05   | 945.76         | -548.34        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7749.74   | -379.64        | 593.22         | 1.00  | 1.00  | 1.000 | 1.000 |
| D24    | Sup. | -2249.98   | 1007.69        | -549.81        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7797.95   | -416.44        | 573.40         | 1.00  | 1.00  | 1.000 | 1.000 |
| D25    | Sup. | -2102.29   | 1128.01        | -429.98        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7702.31   | -714.62        | 507.61         | 1.00  | 1.00  | 1.000 | 1.000 |
| D26    | Sup. | -2164.35   | 1186.07        | -434.90        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7754.23   | -745.09        | 489.70         | 1.00  | 1.00  | 1.000 | 1.000 |
| D27    | Sup. | -2160.82   | 1029.67        | -441.55        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7609.92   | -464.03        | 470.87         | 1.00  | 1.00  | 1.000 | 1.000 |
| D28    | Sup. | -2241.69   | 1064.70        | -464.88        | 1.00  | 1.00  | 1.000 | 1.000 |
|        | Inf. | -7699.49   | -458.87        | 471.61         | 1.00  | 1.00  | 1.000 | 1.000 |


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|-----|------|----------|---------|---------|------|------|-------|-------|
| D29 | Sup. | -1321.84 | 642.82  | -244.76 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -5376.66 | -367.00 | 350.05  | 1.00 | 1.00 | 1.000 | 1.000 |
| D30 | Sup. | -1402.64 | 677.84  | -268.05 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -5466.10 | -361.87 | 350.76  | 1.00 | 1.00 | 1.000 | 1.000 |
| D31 | Sup. | -1875.99 | 920.41  | -357.23 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -7301.59 | -496.82 | 467.86  | 1.00 | 1.00 | 1.000 | 1.000 |
| D32 | Sup. | -1875.99 | 920.41  | -357.23 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -7301.59 | -496.82 | 467.86  | 1.00 | 1.00 | 1.000 | 1.000 |
| D33 | Sup. | -2504.19 | 834.85  | -701.16 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -8240.81 | -664.36 | 309.71  | 1.00 | 1.00 | 1.000 | 1.000 |
| D34 | Sup. | -2504.19 | 834.85  | -701.16 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -8240.81 | -664.36 | 309.71  | 1.00 | 1.00 | 1.000 | 1.000 |
| D35 | Sup. | -2247.19 | 1081.34 | -464.29 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -7712.73 | -473.25 | 471.21  | 1.00 | 1.00 | 1.000 | 1.000 |
| D36 | Sup. | -2247.19 | 1081.34 | -464.29 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -7712.73 | -473.25 | 471.21  | 1.00 | 1.00 | 1.000 | 1.000 |
| D37 | Sup. | -1408.11 | 694.37  | -267.47 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -5479.28 | -376.19 | 350.37  | 1.00 | 1.00 | 1.000 | 1.000 |
| D38 | Sup. | -1408.11 | 694.37  | -267.47 | 1.00 | 1.00 | 1.000 | 1.000 |
|     | Inf. | -5479.28 | -376.19 | 350.37  | 1.00 | 1.00 | 1.000 | 1.000 |

| Estado | Pos. | $\phi^*M_{nxx}$ | $\phi^*M_{nyy}$<br>[Kg*m] | $M_c/(\phi^*M_n)$<br>[Kg*m] | $P_u/(\phi^*P_n)$ | Asreq/Asprov | Relación de resistencia |                        |
|--------|------|-----------------|---------------------------|-----------------------------|-------------------|--------------|-------------------------|------------------------|
| D1     | Sup. | 2104.63         | -833.82                   | 0.50                        | 0.04              | 0.66         | 0.50                    | <div><div></div></div> |
|        | Inf. | -1328.23        | 1290.24                   | 0.42                        | 0.15              | 0.66         | 0.42                    | <div><div></div></div> |
| D2     | Sup. | 1933.46         | -914.63                   | 0.44                        | 0.03              | 0.66         | 0.44                    | <div><div></div></div> |
|        | Inf. | -1111.80        | 1328.07                   | 0.40                        | 0.13              | 0.66         | 0.40                    | <div><div></div></div> |
| D3     | Sup. | 1965.01         | -898.39                   | 0.45                        | 0.03              | 0.66         | 0.45                    | <div><div></div></div> |
|        | Inf. | -1169.91        | 1316.65                   | 0.39                        | 0.13              | 0.66         | 0.39                    | <div><div></div></div> |
| D4     | Sup. | 2177.88         | -792.65                   | 0.43                        | 0.03              | 0.66         | 0.43                    | <div><div></div></div> |
|        | Inf. | -1521.14        | 1212.18                   | 0.40                        | 0.13              | 0.66         | 0.40                    | <div><div></div></div> |
| D5     | Sup. | 2201.11         | -782.70                   | 0.44                        | 0.03              | 0.66         | 0.44                    | <div><div></div></div> |
|        | Inf. | -1562.82        | 1192.76                   | 0.40                        | 0.13              | 0.66         | 0.40                    | <div><div></div></div> |
| D6     | Sup. | 1782.35         | -1001.36                  | 0.44                        | 0.03              | 0.66         | 0.44                    | <div><div></div></div> |
|        | Inf. | -937.57         | 1371.07                   | 0.43                        | 0.13              | 0.66         | 0.43                    | <div><div></div></div> |
| D7     | Sup. | 1846.64         | -965.04                   | 0.46                        | 0.03              | 0.66         | 0.46                    | <div><div></div></div> |
|        | Inf. | -1038.89        | 1345.58                   | 0.42                        | 0.13              | 0.66         | 0.42                    | <div><div></div></div> |
| D8     | Sup. | 2257.50         | -754.29                   | 0.43                        | 0.03              | 0.66         | 0.43                    | <div><div></div></div> |
|        | Inf. | -1673.38        | 1143.57                   | 0.44                        | 0.13              | 0.66         | 0.44                    | <div><div></div></div> |
| D9     | Sup. | 2296.80         | -735.12                   | 0.45                        | 0.03              | 0.66         | 0.45                    | <div><div></div></div> |
|        | Inf. | -1749.93        | 1107.76                   | 0.44                        | 0.13              | 0.66         | 0.44                    | <div><div></div></div> |
| D10    | Sup. | 1664.86         | -1045.10                  | 0.34                        | 0.02              | 0.66         | 0.34                    | <div><div></div></div> |
|        | Inf. | -826.79         | 1379.79                   | 0.34                        | 0.10              | 0.66         | 0.34                    | <div><div></div></div> |
| D11    | Sup. | 1765.44         | -1002.48                  | 0.35                        | 0.03              | 0.66         | 0.35                    | <div><div></div></div> |
|        | Inf. | -948.62         | 1342.73                   | 0.34                        | 0.10              | 0.66         | 0.34                    | <div><div></div></div> |
| D12    | Sup. | 2299.48         | -724.64                   | 0.32                        | 0.02              | 0.66         | 0.32                    | <div><div></div></div> |

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|-----|------|----------|----------|------|------|------|------|--|
|     | Inf. | -1748.24 | 1096.38  | 0.35 | 0.10 | 0.66 | 0.35 |  |
| D13 | Sup. | 2348.16  | -700.99  | 0.34 | 0.02 | 0.66 | 0.34 |  |
|     | Inf. | -1838.56 | 1048.14  | 0.35 | 0.10 | 0.66 | 0.35 |  |
| D14 | Sup. | 1337.03  | -1178.57 | 0.50 | 0.04 | 0.66 | 0.50 |  |
|     | Inf. | -2098.48 | 934.51   | 0.33 | 0.14 | 0.66 | 0.33 |  |
| D15 | Sup. | 1337.03  | -1178.57 | 0.50 | 0.04 | 0.66 | 0.50 |  |
|     | Inf. | -2098.48 | 934.51   | 0.33 | 0.14 | 0.66 | 0.33 |  |
| D16 | Sup. | 1088.97  | -1225.93 | 0.41 | 0.03 | 0.66 | 0.41 |  |
|     | Inf. | -2348.83 | 781.89   | 0.24 | 0.11 | 0.66 | 0.24 |  |
| D17 | Sup. | 1088.97  | -1225.93 | 0.41 | 0.03 | 0.66 | 0.41 |  |
|     | Inf. | -2348.83 | 781.89   | 0.24 | 0.11 | 0.66 | 0.24 |  |
| D18 | Sup. | 1982.34  | -903.32  | 0.59 | 0.04 | 0.66 | 0.59 |  |
|     | Inf. | -1235.15 | 1315.56  | 0.36 | 0.14 | 0.66 | 0.36 |  |
| D19 | Sup. | 2110.51  | -824.28  | 0.42 | 0.03 | 0.66 | 0.42 |  |
|     | Inf. | -1328.73 | 1281.77  | 0.37 | 0.13 | 0.66 | 0.37 |  |
| D20 | Sup. | 2098.43  | -830.74  | 0.43 | 0.03 | 0.66 | 0.43 |  |
|     | Inf. | -1323.41 | 1284.45  | 0.36 | 0.13 | 0.66 | 0.36 |  |
| D21 | Sup. | 2123.34  | -817.52  | 0.41 | 0.03 | 0.66 | 0.41 |  |
|     | Inf. | -1334.03 | 1279.09  | 0.37 | 0.13 | 0.66 | 0.37 |  |
| D22 | Sup. | 2098.43  | -830.74  | 0.43 | 0.03 | 0.66 | 0.43 |  |
|     | Inf. | -1323.41 | 1284.45  | 0.36 | 0.13 | 0.66 | 0.36 |  |
| D23 | Sup. | 1761.88  | -1021.52 | 0.54 | 0.04 | 0.66 | 0.54 |  |
|     | Inf. | -889.78  | 1390.37  | 0.43 | 0.14 | 0.66 | 0.43 |  |
| D24 | Sup. | 1816.19  | -990.93  | 0.55 | 0.04 | 0.66 | 0.55 |  |
|     | Inf. | -990.31  | 1363.56  | 0.42 | 0.14 | 0.66 | 0.42 |  |
| D25 | Sup. | 2139.78  | -815.64  | 0.53 | 0.04 | 0.66 | 0.53 |  |
|     | Inf. | -1632.00 | 1159.25  | 0.44 | 0.14 | 0.66 | 0.44 |  |
| D26 | Sup. | 2178.42  | -798.78  | 0.54 | 0.04 | 0.66 | 0.54 |  |
|     | Inf. | -1711.71 | 1125.01  | 0.44 | 0.14 | 0.66 | 0.44 |  |
| D27 | Sup. | 2041.44  | -875.42  | 0.50 | 0.04 | 0.66 | 0.50 |  |
|     | Inf. | -1282.35 | 1301.26  | 0.36 | 0.14 | 0.66 | 0.36 |  |
| D28 | Sup. | 2028.95  | -885.89  | 0.52 | 0.04 | 0.66 | 0.52 |  |
|     | Inf. | -1269.86 | 1305.12  | 0.36 | 0.14 | 0.66 | 0.36 |  |
| D29 | Sup. | 2123.84  | -808.68  | 0.30 | 0.02 | 0.66 | 0.30 |  |
|     | Inf. | -1311.95 | 1251.35  | 0.28 | 0.10 | 0.66 | 0.28 |  |
| D30 | Sup. | 2089.14  | -826.14  | 0.32 | 0.03 | 0.66 | 0.32 |  |
|     | Inf. | -1296.23 | 1256.45  | 0.28 | 0.10 | 0.66 | 0.28 |  |
| D31 | Sup. | 2117.53  | -821.85  | 0.43 | 0.03 | 0.66 | 0.43 |  |
|     | Inf. | -1352.79 | 1273.94  | 0.37 | 0.13 | 0.66 | 0.37 |  |
| D32 | Sup. | 2117.53  | -821.85  | 0.43 | 0.03 | 0.66 | 0.43 |  |
|     | Inf. | -1352.79 | 1273.94  | 0.37 | 0.13 | 0.66 | 0.37 |  |

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|-----|------|----------|----------|------|------|------|------|--|
| D33 | Sup. | 1396.65  | -1173.00 | 0.60 | 0.04 | 0.66 | 0.60 |  |
|     | Inf. | -2052.67 | 956.92   | 0.32 | 0.15 | 0.66 | 0.32 |  |
| D34 | Sup. | 1396.65  | -1173.00 | 0.60 | 0.04 | 0.66 | 0.60 |  |
|     | Inf. | -2052.67 | 956.92   | 0.32 | 0.15 | 0.66 | 0.32 |  |
| D35 | Sup. | 2042.16  | -876.83  | 0.53 | 0.04 | 0.66 | 0.53 |  |
|     | Inf. | -1304.00 | 1298.38  | 0.36 | 0.14 | 0.66 | 0.36 |  |
| D36 | Sup. | 2042.16  | -876.83  | 0.53 | 0.04 | 0.66 | 0.53 |  |
|     | Inf. | -1304.00 | 1298.38  | 0.36 | 0.14 | 0.66 | 0.36 |  |
| D37 | Sup. | 2114.54  | -814.51  | 0.33 | 0.03 | 0.66 | 0.33 |  |
|     | Inf. | -1339.62 | 1247.67  | 0.28 | 0.10 | 0.66 | 0.28 |  |
| D38 | Sup. | 2114.54  | -814.51  | 0.33 | 0.03 | 0.66 | 0.33 |  |
|     | Inf. | -1339.62 | 1247.67  | 0.28 | 0.10 | 0.66 | 0.28 |  |

#### Cortantes

S adoptado : 12.00 [cm] S calculado : 13.05 [cm]

| Dir | Estado Gob. | Pos. | Vu [Kg] | Vc [Kg] | Vs [Kg] | $\phi \cdot Vn$ [Kg] | $Vu/(\phi \cdot Vn)$ |
|-----|-------------|------|---------|---------|---------|----------------------|----------------------|
| 2   | D9          | Sup. | 710.77  | 3268.62 | 9189.81 | 9343.82              | 0.18                 |
|     |             | Inf. | 1794.33 | 4073.33 | 9189.81 | 9947.35              | 0.18                 |
| 3   | D14         | Sup. | 406.53  | 2822.14 | 3908.31 | 5047.84              | 0.21                 |
|     |             | Inf. | 1172.68 | 3524.73 | 3908.31 | 5574.78              | 0.21                 |

Se utilizo el diseño de la columna más critica a continuación se mostrará el resumen de diseño de las otras columnas.

**Figura 25.** Resumen de diseño de columnas.


| Columnas |             |            |            |          |                 |              |         |         |               |       |            |
|----------|-------------|------------|------------|----------|-----------------|--------------|---------|---------|---------------|-------|------------|
| COL ID   | Faxial [Kg] | M33 [Kg*m] | M22 [Kg*m] | Carga ID | A.cálculo [cm2] | Longitud [m] | V3 [Kg] | V2 [Kg] | Sep. Estribos |       | B x H [cm] |
|          |             |            |            |          |                 |              |         |         | Barra         | [cm]  |            |
| 6        | -4909.00    | -1607.00   | -120.20    | D33      | 5.16            | 4.20         | 66.06   | 237.00  | T8            | 15.00 | 15x30      |
| 5        | -3912.00    | 931.60     | -268.50    | D18      | 4.50            | 4.20         | 164.80  | 457.80  | T8            | 15.00 | 15x30      |
| 8        | -5013.00    | -1552.00   | -141.20    | D33      | 5.14            | 4.20         | 89.24   | 286.80  | T8            | 15.00 | 15x30      |
| 9        | -4100.00    | 1249.00    | 263.90     | D18      | 5.15            | 4.20         | 165.20  | 628.40  | T8            | 15.00 | 15x30      |

Como se aprecia en el resumen de las otras columnas la que se calculó tiene una separación de estribos mucho menor que las demás por tanto tendremos dos tipos de armado distinto:

Columna C-02 (01/02/03/04)

Sección de la columna 15 cm x 30 cm



|   |   |                               |
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Armadura Longitudinal: 6 Ø 12 mm  $A_s = 6.78 \text{ cm}^2$

Armadura Transversal: Ø 8 mm c/15 cm

Columna C-02 (05)

Sección de la columna 15 cm x 30 cm

Armadura Longitudinal: 6 Ø 12 mm  $A_s = 6.78 \text{ cm}^2$

Armadura Transversal: Ø 8 mm c/12 cm

## 8.2. DISEÑO DE VIGAS DE ENCADENADO INFERIOR

### 8.2.1. VIGA VI-01 TRAMO (1-5)

A continuación, se presenta el resultado de diseño de las vigas de hormigón armado con todas las cargas de diseño actuantes.


## Resultados de Diseño Vigas de Hormigón Armado

### Datos Generales

Código de diseño : ACI 318-2019

#### Estados de carga considerados:

|     |   |                     |
|-----|---|---------------------|
| D1  | = | 1.4CM               |
| D2  | = | 1.2CM+0.5VxCASOAPOS |
| D3  | = | 1.2CM+0.5VxCASOANEG |
| D4  | = | 1.2CM+0.5VzCASOAPOS |
| D5  | = | 1.2CM+0.5VzCASOANEG |
| D6  | = | 1.2CM+VxCASOAPOS    |
| D7  | = | 1.2CM+VxCASOANEG    |
| D8  | = | 1.2CM+VzCASOAPOS    |
| D9  | = | 1.2CM+VzCASOANEG    |
| D10 | = | 0.9CM+VxCASOAPOS    |
| D11 | = | 0.9CM+VxCASOANEG    |
| D12 | = | 0.9CM+VzCASOAPOS    |
| D13 | = | 0.9CM+VzCASOANEG    |
| D14 | = | 1.2CM+EQx           |
| D15 | = | 1.2CM+EQz           |
| D16 | = | 0.9CM+EQx           |
| D17 | = | 0.9CM+EQz           |
| D18 | = | 1.2CM+1.6CV         |
| D19 | = | 1.2CM+0.5VzCASOBPOS |
| D20 | = | 1.2CM+0.5VzCASOBNEG |
| D21 | = | 1.2CM+VzCASOBPOS    |
| D22 | = | 1.2CM+VzCASOBNEG    |
| D23 | = | 1.2CM+VxCASOAPOS+CV |
| D24 | = | 1.2CM+VxCASOANEG+CV |
| D25 | = | 1.2CM+VzCASOAPOS+CV |
| D26 | = | 1.2CM+VzCASOANEG+CV |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA: 57 de 140               |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | REV: <b>A</b>                 |

|     |   |                     |
|-----|---|---------------------|
| D27 | = | 1.2CM+VzCASOBPOS+CV |
| D28 | = | 1.2CM+VzCASOBNEG+CV |
| D29 | = | 0.9CM+VzCASOBPOS    |
| D30 | = | 0.9CM+VzCASOBNEG    |
| D31 | = | 1.2CM+EQxCUB        |
| D32 | = | 1.2CM+EQzCUB        |
| D33 | = | 1.2CM+EQx+CV        |
| D34 | = | 1.2CM+EQz+CV        |
| D35 | = | 1.2CM+EQxCUB+CV     |
| D36 | = | 1.2CM+EQzCUB+CV     |
| D37 | = | 0.9CM+EQxCUB        |
| D38 | = | 0.9CM+EQzCUB        |

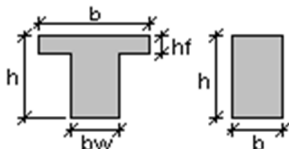
Riesgo sísmico : Riesgo Bajo

#### **Materiales**


|         |                                |                     |                             |          |
|---------|--------------------------------|---------------------|-----------------------------|----------|
| [Kg/m2] | Hormigón, f'c                  | : 2100000.00 [Kg... | Acero longitudinal, fy      | : 4.2E07 |
| [Kg/m2] | Tipo de concreto               | : Normal            | Acero transversal, fyt      | : 4.2E07 |
| [Kg/m2] | Módulo de elasticidad hormigón | : 2.14E09 [Kg/m2]   | Módulo de elasticidad acero | : 2.9E11 |
| [Kg/m2] | Peso unitario                  | : 2400.00 [Kg/m3]   | Recubrimiento epóxico       | : No     |

## Geometría

| Eje | Pos columna | Ancho inferior<br>[cm] | Ancho superior<br>[cm] | Dist x<br>[m] |
|-----|-------------|------------------------|------------------------|---------------|
| 1   | Centro      | 25.00                  | 25.00                  | 0.00          |
| 2   | Centro      | 15.00                  | 15.00                  | 5.95          |
| 3   | Centro      | 15.00                  | 15.00                  | 12.15         |
| 4   | Centro      | 25.00                  | 25.00                  | 14.55         |
| 5   | Centro      | 25.00                  | 25.00                  | 17.35         |



| Tramo | Dist entre ejes<br>[m] | Miembro No | Sección | b<br>[cm] | h<br>[cm] | bw<br>[cm] | hf<br>[cm] |
|-------|------------------------|------------|---------|-----------|-----------|------------|------------|
| 1-2   | 5.95                   | 25         |         | 20.00     | 40.00     | --         | --         |
| 2-3   | 6.20                   | 27         |         | 20.00     | 40.00     | --         | --         |
| 3-4   | 2.40                   | 53         |         | 20.00     | 40.00     | --         | --         |
| 4-5   | 2.80                   | 52         |         | 20.00     | 40.00     | --         | --         |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 58 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

## Diseño

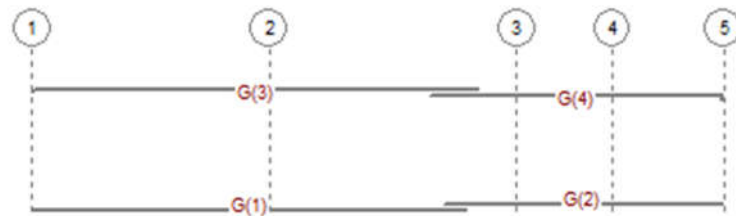
Estatus : Bien

## Reinforcement

### Armadura

Recubrimiento libre : 2.50 [cm]

### Armadura longitudinal




| Grupo | Cantidad | Diámetro | Pos      | Eje Ref. 1 | Dist1<br>[m] | Eje Ref. 2 | Dist2<br>[m] | Gancho1 | Gancho2 |
|-------|----------|----------|----------|------------|--------------|------------|--------------|---------|---------|
| 1     | 2        | 10mm     | Inferior | 1          | 0.02         | 3          | -1.26        | Si      | No      |
| 2     | 2        | 10mm     | Inferior | 3          | -1.84        | 5          | -0.02        | No      | Si      |
| 3     | 3        | 12mm     | Sup.     | 1          | 0.02         | 3          | -0.95        | Si      | No      |
| 4     | 3        | 12mm     | Sup.     | 3          | -2.15        | 5          | -0.02        | No      | Si      |

### Longitudes de anclaje y empalme

| Grupo | Diámetro | Ld<br>[cm] | Ldh<br>[cm] | L. Empalme<br>[cm] | L. total<br>[m] |
|-------|----------|------------|-------------|--------------------|-----------------|
| 1     | 10mm     | 44.00      | 16.00       | 58.00              | 11.02           |
| 2     | 10mm     | 44.00      | 16.00       | 58.00              | 7.16            |
| 3     | 12mm     | 70.00      | 20.00       | 90.00              | 11.36           |
| 4     | 12mm     | 70.00      | 20.00       | 90.00              | 7.50            |

### Armadura transversal

| Tramo | Diámetro | Cantidad | c/<br>[cm] | Ramas | Cerrado |
|-------|----------|----------|------------|-------|---------|
| 1-2   | 8mm      | 34       | 17.00      | 2     | Si      |
| 2-3   | 8mm      | 36       | 17.00      | 2     | Si      |
| 3-4   | 8mm      | 13       | 17.00      | 2     | Si      |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IFE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 59 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

4-5      8mm      16      17.00      2      Si

#### Separación inicial de estribos:

| Tramo | S inicial [cm] | Sin lim [cm] |
|-------|----------------|--------------|
| 0-1   | 7.00           | 18.75        |
| 1-2   | 5.00           | 18.75        |
| 2-3   | 7.90           | 18.75        |
| 3-4   | 0.00           | 18.75        |

## Flexión

Tramo: 1-2

Miembro No: 25

Porcentaje de redistribución de momentos:

Apoyo A = 0.00%

Apoyo B = 0.00%

Cuantía geométrica máxima:

$\rho_{\text{maxsup}} = 1.55\%$


$\rho_{\text{maxinf}} = 1.55\%$

Separación límite entre barras por fisuración:

sb lim = 30.61 [cm]

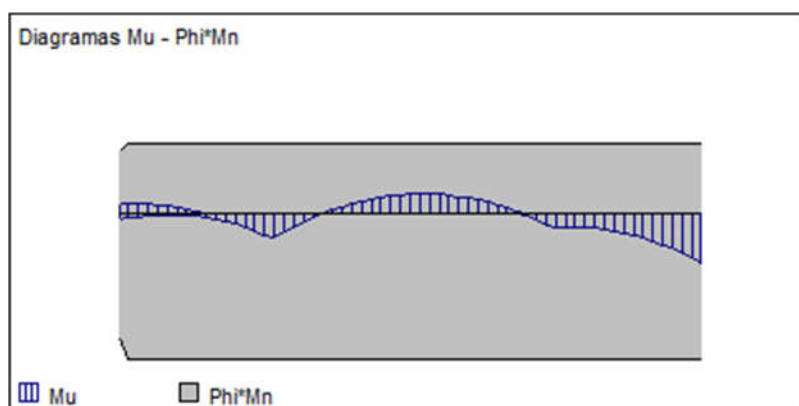
#### Momentos flectores positivos

| Estación          | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm <sup>2</sup> ] | Asprov [cm <sup>2</sup> ] | $\rho$ (%) | sb [cm] |
|-------------------|-------|----------|-------------------|--------------------------|---------------------------|------------|---------|
| Mu/( $\phi^*Mn$ ) |       |          |                   |                          |                           |            |         |
| No. Dist          |       |          |                   |                          |                           |            |         |
| 1    0%           | 36.20 | 272.03   | 1868.97           | 0.20                     | 1.40                      | 0.19       | 9.20    |
| 0.15              |       |          |                   |                          |                           |            |         |
| 2    10%          | 36.20 | 191.71   | 2093.52           | 0.14                     | 1.57                      | 0.22       | 9.20    |
| 0.09              |       |          |                   |                          |                           |            |         |
| 3    20%          | 36.20 | 0.00     | 2093.52           | 0.00                     | 1.57                      | 0.22       | 9.20    |
| 0.07              |       |          |                   |                          |                           |            |         |
| 4    30%          | 36.20 | 0.00     | 2093.52           | 0.00                     | 1.57                      | 0.22       | 9.20    |
| 0.09              |       |          |                   |                          |                           |            |         |
| 5    40%          | 36.20 | 297.52   | 2093.52           | 0.22                     | 1.57                      | 0.22       | 9.20    |
| 0.14              |       |          |                   |                          |                           |            |         |
| 6    50%          | 36.20 | 583.09   | 2093.52           | 0.43                     | 1.57                      | 0.22       | 9.20    |
| 0.28              |       |          |                   |                          |                           |            |         |
| 7    60%          | 36.20 | 462.25   | 2093.52           | 0.34                     | 1.57                      | 0.22       | 9.20    |
| 0.22              |       |          |                   |                          |                           |            |         |
| 8    70%          | 36.20 | 0.00     | 2093.52           | 0.00                     | 1.57                      | 0.22       | 9.20    |
| 0.02              |       |          |                   |                          |                           |            |         |
| 9    80%          | 36.20 | 0.00     | 2093.52           | 0.00                     | 1.57                      | 0.22       | 9.20    |
| 0.10              |       |          |                   |                          |                           |            |         |
| 10   90%          | 36.20 | 0.00     | 2093.52           | 0.00                     | 1.57                      | 0.22       | 9.20    |
| 0.17              |       |          |                   |                          |                           |            |         |
| 11   100%         | 36.20 | 0.00     | 2093.52           | 0.00                     | 1.57                      | 0.22       | 9.20    |
| 0.34              |       |          |                   |                          |                           |            |         |
| C    100%         | 36.20 | 0.00     | 2093.52           | 0.00                     | 1.57                      | 0.22       | 9.20    |
| 0.34              |       |          |                   |                          |                           |            |         |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA: 60 de 140               |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE H<sup>o</sup>A<sup>o</sup> Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | REV: <b>A</b>                 |

#### Momentos flectores negativos

| Estación                      | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm <sup>2</sup> ] | Asprov [cm <sup>2</sup> ] | $\rho$ (%) | sb [cm] |
|-------------------------------|-------|----------|-------------------|--------------------------|---------------------------|------------|---------|
| Mu/( $\phi^*Mn$ )<br>No. Dist |       |          |                   |                          |                           |            |         |
| 1 0%                          | 36.10 | -173.93  | -3748.05          | 0.13                     | 2.88                      | 0.40       | 3.90    |
| 0.15                          |       |          |                   |                          |                           |            |         |
| 2 10%                         | 36.10 | -53.86   | -4370.40          | 0.04                     | 3.39                      | 0.47       | 3.90    |
| 0.09                          |       |          |                   |                          |                           |            |         |
| 3 20%                         | 36.10 | -314.33  | -4370.40          | 0.23                     | 3.39                      | 0.47       | 3.90    |
| 0.07                          |       |          |                   |                          |                           |            |         |
| 4 30%                         | 36.10 | -401.30  | -4370.40          | 0.30                     | 3.39                      | 0.47       | 3.90    |
| 0.09                          |       |          |                   |                          |                           |            |         |
| 5 40%                         | 36.10 | 0.00     | -4370.40          | 0.00                     | 3.39                      | 0.47       | 3.90    |
| 0.14                          |       |          |                   |                          |                           |            |         |
| 6 50%                         | 36.10 | 0.00     | -4370.40          | 0.00                     | 3.39                      | 0.47       | 3.90    |
| 0.28                          |       |          |                   |                          |                           |            |         |
| 7 60%                         | 36.10 | 0.00     | -4370.40          | 0.00                     | 3.39                      | 0.47       | 3.90    |
| 0.22                          |       |          |                   |                          |                           |            |         |
| 8 70%                         | 36.10 | -81.62   | -4370.40          | 0.06                     | 3.39                      | 0.47       | 3.90    |
| 0.02                          |       |          |                   |                          |                           |            |         |
| 9 80%                         | 36.10 | -426.21  | -4370.40          | 0.31                     | 3.39                      | 0.47       | 3.90    |
| 0.10                          |       |          |                   |                          |                           |            |         |
| 10 90%                        | 36.10 | -735.31  | -4370.40          | 0.54                     | 3.39                      | 0.47       | 3.90    |
| 0.17                          |       |          |                   |                          |                           |            |         |
| 11 100%                       | 36.10 | -1474.13 | -4370.40          | 1.10                     | 3.39                      | 0.47       | 3.90    |
| 0.34                          |       |          |                   |                          |                           |            |         |
| C 100%                        | 36.10 | -1474.13 | -4370.40          | 1.10                     | 3.39                      | 0.47       | 3.90    |
| 0.34                          |       |          |                   |                          |                           |            |         |



Tramo: 2-3

Miembro No: 27

Porcentaje de redistribución de momentos:

Apoyo A = 0.00%

Apoyo B = 0.00%


Cuantía geométrica máxima:

$\rho$  maxsup = 1.55%

$\rho$  maxinf = 1.55%

Separación límite entre barras por fisuración:

sb lim = 30.61 [cm]


|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPÉ-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 61 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

#### Momentos flectores positivos

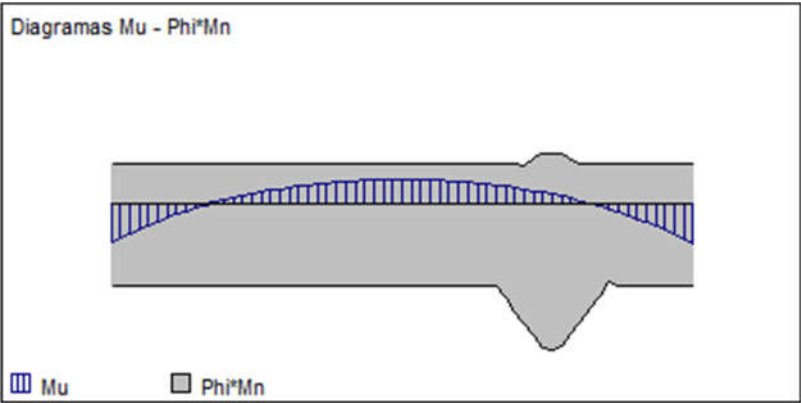
| Estación                      | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%) | sb [cm] |
|-------------------------------|-------|----------|-------------------|-------------|--------------|------------|---------|
| Mu/( $\phi^*Mn$ )<br>No. Dist |       |          |                   |             |              |            |         |
| 1 0%<br>0.48                  | 36.20 | 0.00     | 2093.52           | 0.00        | 1.57         | 0.22       | 9.20    |
| 2 10%<br>0.17                 | 36.20 | 0.00     | 2093.52           | 0.00        | 1.57         | 0.22       | 9.20    |
| 3 20%<br>0.11                 | 36.20 | 220.62   | 2093.52           | 0.16        | 1.57         | 0.22       | 9.20    |
| 4 30%<br>0.40                 | 36.20 | 833.00   | 2093.52           | 0.61        | 1.57         | 0.22       | 9.20    |
| 5 40%<br>0.56                 | 36.20 | 1170.27  | 2093.52           | 0.87        | 1.57         | 0.22       | 9.20    |
| 6 50%<br>0.61                 | 36.20 | 1275.94  | 2093.52           | 0.95        | 1.57         | 0.22       | 9.20    |
| 7 60%<br>0.56                 | 36.20 | 1162.71  | 2093.52           | 0.86        | 1.57         | 0.22       | 9.20    |
| 8 70%<br>0.40                 | 35.49 | 817.09   | 2066.61           | 0.61        | 1.58         | 0.22       | 9.20    |
| 9 80%<br>0.09                 | 35.49 | 194.97   | 2198.50           | 0.15        | 1.69         | 0.24       | 9.20    |
| 10 90%<br>0.18                | 36.20 | 0.00     | 2093.52           | 0.00        | 1.57         | 0.22       | 9.20    |
| 11 100%<br>0.49               | 36.20 | 0.00     | 2093.52           | 0.00        | 1.57         | 0.22       | 9.20    |
| C 50%<br>0.61                 | 36.20 | 1275.94  | 2093.52           | 0.95        | 1.57         | 0.22       | 9.20    |

#### Momentos flectores negativos

| Estación                      | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%) | sb [cm] |
|-------------------------------|-------|----------|-------------------|-------------|--------------|------------|---------|
| Mu/( $\phi^*Mn$ )<br>No. Dist |       |          |                   |             |              |            |         |
| 1 0%<br>0.48                  | 36.10 | -2087.89 | -4370.40          | 1.57        | 3.39         | 0.47       | 3.90    |
| 2 10%<br>0.17                 | 36.10 | -730.32  | -4370.40          | 0.54        | 3.39         | 0.47       | 3.90    |
| 3 20%<br>0.11                 | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 4 30%<br>0.40                 | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 5 40%<br>0.56                 | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 6 50%<br>0.61                 | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 7 60%<br>0.56                 | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 8 70%<br>0.40                 | 34.23 | 0.00     | -5986.29          | 0.00        | 5.07         | 0.74       | 3.90    |

|   |  |                        |
|---|--|------------------------|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:  |
|   | MEMORIA DE CÁLCULO   | IPE-2025-2977-S-MC-011 |
|   | TÍTULO:  | HOJA:                  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | 62 de 140              |
|   |  | REV:                   |
|   |  | A                      |

|      |      |       |          |          |      |      |      |      |
|------|------|-------|----------|----------|------|------|------|------|
| 9    | 80%  | 34.23 | 0.00     | -6498.82 | 0.00 | 5.55 | 0.81 | 3.90 |
| 0.09 |      |       |          |          |      |      |      |      |
| 10   | 90%  | 36.10 | -767.31  | -4370.40 | 0.57 | 3.39 | 0.47 | 3.90 |
| 0.18 |      |       |          |          |      |      |      |      |
| 11   | 100% | 36.10 | -2137.34 | -4370.40 | 1.61 | 3.39 | 0.47 | 3.90 |
| 0.49 |      |       |          |          |      |      |      |      |
| C    | 50%  | 36.10 | 0.00     | -4370.40 | 0.00 | 3.39 | 0.47 | 3.90 |
| 0.61 |      |       |          |          |      |      |      |      |




|  |                          |                          |
|--|--------------------------|--------------------------|
| <b>Tramo: 3-4</b>                              | <b>Miembro No: 53</b>    |                          |
| Porcentaje de redistribución de momentos:      | Apoyo A = 0.00%          | Apoyo B = 0.00%          |
| Cuantía geométrica máxima:                     | $\rho_{maxsup} = 1.55\%$ | $\rho_{maxinf} = 1.55\%$ |
| Separación límite entre barras por fisuración: | sb lim = 30.61 [cm]      |                          |

Momentos flectores positivos

| Estación          | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%) | sb [cm] |
|-------------------|-------|----------|-------------------|-------------|--------------|------------|---------|
| Mu/( $\phi^*Mn$ ) |       |          |                   |             |              |            |         |
| No. Dist          |       |          |                   |             |              |            |         |
| 1                 | 0%    | 36.20    | 0.00              | 2093.52     | 0.00         | 1.57       | 0.22    |
| 0.36              |       |          |                   |             |              |            | 9.20    |
| 2                 | 10%   | 36.20    | 0.00              | 2093.52     | 0.00         | 1.57       | 0.22    |
| 0.26              |       |          |                   |             |              |            | 9.20    |
| 3                 | 20%   | 36.20    | 0.00              | 2093.52     | 0.00         | 1.57       | 0.22    |
| 0.17              |       |          |                   |             |              |            | 9.20    |
| 4                 | 30%   | 36.20    | 0.00              | 2093.52     | 0.00         | 1.57       | 0.22    |
| 0.10              |       |          |                   |             |              |            | 9.20    |
| 5                 | 40%   | 36.20    | 0.00              | 2093.52     | 0.00         | 1.57       | 0.22    |
| 0.05              |       |          |                   |             |              |            | 9.20    |
| 6                 | 50%   | 36.20    | 0.00              | 2093.52     | 0.00         | 1.57       | 0.22    |
| 0.02              |       |          |                   |             |              |            | 9.20    |
| 7                 | 60%   | 36.20    | 58.45             | 2093.52     | 0.04         | 1.57       | 0.22    |
| 0.03              |       |          |                   |             |              |            | 9.20    |
| 8                 | 70%   | 36.20    | 86.34             | 2093.52     | 0.06         | 1.57       | 0.22    |
| 0.04              |       |          |                   |             |              |            | 9.20    |




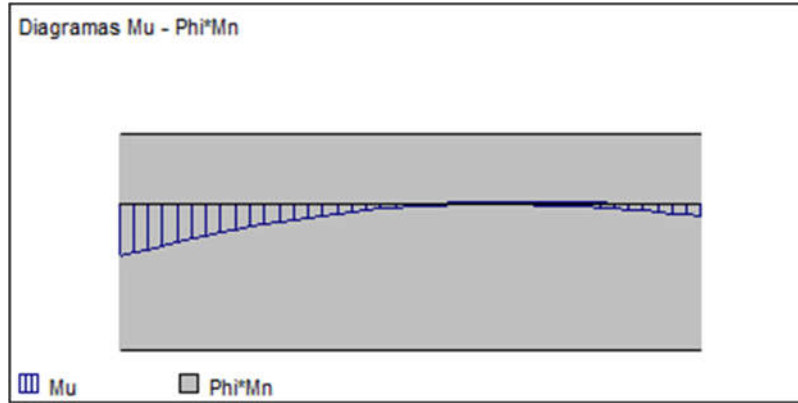
|   |  |                        |
|---|--|------------------------|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:  |
|   | MEMORIA DE CÁLCULO   | IPE-2025-2977-S-MC-011 |
|   | TÍTULO:  | HOJA:                  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | 63 de 140              |
|   |  | REV:                   |
|   |  | A                      |

|      |      |       |       |         |      |      |      |      |
|------|------|-------|-------|---------|------|------|------|------|
| 9    | 80%  | 36.20 | 55.17 | 2093.52 | 0.04 | 1.57 | 0.22 | 9.20 |
| 0.03 |      |       |       |         |      |      |      |      |
| 10   | 90%  | 36.20 | 0.00  | 2093.52 | 0.00 | 1.57 | 0.22 | 9.20 |
| 0.04 |      |       |       |         |      |      |      |      |
| 11   | 100% | 36.20 | 0.00  | 2093.52 | 0.00 | 1.57 | 0.22 | 9.20 |
| 0.09 |      |       |       |         |      |      |      |      |
| C    | 0%   | 36.20 | 0.00  | 2093.52 | 0.00 | 1.57 | 0.22 | 9.20 |
| 0.36 |      |       |       |         |      |      |      |      |

#### Momentos flectores negativos

| Estación  |      | d[cm] | Mu[Kg*m] | ϕ*Mn[Kg*m] | Asreq [cm2] | Asprov [cm2] | ρ (%) | sb [cm] |
|-----------|------|-------|----------|------------|-------------|--------------|-------|---------|
| Mu/(ϕ*Mn) |      |       |          |            |             |              |       |         |
| No. Dist  |      |       |          |            |             |              |       |         |
| 1         | 0%   | 36.10 | -1584.14 | -4370.40   | 1.18        | 3.39         | 0.47  | 3.90    |
| 0.36      |      |       |          |            |             |              |       |         |
| 2         | 10%  | 36.10 | -1138.85 | -4370.40   | 0.85        | 3.39         | 0.47  | 3.90    |
| 0.26      |      |       |          |            |             |              |       |         |
| 3         | 20%  | 36.10 | -763.35  | -4370.40   | 0.56        | 3.39         | 0.47  | 3.90    |
| 0.17      |      |       |          |            |             |              |       |         |
| 4         | 30%  | 36.10 | -457.65  | -4370.40   | 0.34        | 3.39         | 0.47  | 3.90    |
| 0.10      |      |       |          |            |             |              |       |         |
| 5         | 40%  | 36.10 | -221.75  | -4370.40   | 0.16        | 3.39         | 0.47  | 3.90    |
| 0.05      |      |       |          |            |             |              |       |         |
| 6         | 50%  | 36.10 | -71.09   | -4370.40   | 0.05        | 3.39         | 0.47  | 3.90    |
| 0.02      |      |       |          |            |             |              |       |         |
| 7         | 60%  | 36.10 | -20.11   | -4370.40   | 0.01        | 3.39         | 0.47  | 3.90    |
| 0.03      |      |       |          |            |             |              |       |         |
| 8         | 70%  | 36.10 | -26.01   | -4370.40   | 0.02        | 3.39         | 0.47  | 3.90    |
| 0.04      |      |       |          |            |             |              |       |         |
| 9         | 80%  | 36.10 | -76.77   | -4370.40   | 0.06        | 3.39         | 0.47  | 3.90    |
| 0.03      |      |       |          |            |             |              |       |         |
| 10        | 90%  | 36.10 | -195.46  | -4370.40   | 0.14        | 3.39         | 0.47  | 3.90    |
| 0.04      |      |       |          |            |             |              |       |         |
| 11        | 100% | 36.10 | -377.98  | -4370.40   | 0.28        | 3.39         | 0.47  | 3.90    |
| 0.09      |      |       |          |            |             |              |       |         |
| C         | 0%   | 36.10 | -1584.14 | -4370.40   | 1.18        | 3.39         | 0.47  | 3.90    |
| 0.36      |      |       |          |            |             |              |       |         |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA: 64 de 140               |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | REV: <b>A</b>                 |



Tramo: 4-5

Miembro No: 52

Porcentaje de redistribución de momentos:

Apoyo A = 0.00%

Apoyo B = 0.00%

Cuánta geométrica máxima:

$\rho_{\text{maxsup}} = 1.55\%$

$\rho_{\text{maxinf}} = 1.55\%$


Separación límite entre barras por fisuración:

$s_b \text{ lim} = 30.61 \text{ [cm]}$

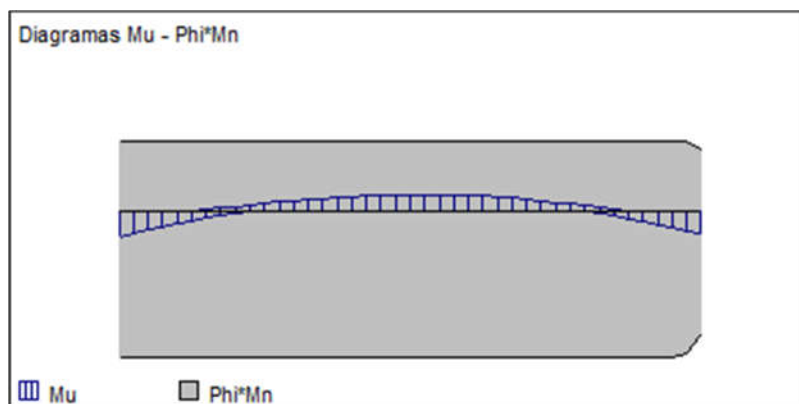
#### Momentos flectores positivos

| Estación                           |      | d[cm] | Mu[Kg*m] | $\Phi^*M_n$ [Kg*m] | Asreq [cm <sup>2</sup> ] | Asprov [cm <sup>2</sup> ] | $\rho$ (%) | sb [cm] |
|------------------------------------|------|-------|----------|--------------------|--------------------------|---------------------------|------------|---------|
| <b>Mu/(<math>\Phi^*M_n</math>)</b> |      |       |          |                    |                          |                           |            |         |
| No.                                | Dist |       |          |                    |                          |                           |            |         |
| 1                                  | 0%   | 36.20 | 0.00     | 2093.52            | 0.00                     | 1.57                      | 0.22       | 9.20    |
| 0.17                               |      |       |          |                    |                          |                           |            |         |
| 2                                  | 10%  | 36.20 | 0.00     | 2093.52            | 0.00                     | 1.57                      | 0.22       | 9.20    |
| 0.08                               |      |       |          |                    |                          |                           |            |         |
| 3                                  | 20%  | 36.20 | 140.73   | 2093.52            | 0.10                     | 1.57                      | 0.22       | 9.20    |
| 0.07                               |      |       |          |                    |                          |                           |            |         |
| 4                                  | 30%  | 36.20 | 312.40   | 2093.52            | 0.23                     | 1.57                      | 0.22       | 9.20    |
| 0.15                               |      |       |          |                    |                          |                           |            |         |
| 5                                  | 40%  | 36.20 | 441.44   | 2093.52            | 0.32                     | 1.57                      | 0.22       | 9.20    |
| 0.21                               |      |       |          |                    |                          |                           |            |         |
| 6                                  | 50%  | 36.20 | 503.01   | 2093.52            | 0.37                     | 1.57                      | 0.22       | 9.20    |
| 0.24                               |      |       |          |                    |                          |                           |            |         |
| 7                                  | 60%  | 36.20 | 474.94   | 2093.52            | 0.35                     | 1.57                      | 0.22       | 9.20    |
| 0.23                               |      |       |          |                    |                          |                           |            |         |
| 8                                  | 70%  | 36.20 | 356.06   | 2093.52            | 0.26                     | 1.57                      | 0.22       | 9.20    |
| 0.17                               |      |       |          |                    |                          |                           |            |         |
| 9                                  | 80%  | 36.20 | 177.82   | 2093.52            | 0.13                     | 1.57                      | 0.22       | 9.20    |
| 0.08                               |      |       |          |                    |                          |                           |            |         |
| 10                                 | 90%  | 36.20 | 0.00     | 2093.52            | 0.00                     | 1.57                      | 0.22       | 9.20    |
| 0.07                               |      |       |          |                    |                          |                           |            |         |
| 11                                 | 100% | 36.20 | 0.00     | 1868.97            | 0.00                     | 1.40                      | 0.19       | 9.20    |
| 0.18                               |      |       |          |                    |                          |                           |            |         |
| C                                  | 52%  | 36.20 | 504.66   | 2093.52            | 0.37                     | 1.57                      | 0.22       | 9.20    |
| 0.24                               |      |       |          |                    |                          |                           |            |         |

#### Momentos flectores negativos

|   |  |  |                        |
|---|--|--|------------------------|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |
|   | MEMORIA DE CÁLCULO   |  | IPE-2025-2977-S-MC-011 |
|   | TÍTULO:  |  | HOJA:                  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 65 de 140              |
|   |  |  | REV:                   |
|   |  |  | A                      |

| Estación<br>Mu/( $\phi^*Mn$ )<br>No. Dist | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%) | sb [cm] |
|---|-------|----------|-------------------|-------------|--------------|------------|---------|
| 1 0%<br>0.17                              | 36.10 | -761.93  | -4370.40          | 0.56        | 3.39         | 0.47       | 3.90    |
| 2 10%<br>0.08                             | 36.10 | -363.75  | -4370.40          | 0.27        | 3.39         | 0.47       | 3.90    |
| 3 20%<br>0.07                             | 36.10 | -53.67   | -4370.40          | 0.04        | 3.39         | 0.47       | 3.90    |
| 4 30%<br>0.15                             | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 5 40%<br>0.21                             | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 6 50%<br>0.24                             | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 7 60%<br>0.23                             | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 8 70%<br>0.17                             | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 9 80%<br>0.08                             | 36.10 | -28.00   | -4370.40          | 0.02        | 3.39         | 0.47       | 3.90    |
| 10 90%<br>0.07                            | 36.10 | -308.90  | -4370.40          | 0.23        | 3.39         | 0.47       | 3.90    |
| 11 100%<br>0.18                           | 36.10 | -688.50  | -3748.05          | 0.51        | 2.88         | 0.40       | 3.90    |
| C 52%<br>0.24                             | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |




## Corte y Torsión

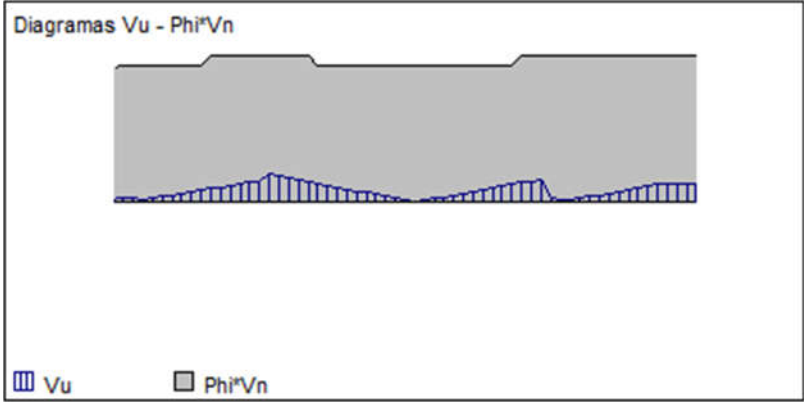
Tramo: 1-2

Miembro No: 25

| Estación                | Estribos | Spc prov | Spc lim | Tu | $\phi^*Tn$ | Al | Vu | Vs | Vc |
|-------------------------|----------|----------|---------|----|------------|----|----|----|----|
| $\phi^*VnVu/(\phi^*Vn)$ |          |          |         |    |            |    |    |    |    |

|   |  |  |  |
|---|--|--|--|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:                            |
|   | MEMORIA DE CÁLCULO   |  | <b>IPE-2025-2977-S-MC-011</b><br>HOJA: 66 de 140 |
|   | TÍTULO:<br><b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> |  | REV:<br><b>A</b>                                 |


| No.         | Dist | Diám | VCT | [cm]  | [cm]  | [Kg*m] | [Kg*m] | [cm2] | [Kg]    | [Kg]    | [Kg]    | [Kg] |
|-------------|------|------|-----|-------|-------|--------|--------|-------|---------|---------|---------|------|
| 1           | 0%   | 8mm  |     | 17.00 | 18.10 | 80.14  | 769.47 | 0.00  | 222.11  | 8997.19 | 2771.08 |      |
| 8826.210.03 |      |      |     |       |       |        |        |       |         |         |         |      |
| 2           | 10%  | 8mm  |     | 17.00 | 18.10 | 80.14  | 769.47 | 0.00  | 443.02  | 8997.19 | 2880.65 |      |
| 8908.380.05 |      |      |     |       |       |        |        |       |         |         |         |      |
| 3           | 20%  | 8mm  |     | 17.00 | 18.05 | 80.14  | 769.47 | 0.00  | 1059.74 | 8972.34 | 3716.40 |      |
| 9516.550.11 |      |      |     |       |       |        |        |       |         |         |         |      |
| 4           | 30%  | 8mm  | V   | 17.00 | 18.05 | 4.68   | 769.47 | 0.00  | 1528.14 | 8972.34 | 3716.40 |      |
| 9516.550.16 |      |      |     |       |       |        |        |       |         |         |         |      |
| 5           | 40%  | 8mm  |     | 17.00 | 18.10 | 4.68   | 769.47 | 0.00  | 822.83  | 8997.19 | 2880.65 |      |
| 8908.380.09 |      |      |     |       |       |        |        |       |         |         |         |      |
| 6           | 50%  | 8mm  |     | 17.00 | 18.10 | 4.68   | 769.47 | 0.00  | 142.34  | 8997.19 | 2880.65 |      |
| 8908.380.02 |      |      |     |       |       |        |        |       |         |         |         |      |
| 7           | 60%  | 8mm  |     | 17.00 | 18.10 | 4.68   | 769.47 | 0.00  | 543.94  | 8997.19 | 2880.65 |      |
| 8908.380.06 |      |      |     |       |       |        |        |       |         |         |         |      |
| 8           | 70%  | 8mm  |     | 17.00 | 18.05 | 4.68   | 769.47 | 0.00  | 1243.34 | 8972.34 | 3716.40 |      |
| 9516.550.13 |      |      |     |       |       |        |        |       |         |         |         |      |
| 9           | 80%  | 8mm  |     | 17.00 | 18.05 | 84.31  | 769.47 | 0.00  | 242.98  | 8972.34 | 3716.40 |      |
| 9516.550.03 |      |      |     |       |       |        |        |       |         |         |         |      |
| 10          | 90%  | 8mm  |     | 17.00 | 18.05 | 84.31  | 769.47 | 0.00  | 880.61  | 8972.34 | 3716.40 |      |
| 9516.550.09 |      |      |     |       |       |        |        |       |         |         |         |      |
| 11          | 100% | 8mm  |     | 17.00 | 18.05 | 84.31  | 769.47 | 0.00  | 1148.14 | 8972.34 | 3716.40 |      |
| 9516.550.12 |      |      |     |       |       |        |        |       |         |         |         |      |
|             |      |      |     |       |       |        |        |       |         |         |         |      |
| C           | 27%  | 8mm  | V   | 17.00 | 18.05 | 4.68   | 769.47 | 0.00  | 1768.19 | 8972.34 | 3716.40 |      |
| 9516.550.19 |      |      |     |       |       |        |        |       |         |         |         |      |



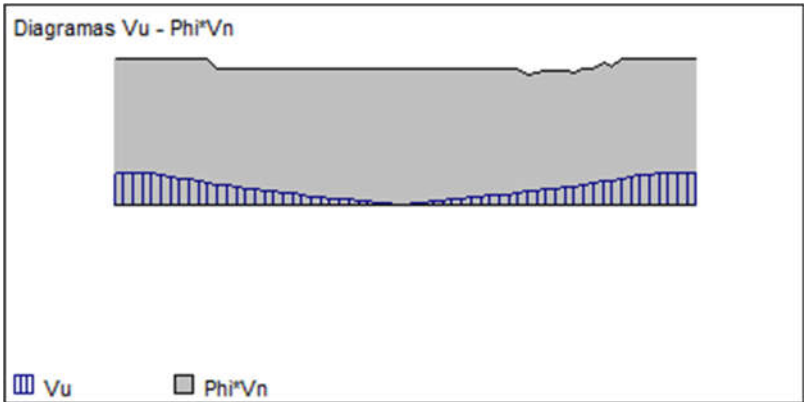
Tramo: 2-3

Miembro No: 27

| Estación                |      | Estribos |     | Spc prov | Spc lim | Tu     | $\phi^*Tn$ | Al    | Vu      | Vs      | Vc        |
|-------------------------|------|----------|-----|----------|---------|--------|------------|-------|---------|---------|-----------|
| $\phi^*VnVu/(\phi^*Vn)$ |      |          |     |          |         |        |            |       |         |         |           |
| No.                     | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m]     | [cm2] | [Kg]    | [Kg]    | [Kg] [Kg] |
| 1                       | 0%   | 8mm      | V   | 17.00    | 18.05   | 2.47   | 769.47     | 0.00  | 2112.26 | 8972.34 | 3716.40   |
| 9516.550.22             |      |          |     |          |         |        |            |       |         |         |           |
| 2                       | 10%  | 8mm      | V   | 17.00    | 18.05   | 2.47   | 769.47     | 0.00  | 1834.25 | 8972.34 | 3716.40   |
| 9516.550.19             |      |          |     |          |         |        |            |       |         |         |           |
| 3                       | 20%  | 8mm      | V   | 17.00    | 18.10   | 2.47   | 769.47     | 0.00  | 1222.60 | 8997.19 | 2880.65   |
| 8908.380.14             |      |          |     |          |         |        |            |       |         |         |           |
| 4                       | 30%  | 8mm      |     | 17.00    | 18.10   | 2.47   | 769.47     | 0.00  | 729.92  | 8997.19 | 2880.65   |
| 8908.380.08             |      |          |     |          |         |        |            |       |         |         |           |


|   |  |                        |
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|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:  |
|   | MEMORIA DE CÁLCULO   | IPE-2025-2977-S-MC-011 |
|   | TÍTULO:  | HOJA:                  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | 67 de 140              |
|   |  | REV:                   |
|   |  | A                      |

|             |      |     |   |       |       |      |        |      |         |         |         |
|-------------|------|-----|---|-------|-------|------|--------|------|---------|---------|---------|
| 5           | 40%  | 8mm |   | 17.00 | 18.10 | 2.47 | 769.47 | 0.00 | 334.87  | 8997.19 | 2880.65 |
| 8908.380.04 |      |     |   |       |       |      |        |      |         |         |         |
| 6           | 50%  | 8mm |   | 17.00 | 18.10 | 2.47 | 769.47 | 0.00 | 14.76   | 8997.19 | 2880.65 |
| 8908.380.00 |      |     |   |       |       |      |        |      |         |         |         |
| 7           | 60%  | 8mm |   | 17.00 | 18.10 | 2.47 | 769.47 | 0.00 | 371.72  | 8997.19 | 2880.65 |
| 8908.380.04 |      |     |   |       |       |      |        |      |         |         |         |
| 8           | 70%  | 8mm |   | 17.00 | 17.75 | 2.47 | 769.47 | 0.00 | 783.21  | 8821.22 | 2849.99 |
| 8753.410.09 |      |     |   |       |       |      |        |      |         |         |         |
| 9           | 80%  | 8mm | V | 17.00 | 17.75 | 2.47 | 769.47 | 0.00 | 1277.82 | 8821.22 | 2909.66 |
| 8798.160.15 |      |     |   |       |       |      |        |      |         |         |         |
| 10          | 90%  | 8mm | V | 17.00 | 18.05 | 2.47 | 769.47 | 0.00 | 1876.47 | 8972.34 | 3716.40 |
| 9516.550.20 |      |     |   |       |       |      |        |      |         |         |         |
| 11          | 100% | 8mm | V | 17.00 | 18.05 | 2.47 | 769.47 | 0.00 | 2145.31 | 8972.34 | 3716.40 |
| 9516.550.23 |      |     |   |       |       |      |        |      |         |         |         |
| <hr/>       |      |     |   |       |       |      |        |      |         |         |         |
| C           | 95%  | 8mm | V | 17.00 | 18.05 | 2.47 | 769.47 | 0.00 | 2145.31 | 8972.34 | 3716.40 |
| 9516.550.23 |      |     |   |       |       |      |        |      |         |         |         |

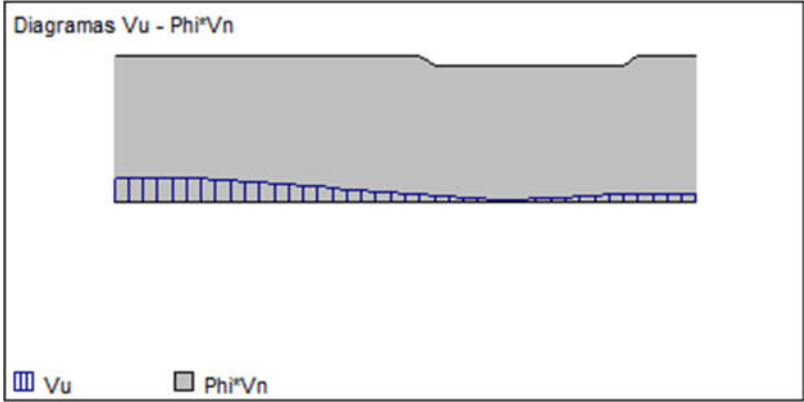


Tramo: 3-4                      Miembro No: 53

| Estación                |      | Estribos |     | Spc prov | Spc lim | Tu     | $\phi^*Tn$ | Al    | Vu      | Vs      | Vc        |
|-------------------------|------|----------|-----|----------|---------|--------|------------|-------|---------|---------|-----------|
| $\phi^*VnVu/(\phi^*Vn)$ |      |          |     |          |         |        |            |       |         |         |           |
| No.                     | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m]     | [cm2] | [Kg]    | [Kg]    | [Kg] [Kg] |
| 1                       | 0%   | 8mm      | V   | 17.00    | 18.05   | 18.11  | 769.47     | 0.00  | 1523.12 | 8972.34 | 3716.40   |
| 9516.550.16             |      |          |     |          |         |        |            |       |         |         |           |
| 2                       | 10%  | 8mm      | V   | 17.00    | 18.05   | 18.11  | 769.47     | 0.00  | 1523.12 | 8972.34 | 3716.40   |
| 9516.550.16             |      |          |     |          |         |        |            |       |         |         |           |
| 3                       | 20%  | 8mm      | V   | 17.00    | 18.05   | 18.11  | 769.47     | 0.00  | 1420.36 | 8972.34 | 3716.40   |
| 9516.550.15             |      |          |     |          |         |        |            |       |         |         |           |
| 4                       | 30%  | 8mm      |     | 17.00    | 18.05   | 18.11  | 769.47     | 0.00  | 1129.29 | 8972.34 | 3716.40   |
| 9516.550.12             |      |          |     |          |         |        |            |       |         |         |           |
| 5                       | 40%  | 8mm      |     | 17.00    | 18.05   | 18.11  | 769.47     | 0.00  | 838.22  | 8972.34 | 3716.40   |
| 9516.550.09             |      |          |     |          |         |        |            |       |         |         |           |
| 6                       | 50%  | 8mm      |     | 17.00    | 18.05   | 18.11  | 769.47     | 0.00  | 548.64  | 8972.34 | 3716.40   |
| 9516.550.06             |      |          |     |          |         |        |            |       |         |         |           |
| 7                       | 60%  | 8mm      |     | 17.00    | 18.10   | 18.11  | 769.47     | 0.00  | 299.07  | 8997.19 | 2880.65   |
| 8908.380.03             |      |          |     |          |         |        |            |       |         |         |           |
| 8                       | 70%  | 8mm      |     | 17.00    | 18.10   | 18.11  | 769.47     | 0.00  | 138.13  | 8997.19 | 2880.65   |
| 8908.380.02             |      |          |     |          |         |        |            |       |         |         |           |
| 9                       | 80%  | 8mm      |     | 17.00    | 18.10   | 18.11  | 769.47     | 0.00  | 387.62  | 8997.19 | 2880.65   |
| 8908.380.04             |      |          |     |          |         |        |            |       |         |         |           |


|   |  |  |                        |  |
|---|--|--|------------------------|--|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |  |
|   | MEMORIA DE CÁLCULO   |  | IPE-2025-2977-S-MC-011 |  |
|   | TÍTULO:  |  | HOJA:                  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 68 de 140              |  |
|   |  |  | REV:                   |  |
|   |  |  | A                      |  |

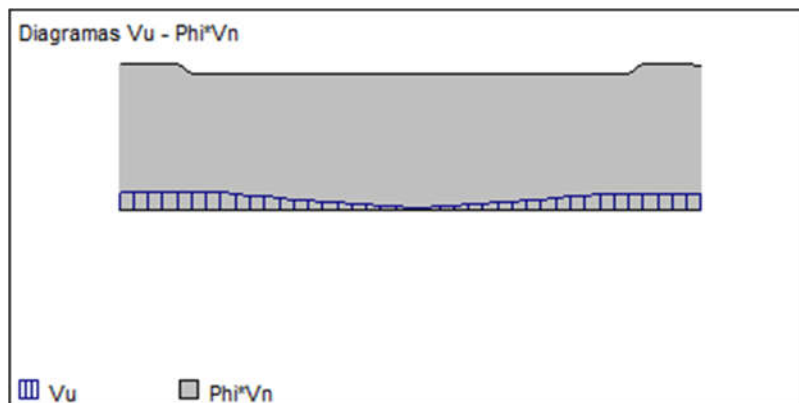
|             |      |     |   |       |       |       |        |      |         |         |         |
|-------------|------|-----|---|-------|-------|-------|--------|------|---------|---------|---------|
| 10          | 90%  | 8mm |   | 17.00 | 18.05 | 18.11 | 769.47 | 0.00 | 475.67  | 8972.34 | 3716.40 |
| 9516.550.05 |      |     |   |       |       |       |        |      |         |         |         |
| 11          | 100% | 8mm |   | 17.00 | 18.05 | 18.11 | 769.47 | 0.00 | 475.67  | 8972.34 | 3716.40 |
| 9516.550.05 |      |     |   |       |       |       |        |      |         |         |         |
| <hr/>       |      |     |   |       |       |       |        |      |         |         |         |
| C           | 0%   | 8mm | V | 17.00 | 18.05 | 18.11 | 769.47 | 0.00 | 1523.12 | 8972.34 | 3716.40 |
| 9516.550.16 |      |     |   |       |       |       |        |      |         |         |         |
| <hr/>       |      |     |   |       |       |       |        |      |         |         |         |



Tramo: 4-5                      Miembro No: 52

| Estación    |      | Estribos |     | Spc prov | Spc lim | Tu     | φ*Tn   | Al    | Vu      | Vs      | Vc        |
|-------------|------|----------|-----|----------|---------|--------|--------|-------|---------|---------|-----------|
| φ*Vu/(φ*Vn) |      |          |     |          |         |        |        |       |         |         |           |
| No.         | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m] | [cm2] | [Kg]    | [Kg]    | [Kg] [Kg] |
| 1           | 0%   | 8mm      |     | 17.00    | 18.05   | 7.41   | 769.47 | 0.00  | 1227.95 | 8972.34 | 3716.40   |
| 9516.550.13 |      |          |     |          |         |        |        |       |         |         |           |
| 2           | 10%  | 8mm      |     | 17.00    | 18.05   | 7.41   | 769.47 | 0.00  | 1227.95 | 8972.34 | 3716.40   |
| 9516.550.13 |      |          |     |          |         |        |        |       |         |         |           |
| 3           | 20%  | 8mm      |     | 17.00    | 18.10   | 7.41   | 769.47 | 0.00  | 1032.43 | 8997.19 | 2880.65   |
| 8908.380.12 |      |          |     |          |         |        |        |       |         |         |           |
| 4           | 30%  | 8mm      |     | 17.00    | 18.10   | 7.41   | 769.47 | 0.00  | 718.46  | 8997.19 | 2880.65   |
| 8908.380.08 |      |          |     |          |         |        |        |       |         |         |           |
| 5           | 40%  | 8mm      |     | 17.00    | 18.10   | 7.41   | 769.47 | 0.00  | 436.75  | 8997.19 | 2880.65   |
| 8908.380.05 |      |          |     |          |         |        |        |       |         |         |           |
| 6           | 50%  | 8mm      |     | 17.00    | 18.10   | 7.41   | 769.47 | 0.00  | 166.87  | 8997.19 | 2880.65   |
| 8908.380.02 |      |          |     |          |         |        |        |       |         |         |           |
| 7           | 60%  | 8mm      |     | 17.00    | 18.10   | 7.41   | 769.47 | 0.00  | 363.82  | 8997.19 | 2880.65   |
| 8908.380.04 |      |          |     |          |         |        |        |       |         |         |           |
| 8           | 70%  | 8mm      |     | 17.00    | 18.10   | 7.41   | 769.47 | 0.00  | 646.25  | 8997.19 | 2880.65   |
| 8908.380.07 |      |          |     |          |         |        |        |       |         |         |           |
| 9           | 80%  | 8mm      |     | 17.00    | 18.10   | 7.41   | 769.47 | 0.00  | 924.40  | 8997.19 | 2880.65   |
| 8908.380.10 |      |          |     |          |         |        |        |       |         |         |           |
| 10          | 90%  | 8mm      |     | 17.00    | 18.05   | 7.41   | 769.47 | 0.00  | 1106.69 | 8972.34 | 3716.40   |
| 9516.550.12 |      |          |     |          |         |        |        |       |         |         |           |
| 11          | 100% | 8mm      |     | 17.00    | 18.05   | 7.41   | 769.47 | 0.00  | 1106.69 | 8972.34 | 3520.64   |
| 9369.730.12 |      |          |     |          |         |        |        |       |         |         |           |
| <hr/>       |      |          |     |          |         |        |        |       |         |         |           |
| C           | 12%  | 8mm      | V   | 17.00    | 18.10   | 7.41   | 769.47 | 0.00  | 1227.95 | 8997.19 | 2880.65   |
| 8908.380.14 |      |          |     |          |         |        |        |       |         |         |           |
| <hr/>       |      |          |     |          |         |        |        |       |         |         |           |

|   |   |                               |
|---|---|-------------------------------|
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|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPe-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 69 de 140                     |
|   |   | REV:                          |
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Armadura longitudinal distribuidos uniformemente

Superior 3 Ø 12 mm.

Inferior 2 Ø 10 mm.

Estribos Ø 8 mm c/17 cm para armadura transversal.

## 8.2.2. VIGA VI-03 TRAMO (1-5)

# Resultados de Diseño Vigas de Hormigón Armado


## Datos Generales

Código de diseño : ACI 318-2019

### Estados de carga considerados:

|     |   |                     |
|-----|---|---------------------|
| D1  | = | 1.4CM               |
| D2  | = | 1.2CM+0.5VxCASOAPOS |
| D3  | = | 1.2CM+0.5VxCASOANEG |
| D4  | = | 1.2CM+0.5VzCASOAPOS |
| D5  | = | 1.2CM+0.5VzCASOANEG |
| D6  | = | 1.2CM+VxCASOAPOS    |
| D7  | = | 1.2CM+VxCASOANEG    |
| D8  | = | 1.2CM+VzCASOAPOS    |
| D9  | = | 1.2CM+VzCASOANEG    |
| D10 | = | 0.9CM+VxCASOAPOS    |
| D11 | = | 0.9CM+VxCASOANEG    |
| D12 | = | 0.9CM+VzCASOAPOS    |
| D13 | = | 0.9CM+VzCASOANEG    |
| D14 | = | 1.2CM+EQx           |
| D15 | = | 1.2CM+EQz           |
| D16 | = | 0.9CM+EQx           |
| D17 | = | 0.9CM+EQz           |
| D18 | = | 1.2CM+1.6CV         |



|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA: 70 de 140               |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | REV: <b>A</b>                 |

|     |   |                     |
|-----|---|---------------------|
| D19 | = | 1.2CM+0.5VzCASOBPOS |
| D20 | = | 1.2CM+0.5VzCASOBNEG |
| D21 | = | 1.2CM+VzCASOBPOS    |
| D22 | = | 1.2CM+VzCASOBNEG    |
| D23 | = | 1.2CM+VxCASOAPOS+CV |
| D24 | = | 1.2CM+VxCASOANEG+CV |
| D25 | = | 1.2CM+VzCASOAPOS+CV |
| D26 | = | 1.2CM+VzCASOANEG+CV |
| D27 | = | 1.2CM+VzCASOBPOS+CV |
| D28 | = | 1.2CM+VzCASOBNEG+CV |
| D29 | = | 0.9CM+VzCASOBPOS    |
| D30 | = | 0.9CM+VzCASOBNEG    |
| D31 | = | 1.2CM+EQxCUB        |
| D32 | = | 1.2CM+EQzCUB        |
| D33 | = | 1.2CM+EQx+CV        |
| D34 | = | 1.2CM+EQz+CV        |
| D35 | = | 1.2CM+EQxCUB+CV     |
| D36 | = | 1.2CM+EQzCUB+CV     |
| D37 | = | 0.9CM+EQxCUB        |
| D38 | = | 0.9CM+EQzCUB        |

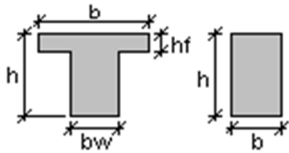
Riesgo sísmico : Riesgo Bajo

#### Materiales


|         |                                |                     |                             |          |
|---------|--------------------------------|---------------------|-----------------------------|----------|
| [Kg/m2] | Hormigón, f'c                  | : 2100000.00 [Kg... | Acero longitudinal, fy      | : 4.2E07 |
| [Kg/m2] | Tipo de concreto               | : Normal            | Acero transversal, fyt      | : 4.2E07 |
| [Kg/m2] | Módulo de elasticidad hormigón | : 2.14E09 [Kg/m2]   | Módulo de elasticidad acero | : 2.9E11 |
| [Kg/m2] | Peso unitario                  | : 2400.00 [Kg/m3]   | Recubrimiento epóxico       | : No     |

## Geometría

| Eje | Pos columna | Ancho inferior<br>[cm] | Ancho superior<br>[cm] | Dist x<br>[m] |
|-----|-------------|------------------------|------------------------|---------------|
| 1   | Centro      | 25.00                  | 25.00                  | 0.00          |
| 2   | Centro      | 15.00                  | 15.00                  | 5.95          |
| 3   | Centro      | 15.00                  | 15.00                  | 12.15         |
| 4   | Centro      | 0.00                   | 15.00                  | 14.55         |
| 5   | Centro      | 30.00                  | 30.00                  | 17.35         |



| Tramo | Dist entre ejes<br>[m] | Miembro No | Sección | b<br>[cm] | h<br>[cm] | bw<br>[cm] | hf<br>[cm] |
|-------|------------------------|------------|---------|-----------|-----------|------------|------------|
| 1-2   | 5.95                   | 33         |         | 20.00     | 40.00     | --         | --         |

|   |  |                               |
|---|--|-------------------------------|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:         |
|   | MEMORIA DE CÁLCULO   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:  | HOJA:                         |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | 71 de 140                     |
|   |  | REV:                          |
|   |  | <b>A</b>                      |

|     |      |    |       |       |    |    |
|-----|------|----|-------|-------|----|----|
| 2-3 | 6.20 | 31 | 20.00 | 40.00 | -- | -- |
| 3-4 | 2.40 | 57 | 15.00 | 40.00 | -- | -- |
| 4-5 | 2.80 | 62 | 15.00 | 40.00 | -- | -- |

## Diseño

Estatus : Bien

## Reinforcement

### Armadura

Recubrimiento libre : 2.50 [cm]

### Armadura longitudinal




| Grupo | Cantidad | Diámetro | Pos      | Eje Ref. 1 | Dist1 | Eje Ref. 2 | Dist2 | Gancho1 | Gancho2 |
|-------|----------|----------|----------|------------|-------|------------|-------|---------|---------|
|       |          |          |          |            | [m]   |            | [m]   |         |         |
| 1     | 2        | 12mm     | Inferior | 1          | 0.02  | 5          | -0.02 | Si      | Si      |
| 2     | 3        | 12mm     | Sup.     | 1          | 0.02  | 5          | -0.02 | Si      | Si      |

### Longitudes de anclaje y empalme

| Grupo | Diámetro | Ld<br>[cm] | Ldh<br>[cm] | L. Empalme<br>[cm] | L. total<br>[m] |
|-------|----------|------------|-------------|--------------------|-----------------|
| 1     | 12mm     | 54.00      | 20.00       | 70.00              | 17.64           |
| 2     | 12mm     | 70.00      | 20.00       | 90.00              | 17.64           |

### Armadura transversal

| Tramo | Diámetro | Cantidad | c/<br>[cm] | Ramas | Cerrado |
|-------|----------|----------|------------|-------|---------|
|-------|----------|----------|------------|-------|---------|

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPe-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 72 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

|     |     |    |       |   |    |
|-----|-----|----|-------|---|----|
| 1-2 | 8mm | 35 | 17.00 | 2 | Si |
| 2-3 | 8mm | 37 | 17.00 | 2 | Si |
| 3-4 | 8mm | 15 | 17.00 | 2 | Si |
| 4-5 | 8mm | 17 | 17.00 | 2 | Si |

#### Separación inicial de estribos:

| Tramo | S inicial<br>[cm] | Sin lim<br>[cm] |
|-------|-------------------|-----------------|
| 0-1   | 0.00              | 18.75           |
| 1-2   | 0.00              | 18.75           |
| 2-3   | 0.00              | 18.75           |
| 3-4   | 0.00              | 18.75           |

## Flexión

**Tramo: 1-2**

**Miembro No: 33**

Porcentaje de redistribución de momentos:

Apoyo A = 0.00%

Apoyo B = 0.00%

Cuantía geométrica máxima:

$\rho_{maxsup} = 1.55\%$


$\rho_{maxinf} = 1.55\%$

Separación límite entre barras por fisuración:

$s_b \text{ lim} = 30.61 \text{ [cm]}$

#### Momentos flectores positivos

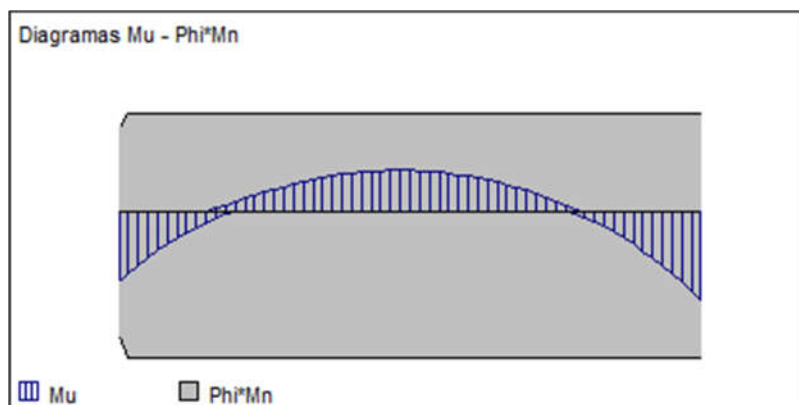
| Estación     | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%) | sb [cm] |
|--------------|-------|----------|-------------------|-------------|--------------|------------|---------|
| Mu/(\phi*Mn) |       |          |                   |             |              |            |         |
| No. Dist     |       |          |                   |             |              |            |         |
| 1 0%         | 36.10 | 0.00     | 2512.18           | 0.00        | 1.90         | 0.26       | 9.00    |
| 0.57         |       |          |                   |             |              |            |         |
| 2 10%        | 36.10 | 0.00     | 2970.38           | 0.00        | 2.26         | 0.31       | 9.00    |
| 0.18         |       |          |                   |             |              |            |         |
| 3 20%        | 36.10 | 306.61   | 2970.38           | 0.23        | 2.26         | 0.31       | 9.00    |
| 0.10         |       |          |                   |             |              |            |         |
| 4 30%        | 36.10 | 823.91   | 2970.38           | 0.61        | 2.26         | 0.31       | 9.00    |
| 0.28         |       |          |                   |             |              |            |         |
| 5 40%        | 36.10 | 1157.84  | 2970.38           | 0.86        | 2.26         | 0.31       | 9.00    |
| 0.39         |       |          |                   |             |              |            |         |
| 6 50%        | 36.10 | 1236.03  | 2970.38           | 0.92        | 2.26         | 0.31       | 9.00    |
| 0.42         |       |          |                   |             |              |            |         |
| 7 60%        | 36.10 | 1067.28  | 2970.38           | 0.79        | 2.26         | 0.31       | 9.00    |
| 0.36         |       |          |                   |             |              |            |         |
| 8 70%        | 36.10 | 635.75   | 2970.38           | 0.47        | 2.26         | 0.31       | 9.00    |
| 0.21         |       |          |                   |             |              |            |         |
| 9 80%        | 36.10 | 0.00     | 2970.38           | 0.00        | 2.26         | 0.31       | 9.00    |
| 0.04         |       |          |                   |             |              |            |         |
| 10 90%       | 36.10 | 0.00     | 2970.38           | 0.00        | 2.26         | 0.31       | 9.00    |
| 0.27         |       |          |                   |             |              |            |         |
| 11 100%      | 36.10 | 0.00     | 2970.38           | 0.00        | 2.26         | 0.31       | 9.00    |
| 0.61         |       |          |                   |             |              |            |         |

|   |   |  |                        |  |
|---|---|--|------------------------|--|
|  | TIPO DE DOCUMENTO:  |  | CÓDIGO DEL DOCUMENTO:  |  |
|   | MEMORIA DE CÁLCULO  |  | IPE-2025-2977-S-MC-011 |  |
|   | TÍTULO:   |  | HOJA:                  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE H <sup>o</sup> A <sup>o</sup> Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 73 de 140              |  |
|   |   |  | REV:                   |  |
|   |   |  | A                      |  |

|      |      |       |      |         |      |      |      |      |
|------|------|-------|------|---------|------|------|------|------|
| C    | 100% | 36.10 | 0.00 | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.61 |      |       |      |         |      |      |      |      |


#### Momentos flectores negativos

| Estación                          | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm <sup>2</sup> ] | Asprov [cm <sup>2</sup> ] | $\rho$ (%) | sb [cm] |
|-----------------------------------|-------|----------|-------------------|--------------------------|---------------------------|------------|---------|
| <b>Mu/(<math>\phi^*Mn</math>)</b> |       |          |                   |                          |                           |            |         |
| No. Dist                          |       |          |                   |                          |                           |            |         |
| 1 0%                              | 36.10 | -2099.12 | -3708.08          | 1.58                     | 2.85                      | 0.39       | 3.90    |
| 0.57                              |       |          |                   |                          |                           |            |         |
| 2 10%                             | 36.10 | -807.09  | -4370.40          | 0.60                     | 3.39                      | 0.47       | 3.90    |
| 0.18                              |       |          |                   |                          |                           |            |         |
| 3 20%                             | 36.10 | 0.00     | -4370.40          | 0.00                     | 3.39                      | 0.47       | 3.90    |
| 0.10                              |       |          |                   |                          |                           |            |         |
| 4 30%                             | 36.10 | 0.00     | -4370.40          | 0.00                     | 3.39                      | 0.47       | 3.90    |
| 0.28                              |       |          |                   |                          |                           |            |         |
| 5 40%                             | 36.10 | 0.00     | -4370.40          | 0.00                     | 3.39                      | 0.47       | 3.90    |
| 0.39                              |       |          |                   |                          |                           |            |         |
| 6 50%                             | 36.10 | 0.00     | -4370.40          | 0.00                     | 3.39                      | 0.47       | 3.90    |
| 0.42                              |       |          |                   |                          |                           |            |         |
| 7 60%                             | 36.10 | 0.00     | -4370.40          | 0.00                     | 3.39                      | 0.47       | 3.90    |
| 0.36                              |       |          |                   |                          |                           |            |         |
| 8 70%                             | 36.10 | 0.00     | -4370.40          | 0.00                     | 3.39                      | 0.47       | 3.90    |
| 0.21                              |       |          |                   |                          |                           |            |         |
| 9 80%                             | 36.10 | -157.13  | -4370.40          | 0.12                     | 3.39                      | 0.47       | 3.90    |
| 0.04                              |       |          |                   |                          |                           |            |         |
| 10 90%                            | 36.10 | -1176.21 | -4370.40          | 0.87                     | 3.39                      | 0.47       | 3.90    |
| 0.27                              |       |          |                   |                          |                           |            |         |
| 11 100%                           | 36.10 | -2652.64 | -4370.40          | 2.01                     | 3.39                      | 0.47       | 3.90    |
| 0.61                              |       |          |                   |                          |                           |            |         |
| C 100%                            | 36.10 | -2652.64 | -4370.40          | 2.01                     | 3.39                      | 0.47       | 3.90    |
| 0.61                              |       |          |                   |                          |                           |            |         |



Tramo: 2-3

Miembro No: 31

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IFE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 74 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |


Porcentaje de redistribución de momentos: Apoyo A = 0.00% Apoyo B = 0.00%  
 Cuantía geométrica máxima:  $\rho_{\text{maxsup}} = 1.55\%$   $\rho_{\text{maxinf}} = 1.55\%$   
 Separación límite entre barras por fisuración:  $s_b \text{ lim} = 30.61 \text{ [cm]}$

#### Momentos flectores positivos

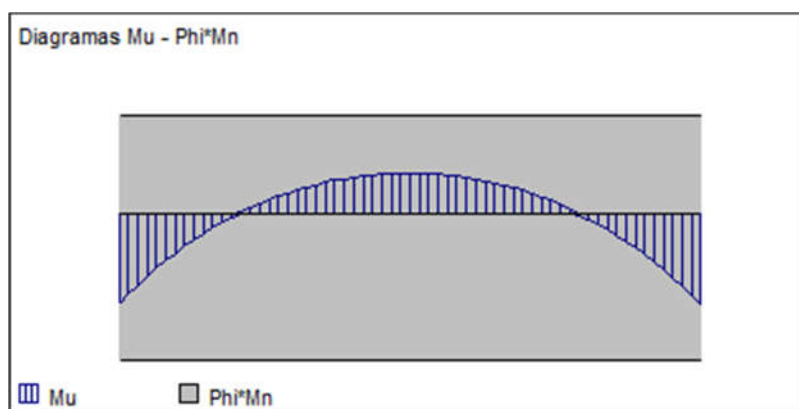
| Estación                          | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%) | sb [cm] |
|-----------------------------------|-------|----------|-------------------|-------------|--------------|------------|---------|
| <b>Mu/(<math>\phi^*Mn</math>)</b> |       |          |                   |             |              |            |         |
| No. Dist                          |       |          |                   |             |              |            |         |
| 1 0%                              | 36.10 | 0.00     | 2970.38           | 0.00        | 2.26         | 0.31       | 9.00    |
| 0.61                              |       |          |                   |             |              |            |         |
| 2 10%                             | 36.10 | 0.00     | 2970.38           | 0.00        | 2.26         | 0.31       | 9.00    |
| 0.26                              |       |          |                   |             |              |            |         |
| 3 20%                             | 36.10 | 35.02    | 2970.38           | 0.03        | 2.26         | 0.31       | 9.00    |
| 0.02                              |       |          |                   |             |              |            |         |
| 4 30%                             | 36.10 | 676.28   | 2970.38           | 0.50        | 2.26         | 0.31       | 9.00    |
| 0.23                              |       |          |                   |             |              |            |         |
| 5 40%                             | 36.10 | 1083.22  | 2970.38           | 0.80        | 2.26         | 0.31       | 9.00    |
| 0.36                              |       |          |                   |             |              |            |         |
| 6 50%                             | 36.10 | 1212.15  | 2970.38           | 0.90        | 2.26         | 0.31       | 9.00    |
| 0.41                              |       |          |                   |             |              |            |         |
| 7 60%                             | 36.10 | 1074.79  | 2970.38           | 0.80        | 2.26         | 0.31       | 9.00    |
| 0.36                              |       |          |                   |             |              |            |         |
| 8 70%                             | 36.10 | 658.53   | 2970.38           | 0.49        | 2.26         | 0.31       | 9.00    |
| 0.22                              |       |          |                   |             |              |            |         |
| 9 80%                             | 36.10 | 7.12     | 2970.38           | 0.01        | 2.26         | 0.31       | 9.00    |
| 0.03                              |       |          |                   |             |              |            |         |
| 10 90%                            | 36.10 | 0.00     | 2970.38           | 0.00        | 2.26         | 0.31       | 9.00    |
| 0.27                              |       |          |                   |             |              |            |         |
| 11 100%                           | 36.10 | 0.00     | 2970.38           | 0.00        | 2.26         | 0.31       | 9.00    |
| 0.62                              |       |          |                   |             |              |            |         |
| C 100%                            | 36.10 | 0.00     | 2970.38           | 0.00        | 2.26         | 0.31       | 9.00    |
| 0.62                              |       |          |                   |             |              |            |         |

#### Momentos flectores negativos

| Estación                          | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%) | sb [cm] |
|-----------------------------------|-------|----------|-------------------|-------------|--------------|------------|---------|
| <b>Mu/(<math>\phi^*Mn</math>)</b> |       |          |                   |             |              |            |         |
| No. Dist                          |       |          |                   |             |              |            |         |
| 1 0%                              | 36.10 | -2676.80 | -4370.40          | 2.03        | 3.39         | 0.47       | 3.90    |
| 0.61                              |       |          |                   |             |              |            |         |
| 2 10%                             | 36.10 | -1148.27 | -4370.40          | 0.85        | 3.39         | 0.47       | 3.90    |
| 0.26                              |       |          |                   |             |              |            |         |
| 3 20%                             | 36.10 | -83.83   | -4370.40          | 0.06        | 3.39         | 0.47       | 3.90    |
| 0.02                              |       |          |                   |             |              |            |         |
| 4 30%                             | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 0.23                              |       |          |                   |             |              |            |         |
| 5 40%                             | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 0.36                              |       |          |                   |             |              |            |         |
| 6 50%                             | 36.10 | 0.00     | -4370.40          | 0.00        | 3.39         | 0.47       | 3.90    |
| 0.41                              |       |          |                   |             |              |            |         |

|   |  |  |  |  |  |                        |  |  |
|---|--|--|--|--|--|------------------------|--|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  | IPE-2025-2977-S-MC-011 |  |  |
|   | TÍTULO:  |  |  |  |  | HOJA:                  |  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  | 75 de 140              |  |  |
|   |  |  |  |  |  | REV:                   |  |  |
|   |  |  |  |  |  | A                      |  |  |

|      |      |       |          |          |      |      |      |      |
|------|------|-------|----------|----------|------|------|------|------|
| 7    | 60%  | 36.10 | 0.00     | -4370.40 | 0.00 | 3.39 | 0.47 | 3.90 |
| 0.36 |      |       |          |          |      |      |      |      |
| 8    | 70%  | 36.10 | 0.00     | -4370.40 | 0.00 | 3.39 | 0.47 | 3.90 |
| 0.22 |      |       |          |          |      |      |      |      |
| 9    | 80%  | 36.10 | -120.13  | -4370.40 | 0.09 | 3.39 | 0.47 | 3.90 |
| 0.03 |      |       |          |          |      |      |      |      |
| 10   | 90%  | 36.10 | -1189.46 | -4370.40 | 0.88 | 3.39 | 0.47 | 3.90 |
| 0.27 |      |       |          |          |      |      |      |      |
| 11   | 100% | 36.10 | -2730.65 | -4370.40 | 2.07 | 3.39 | 0.47 | 3.90 |
| 0.62 |      |       |          |          |      |      |      |      |
| C    | 100% | 36.10 | -2730.65 | -4370.40 | 2.07 | 3.39 | 0.47 | 3.90 |
| 0.62 |      |       |          |          |      |      |      |      |



Tramo: 3-4

Miembro No: 57

Porcentaje de redistribución de momentos:

Apoyo A = 0.00%

Apoyo B = 0.00%

Cuantía geométrica máxima:

$\rho_{maxsup} = 1.55\%$


$\rho_{maxinf} = 1.55\%$

Separación límite entre barras por fisuración:

sb lim = 30.61 [cm]

#### Momentos flectores positivos


| Estación         |      | d[cm] | Mu[Kg*m] | $\phi$ *Mn[Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%) | sb [cm] |
|------------------|------|-------|----------|------------------|-------------|--------------|------------|---------|
| Mu/( $\phi$ *Mn) |      |       |          |                  |             |              |            |         |
| No.              | Dist |       |          |                  |             |              |            |         |
| 1                | 0%   | 36.10 | 0.00     | 2932.53          | 0.00        | 2.26         | 0.42       | 4.00    |
| 0.69             |      |       |          |                  |             |              |            |         |
| 2                | 10%  | 36.10 | 0.00     | 2932.53          | 0.00        | 2.26         | 0.42       | 4.00    |
| 0.52             |      |       |          |                  |             |              |            |         |
| 3                | 20%  | 36.10 | 0.00     | 2932.53          | 0.00        | 2.26         | 0.42       | 4.00    |
| 0.37             |      |       |          |                  |             |              |            |         |
| 4                | 30%  | 36.10 | 0.00     | 2932.53          | 0.00        | 2.26         | 0.42       | 4.00    |
| 0.23             |      |       |          |                  |             |              |            |         |
| 5                | 40%  | 36.10 | 0.00     | 2932.53          | 0.00        | 2.26         | 0.42       | 4.00    |
| 0.11             |      |       |          |                  |             |              |            |         |
| 6                | 50%  | 36.10 | 57.82    | 2932.53          | 0.04        | 2.26         | 0.42       | 4.00    |
| 0.02             |      |       |          |                  |             |              |            |         |

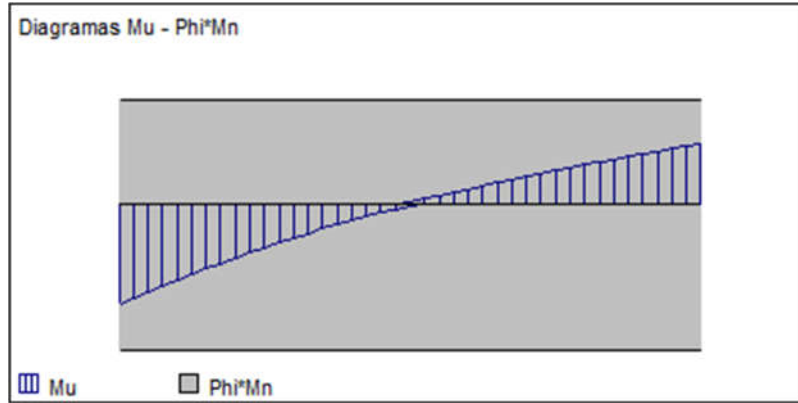
|   |  |  |                        |  |
|---|--|--|------------------------|--|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |  |
|   | MEMORIA DE CÁLCULO   |  | IPE-2025-2977-S-MC-011 |  |
|   | TÍTULO:  |  | HOJA:                  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 76 de 140              |  |
|   |  |  | REV:                   |  |
|   |  |  | A                      |  |

|      |      |       |         |         |      |      |      |      |
|------|------|-------|---------|---------|------|------|------|------|
| 7    | 60%  | 36.10 | 417.33  | 2932.53 | 0.31 | 2.26 | 0.42 | 4.00 |
| 0.14 |      |       |         |         |      |      |      |      |
| 8    | 70%  | 36.10 | 788.92  | 2932.53 | 0.59 | 2.26 | 0.42 | 4.00 |
| 0.27 |      |       |         |         |      |      |      |      |
| 9    | 80%  | 36.10 | 1122.85 | 2932.53 | 0.84 | 2.26 | 0.42 | 4.00 |
| 0.38 |      |       |         |         |      |      |      |      |
| 10   | 90%  | 36.10 | 1422.92 | 2932.53 | 1.07 | 2.26 | 0.42 | 4.00 |
| 0.49 |      |       |         |         |      |      |      |      |
| 11   | 100% | 36.10 | 1692.22 | 2932.53 | 1.28 | 2.26 | 0.42 | 4.00 |
| 0.58 |      |       |         |         |      |      |      |      |
| C    | 0%   | 36.10 | 0.00    | 2932.53 | 0.00 | 2.26 | 0.42 | 4.00 |
| 0.69 |      |       |         |         |      |      |      |      |

#### Momentos flectores negativos

| Estación  |      | d[cm] | Mu[Kg*m] | ϕ*Mn[Kg*m] | Asreq [cm2] | Asprov [cm2] | ρ (%) | sb [cm] |
|-----------|------|-------|----------|------------|-------------|--------------|-------|---------|
| Mu/(ϕ*Mn) |      |       |          |            |             |              |       |         |
| No. Dist  |      |       |          |            |             |              |       |         |
| 1         | 0%   | 34.85 | -2850.60 | -4125.47   | 2.28        | 3.39         | 0.65  | 4.00    |
| 0.69      |      |       |          |            |             |              |       |         |
| 2         | 10%  | 34.85 | -2159.87 | -4125.47   | 1.70        | 3.39         | 0.65  | 4.00    |
| 0.52      |      |       |          |            |             |              |       |         |
| 3         | 20%  | 34.85 | -1532.20 | -4125.47   | 1.20        | 3.39         | 0.65  | 4.00    |
| 0.37      |      |       |          |            |             |              |       |         |
| 4         | 30%  | 34.85 | -964.92  | -4125.47   | 0.74        | 3.39         | 0.65  | 4.00    |
| 0.23      |      |       |          |            |             |              |       |         |
| 5         | 40%  | 34.85 | -454.36  | -4125.47   | 0.35        | 3.39         | 0.65  | 4.00    |
| 0.11      |      |       |          |            |             |              |       |         |
| 6         | 50%  | 34.85 | -49.44   | -4125.47   | 0.04        | 3.39         | 0.65  | 4.00    |
| 0.02      |      |       |          |            |             |              |       |         |
| 7         | 60%  | 34.85 | 0.00     | -4125.47   | 0.00        | 3.39         | 0.65  | 4.00    |
| 0.14      |      |       |          |            |             |              |       |         |
| 8         | 70%  | 34.85 | 0.00     | -4125.47   | 0.00        | 3.39         | 0.65  | 4.00    |
| 0.27      |      |       |          |            |             |              |       |         |
| 9         | 80%  | 34.85 | 0.00     | -4125.47   | 0.00        | 3.39         | 0.65  | 4.00    |
| 0.38      |      |       |          |            |             |              |       |         |
| 10        | 90%  | 34.85 | 0.00     | -4125.47   | 0.00        | 3.39         | 0.65  | 4.00    |
| 0.49      |      |       |          |            |             |              |       |         |
| 11        | 100% | 34.85 | 0.00     | -4125.47   | 0.00        | 3.39         | 0.65  | 4.00    |
| 0.58      |      |       |          |            |             |              |       |         |
| C         | 0%   | 34.85 | -2850.60 | -4125.47   | 2.28        | 3.39         | 0.65  | 4.00    |
| 0.69      |      |       |          |            |             |              |       |         |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 77 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |



Tramo: 4-5

Miembro No: 62

Porcentaje de redistribución de momentos:

Apoyo A = 0.00%

Apoyo B = 0.00%

Cuantía geométrica máxima:

$\rho_{\max\sup} = 1.55\%$

$\rho_{\max\inf} = 1.55\%$

Separación límite entre barras por fisuración:


sb lim = 30.61 [cm]

#### Momentos flectores positivos

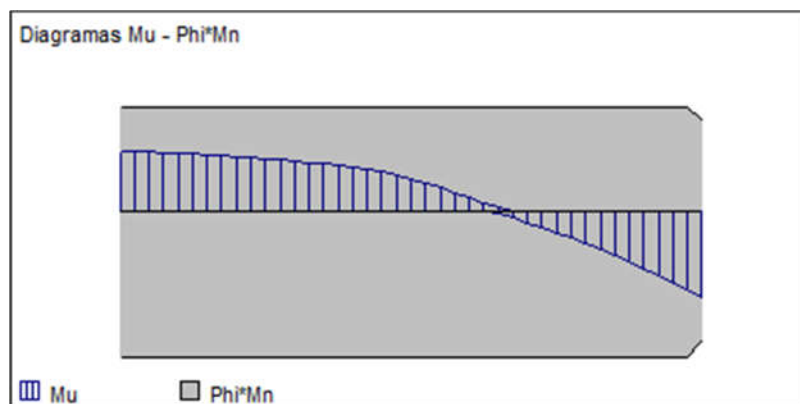
| Estación                           | d[cm] | Mu[Kg*m] | $\Phi^*M_n$ [Kg*m] | Asreq [cm <sup>2</sup> ] | Asprov [cm <sup>2</sup> ] | $\rho$ (%) | sb [cm] |
|------------------------------------|-------|----------|--------------------|--------------------------|---------------------------|------------|---------|
| <b>Mu/(<math>\Phi^*M_n</math>)</b> |       |          |                    |                          |                           |            |         |
| No. Dist                           |       |          |                    |                          |                           |            |         |
| 1 0%                               | 36.10 | 1695.33  | 2932.53            | 1.28                     | 2.26                      | 0.42       | 4.00    |
| 0.58                               |       |          |                    |                          |                           |            |         |
| 2 10%                              | 36.10 | 1641.05  | 2932.53            | 1.24                     | 2.26                      | 0.42       | 4.00    |
| 0.56                               |       |          |                    |                          |                           |            |         |
| 3 20%                              | 36.10 | 1546.41  | 2932.53            | 1.16                     | 2.26                      | 0.42       | 4.00    |
| 0.53                               |       |          |                    |                          |                           |            |         |
| 4 30%                              | 36.10 | 1415.80  | 2932.53            | 1.06                     | 2.26                      | 0.42       | 4.00    |
| 0.48                               |       |          |                    |                          |                           |            |         |
| 5 40%                              | 36.10 | 1246.34  | 2932.53            | 0.93                     | 2.26                      | 0.42       | 4.00    |
| 0.43                               |       |          |                    |                          |                           |            |         |
| 6 50%                              | 36.10 | 920.13   | 2932.53            | 0.68                     | 2.26                      | 0.42       | 4.00    |
| 0.31                               |       |          |                    |                          |                           |            |         |
| 7 60%                              | 36.10 | 385.25   | 2932.53            | 0.28                     | 2.26                      | 0.42       | 4.00    |
| 0.13                               |       |          |                    |                          |                           |            |         |
| 8 70%                              | 36.10 | 0.00     | 2932.53            | 0.00                     | 2.26                      | 0.42       | 4.00    |
| 0.08                               |       |          |                    |                          |                           |            |         |
| 9 80%                              | 36.10 | 0.00     | 2932.53            | 0.00                     | 2.26                      | 0.42       | 4.00    |
| 0.22                               |       |          |                    |                          |                           |            |         |
| 10 90%                             | 36.10 | 0.00     | 2932.53            | 0.00                     | 2.26                      | 0.42       | 4.00    |
| 0.39                               |       |          |                    |                          |                           |            |         |
| 11 100%                            | 36.10 | 0.00     | 2619.91            | 0.00                     | 2.01                      | 0.37       | 4.00    |
| 0.66                               |       |          |                    |                          |                           |            |         |
| C 100%                             | 36.10 | 0.00     | 2619.91            | 0.00                     | 2.01                      | 0.37       | 4.00    |
| 0.66                               |       |          |                    |                          |                           |            |         |

#### Momentos flectores negativos



|   |  |  |                        |
|---|--|--|------------------------|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |
|   | MEMORIA DE CÁLCULO   |  | IPE-2025-2977-S-MC-011 |
|   | TÍTULO:  |  | HOJA:                  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 78 de 140              |
|   |  |  | REV:                   |
|   |  |  | A                      |

| Estación<br>Mu/( $\phi^*Mn$ )<br>No. Dist | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%) | sb [cm] |
|---|-------|----------|-------------------|-------------|--------------|------------|---------|
| 1 0%<br>0.58                              | 34.85 | 0.00     | -4125.47          | 0.00        | 3.39         | 0.65       | 4.00    |
| 2 10%<br>0.56                             | 34.85 | 0.00     | -4125.47          | 0.00        | 3.39         | 0.65       | 4.00    |
| 3 20%<br>0.53                             | 34.85 | 0.00     | -4125.47          | 0.00        | 3.39         | 0.65       | 4.00    |
| 4 30%<br>0.48                             | 34.85 | 0.00     | -4125.47          | 0.00        | 3.39         | 0.65       | 4.00    |
| 5 40%<br>0.43                             | 34.85 | 0.00     | -4125.47          | 0.00        | 3.39         | 0.65       | 4.00    |
| 6 50%<br>0.31                             | 34.85 | 0.00     | -4125.47          | 0.00        | 3.39         | 0.65       | 4.00    |
| 7 60%<br>0.13                             | 34.85 | 0.00     | -4125.47          | 0.00        | 3.39         | 0.65       | 4.00    |
| 8 70%<br>0.08                             | 34.85 | -317.51  | -4125.47          | 0.24        | 3.39         | 0.65       | 4.00    |
| 9 80%<br>0.22                             | 34.85 | -916.65  | -4125.47          | 0.71        | 3.39         | 0.65       | 4.00    |
| 10 90%<br>0.39                            | 34.85 | -1618.42 | -4125.47          | 1.26        | 3.39         | 0.65       | 4.00    |
| 11 100%<br>0.66                           | 34.85 | -2443.62 | -3698.35          | 1.94        | 3.01         | 0.58       | 4.00    |
| C 100%<br>0.66                            | 34.85 | -2443.62 | -3698.35          | 1.94        | 3.01         | 0.58       | 4.00    |




## Corte y Torsión

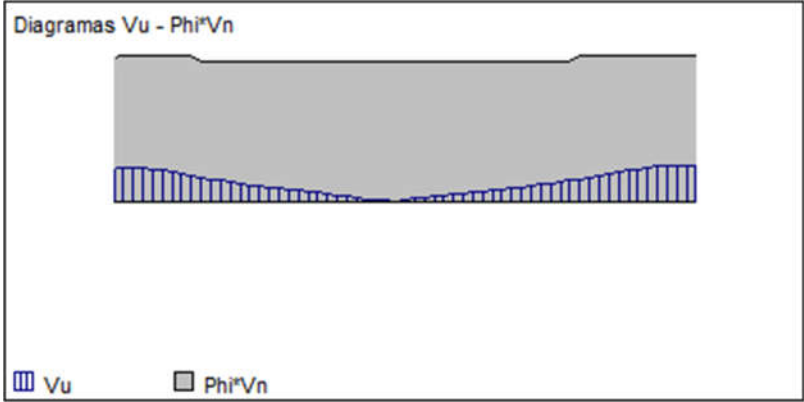
Tramo: 1-2

Miembro No: 33

| Estación                | Estribos | Spc prov | Spc lim | Tu | $\phi^*Tn$ | Al | Vu | Vs | Vc |
|-------------------------|----------|----------|---------|----|------------|----|----|----|----|
| $\phi^*VnVu/(\phi^*Vn)$ |          |          |         |    |            |    |    |    |    |

|   |  |                               |
|---|--|-------------------------------|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:         |
|   | MEMORIA DE CÁLCULO   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:  | HOJA:                         |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | 79 de 140                     |
|   |  | REV:                          |
|   |  | <b>A</b>                      |


| No.         | Dist | Diám | VCT | [cm]  | [cm]  | [Kg*m] | [Kg*m] | [cm2] | [Kg]    | [Kg]    | [Kg]    | [Kg] |
|-------------|------|------|-----|-------|-------|--------|--------|-------|---------|---------|---------|------|
| 1           | 0%   | 8mm  | V   | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 2163.88 | 8972.34 | 3507.43 |      |
| 9359.830.23 |      |      |     |       |       |        |        |       |         |         |         |      |
| 2           | 10%  | 8mm  | V   | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 1910.28 | 8972.34 | 3716.40 |      |
| 9516.550.20 |      |      |     |       |       |        |        |       |         |         |         |      |
| 3           | 20%  | 8mm  | V   | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 1293.46 | 8972.34 | 3246.57 |      |
| 9164.180.14 |      |      |     |       |       |        |        |       |         |         |         |      |
| 4           | 30%  | 8mm  |     | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 772.35  | 8972.34 | 3246.57 |      |
| 9164.180.08 |      |      |     |       |       |        |        |       |         |         |         |      |
| 5           | 40%  | 8mm  |     | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 328.86  | 8972.34 | 3246.57 |      |
| 9164.180.04 |      |      |     |       |       |        |        |       |         |         |         |      |
| 6           | 50%  | 8mm  |     | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 115.84  | 8972.34 | 3246.57 |      |
| 9164.180.01 |      |      |     |       |       |        |        |       |         |         |         |      |
| 7           | 60%  | 8mm  |     | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 485.32  | 8972.34 | 3246.57 |      |
| 9164.180.05 |      |      |     |       |       |        |        |       |         |         |         |      |
| 8           | 70%  | 8mm  |     | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 947.05  | 8972.34 | 3246.57 |      |
| 9164.180.10 |      |      |     |       |       |        |        |       |         |         |         |      |
| 9           | 80%  | 8mm  | V   | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 1492.42 | 8972.34 | 3716.40 |      |
| 9516.550.16 |      |      |     |       |       |        |        |       |         |         |         |      |
| 10          | 90%  | 8mm  | V   | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 2129.77 | 8972.34 | 3716.40 |      |
| 9516.550.22 |      |      |     |       |       |        |        |       |         |         |         |      |
| 11          | 100% | 8mm  | V   | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 2387.04 | 8972.34 | 3716.40 |      |
| 9516.550.25 |      |      |     |       |       |        |        |       |         |         |         |      |
| C           | 95%  | 8mm  | V   | 17.00 | 18.05 | 3.20   | 769.47 | 0.00  | 2387.04 | 8972.34 | 3716.40 |      |
| 9516.550.25 |      |      |     |       |       |        |        |       |         |         |         |      |



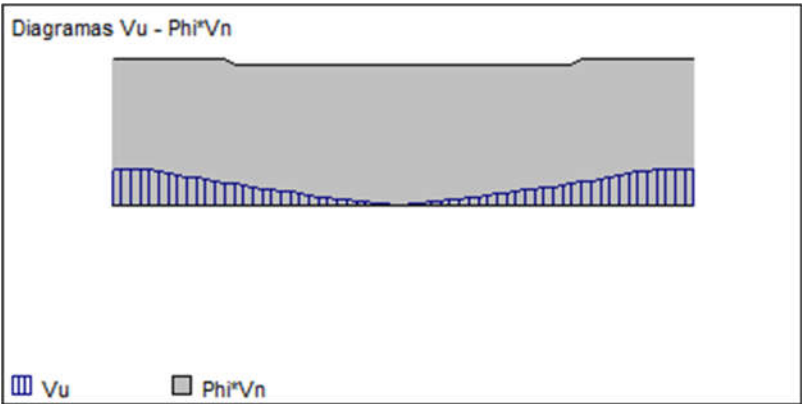
Tramo: 2-3

Miembro No: 31

| Estación                |      | Estribos |     | Spc prov | Spc lim | Tu     | $\phi^*Tn$ | Al    | Vu      | Vs      | Vc      |      |
|-------------------------|------|----------|-----|----------|---------|--------|------------|-------|---------|---------|---------|------|
| $\phi^*VnVu/(\phi^*Vn)$ |      |          |     |          |         |        |            |       |         |         |         |      |
| No.                     | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m]     | [cm2] | [Kg]    | [Kg]    | [Kg]    | [Kg] |
| 1                       | 0%   | 8mm      | V   | 17.00    | 18.05   | 2.13   | 769.47     | 0.00  | 2389.17 | 8972.34 | 3716.40 |      |
| 9516.550.25             |      |          |     |          |         |        |            |       |         |         |         |      |
| 2                       | 10%  | 8mm      | V   | 17.00    | 18.05   | 2.13   | 769.47     | 0.00  | 2099.78 | 8972.34 | 3716.40 |      |
| 9516.550.22             |      |          |     |          |         |        |            |       |         |         |         |      |
| 3                       | 20%  | 8mm      | V   | 17.00    | 18.05   | 2.13   | 769.47     | 0.00  | 1440.89 | 8972.34 | 3528.47 |      |
| 9375.600.15             |      |          |     |          |         |        |            |       |         |         |         |      |
| 4                       | 30%  | 8mm      |     | 17.00    | 18.05   | 2.13   | 769.47     | 0.00  | 882.30  | 8972.34 | 3246.57 |      |
| 9164.180.10             |      |          |     |          |         |        |            |       |         |         |         |      |


|   |  |  |                        |  |
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|   | MEMORIA DE CÁLCULO   |  | IPE-2025-2977-S-MC-011 |  |
|   | TÍTULO:  |  | HOJA:                  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 80 de 140              |  |
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|   |  |  | A                      |  |

|             |      |     |   |       |       |      |        |      |         |         |         |
|-------------|------|-----|---|-------|-------|------|--------|------|---------|---------|---------|
| 5           | 40%  | 8mm |   | 17.00 | 18.05 | 2.13 | 769.47 | 0.00 | 412.44  | 8972.34 | 3246.57 |
| 9164.180.05 |      |     |   |       |       |      |        |      |         |         |         |
| 6           | 50%  | 8mm |   | 17.00 | 18.05 | 2.13 | 769.47 | 0.00 | 31.20   | 8972.34 | 3246.57 |
| 9164.180.00 |      |     |   |       |       |      |        |      |         |         |         |
| 7           | 60%  | 8mm |   | 17.00 | 18.05 | 2.13 | 769.47 | 0.00 | 445.91  | 8972.34 | 3246.57 |
| 9164.180.05 |      |     |   |       |       |      |        |      |         |         |         |
| 8           | 70%  | 8mm |   | 17.00 | 18.05 | 2.13 | 769.47 | 0.00 | 928.30  | 8972.34 | 3246.57 |
| 9164.180.10 |      |     |   |       |       |      |        |      |         |         |         |
| 9           | 80%  | 8mm | V | 17.00 | 18.05 | 2.13 | 769.47 | 0.00 | 1486.89 | 8972.34 | 3528.47 |
| 9375.600.16 |      |     |   |       |       |      |        |      |         |         |         |
| 10          | 90%  | 8mm | V | 17.00 | 18.05 | 2.13 | 769.47 | 0.00 | 2135.10 | 8972.34 | 3716.40 |
| 9516.550.22 |      |     |   |       |       |      |        |      |         |         |         |
| 11          | 100% | 8mm | V | 17.00 | 18.05 | 2.13 | 769.47 | 0.00 | 2418.76 | 8972.34 | 3716.40 |
| 9516.550.25 |      |     |   |       |       |      |        |      |         |         |         |
| <hr/>       |      |     |   |       |       |      |        |      |         |         |         |
| C           | 95%  | 8mm | V | 17.00 | 18.05 | 2.13 | 769.47 | 0.00 | 2418.76 | 8972.34 | 3716.40 |
| 9516.550.25 |      |     |   |       |       |      |        |      |         |         |         |

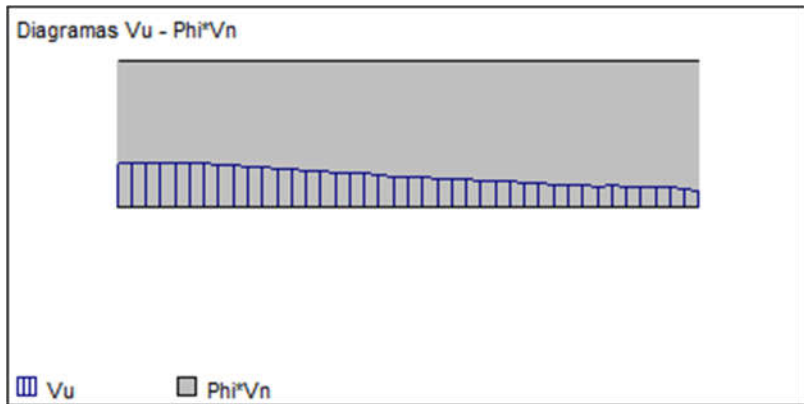


Tramo: 3-4                      Miembro No: 57

| Estación                |      | Estribos |     | Spc prov | Spc lim | Tu     | $\phi^*Tn$ | Al    | Vu      | Vs      | Vc        |
|-------------------------|------|----------|-----|----------|---------|--------|------------|-------|---------|---------|-----------|
| $\phi^*VnVu/(\phi^*Vn)$ |      |          |     |          |         |        |            |       |         |         |           |
| No.                     | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m]     | [cm2] | [Kg]    | [Kg]    | [Kg] [Kg] |
| 1                       | 0%   | 8mm      | V   | 17.00    | 17.43   | 9.31   | 471.53     | 0.00  | 2599.48 | 8662.49 | 2996.78   |
| 8744.450.30             |      |          |     |          |         |        |            |       |         |         |           |
| 2                       | 10%  | 8mm      | V   | 17.00    | 17.43   | 9.31   | 471.53     | 0.00  | 2599.48 | 8662.49 | 2996.78   |
| 8744.450.30             |      |          |     |          |         |        |            |       |         |         |           |
| 3                       | 20%  | 8mm      | V   | 17.00    | 17.43   | 9.31   | 480.04     | 0.00  | 2488.55 | 8662.49 | 2996.78   |
| 8744.450.28             |      |          |     |          |         |        |            |       |         |         |           |
| 4                       | 30%  | 8mm      | V   | 17.00    | 17.43   | 9.31   | 498.53     | 0.00  | 2238.99 | 8662.49 | 2996.78   |
| 8744.450.26             |      |          |     |          |         |        |            |       |         |         |           |
| 5                       | 40%  | 8mm      | V   | 17.00    | 17.43   | 9.31   | 498.53     | 0.00  | 2002.13 | 8662.49 | 2996.78   |
| 8744.450.23             |      |          |     |          |         |        |            |       |         |         |           |
| 6                       | 50%  | 8mm      | V   | 17.00    | 18.05   | 9.31   | 498.53     | 0.00  | 1779.38 | 8972.34 | 2679.99   |
| 8739.240.20             |      |          |     |          |         |        |            |       |         |         |           |
| 7                       | 60%  | 8mm      | V   | 17.00    | 18.05   | 9.31   | 498.53     | 0.00  | 1653.15 | 8972.34 | 2679.99   |
| 8739.240.19             |      |          |     |          |         |        |            |       |         |         |           |
| 8                       | 70%  | 8mm      | V   | 17.00    | 18.05   | 9.31   | 498.53     | 0.00  | 1474.02 | 8972.34 | 2679.99   |
| 8739.240.17             |      |          |     |          |         |        |            |       |         |         |           |
| 9                       | 80%  | 8mm      | V   | 17.00    | 18.05   | 9.31   | 498.53     | 0.00  | 1307.77 | 8972.34 | 2679.99   |
| 8739.240.15             |      |          |     |          |         |        |            |       |         |         |           |


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|   | TÍTULO:  | HOJA:                  |
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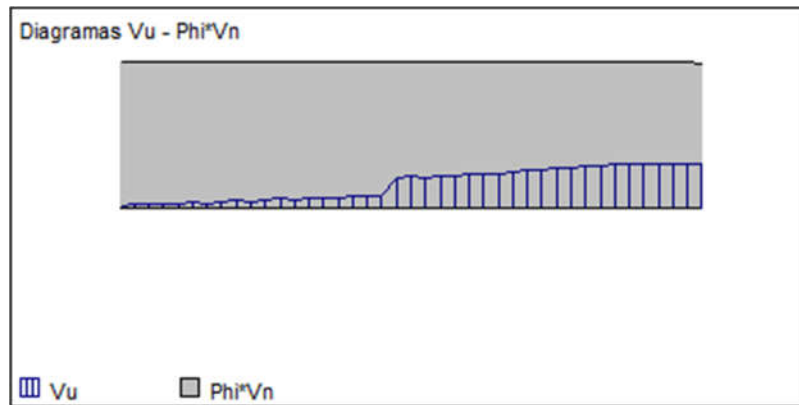
|             |      |     |   |       |       |      |        |      |         |         |         |
|-------------|------|-----|---|-------|-------|------|--------|------|---------|---------|---------|
| 10          | 90%  | 8mm | V | 17.00 | 18.05 | 9.31 | 498.53 | 0.00 | 1152.65 | 8972.34 | 2679.99 |
| 8739.240.13 |      |     |   |       |       |      |        |      |         |         |         |
| 11          | 100% | 8mm | V | 17.00 | 18.05 | 9.31 | 498.53 | 0.00 | 1006.41 | 8972.34 | 2679.99 |
| 8739.240.12 |      |     |   |       |       |      |        |      |         |         |         |
| C           | 0%   | 8mm | V | 17.00 | 17.43 | 9.31 | 471.53 | 0.00 | 2599.48 | 8662.49 | 2996.78 |
| 8744.450.30 |      |     |   |       |       |      |        |      |         |         |         |



Tramo: 4-5                      Miembro No: 62

| Estación                |      | Estribos |     | Spc prov | Spc lim | Tu     | $\phi^*Tn$ | Al    | Vu      | Vs      | Vc        |
|-------------------------|------|----------|-----|----------|---------|--------|------------|-------|---------|---------|-----------|
| $\phi^*VnVu/(\phi^*Vn)$ |      |          |     |          |         |        |            |       |         |         |           |
| No.                     | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m]     | [cm2] | [Kg]    | [Kg]    | [Kg] [Kg] |
| 1                       | 0%   | 8mm      |     | 17.00    | 18.05   | 2.64   | 498.53     | 0.00  | 119.74  | 8972.34 | 2679.99   |
| 8739.240.01             |      |          |     |          |         |        |            |       |         |         |           |
| 2                       | 10%  | 8mm      |     | 17.00    | 18.05   | 2.64   | 498.53     | 0.00  | 278.45  | 8972.34 | 2679.99   |
| 8739.240.03             |      |          |     |          |         |        |            |       |         |         |           |
| 3                       | 20%  | 8mm      |     | 17.00    | 18.05   | 2.64   | 498.53     | 0.00  | 438.65  | 8972.34 | 2679.99   |
| 8739.240.05             |      |          |     |          |         |        |            |       |         |         |           |
| 4                       | 30%  | 8mm      |     | 17.00    | 18.05   | 2.64   | 498.53     | 0.00  | 494.89  | 8972.34 | 2679.99   |
| 8739.240.06             |      |          |     |          |         |        |            |       |         |         |           |
| 5                       | 40%  | 8mm      |     | 17.00    | 18.05   | 2.64   | 498.53     | 0.00  | 694.58  | 8972.34 | 2679.99   |
| 8739.240.08             |      |          |     |          |         |        |            |       |         |         |           |
| 6                       | 50%  | 8mm      | V   | 17.00    | 18.05   | 4.90   | 498.53     | 0.00  | 1868.53 | 8972.34 | 2679.99   |
| 8739.240.21             |      |          |     |          |         |        |            |       |         |         |           |
| 7                       | 60%  | 8mm      | V   | 17.00    | 18.05   | 4.90   | 498.53     | 0.00  | 2008.47 | 8972.34 | 2679.99   |
| 8739.240.23             |      |          |     |          |         |        |            |       |         |         |           |
| 8                       | 70%  | 8mm      | V   | 17.00    | 17.43   | 4.90   | 497.44     | 0.00  | 2261.83 | 8662.49 | 2996.78   |
| 8744.450.26             |      |          |     |          |         |        |            |       |         |         |           |
| 9                       | 80%  | 8mm      | V   | 17.00    | 17.43   | 4.90   | 479.59     | 0.00  | 2494.49 | 8662.49 | 2996.78   |
| 8744.450.29             |      |          |     |          |         |        |            |       |         |         |           |
| 10                      | 90%  | 8mm      | V   | 17.00    | 17.43   | 4.90   | 464.83     | 0.00  | 2686.77 | 8662.49 | 2996.78   |
| 8744.450.31             |      |          |     |          |         |        |            |       |         |         |           |
| 11                      | 100% | 8mm      | V   | 17.00    | 17.43   | 4.90   | 458.15     | 0.00  | 2686.77 | 8662.49 | 2880.73   |
| 8657.420.31             |      |          |     |          |         |        |            |       |         |         |           |
| C                       | 100% | 8mm      | V   | 17.00    | 17.43   | 4.90   | 458.15     | 0.00  | 2686.77 | 8662.49 | 2880.73   |
| 8657.420.31             |      |          |     |          |         |        |            |       |         |         |           |

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|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 82 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |




Armadura longitudinal distribuidos uniformemente

Superior 3 Ø 12 mm.

Inferior 2 Ø 12 mm.

Estribos Ø 8 mm c/17 cm para armadura transversal.


|   |  |                        |
|---|--|------------------------|
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|   | TÍTULO:  | HOJA:                  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | 83 de 140              |
|   |  | REV:                   |
|   |  | A                      |

### 8.2.3. VIGA VI-02 TRAMO (4-5), VI-04 TRAMO (A-B) Y VIGA VI-05/ VI-06/ VI-07/VI-08/ VI-09 TRAMO (A-B)

Para el cálculo de las demás vigas al ser las menos solicitadas se realizó el resumen de diseño:

**Figura 26.** Resumen de diseño (Vigas de encadenado).

| Vigas                     |                             |                    |                          |        |         |       |                    |       |       |       |   |
|---------------------------|-----------------------------|--------------------|--------------------------|--------|---------|-------|--------------------|-------|-------|-------|---|
| VIGA                      | A.izq                       | A.cent             | A.der                    | P.lizq | P.l.der | PIEL  | Sep. Estribos [cm] |       |       | TIPO  |   |
| ID                        | Mmin/max<br>[cm2]<br>[Kg*m] | V [Kg]<br>T [Kg*m] | Longitud<br>[cm2]<br>[m] | [m]    | [m]     | [cm2] | Barra              | IZQ.  | CENT. | DER.  |   |
| <b>34 RcBeamM 20x40cm</b> |                             |                    |                          |        |         |       |                    |       |       |       |   |
| SUP:                      | 2.34                        | 0.00               | 2.34                     | 0.79   | 2.97    | 0.00  | T8                 | 17.50 | 17.50 | 17.50 | U |
|                           | 841.30                      | 1632.00            | 3.80                     |        |         |       |                    |       |       |       |   |
| INF:                      | 0.00                        | 2.34               | 0.00                     | 0.40   | 3.17    |       |                    |       |       |       |   |
|                           | -1300.00                    | 6.73               |                          |        |         |       |                    |       |       |       |   |
| <b>32 RcBeamM 15X40</b>   |                             |                    |                          |        |         |       |                    |       |       |       |   |
| SUP:                      | 1.88                        | 0.00               | 1.88                     | 1.08   | 2.80    | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|                           | 751.80                      | 1728.00            | 3.80                     |        |         |       |                    |       |       |       |   |
| INF:                      | 0.00                        | 0.00               | 1.88                     | 0.66   | 0.00    |       |                    |       |       |       |   |
|                           | -1697.00                    | 3.95               |                          |        |         |       |                    |       |       |       |   |
| <b>30 RcBeamM 15X40</b>   |                             |                    |                          |        |         |       |                    |       |       |       |   |
| SUP:                      | 1.88                        | 0.00               | 1.88                     | 0.96   | 2.69    | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|                           | 761.10                      | 1770.00            | 3.80                     |        |         |       |                    |       |       |       |   |
| INF:                      | 1.88                        | 0.00               | 0.00                     | 3.04   | 0.00    |       |                    |       |       |       |   |
|                           | -1769.00                    | 4.72               |                          |        |         |       |                    |       |       |       |   |
| <b>50 RcBeamM 15X40</b>   |                             |                    |                          |        |         |       |                    |       |       |       |   |
| SUP:                      | 0.00                        | 0.00               | 1.88                     | 0.03   | 2.93    | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|                           | 1168.00                     | 2752.00            | 3.80                     |        |         |       |                    |       |       |       |   |
| INF:                      | 0.00                        | 1.88               | 0.00                     | 0.00   | 3.23    |       |                    |       |       |       |   |
|                           | -2038.00                    | 16.88              |                          |        |         |       |                    |       |       |       |   |
| <b>22 RcBeamM 15X40</b>   |                             |                    |                          |        |         |       |                    |       |       |       |   |
| SUP:                      | 0.00                        | 0.00               | 0.00                     | 0.02   | 0.00    | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|                           | 613.20                      | 622.10             | 2.65                     |        |         |       |                    |       |       |       |   |
| INF:                      | 0.00                        | 0.00               | 1.88                     | 0.00   | 0.00    |       |                    |       |       |       |   |
|                           | -12.55                      | 10.70              |                          |        |         |       |                    |       |       |       |   |
| <b>28 RcBeamM 15X40</b>   |                             |                    |                          |        |         |       |                    |       |       |       |   |
| SUP:                      | 1.88                        | 0.00               | 1.88                     | 0.71   | 2.98    | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|                           | 1326.00                     | 2504.00            | 3.80                     |        |         |       |                    |       |       |       |   |
| INF:                      | 0.00                        | 1.88               | 0.00                     | 0.37   | 3.16    |       |                    |       |       |       |   |
|                           | -1597.00                    | 25.40              |                          |        |         |       |                    |       |       |       |   |
| <b>48 RcBeamM 15X40</b>   |                             |                    |                          |        |         |       |                    |       |       |       |   |
| SUP:                      | 0.00                        | 0.00               | 0.00                     | 0.02   | 2.77    | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|                           | 1316.00                     | 1239.00            | 2.80                     |        |         |       |                    |       |       |       |   |
| INF:                      | 0.00                        | 1.88               | 0.00                     | 0.01   | 2.79    |       |                    |       |       |       |   |
|                           | -31.23                      | 25.80              |                          |        |         |       |                    |       |       |       |   |

|   |   |                               |
|---|---|-------------------------------|
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|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 84 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

Armado de vigas:

Viga VI-02 TRAMO (4-5)

Sección de la viga 15 cm x 40 cm

Armadura Longitudinal: 4 Ø 10 mm  $A_s = 3.14 \text{ cm}^2$

Armadura Transversal: Ø 8 mm c/17 cm

Viga VI-04 TRAMO (A-B)

Sección de la viga 20 cm x 40 cm

Armadura Longitudinal: 4 Ø 10 mm  $A_s = 3.14 \text{ cm}^2$

Armadura Transversal: Ø 8 mm c/17 cm

Viga VI-05/VI-06 /VI-07/VI-09 TRAMO (A-B)

Sección de la viga 15 cm x 40 cm

Armadura Longitudinal superior: 2 Ø 12 mm  $A_s = 2.26 \text{ cm}^2$

Armadura Longitudinal inferior: 2 Ø 10 mm  $A_s = 1.56 \text{ cm}^2$


Armadura Transversal: Ø 8 mm c/17 cm

VIGA VI-08 TRAMO (A-B)

Sección de la viga 15 cm x 40 cm

Armadura Longitudinal: 4 Ø 10 mm  $A_s = 3.14 \text{ cm}^2$

Armadura Transversal: Ø 8 mm c/17 cm

|   |  |                               |
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|   | TÍTULO:  | HOJA: 85 de 140               |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | REV: <b>A</b>                 |

### 8.3. DISEÑO DE VIGAS DE ENCADENADO SUPERIOR

#### 8.3.1. VIGA VS-01 TRAMO (1-5)

## Resultados de Diseño

### Vigas de Hormigón Armado


### Datos Generales

Código de diseño : ACI 318-2019

#### Estados de carga considerados:

|     |   |                      |
|-----|---|----------------------|
| D1  | = | 1.4CM                |
| D2  | = | 1.2CM+0.5VxCASO APOS |
| D3  | = | 1.2CM+0.5VxCASO ANEG |
| D4  | = | 1.2CM+0.5VzCASO APOS |
| D5  | = | 1.2CM+0.5VzCASO ANEG |
| D6  | = | 1.2CM+VxCASO APOS    |
| D7  | = | 1.2CM+VxCASO ANEG    |
| D8  | = | 1.2CM+VzCASO APOS    |
| D9  | = | 1.2CM+VzCASO ANEG    |
| D10 | = | 0.9CM+VxCASO APOS    |
| D11 | = | 0.9CM+VxCASO ANEG    |
| D12 | = | 0.9CM+VzCASO APOS    |
| D13 | = | 0.9CM+VzCASO ANEG    |
| D14 | = | 1.2CM+EQx            |
| D15 | = | 1.2CM+EQz            |
| D16 | = | 0.9CM+EQx            |




|   |   |                               |
|---|---|-------------------------------|
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|   | TÍTULO:   | HOJA:                         |
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|   |   | REV:                          |
|   |   | <b>A</b>                      |

|     |   |                     |
|-----|---|---------------------|
| D17 | = | 0.9CM+EQz           |
| D18 | = | 1.2CM+1.6CV         |
| D19 | = | 1.2CM+0.5VzCASOBPOS |
| D20 | = | 1.2CM+0.5VzCASOBNEG |
| D21 | = | 1.2CM+VzCASOBPOS    |
| D22 | = | 1.2CM+VzCASOBNEG    |
| D23 | = | 1.2CM+VxCASOAPOS+CV |
| D24 | = | 1.2CM+VxCASOANEG+CV |
| D25 | = | 1.2CM+VzCASOAPOS+CV |
| D26 | = | 1.2CM+VzCASOANEG+CV |
| D27 | = | 1.2CM+VzCASOBPOS+CV |
| D28 | = | 1.2CM+VzCASOBNEG+CV |
| D29 | = | 0.9CM+VzCASOBPOS    |
| D30 | = | 0.9CM+VzCASOBNEG    |
| D31 | = | 1.2CM+EQxCUB        |
| D32 | = | 1.2CM+EQzCUB        |
| D33 | = | 1.2CM+EQx+CV        |
| D34 | = | 1.2CM+EQz+CV        |
| D35 | = | 1.2CM+EQxCUB+CV     |
| D36 | = | 1.2CM+EQzCUB+CV     |
| D37 | = | 0.9CM+EQxCUB        |
| D38 | = | 0.9CM+EQzCUB        |

Riesgo sísmico : Riesgo Bajo

#### **Materiales**

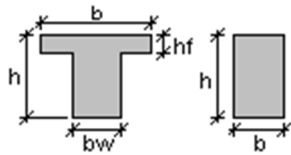
|                          |   |                                 |                                    |   |        |
|--------------------------|---|---------------------------------|------------------------------------|---|--------|
| Hormigón, f <sub>c</sub> | : | 2100000.00 [Kg/m <sup>2</sup> ] | Acero longitudinal, f <sub>y</sub> | : | 4.2E07 |
| Tipo de concreto         | : | Normal                          | Acero transversal, f <sub>yt</sub> | : | 4.2E07 |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 87 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |


|                                |   |                 |                             |   |                |
|--------------------------------|---|-----------------|-----------------------------|---|----------------|
| Módulo de elasticidad hormigón | : | 2.14E09 [Kg/m2] | Módulo de elasticidad acero | : | 2.9E11 [Kg/m2] |
| Peso unitario                  | : | 2400.00 [Kg/m3] | Recubrimiento epóxico       | : | No             |

## Geometría

| Eje | Pos columna | Ancho inferior<br>[cm] | Ancho superior<br>[cm] | Dist x<br>[m] |
|-----|-------------|------------------------|------------------------|---------------|
| 1   | Centro      | 25.00                  | 0.00                   | 0.00          |
| 2   | Centro      | 15.00                  | 0.00                   | 5.95          |
| 3   | Centro      | 15.00                  | 0.00                   | 12.15         |
| 4   | Centro      | 25.00                  | 0.00                   | 14.55         |
| 5   | Centro      | 25.00                  | 0.00                   | 17.35         |



| Tramo | Dist entre ejes<br>[m] | Miembro No | Sección | b<br>[cm] | h<br>[cm] | bw<br>[cm] | hf<br>[cm] |
|-------|------------------------|------------|---------|-----------|-----------|------------|------------|
| 1-2   | 5.95                   | 39         |         | 20.00     | 40.00     | --         | --         |
| 2-3   | 6.20                   | 40         |         | 20.00     | 40.00     | --         | --         |

|   |  |  |  |  |                        |  |
|---|--|--|--|--|------------------------|--|
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|   | TÍTULO:  |  |  |  | HOJA:                  |  |
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|   |  |  |  |  | REV:                   |  |
|   |  |  |  |  | A                      |  |

|     |      |    |       |       |    |    |
|-----|------|----|-------|-------|----|----|
| 3-4 | 2.40 | 54 | 20.00 | 40.00 | -- | -- |
| 4-5 | 2.80 | 55 | 20.00 | 40.00 | -- | -- |

Diseño

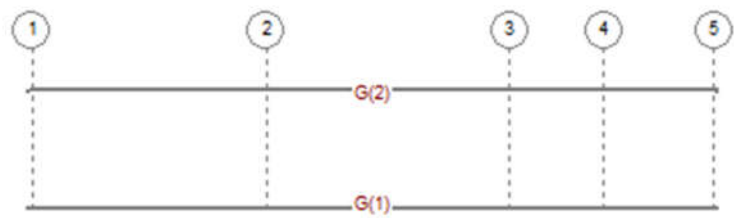
Estatus : Bien

Reinforcement


Armadura

Recubrimiento libre : 2.50 [cm]

Armadura longitudinal



| Grupo | Cantidad | Diámetro | Pos | Eje Ref. 1 | Dist1 | Eje Ref. 2 | Dist2 | Gancho1 | Gancho2 |
|-------|----------|----------|-----|------------|-------|------------|-------|---------|---------|
|       |          |          |     |            | [m]   |            | [m]   |         |         |

|   |  |  |                        |  |
|---|--|--|------------------------|--|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |  |
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|   | TÍTULO:  |  | HOJA:                  |  |
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|   |   |      |          |   |       |   |      |    |    |
|---|---|------|----------|---|-------|---|------|----|----|
| 1 | 2 | 12mm | Inferior | 1 | -0.11 | 5 | 0.11 | Si | Si |
| 2 | 2 | 12mm | Sup.     | 1 | -0.11 | 5 | 0.11 | Si | Si |

#### Longitudes de anclaje y empalme


| Grupo | Diámetro | Ld    | Ldh   | L. Empalme | L. total |
|-------|----------|-------|-------|------------|----------|
|       |          | [cm]  | [cm]  | [cm]       | [m]      |
| 1     | 12mm     | 54.00 | 20.00 | 70.00      | 17.90    |
| 2     | 12mm     | 70.00 | 20.00 | 90.00      | 17.90    |

#### Armadura transversal

| Tramo | Diámetro | Cantidad | c/<br>[cm] | Ramas | Cerrado |
|-------|----------|----------|------------|-------|---------|
| 1-2   | 8mm      | 48       | 12.00      | 2     | Si      |
| 2-3   | 8mm      | 51       | 12.00      | 2     | Si      |
| 3-4   | 8mm      | 19       | 12.00      | 2     | Si      |
| 4-5   | 8mm      | 22       | 12.00      | 2     | Si      |

#### Separación inicial de estribos:

| Tramo | S inicial | Sin lim |
|-------|-----------|---------|
|       | [cm]      | [cm]    |

|   |  |  |                               |
|---|--|--|-------------------------------|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:         |
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|   | TÍTULO:  |  | HOJA:                         |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 90 de 140                     |
|   |  |  | REV:                          |
|   |  |  | <b>A</b>                      |

|     |      |       |
|-----|------|-------|
| 0-1 | 5.50 | 18.75 |
| 1-2 | 2.50 | 18.75 |
| 2-3 | 1.90 | 18.75 |
| 3-4 | 1.50 | 18.75 |


Flexión

Tramo: 1-2                      Miembro No: 39

|  |                            |                          |
|--|----------------------------|--------------------------|
| Porcentaje de redistribución de momentos:      | Apoyo A = 0.00%            | Apoyo B = 0.00%          |
| Cuantía geométrica máxima:                     | $\rho_{maxsup} = 1.55\%$   | $\rho_{maxinf} = 1.55\%$ |
| Separación límite entre barras por fisuración: | $s_{b\ lim} = 30.61\ [cm]$ |                          |

Momentos flectores positivos


| Estación         | d[cm] | Mu[Kg*m] | $\phi*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho\ (\%)sb$ | [cm] |
|------------------|-------|----------|------------------|-------------|--------------|----------------|------|
| Mu/( $\phi*Mn$ ) |       |          |                  |             |              |                |      |
| No. Dist         |       |          |                  |             |              |                |      |
| 1    0%          | 36.10 | 168.31   | 2970.38          | 0.12        | 2.26         | 0.31           | 9.00 |
| 0.06             |       |          |                  |             |              |                |      |
| 2    10%         | 36.10 | 83.05    | 2970.38          | 0.06        | 2.26         | 0.31           | 9.00 |
| 0.03             |       |          |                  |             |              |                |      |
| 3    20%         | 36.10 | 0.00     | 2970.38          | 0.00        | 2.26         | 0.31           | 9.00 |
| 0.06             |       |          |                  |             |              |                |      |
| 4    30%         | 36.10 | 0.00     | 2970.38          | 0.00        | 2.26         | 0.31           | 9.00 |
| 0.10             |       |          |                  |             |              |                |      |

|   |  |  |  |  |  |  |                        |  |  |
|---|--|--|--|--|--|--|------------------------|--|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  |  | IPE-2025-2977-S-MC-011 |  |  |
|   | TÍTULO:  |  |  |  |  |  | HOJA:                  |  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  |  | 91 de 140              |  |  |
|   |  |  |  |  |  |  | REV:                   |  |  |
|   |  |  |  |  |  |  | A                      |  |  |

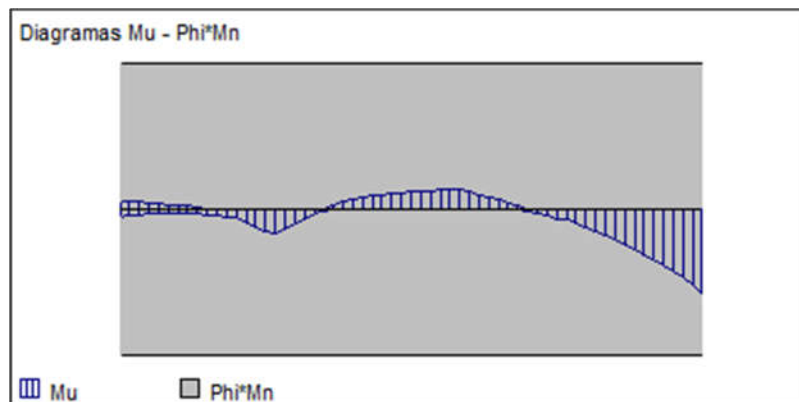
|      |      |       |        |         |      |      |      |      |
|------|------|-------|--------|---------|------|------|------|------|
| 5    | 40%  | 36.10 | 217.86 | 2970.38 | 0.16 | 2.26 | 0.31 | 9.00 |
| 0.07 |      |       |        |         |      |      |      |      |
| 6    | 50%  | 36.10 | 362.87 | 2970.38 | 0.27 | 2.26 | 0.31 | 9.00 |
| 0.12 |      |       |        |         |      |      |      |      |
| 7    | 60%  | 36.10 | 354.72 | 2970.38 | 0.26 | 2.26 | 0.31 | 9.00 |
| 0.12 |      |       |        |         |      |      |      |      |
| 8    | 70%  | 36.10 | 2.53   | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.01 |      |       |        |         |      |      |      |      |
| 9    | 80%  | 36.10 | 0.00   | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.12 |      |       |        |         |      |      |      |      |
| 10   | 90%  | 36.10 | 0.00   | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.31 |      |       |        |         |      |      |      |      |
| 11   | 100% | 36.10 | 0.00   | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.57 |      |       |        |         |      |      |      |      |
|      |      |       |        |         |      |      |      |      |
| C    | 100% | 36.10 | 0.00   | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.57 |      |       |        |         |      |      |      |      |

**Momentos flectores negativos**

| Estación         | d[cm] | Mu[Kg*m] | $\phi$ *Mn[Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%)sb | [cm] |
|------------------|-------|----------|------------------|-------------|--------------|--------------|------|
| Mu/( $\phi$ *Mn) |       |          |                  |             |              |              |      |
| No. Dist         |       |          |                  |             |              |              |      |
| 1                | 0%    | 36.10    | -149.17          | -2970.38    | 0.11         | 2.26         | 0.31 |
| 0.06             |       |          |                  |             |              |              |      |
| 2                | 10%   | 36.10    | -84.14           | -2970.38    | 0.06         | 2.26         | 0.31 |
| 0.03             |       |          |                  |             |              |              |      |
| 3                | 20%   | 36.10    | -181.45          | -2970.38    | 0.13         | 2.26         | 0.31 |
| 0.06             |       |          |                  |             |              |              |      |


|   |  |  |  |  |  |                        |  |  |
|---|--|--|--|--|--|------------------------|--|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  | IPE-2025-2977-S-MC-011 |  |  |
|   | TÍTULO:  |  |  |  |  | HOJA:                  |  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  | 92 de 140              |  |  |
|   |  |  |  |  |  | REV:                   |  |  |
|   |  |  |  |  |  | A                      |  |  |

|      |      |       |          |          |      |      |      |      |
|------|------|-------|----------|----------|------|------|------|------|
| 4    | 30%  | 36.10 | -291.48  | -2970.38 | 0.21 | 2.26 | 0.31 | 9.00 |
| 0.10 |      |       |          |          |      |      |      |      |
| 5    | 40%  | 36.10 | 0.00     | -2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.07 |      |       |          |          |      |      |      |      |
| 6    | 50%  | 36.10 | 0.00     | -2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.12 |      |       |          |          |      |      |      |      |
| 7    | 60%  | 36.10 | 0.00     | -2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.12 |      |       |          |          |      |      |      |      |
| 8    | 70%  | 36.10 | -21.76   | -2970.38 | 0.02 | 2.26 | 0.31 | 9.00 |
| 0.01 |      |       |          |          |      |      |      |      |
| 9    | 80%  | 36.10 | -356.33  | -2970.38 | 0.26 | 2.26 | 0.31 | 9.00 |
| 0.12 |      |       |          |          |      |      |      |      |
| 10   | 90%  | 36.10 | -933.81  | -2970.38 | 0.69 | 2.26 | 0.31 | 9.00 |
| 0.31 |      |       |          |          |      |      |      |      |
| 11   | 100% | 36.10 | -1700.04 | -2970.38 | 1.27 | 2.26 | 0.31 | 9.00 |
| 0.57 |      |       |          |          |      |      |      |      |
| C    | 100% | 36.10 | -1700.04 | -2970.38 | 1.27 | 2.26 | 0.31 | 9.00 |
| 0.57 |      |       |          |          |      |      |      |      |



Tramo: 2-3

Miembro No: 40

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 93 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

Porcentaje de redistribución de momentos: Apoyo A = 0.00% Apoyo B = 0.00%  
 Cuantía geométrica máxima:  $\rho_{\text{maxsup}} = 1.55\%$   $\rho_{\text{maxinf}} = 1.55\%$   
 Separación límite entre barras por fisuración:  $s_b \text{ lim} = 30.61 \text{ [cm]}$

#### Momentos flectores positivos

| Estación         | d[cm] | Mu[Kg*m] | $\phi*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%)sb | [cm] |
|------------------|-------|----------|------------------|-------------|--------------|--------------|------|
| Mu/( $\phi*Mn$ ) |       |          |                  |             |              |              |      |
| No. Dist         |       |          |                  |             |              |              |      |
| 1 0%             | 36.10 | 0.00     | 2970.38          | 0.00        | 2.26         | 0.31         | 9.00 |
| 0.66             |       |          |                  |             |              |              |      |
| 2 10%            | 36.10 | 0.00     | 2970.38          | 0.00        | 2.26         | 0.31         | 9.00 |
| 0.26             |       |          |                  |             |              |              |      |
| 3 20%            | 36.10 | 209.11   | 2970.38          | 0.15        | 2.26         | 0.31         | 9.00 |
| 0.07             |       |          |                  |             |              |              |      |
| 4 30%            | 36.10 | 894.63   | 2970.38          | 0.66        | 2.26         | 0.31         | 9.00 |
| 0.30             |       |          |                  |             |              |              |      |
| 5 40%            | 36.10 | 1299.48  | 2970.38          | 0.97        | 2.26         | 0.31         | 9.00 |
| 0.44             |       |          |                  |             |              |              |      |
| 6 50%            | 36.10 | 1461.33  | 2970.38          | 1.09        | 2.26         | 0.31         | 9.00 |
| 0.49             |       |          |                  |             |              |              |      |
| 7 60%            | 36.10 | 1300.56  | 2970.38          | 0.97        | 2.26         | 0.31         | 9.00 |
| 0.44             |       |          |                  |             |              |              |      |
| 8 70%            | 36.10 | 938.06   | 2970.38          | 0.70        | 2.26         | 0.31         | 9.00 |
| 0.32             |       |          |                  |             |              |              |      |
| 9 80%            | 36.10 | 212.46   | 2970.38          | 0.16        | 2.26         | 0.31         | 9.00 |
| 0.07             |       |          |                  |             |              |              |      |
| 10 90%           | 36.10 | 0.00     | 2970.38          | 0.00        | 2.26         | 0.31         | 9.00 |
| 0.23             |       |          |                  |             |              |              |      |




|  |  |                        |
|--|--|------------------------|
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|  | TÍTULO:  | HOJA:                  |
|  | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | 94 de 140              |
|  |  | REV:                   |
|  |  | A                      |

11    100%    36.10            0.00            2970.38            0.00            2.26            0.31            9.00  
0.66

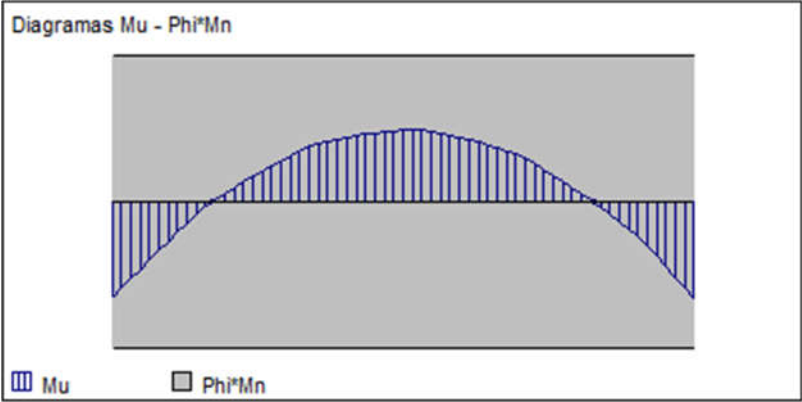
C    0%            36.10            0.00            2970.38            0.00            2.26            0.31            9.00  
0.66

**Momentos flectores negativos**

| Estación  |     | d[cm] | Mu[Kg*m] | ϕ*Mn[Kg*m] | Asreq [cm2] | Asprov [cm2] | ρ (%)sb | [cm] |
|-----------|-----|-------|----------|------------|-------------|--------------|---------|------|
| Mu/(ϕ*Mn) |     |       |          |            |             |              |         |      |
| No. Dist  |     |       |          |            |             |              |         |      |
| 1         | 0%  | 36.10 | -1969.40 | -2970.38   | 1.48        | 2.26         | 0.31    | 9.00 |
| 0.66      |     |       |          |            |             |              |         |      |
| 2         | 10% | 36.10 | -760.53  | -2970.38   | 0.56        | 2.26         | 0.31    | 9.00 |
| 0.26      |     |       |          |            |             |              |         |      |
| 3         | 20% | 36.10 | 0.00     | -2970.38   | 0.00        | 2.26         | 0.31    | 9.00 |
| 0.07      |     |       |          |            |             |              |         |      |
| 4         | 30% | 36.10 | 0.00     | -2970.38   | 0.00        | 2.26         | 0.31    | 9.00 |
| 0.30      |     |       |          |            |             |              |         |      |
| 5         | 40% | 36.10 | 0.00     | -2970.38   | 0.00        | 2.26         | 0.31    | 9.00 |
| 0.44      |     |       |          |            |             |              |         |      |
| 6         | 50% | 36.10 | 0.00     | -2970.38   | 0.00        | 2.26         | 0.31    | 9.00 |
| 0.49      |     |       |          |            |             |              |         |      |
| 7         | 60% | 36.10 | 0.00     | -2970.38   | 0.00        | 2.26         | 0.31    | 9.00 |
| 0.44      |     |       |          |            |             |              |         |      |
| 8         | 70% | 36.10 | 0.00     | -2970.38   | 0.00        | 2.26         | 0.31    | 9.00 |
| 0.32      |     |       |          |            |             |              |         |      |
| 9         | 80% | 36.10 | 0.00     | -2970.38   | 0.00        | 2.26         | 0.31    | 9.00 |
| 0.07      |     |       |          |            |             |              |         |      |

|   |   |                               |
|---|---|-------------------------------|
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|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 95 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

|    |      |       |          |          |      |      |      |      |
|----|------|-------|----------|----------|------|------|------|------|
| 10 | 90%  | 36.10 | -681.24  | -2970.38 | 0.50 | 2.26 | 0.31 | 9.00 |
|    |      |       |          |          |      |      |      | 0.23 |
| 11 | 100% | 36.10 | -1963.96 | -2970.38 | 1.47 | 2.26 | 0.31 | 9.00 |
|    |      |       |          |          |      |      |      | 0.66 |
| C  | 0%   | 36.10 | -1969.40 | -2970.38 | 1.48 | 2.26 | 0.31 | 9.00 |
|    |      |       |          |          |      |      |      | 0.66 |




Tramo: 3-4                      Miembro No: 54

|  |                                 |                                 |
|--|---------------------------------|---------------------------------|
| Porcentaje de redistribución de momentos:      | Apoyo A = 0.00%                 | Apoyo B = 0.00%                 |
| Cuantía geométrica máxima:                     | $\rho_{\text{maxsup}} = 1.55\%$ | $\rho_{\text{maxinf}} = 1.55\%$ |
| Separación límite entre barras por fisuración: | sb lim = 30.61 [cm]             |                                 |

**Momentos flectores positivos**


| Estación                          | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm <sup>2</sup> ] | Asprov [cm <sup>2</sup> ] | $\rho$ (%)sb | [cm] |
|-----------------------------------|-------|----------|-------------------|--------------------------|---------------------------|--------------|------|
| <b>Mu/(<math>\phi^*Mn</math>)</b> |       |          |                   |                          |                           |              |      |
| No.                               | Dist  |          |                   |                          |                           |              |      |

|   |  |                        |
|---|--|------------------------|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:  |
|   | MEMORIA DE CÁLCULO   | IPE-2025-2977-S-MC-011 |
|   | TÍTULO:  | HOJA: 96 de 140        |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | REV: A                 |

|    |      |       |       |         |      |      |      |      |
|----|------|-------|-------|---------|------|------|------|------|
| 1  | 0%   | 36.10 | 0.00  | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.57 |
| 2  | 10%  | 36.10 | 0.00  | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.45 |
| 3  | 20%  | 36.10 | 0.00  | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.33 |
| 4  | 30%  | 36.10 | 0.00  | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.25 |
| 5  | 40%  | 36.10 | 0.00  | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.18 |
| 6  | 50%  | 36.10 | 0.00  | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.12 |
| 7  | 60%  | 36.10 | 0.00  | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.07 |
| 8  | 70%  | 36.10 | 0.00  | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.03 |
| 9  | 80%  | 36.10 | 24.82 | 2970.38 | 0.02 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.03 |
| 10 | 90%  | 36.10 | 41.50 | 2970.38 | 0.03 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.03 |
| 11 | 100% | 36.10 | 44.76 | 2970.38 | 0.03 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.04 |
| C  | 0%   | 36.10 | 0.00  | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
|    |      |       |       |         |      |      |      | 0.57 |


#### Momentos flectores negativos

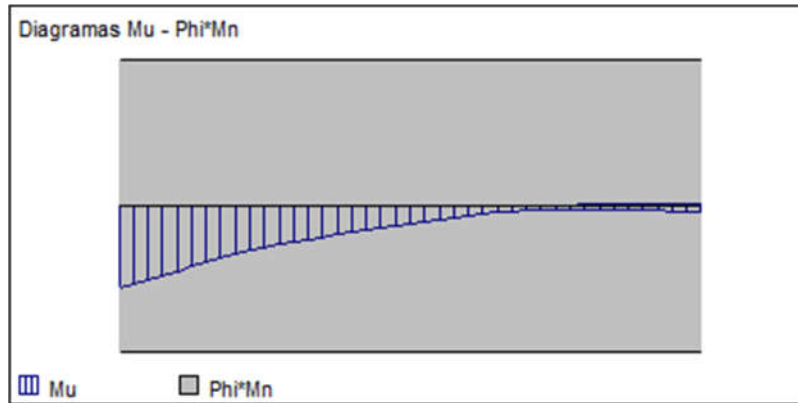
| Estación          | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%)sb | [cm] |
|-------------------|-------|----------|-------------------|-------------|--------------|--------------|------|
| Mu/( $\phi^*Mn$ ) |       |          |                   |             |              |              |      |

|   |  |  |  |  |  |                        |  |  |
|---|--|--|--|--|--|------------------------|--|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  | IPE-2025-2977-S-MC-011 |  |  |
|   | TÍTULO:  |  |  |  |  | HOJA:                  |  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  | 97 de 140              |  |  |
|   |  |  |  |  |  | REV:                   |  |  |
|   |  |  |  |  |  | A                      |  |  |

No. Dist

|      |      |       |          |          |      |      |      |      |
|------|------|-------|----------|----------|------|------|------|------|
| 1    | 0%   | 36.10 | -1691.81 | -2970.38 | 1.27 | 2.26 | 0.31 | 9.00 |
| 0.57 |      |       |          |          |      |      |      |      |
| 2    | 10%  | 36.10 | -1328.31 | -2970.38 | 0.99 | 2.26 | 0.31 | 9.00 |
| 0.45 |      |       |          |          |      |      |      |      |
| 3    | 20%  | 36.10 | -982.72  | -2970.38 | 0.73 | 2.26 | 0.31 | 9.00 |
| 0.33 |      |       |          |          |      |      |      |      |
| 4    | 30%  | 36.10 | -742.87  | -2970.38 | 0.55 | 2.26 | 0.31 | 9.00 |
| 0.25 |      |       |          |          |      |      |      |      |
| 5    | 40%  | 36.10 | -543.74  | -2970.38 | 0.40 | 2.26 | 0.31 | 9.00 |
| 0.18 |      |       |          |          |      |      |      |      |
| 6    | 50%  | 36.10 | -362.51  | -2970.38 | 0.27 | 2.26 | 0.31 | 9.00 |
| 0.12 |      |       |          |          |      |      |      |      |
| 7    | 60%  | 36.10 | -199.19  | -2970.38 | 0.15 | 2.26 | 0.31 | 9.00 |
| 0.07 |      |       |          |          |      |      |      |      |
| 8    | 70%  | 36.10 | -95.47   | -2970.38 | 0.07 | 2.26 | 0.31 | 9.00 |
| 0.03 |      |       |          |          |      |      |      |      |
| 9    | 80%  | 36.10 | -79.11   | -2970.38 | 0.06 | 2.26 | 0.31 | 9.00 |
| 0.03 |      |       |          |          |      |      |      |      |
| 10   | 90%  | 36.10 | -90.75   | -2970.38 | 0.07 | 2.26 | 0.31 | 9.00 |
| 0.03 |      |       |          |          |      |      |      |      |
| 11   | 100% | 36.10 | -120.29  | -2970.38 | 0.09 | 2.26 | 0.31 | 9.00 |
| 0.04 |      |       |          |          |      |      |      |      |
| C    | 0%   | 36.10 | -1691.81 | -2970.38 | 1.27 | 2.26 | 0.31 | 9.00 |
| 0.57 |      |       |          |          |      |      |      |      |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 98 de 140                     |
|   |   | REV:                          |
|   |   | <b>A</b>                      |




Tramo: 4-5

Miembro No: 55

|  |                                 |                                 |
|--|---------------------------------|---------------------------------|
| Porcentaje de redistribución de momentos:      | Apoyo A = 0.00%                 | Apoyo B = 0.00%                 |
| Cuantía geométrica máxima:                     | $\rho_{\text{maxsup}} = 1.55\%$ | $\rho_{\text{maxinf}} = 1.55\%$ |
| Separación límite entre barras por fisuración: | sb lim = 30.61 [cm]             |                                 |

#### Momentos flectores positivos


| Estación                           | d[cm] | Mu[Kg*m] | $\Phi^*M_n$ [Kg*m] | Asreq [cm <sup>2</sup> ] | Asprov [cm <sup>2</sup> ] | $\rho$ (%)sb | [cm] |
|------------------------------------|-------|----------|--------------------|--------------------------|---------------------------|--------------|------|
| <b>Mu/(<math>\Phi^*M_n</math>)</b> |       |          |                    |                          |                           |              |      |
| No.                                | Dist  |          |                    |                          |                           |              |      |
| 1                                  | 0%    | 36.10    | 61.76              | 2970.38                  | 0.05                      | 2.26         | 0.31 |
|                                    | 0.12  |          |                    |                          |                           |              | 9.00 |
| 2                                  | 10%   | 36.10    | 88.39              | 2970.38                  | 0.06                      | 2.26         | 0.31 |
|                                    | 0.04  |          |                    |                          |                           |              | 9.00 |
| 3                                  | 20%   | 36.10    | 191.27             | 2970.38                  | 0.14                      | 2.26         | 0.31 |
|                                    | 0.06  |          |                    |                          |                           |              | 9.00 |
| 4                                  | 30%   | 36.10    | 280.43             | 2970.38                  | 0.21                      | 2.26         | 0.31 |
|                                    | 0.09  |          |                    |                          |                           |              | 9.00 |

|   |  |  |  |  |  |  |                        |  |
|---|--|--|--|--|--|--|------------------------|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  |  | IPE-2025-2977-S-MC-011 |  |
|   | TÍTULO:  |  |  |  |  |  | HOJA:                  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  |  | 99 de 140              |  |
|   |  |  |  |  |  |  | REV:                   |  |
|   |  |  |  |  |  |  | A                      |  |

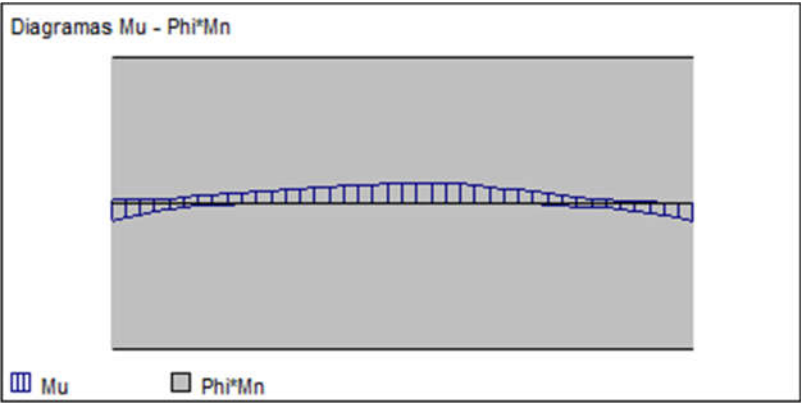
|      |      |       |        |         |      |      |      |      |
|------|------|-------|--------|---------|------|------|------|------|
| 5    | 40%  | 36.10 | 356.33 | 2970.38 | 0.26 | 2.26 | 0.31 | 9.00 |
| 0.12 |      |       |        |         |      |      |      |      |
| 6    | 50%  | 36.10 | 407.82 | 2970.38 | 0.30 | 2.26 | 0.31 | 9.00 |
| 0.14 |      |       |        |         |      |      |      |      |
| 7    | 60%  | 36.10 | 391.87 | 2970.38 | 0.29 | 2.26 | 0.31 | 9.00 |
| 0.13 |      |       |        |         |      |      |      |      |
| 8    | 70%  | 36.10 | 270.78 | 2970.38 | 0.20 | 2.26 | 0.31 | 9.00 |
| 0.09 |      |       |        |         |      |      |      |      |
| 9    | 80%  | 36.10 | 127.27 | 2970.38 | 0.09 | 2.26 | 0.31 | 9.00 |
| 0.04 |      |       |        |         |      |      |      |      |
| 10   | 90%  | 36.10 | 35.29  | 2970.38 | 0.03 | 2.26 | 0.31 | 9.00 |
| 0.06 |      |       |        |         |      |      |      |      |
| 11   | 100% | 36.10 | 0.00   | 2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.12 |      |       |        |         |      |      |      |      |
|      |      |       |        |         |      |      |      |      |
| C    | 55%  | 36.10 | 424.41 | 2970.38 | 0.31 | 2.26 | 0.31 | 9.00 |
| 0.14 |      |       |        |         |      |      |      |      |


**Momentos flectores negativos**

| Estación         | d[cm] | Mu[Kg*m] | $\phi$ *Mn[Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%)sb | [cm] |
|------------------|-------|----------|------------------|-------------|--------------|--------------|------|
| Mu/( $\phi$ *Mn) |       |          |                  |             |              |              |      |
| No. Dist         |       |          |                  |             |              |              |      |
| 1                | 0%    | 36.10    | -364.69          | -2970.38    | 0.27         | 2.26         | 0.31 |
| 0.12             |       |          |                  |             |              |              |      |
| 2                | 10%   | 36.10    | -122.09          | -2970.38    | 0.09         | 2.26         | 0.31 |
| 0.04             |       |          |                  |             |              |              |      |
| 3                | 20%   | 36.10    | -20.53           | -2970.38    | 0.02         | 2.26         | 0.31 |
| 0.06             |       |          |                  |             |              |              |      |

|   |  |  |  |  |  |                        |  |  |  |
|---|--|--|--|--|--|------------------------|--|--|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  | IPE-2025-2977-S-MC-011 |  |  |  |
|   | TÍTULO:  |  |  |  |  | HOJA:                  |  |  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  | 100 de 140             |  |  |  |
|   |  |  |  |  |  | REV:                   |  |  |  |
|   |  |  |  |  |  | A                      |  |  |  |

|      |      |       |         |          |      |      |      |      |
|------|------|-------|---------|----------|------|------|------|------|
| 4    | 30%  | 36.10 | 0.00    | -2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.09 |      |       |         |          |      |      |      |      |
| 5    | 40%  | 36.10 | 0.00    | -2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.12 |      |       |         |          |      |      |      |      |
| 6    | 50%  | 36.10 | 0.00    | -2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.14 |      |       |         |          |      |      |      |      |
| 7    | 60%  | 36.10 | 0.00    | -2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.13 |      |       |         |          |      |      |      |      |
| 8    | 70%  | 36.10 | -7.18   | -2970.38 | 0.01 | 2.26 | 0.31 | 9.00 |
| 0.09 |      |       |         |          |      |      |      |      |
| 9    | 80%  | 36.10 | -63.76  | -2970.38 | 0.05 | 2.26 | 0.31 | 9.00 |
| 0.04 |      |       |         |          |      |      |      |      |
| 10   | 90%  | 36.10 | -163.39 | -2970.38 | 0.12 | 2.26 | 0.31 | 9.00 |
| 0.06 |      |       |         |          |      |      |      |      |
| 11   | 100% | 36.10 | -364.79 | -2970.38 | 0.27 | 2.26 | 0.31 | 9.00 |
| 0.12 |      |       |         |          |      |      |      |      |
| C    | 55%  | 36.10 | 0.00    | -2970.38 | 0.00 | 2.26 | 0.31 | 9.00 |
| 0.14 |      |       |         |          |      |      |      |      |




|   |  |  |                        |
|---|--|--|------------------------|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |
|   | MEMORIA DE CÁLCULO   |  | IPE-2025-2977-S-MC-011 |
|   | TÍTULO:  |  | HOJA: 101 de 140       |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | REV: A                 |

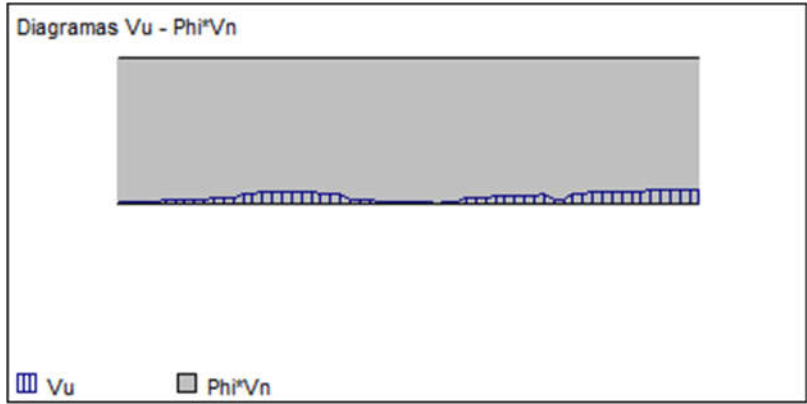
Corte y Torsión

Tramo: 1-2                      Miembro No: 39

| Estación                   |      | Estribos |     | Spc prov | Spc lim | Tu     | $\phi^*T_n$ | Al    | Vu      | Vs       | Vc        |
|----------------------------|------|----------|-----|----------|---------|--------|-------------|-------|---------|----------|-----------|
| $\phi^*V_nV_u/(\phi^*V_n)$ |      |          |     |          |         |        |             |       |         |          |           |
| No.                        | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m]      | [cm2] | [Kg]    | [Kg]     | [Kg] [Kg] |
| <hr/>                      |      |          |     |          |         |        |             |       |         |          |           |
| 1                          | 0%   | 8mm      | T   | 12.00    | 12.10   | 574.09 | 1090.09     | 2.14  | 213.57  | 12710.81 | 3246.57   |
| 11968.040.02               |      |          |     |          |         |        |             |       |         |          |           |
| 2                          | 10%  | 8mm      | T   | 12.00    | 12.10   | 361.56 | 1090.09     | 2.31  | 292.94  | 12710.81 | 3246.57   |
| 11968.040.02               |      |          |     |          |         |        |             |       |         |          |           |
| 3                          | 20%  | 8mm      | T   | 12.00    | 12.10   | 361.56 | 1090.09     | 2.31  | 478.22  | 12710.81 | 3246.57   |
| 11968.040.04               |      |          |     |          |         |        |             |       |         |          |           |
| 4                          | 30%  | 8mm      | T   | 12.00    | 12.10   | 448.52 | 1090.09     | 1.99  | 989.22  | 12710.81 | 3246.57   |
| 11968.040.08               |      |          |     |          |         |        |             |       |         |          |           |
| 5                          | 40%  | 8mm      |     | 12.00    | 18.05   | 31.31  | 1090.09     | 0.00  | 336.35  | 12710.81 | 3246.57   |
| 11968.040.03               |      |          |     |          |         |        |             |       |         |          |           |
| 6                          | 50%  | 8mm      |     | 12.00    | 18.05   | 31.31  | 1090.09     | 0.00  | 151.06  | 12710.81 | 3246.57   |
| 11968.040.01               |      |          |     |          |         |        |             |       |         |          |           |
| 7                          | 60%  | 8mm      | T   | 12.00    | 12.10   | 385.05 | 1090.09     | 2.23  | 502.33  | 12710.81 | 3246.57   |
| 11968.040.04               |      |          |     |          |         |        |             |       |         |          |           |
| 8                          | 70%  | 8mm      | T   | 12.00    | 12.10   | 385.05 | 1090.09     | 2.23  | 687.61  | 12710.81 | 3246.57   |
| 11968.040.06               |      |          |     |          |         |        |             |       |         |          |           |
| 9                          | 80%  | 8mm      | T   | 12.00    | 12.10   | 298.36 | 1090.09     | 2.55  | 877.92  | 12710.81 | 3246.57   |
| 11968.040.07               |      |          |     |          |         |        |             |       |         |          |           |
| 10                         | 90%  | 8mm      | T   | 12.00    | 12.10   | 298.36 | 1090.09     | 2.55  | 1063.20 | 12710.81 | 3246.57   |
| 11968.040.09               |      |          |     |          |         |        |             |       |         |          |           |
| 11                         | 100% | 8mm      | T   | 12.00    | 12.10   | 704.25 | 1090.09     | 2.62  | 1132.16 | 12710.81 | 3246.57   |
| 11968.040.09               |      |          |     |          |         |        |             |       |         |          |           |
| <hr/>                      |      |          |     |          |         |        |             |       |         |          |           |
| C                          | 95%  | 8mm      | T   | 12.00    | 12.10   | 298.36 | 1090.09     | 2.55  | 1132.16 | 12710.81 | 3246.57   |
| 11968.040.09               |      |          |     |          |         |        |             |       |         |          |           |




|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 102 de 140                    |
|   |   | REV:                          |
|   |   | <b>A</b>                      |



Tramo: 2-3

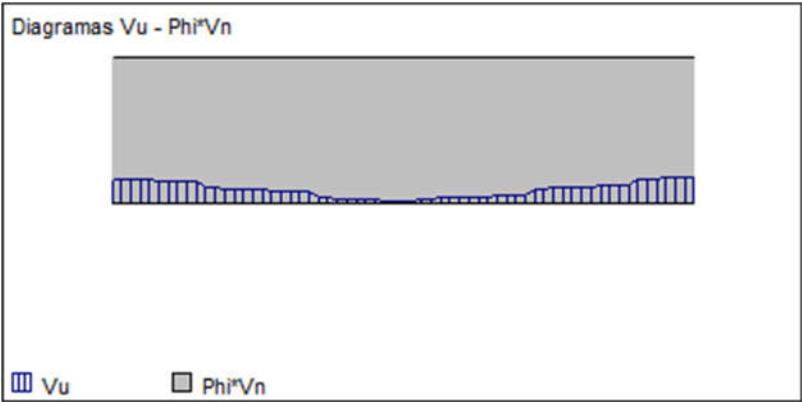
Miembro No: 40

| Estación                   |      | Estribos |     | Spc prov | Spc lim | Tu     | $\phi^*T_n$ | Al    | Vu      | Vs       | Vc        |
|----------------------------|------|----------|-----|----------|---------|--------|-------------|-------|---------|----------|-----------|
| $\phi^*V_nV_u/(\phi^*V_n)$ |      |          |     |          |         |        |             |       |         |          |           |
| No.                        | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m]      | [cm2] | [Kg]    | [Kg]     | [Kg] [Kg] |
| 1                          | 0%   | 8mm      | VT  | 12.00    | 12.10   | 949.02 | 1088.97     | 3.53  | 1931.22 | 12710.81 | 3246.57   |
| 11968.040.16               |      |          |     |          |         |        |             |       |         |          |           |
| 2                          | 10%  | 8mm      | VT  | 12.00    | 12.10   | 949.02 | 1089.42     | 3.53  | 1853.35 | 12710.81 | 3246.57   |
| 11968.040.15               |      |          |     |          |         |        |             |       |         |          |           |
| 3                          | 20%  | 8mm      | T   | 12.00    | 12.10   | 543.53 | 1090.09     | 2.02  | 1201.86 | 12710.81 | 3246.57   |
| 11968.040.10               |      |          |     |          |         |        |             |       |         |          |           |
| 4                          | 30%  | 8mm      | T   | 12.00    | 12.10   | 543.53 | 1090.09     | 2.02  | 1008.79 | 12710.81 | 3246.57   |
| 11968.040.08               |      |          |     |          |         |        |             |       |         |          |           |
| 5                          | 40%  | 8mm      |     | 12.00    | 18.05   | 137.77 | 1090.09     | 0.00  | 357.07  | 12710.81 | 3246.57   |
| 11968.040.03               |      |          |     |          |         |        |             |       |         |          |           |
| 6                          | 50%  | 8mm      |     | 12.00    | 18.05   | 137.77 | 1090.09     | 0.00  | 164.00  | 12710.81 | 3246.57   |
| 11968.040.01               |      |          |     |          |         |        |             |       |         |          |           |
| 7                          | 60%  | 8mm      | T   | 12.00    | 12.10   | 267.99 | 1090.09     | 2.66  | 487.73  | 12710.81 | 3246.57   |
| 11968.040.04               |      |          |     |          |         |        |             |       |         |          |           |

|   |  |  |                        |  |
|---|--|--|------------------------|--|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |  |
|   | MEMORIA DE CÁLCULO   |  | IPE-2025-2977-S-MC-011 |  |
|   | TÍTULO:  |  | HOJA:                  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 103 de 140             |  |
|   |  |  | REV:                   |  |
|   |  |  | A                      |  |


|              |      |     |    |       |       |         |         |      |         |          |         |
|--------------|------|-----|----|-------|-------|---------|---------|------|---------|----------|---------|
| 8            | 70%  | 8mm | T  | 12.00 | 12.10 | 267.99  | 1090.09 | 2.66 | 680.80  | 12710.81 | 3246.57 |
| 11968.040.06 |      |     |    |       |       |         |         |      |         |          |         |
| 9            | 80%  | 8mm | VT | 12.00 | 12.10 | 673.49  | 1090.09 | 2.51 | 1332.31 | 12710.81 | 3246.57 |
| 11968.040.11 |      |     |    |       |       |         |         |      |         |          |         |
| 10           | 90%  | 8mm | VT | 12.00 | 12.10 | 998.17  | 1088.91 | 3.72 | 1892.40 | 12710.81 | 3246.57 |
| 11968.040.16 |      |     |    |       |       |         |         |      |         |          |         |
| 11           | 100% | 8mm | VT | 12.00 | 12.10 | 1079.34 | 1088.18 | 4.02 | 2062.02 | 12710.81 | 3246.57 |
| 11968.040.17 |      |     |    |       |       |         |         |      |         |          |         |

|              |     |     |    |       |       |         |         |      |         |          |         |
|--------------|-----|-----|----|-------|-------|---------|---------|------|---------|----------|---------|
| C            | 95% | 8mm | VT | 12.00 | 12.10 | 1079.34 | 1088.18 | 4.02 | 2062.02 | 12710.81 | 3246.57 |
| 11968.040.17 |     |     |    |       |       |         |         |      |         |          |         |



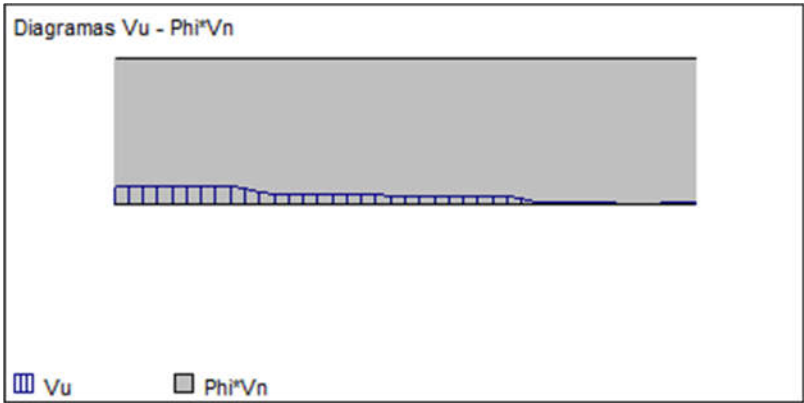
Tramo: 3-4                      Miembro No: 54

| Estación                |      | Estribos |     | Spc prov | Spc lim | Tu     | $\phi^*Tn$ | Al    | Vu      | Vs       | Vc        |
|-------------------------|------|----------|-----|----------|---------|--------|------------|-------|---------|----------|-----------|
| $\phi^*VnVu/(\phi^*Vn)$ |      |          |     |          |         |        |            |       |         |          |           |
| No.                     | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m]     | [cm2] | [Kg]    | [Kg]     | [Kg] [Kg] |
| <hr/>                   |      |          |     |          |         |        |            |       |         |          |           |
| 1                       | 0%   | 8mm      | VT  | 12.00    | 12.10   | 446.92 | 1090.09    | 2.00  | 1430.58 | 12710.81 | 3246.57   |
| 11968.040.12            |      |          |     |          |         |        |            |       |         |          |           |
| 2                       | 10%  | 8mm      | VT  | 12.00    | 12.10   | 446.92 | 1090.09    | 2.00  | 1430.58 | 12710.81 | 3246.57   |
| 11968.040.12            |      |          |     |          |         |        |            |       |         |          |           |

|   |  |  |  |  |  |  |  |  |                        |  |  |
|---|--|--|--|--|--|--|--|--|------------------------|--|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  |  |  |  | IPE-2025-2977-S-MC-011 |  |  |
|   | TÍTULO:  |  |  |  |  |  |  |  | HOJA:                  |  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  |  |  |  | 104 de 140             |  |  |
|   |  |  |  |  |  |  |  |  | REV:                   |  |  |
|   |  |  |  |  |  |  |  |  | A                      |  |  |


|              |      |     |    |       |       |        |         |      |         |          |         |
|--------------|------|-----|----|-------|-------|--------|---------|------|---------|----------|---------|
| 3            | 20%  | 8mm | VT | 12.00 | 12.10 | 446.92 | 1090.09 | 2.00 | 1403.88 | 12710.81 | 3246.57 |
| 11968.040.12 |      |     |    |       |       |        |         |      |         |          |         |
| 4            | 30%  | 8mm |    | 12.00 | 18.05 | 37.99  | 1090.09 | 0.00 | 867.75  | 12710.81 | 3246.57 |
| 11968.040.07 |      |     |    |       |       |        |         |      |         |          |         |
| 5            | 40%  | 8mm |    | 12.00 | 18.05 | 37.99  | 1090.09 | 0.00 | 793.07  | 12710.81 | 3246.57 |
| 11968.040.07 |      |     |    |       |       |        |         |      |         |          |         |
| 6            | 50%  | 8mm |    | 12.00 | 18.05 | 37.99  | 1090.09 | 0.00 | 718.40  | 12710.81 | 3246.57 |
| 11968.040.06 |      |     |    |       |       |        |         |      |         |          |         |
| 7            | 60%  | 8mm |    | 12.00 | 18.05 | 37.99  | 1090.09 | 0.00 | 643.73  | 12710.81 | 3246.57 |
| 11968.040.05 |      |     |    |       |       |        |         |      |         |          |         |
| 8            | 70%  | 8mm |    | 12.00 | 18.05 | 37.99  | 1090.09 | 0.00 | 569.05  | 12710.81 | 3246.57 |
| 11968.040.05 |      |     |    |       |       |        |         |      |         |          |         |
| 9            | 80%  | 8mm | T  | 12.00 | 12.10 | 378.09 | 1090.09 | 2.25 | 119.94  | 12710.81 | 3246.57 |
| 11968.040.01 |      |     |    |       |       |        |         |      |         |          |         |
| 10           | 90%  | 8mm | T  | 12.00 | 12.10 | 378.09 | 1090.09 | 2.25 | 48.16   | 12710.81 | 3246.57 |
| 11968.040.00 |      |     |    |       |       |        |         |      |         |          |         |
| 11           | 100% | 8mm | T  | 12.00 | 12.10 | 378.09 | 1090.09 | 2.25 | 93.24   | 12710.81 | 3246.57 |
| 11968.040.01 |      |     |    |       |       |        |         |      |         |          |         |

|              |    |     |    |       |       |        |         |      |         |          |         |
|--------------|----|-----|----|-------|-------|--------|---------|------|---------|----------|---------|
| C            | 0% | 8mm | VT | 12.00 | 12.10 | 446.92 | 1090.09 | 2.00 | 1430.58 | 12710.81 | 3246.57 |
| 11968.040.12 |    |     |    |       |       |        |         |      |         |          |         |




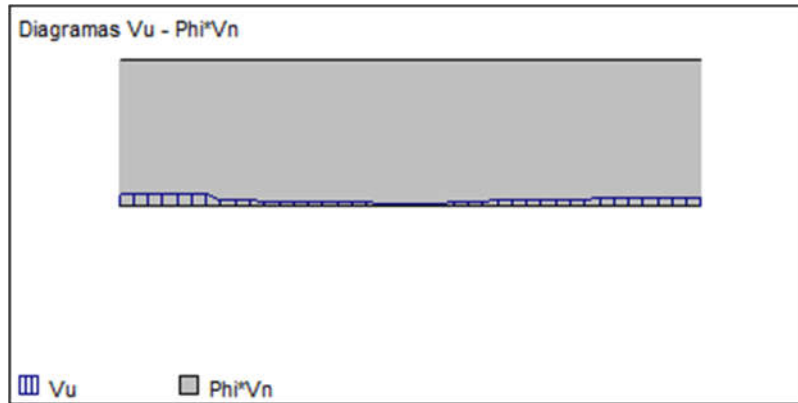
Tramo: 4-5

Miembro No: 55

|   |  |  |  |
|---|--|--|--|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:                  |
|   | MEMORIA DE CÁLCULO   |  | <b>IPe-2025-2977-S-MC-011</b><br>HOJA: |
|   | TÍTULO:  |  | 105 de 140<br>REV:                     |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | <b>A</b>                               |

| Estación                                |      | Estribos |     | Spc prov | Spc lim | Tu     | $\phi \cdot T_n$ | Al    | Vu     | Vs       | Vc        |
|---|------|----------|-----|----------|---------|--------|------------------|-------|--------|----------|-----------|
| $\phi \cdot V_n V_u / (\phi \cdot V_n)$ |      |          |     |          |         |        |                  |       |        |          |           |
| No.                                     | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m]           | [cm2] | [Kg]   | [Kg]     | [Kg] [Kg] |
| <hr/>                                   |      |          |     |          |         |        |                  |       |        |          |           |
| 1                                       | 0%   | 8mm      | T   | 12.00    | 12.10   | 503.78 | 1090.09          | 1.88  | 921.19 | 12710.81 | 3246.57   |
| 11968.040.08                            |      |          |     |          |         |        |                  |       |        |          |           |
| 2                                       | 10%  | 8mm      | T   | 12.00    | 12.10   | 503.78 | 1090.09          | 1.88  | 921.19 | 12710.81 | 3246.57   |
| 11968.040.08                            |      |          |     |          |         |        |                  |       |        |          |           |
| 3                                       | 20%  | 8mm      |     | 12.00    | 18.05   | 86.18  | 1090.09          | 0.00  | 453.38 | 12710.81 | 3246.57   |
| 11968.040.04                            |      |          |     |          |         |        |                  |       |        |          |           |
| 4                                       | 30%  | 8mm      |     | 12.00    | 18.05   | 86.18  | 1090.09          | 0.00  | 366.19 | 12710.81 | 3246.57   |
| 11968.040.03                            |      |          |     |          |         |        |                  |       |        |          |           |
| 5                                       | 40%  | 8mm      |     | 12.00    | 18.05   | 86.18  | 1090.09          | 0.00  | 279.00 | 12710.81 | 3246.57   |
| 11968.040.02                            |      |          |     |          |         |        |                  |       |        |          |           |
| 6                                       | 50%  | 8mm      |     | 12.00    | 18.05   | 86.18  | 1090.09          | 0.00  | 191.81 | 12710.81 | 3246.57   |
| 11968.040.02                            |      |          |     |          |         |        |                  |       |        |          |           |
| 7                                       | 60%  | 8mm      | T   | 12.00    | 12.10   | 293.00 | 1090.09          | 2.57  | 388.81 | 12710.81 | 3246.57   |
| 11968.040.03                            |      |          |     |          |         |        |                  |       |        |          |           |
| 8                                       | 70%  | 8mm      | T   | 12.00    | 12.10   | 293.00 | 1090.09          | 2.57  | 476.00 | 12710.81 | 3246.57   |
| 11968.040.04                            |      |          |     |          |         |        |                  |       |        |          |           |
| 9                                       | 80%  | 8mm      | T   | 12.00    | 12.10   | 293.00 | 1090.09          | 2.57  | 563.19 | 12710.81 | 3246.57   |
| 11968.040.05                            |      |          |     |          |         |        |                  |       |        |          |           |
| 10                                      | 90%  | 8mm      | T   | 12.00    | 12.10   | 293.00 | 1090.09          | 2.57  | 614.14 | 12710.81 | 3246.57   |
| 11968.040.05                            |      |          |     |          |         |        |                  |       |        |          |           |
| 11                                      | 100% | 8mm      | T   | 12.00    | 12.10   | 511.48 | 1090.09          | 1.90  | 614.14 | 12710.81 | 3246.57   |
| 11968.040.05                            |      |          |     |          |         |        |                  |       |        |          |           |
| <hr/>                                   |      |          |     |          |         |        |                  |       |        |          |           |
| C                                       | 0%   | 8mm      | T   | 12.00    | 12.10   | 503.78 | 1090.09          | 1.88  | 921.19 | 12710.81 | 3246.57   |
| 11968.040.08                            |      |          |     |          |         |        |                  |       |        |          |           |
| <hr/>                                   |      |          |     |          |         |        |                  |       |        |          |           |

|   |  |                               |
|---|--|-------------------------------|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>  | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:  | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE H<sup>º</sup>Aº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 106 de 140                    |
|   |  | REV:                          |
|   |  | <b>A</b>                      |



Armadura longitudinal distribuidos uniformemente

Superior 2 Ø 12 mm.

Inferior 2 Ø 12 mm.

Estribos Ø 8 mm c/12 cm para armadura transversal.

### 8.3.2. VIGA VS-03 TRAMO (1-5)

## Resultados de Diseño


## Vigas de Hormigón Armado

### Datos Generales


Código de diseño : ACI 318-2019

#### Estados de carga considerados:

|    |   |                      |
|----|---|----------------------|
| D1 | = | 1.4CM                |
| D2 | = | 1.2CM+0.5VxCASO APOS |
| D3 | = | 1.2CM+0.5VxCASO ANEG |
| D4 | = | 1.2CM+0.5VzCASO APOS |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 107 de 140                    |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

|     |   |                     |
|-----|---|---------------------|
| D5  | = | 1.2CM+0.5VzCASOANEG |
| D6  | = | 1.2CM+VxCASOAPOS    |
| D7  | = | 1.2CM+VxCASOANEG    |
| D8  | = | 1.2CM+VzCASOAPOS    |
| D9  | = | 1.2CM+VzCASOANEG    |
| D10 | = | 0.9CM+VxCASOAPOS    |
| D11 | = | 0.9CM+VxCASOANEG    |
| D12 | = | 0.9CM+VzCASOAPOS    |
| D13 | = | 0.9CM+VzCASOANEG    |
| D14 | = | 1.2CM+EQx           |
| D15 | = | 1.2CM+EQz           |
| D16 | = | 0.9CM+EQx           |
| D17 | = | 0.9CM+EQz           |
| D18 | = | 1.2CM+1.6CV         |
| D19 | = | 1.2CM+0.5VzCASOBPOS |
| D20 | = | 1.2CM+0.5VzCASOBNEG |
| D21 | = | 1.2CM+VzCASOBPOS    |
| D22 | = | 1.2CM+VzCASOBNEG    |
| D23 | = | 1.2CM+VxCASOAPOS+CV |
| D24 | = | 1.2CM+VxCASOANEG+CV |
| D25 | = | 1.2CM+VzCASOAPOS+CV |
| D26 | = | 1.2CM+VzCASOANEG+CV |
| D27 | = | 1.2CM+VzCASOBPOS+CV |
| D28 | = | 1.2CM+VzCASOBNEG+CV |
| D29 | = | 0.9CM+VzCASOBPOS    |
| D30 | = | 0.9CM+VzCASOBNEG    |
| D31 | = | 1.2CM+EQxCUB        |
| D32 | = | 1.2CM+EQzCUB        |
| D33 | = | 1.2CM+EQx+CV        |
| D34 | = | 1.2CM+EQz+CV        |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 108 de 140                    |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

|     |   |                 |
|-----|---|-----------------|
| D35 | = | 1.2CM+EQxCUB+CV |
| D36 | = | 1.2CM+EQzCUB+CV |
| D37 | = | 0.9CM+EQxCUB    |
| D38 | = | 0.9CM+EQzCUB    |


Riesgo sísmico : Riesgo Bajo

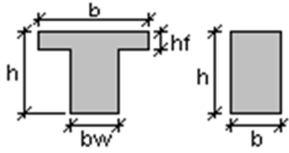
**Materiales**

|         |                                |   |                   |                                     |   |        |
|---------|--------------------------------|---|-------------------|-------------------------------------|---|--------|
| [Kg/m2] | Hormigón, f <sub>c</sub>       | : | 2100000.00 [Kg... | Acero longitudinal, f <sub>y</sub>  | : | 4.2E07 |
|         | Tipo de concreto               | : | Normal            | Acero transversal, f <sub>y</sub> t | : | 4.2E07 |
| [Kg/m2] | Módulo de elasticidad hormigón | : | 2.14E09 [Kg/m2]   | Módulo de elasticidad acero         | : | 2.9E11 |
|         | Peso unitario                  | : | 2400.00 [Kg/m3]   | Recubrimiento epóxico               | : | No     |

# Geometría

| Eje   | Pos columna | Ancho inferior | Ancho superior | Dist x |
|-------|-------------|----------------|----------------|--------|
|       |             | [cm]           | [cm]           | [m]    |
| <hr/> |             |                |                |        |
| 1     | Centro      | 25.00          | 0.00           | 0.00   |
| 2     | Centro      | 15.00          | 0.00           | 5.95   |
| 3     | Centro      | 15.00          | 0.00           | 12.15  |
| 4     | Centro      | 0.00           | 0.00           | 14.55  |
| 5     | Centro      | 30.00          | 0.00           | 17.35  |
| <hr/> |             |                |                |        |

|   |  |   |
|---|--|---|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:                             |
|   | MEMORIA DE CÁLCULO   | <b>IPe-2025-2977-S-MC-011</b><br>HOJA: 109 de 140 |
|   | TÍTULO:<br><b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | REV: <b>A</b>                                     |



| Tramo | Dist entre ejes<br>[m] | Miembro No | Sección | b<br>[cm] | h<br>[cm] | bw<br>[cm] | hf<br>[cm] |
|-------|------------------------|------------|---------|-----------|-----------|------------|------------|
| <hr/> |                        |            |         |           |           |            |            |
| 1-2   | 5.95                   | 46         |         | 20.00     | 40.00     | --         | --         |
| 2-3   | 6.20                   | 44         |         | 20.00     | 40.00     | --         | --         |
| 3-4   | 2.40                   | 58         |         | 15.00     | 40.00     | --         | --         |
| 4-5   | 2.80                   | 61         |         | 15.00     | 40.00     | --         | --         |
| <hr/> |                        |            |         |           |           |            |            |

## Diseño


Estatus : **Bien**

## Reinforcement

### Armadura

Recubrimiento libre : 2.00 [cm]



|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 110 de 140                    |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

#### Armadura longitudinal




| Grupo | Cantidad | Diámetro | Pos      | Eje Ref. 1 | Dist1 | Eje Ref. 2 | Dist2 | Gancho1 | Gancho2 |
|-------|----------|----------|----------|------------|-------|------------|-------|---------|---------|
|       |          |          |          |            | [m]   |            | [m]   |         |         |
| 1     | 2        | 12mm     | Inferior | 1          | -0.11 | 5          | 0.13  | Si      | Si      |
| 2     | 3        | 12mm     | Sup.     | 1          | -0.11 | 5          | 0.13  | Si      | Si      |

#### Longitudes de anclaje y empalme

| Grupo | Diámetro | Ld    | Ldh   | L. Empalme | L. total |
|-------|----------|-------|-------|------------|----------|
|       |          | [cm]  | [cm]  | [cm]       | [m]      |
| 1     | 12mm     | 54.00 | 20.00 | 70.00      | 17.92    |
| 2     | 12mm     | 70.00 | 20.00 | 90.00      | 17.92    |

#### Armadura transversal

| Tramo | Diámetro | Cantidad | c/ | Ramas | Cerrado |
|-------|----------|----------|----|-------|---------|
|-------|----------|----------|----|-------|---------|

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IFE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 111 de 140                    |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

[cm]

|     |     |    |       |   |    |
|-----|-----|----|-------|---|----|
| 1-2 | 8mm | 48 | 12.00 | 2 | Si |
| 2-3 | 8mm | 51 | 12.00 | 2 | Si |
| 3-4 | 8mm | 22 | 11.00 | 2 | Si |
| 4-5 | 8mm | 25 | 11.00 | 2 | Si |

**Separación inicial de estribos:**

| Tramo | S inicial | Sin lim |
|-------|-----------|---------|
|       | [cm]      | [cm]    |
| 0-1   | 5.50      | 19.00   |
| 1-2   | 2.50      | 19.00   |
| 2-3   | 0.65      | 19.00   |
| 3-4   | 0.50      | 19.00   |

## Flexión

**Tramo: 1-2**


**Miembro No: 46**

|  |                          |                          |
|--|--------------------------|--------------------------|
| Porcentaje de redistribución de momentos:      | Apoyo A = 0.00%          | Apoyo B = 0.00%          |
| Cuantía geométrica máxima:                     | $\rho_{maxsup} = 1.55\%$ | $\rho_{maxinf} = 1.55\%$ |
| Separación límite entre barras por fisuración: | sb lim = 30.61 [cm]      |                          |

**Momentos flectores positivos**


|  |  |                               |
|--|--|-------------------------------|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:         |
|  | MEMORIA DE CÁLCULO   | <b>IPE-2025-2977-S-MC-011</b> |
|  | TÍTULO:  | HOJA:                         |
|  | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | 112 de 140                    |
|  |  | REV:                          |
|  |  | <b>A</b>                      |

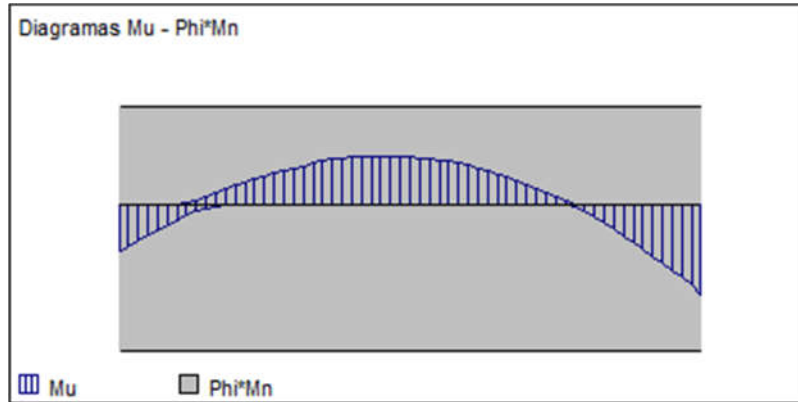
| Estación         |      | d[cm] | Mu[Kg*m] | $\phi*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%)sb | [cm]  |
|------------------|------|-------|----------|------------------|-------------|--------------|--------------|-------|
| Mu/( $\phi*Mn$ ) |      |       |          |                  |             |              |              |       |
| No. Dist         |      |       |          |                  |             |              |              |       |
| 1                | 0%   | 36.60 | 0.00     | 3013.10          | 0.00        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.32  |          |                  |             |              |              |       |
| 2                | 10%  | 36.60 | 0.00     | 3013.10          | 0.00        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.10  |          |                  |             |              |              |       |
| 3                | 20%  | 36.60 | 585.95   | 3013.10          | 0.43        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.19  |          |                  |             |              |              |       |
| 4                | 30%  | 36.60 | 1113.78  | 3013.10          | 0.82        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.37  |          |                  |             |              |              |       |
| 5                | 40%  | 36.60 | 1470.18  | 3013.10          | 1.08        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.49  |          |                  |             |              |              |       |
| 6                | 50%  | 36.60 | 1433.84  | 3013.10          | 1.05        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.48  |          |                  |             |              |              |       |
| 7                | 60%  | 36.60 | 1210.14  | 3013.10          | 0.89        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.40  |          |                  |             |              |              |       |
| 8                | 70%  | 36.60 | 609.69   | 3013.10          | 0.44        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.20  |          |                  |             |              |              |       |
| 9                | 80%  | 36.60 | 0.00     | 3013.10          | 0.00        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.05  |          |                  |             |              |              |       |
| 10               | 90%  | 36.60 | 0.00     | 3013.10          | 0.00        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.31  |          |                  |             |              |              |       |
| 11               | 100% | 36.60 | 0.00     | 3013.10          | 0.00        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.62  |          |                  |             |              |              |       |
| C                | 100% | 36.60 | 0.00     | 3013.10          | 0.00        | 2.26         | 0.31         | 10.00 |
|                  |      | 0.62  |          |                  |             |              |              |       |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 113 de 140                    |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

#### Momentos flectores negativos

| Estación                          | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%)sb | [cm] |
|-----------------------------------|-------|----------|-------------------|-------------|--------------|--------------|------|
| <b>Mu/(<math>\phi^*Mn</math>)</b> |       |          |                   |             |              |              |      |
| No. Dist                          |       |          |                   |             |              |              |      |
| 1 0%                              | 36.60 | -1438.84 | -4434.47          | 1.06        | 3.39         | 0.46         | 4.40 |
| 0.32                              |       |          |                   |             |              |              |      |
| 2 10%                             | 36.60 | -462.45  | -4434.47          | 0.34        | 3.39         | 0.46         | 4.40 |
| 0.10                              |       |          |                   |             |              |              |      |
| 3 20%                             | 36.60 | 0.00     | -4434.47          | 0.00        | 3.39         | 0.46         | 4.40 |
| 0.19                              |       |          |                   |             |              |              |      |
| 4 30%                             | 36.60 | 0.00     | -4434.47          | 0.00        | 3.39         | 0.46         | 4.40 |
| 0.37                              |       |          |                   |             |              |              |      |
| 5 40%                             | 36.60 | 0.00     | -4434.47          | 0.00        | 3.39         | 0.46         | 4.40 |
| 0.49                              |       |          |                   |             |              |              |      |
| 6 50%                             | 36.60 | 0.00     | -4434.47          | 0.00        | 3.39         | 0.46         | 4.40 |
| 0.48                              |       |          |                   |             |              |              |      |
| 7 60%                             | 36.60 | 0.00     | -4434.47          | 0.00        | 3.39         | 0.46         | 4.40 |
| 0.40                              |       |          |                   |             |              |              |      |
| 8 70%                             | 36.60 | 0.00     | -4434.47          | 0.00        | 3.39         | 0.46         | 4.40 |
| 0.20                              |       |          |                   |             |              |              |      |
| 9 80%                             | 36.60 | -210.16  | -4434.47          | 0.15        | 3.39         | 0.46         | 4.40 |
| 0.05                              |       |          |                   |             |              |              |      |
| 10 90%                            | 36.60 | -1353.02 | -4434.47          | 0.99        | 3.39         | 0.46         | 4.40 |
| 0.31                              |       |          |                   |             |              |              |      |
| 11 100%                           | 36.60 | -2730.09 | -4434.47          | 2.04        | 3.39         | 0.46         | 4.40 |
| 0.62                              |       |          |                   |             |              |              |      |
| C 100%                            | 36.60 | -2730.09 | -4434.47          | 2.04        | 3.39         | 0.46         | 4.40 |
| 0.62                              |       |          |                   |             |              |              |      |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 114 de 140                    |
|   |   | REV:                          |
|   |   | <b>A</b>                      |




Tramo: 2-3

Miembro No: 44

|  |  |                                 |
|--|--|---------------------------------|
| Porcentaje de redistribución de momentos:      | Apoyo A = 0.00%                        | Apoyo B = 0.00%                 |
| Cuantía geométrica máxima:                     | $\rho_{\text{maxsup}} = 1.55\%$        | $\rho_{\text{maxinf}} = 1.55\%$ |
| Separación límite entre barras por fisuración: | $s_b \text{ lim} = 30.61 \text{ [cm]}$ |                                 |

#### Momentos flectores positivos


| Estación                           | d[cm] | Mu[Kg*m] | $\Phi^*M_n$ [Kg*m] | Asreq [cm <sup>2</sup> ] | Asprov [cm <sup>2</sup> ] | $\rho$ (%)sb | [cm]  |
|------------------------------------|-------|----------|--------------------|--------------------------|---------------------------|--------------|-------|
| <b>Mu/(<math>\Phi^*M_n</math>)</b> |       |          |                    |                          |                           |              |       |
| No.                                | Dist  |          |                    |                          |                           |              |       |
| 1                                  | 0%    | 36.60    | 0.00               | 3013.10                  | 0.00                      | 2.26         | 0.31  |
|                                    |       |          |                    |                          |                           |              | 10.00 |
|                                    | 0.61  |          |                    |                          |                           |              |       |
| 2                                  | 10%   | 36.60    | 0.00               | 3013.10                  | 0.00                      | 2.26         | 0.31  |
|                                    |       |          |                    |                          |                           |              | 10.00 |
|                                    | 0.30  |          |                    |                          |                           |              |       |
| 3                                  | 20%   | 36.60    | 0.00               | 3013.10                  | 0.00                      | 2.26         | 0.31  |
|                                    |       |          |                    |                          |                           |              | 10.00 |
|                                    | 0.04  |          |                    |                          |                           |              |       |

|  |                    |  |  |  |  |      |                        |            |
|--|--------------------|--|--|--|--|------|------------------------|------------|
|   | TIPO DE DOCUMENTO: |  |  |  |  |      | CÓDIGO DEL DOCUMENTO:  |            |
|  | MEMORIA DE CÁLCULO |  |  |  |  |      | IPE-2025-2977-S-MC-011 |            |
|  | TÍTULO:            |  |  |  |  |      | HOJA:                  | 115 de 140 |
| MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |                    |  |  |  |  | REV: |                        |            |
|  |                    |  |  |  |  | A    |                        |            |

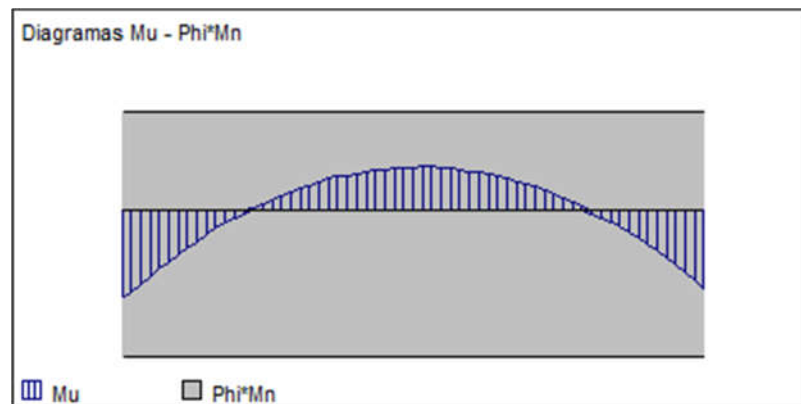
|      |      |       |         |         |      |      |      |       |
|------|------|-------|---------|---------|------|------|------|-------|
| 4    | 30%  | 36.60 | 606.29  | 3013.10 | 0.44 | 2.26 | 0.31 | 10.00 |
| 0.20 |      |       |         |         |      |      |      |       |
| 5    | 40%  | 36.60 | 1104.13 | 3013.10 | 0.81 | 2.26 | 0.31 | 10.00 |
| 0.37 |      |       |         |         |      |      |      |       |
| 6    | 50%  | 36.60 | 1305.60 | 3013.10 | 0.96 | 2.26 | 0.31 | 10.00 |
| 0.43 |      |       |         |         |      |      |      |       |
| 7    | 60%  | 36.60 | 1172.27 | 3013.10 | 0.86 | 2.26 | 0.31 | 10.00 |
| 0.39 |      |       |         |         |      |      |      |       |
| 8    | 70%  | 36.60 | 776.54  | 3013.10 | 0.57 | 2.26 | 0.31 | 10.00 |
| 0.26 |      |       |         |         |      |      |      |       |
| 9    | 80%  | 36.60 | 40.10   | 3013.10 | 0.03 | 2.26 | 0.31 | 10.00 |
| 0.01 |      |       |         |         |      |      |      |       |
| 10   | 90%  | 36.60 | 0.00    | 3013.10 | 0.00 | 2.26 | 0.31 | 10.00 |
| 0.22 |      |       |         |         |      |      |      |       |
| 11   | 100% | 36.60 | 0.00    | 3013.10 | 0.00 | 2.26 | 0.31 | 10.00 |
| 0.53 |      |       |         |         |      |      |      |       |
|      |      |       |         |         |      |      |      |       |
| C    | 0%   | 36.60 | 0.00    | 3013.10 | 0.00 | 2.26 | 0.31 | 10.00 |
| 0.61 |      |       |         |         |      |      |      |       |


Momentos flectores negativos

| Estación         | d[cm] | Mu[Kg*m] | $\phi$ *Mn[Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%)sb | [cm] |
|------------------|-------|----------|------------------|-------------|--------------|--------------|------|
| Mu/( $\phi$ *Mn) |       |          |                  |             |              |              |      |
| No. Dist         |       |          |                  |             |              |              |      |
| 1                | 0%    | 36.60    | -2710.78         | -4434.47    | 2.03         | 3.39         | 0.46 |
| 0.61             |       |          |                  |             |              |              |      |
| 2                | 10%   | 36.60    | -1318.40         | -4434.47    | 0.97         | 3.39         | 0.46 |
| 0.30             |       |          |                  |             |              |              |      |

|   |  |  |  |  |  |                        |  |  |
|---|--|--|--|--|--|------------------------|--|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  | IPE-2025-2977-S-MC-011 |  |  |
|   | TÍTULO:  |  |  |  |  | HOJA:                  |  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  | 116 de 140             |  |  |
|   |  |  |  |  |  | REV:                   |  |  |
|   |  |  |  |  |  | A                      |  |  |

|      |      |       |          |          |      |      |      |      |
|------|------|-------|----------|----------|------|------|------|------|
| 3    | 20%  | 36.60 | -191.15  | -4434.47 | 0.14 | 3.39 | 0.46 | 4.40 |
| 0.04 |      |       |          |          |      |      |      |      |
| 4    | 30%  | 36.60 | 0.00     | -4434.47 | 0.00 | 3.39 | 0.46 | 4.40 |
| 0.20 |      |       |          |          |      |      |      |      |
| 5    | 40%  | 36.60 | 0.00     | -4434.47 | 0.00 | 3.39 | 0.46 | 4.40 |
| 0.37 |      |       |          |          |      |      |      |      |
| 6    | 50%  | 36.60 | 0.00     | -4434.47 | 0.00 | 3.39 | 0.46 | 4.40 |
| 0.43 |      |       |          |          |      |      |      |      |
| 7    | 60%  | 36.60 | 0.00     | -4434.47 | 0.00 | 3.39 | 0.46 | 4.40 |
| 0.39 |      |       |          |          |      |      |      |      |
| 8    | 70%  | 36.60 | 0.00     | -4434.47 | 0.00 | 3.39 | 0.46 | 4.40 |
| 0.26 |      |       |          |          |      |      |      |      |
| 9    | 80%  | 36.60 | -61.35   | -4434.47 | 0.04 | 3.39 | 0.46 | 4.40 |
| 0.01 |      |       |          |          |      |      |      |      |
| 10   | 90%  | 36.60 | -973.33  | -4434.47 | 0.71 | 3.39 | 0.46 | 4.40 |
| 0.22 |      |       |          |          |      |      |      |      |
| 11   | 100% | 36.60 | -2370.47 | -4434.47 | 1.76 | 3.39 | 0.46 | 4.40 |
| 0.53 |      |       |          |          |      |      |      |      |
|      |      |       |          |          |      |      |      |      |
| C    | 0%   | 36.60 | -2710.78 | -4434.47 | 2.03 | 3.39 | 0.46 | 4.40 |
| 0.61 |      |       |          |          |      |      |      |      |



|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 117 de 140                    |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

Tramo: 3-4

Miembro No: 58

Porcentaje de redistribución de momentos: Apoyo A = 0.00% Apoyo B = 0.00%


Cuantía geométrica máxima:  $\rho_{\text{maxsup}} = 1.55\%$   $\rho_{\text{maxinf}} = 1.55\%$

Separación límite entre barras por fisuración:  $s_b \text{ lim} = 30.61 \text{ [cm]}$

### Momentos flectores positivos

| Estación           | d[cm] | Mu[Kg*m] | $\phi * Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%)sb | [cm] |
|--------------------|-------|----------|--------------------|-------------|--------------|--------------|------|
| Mu/( $\phi * Mn$ ) |       |          |                    |             |              |              |      |
| No. Dist           |       |          |                    |             |              |              |      |
| 1 0%               | 36.60 | 0.00     | 2975.24            | 0.00        | 2.26         | 0.41         | 5.00 |
| 0.56               |       |          |                    |             |              |              |      |
| 2 10%              | 36.60 | 0.00     | 2975.24            | 0.00        | 2.26         | 0.41         | 5.00 |
| 0.43               |       |          |                    |             |              |              |      |
| 3 20%              | 36.60 | 0.00     | 2975.24            | 0.00        | 2.26         | 0.41         | 5.00 |
| 0.31               |       |          |                    |             |              |              |      |
| 4 30%              | 36.60 | 0.00     | 2975.24            | 0.00        | 2.26         | 0.41         | 5.00 |
| 0.20               |       |          |                    |             |              |              |      |
| 5 40%              | 36.60 | 0.00     | 2975.24            | 0.00        | 2.26         | 0.41         | 5.00 |
| 0.11               |       |          |                    |             |              |              |      |
| 6 50%              | 36.60 | 0.00     | 2975.24            | 0.00        | 2.26         | 0.41         | 5.00 |
| 0.03               |       |          |                    |             |              |              |      |
| 7 60%              | 36.60 | 233.61   | 2975.24            | 0.17        | 2.26         | 0.41         | 5.00 |
| 0.08               |       |          |                    |             |              |              |      |
| 8 70%              | 36.60 | 546.62   | 2975.24            | 0.40        | 2.26         | 0.41         | 5.00 |
| 0.18               |       |          |                    |             |              |              |      |
| 9 80%              | 36.60 | 757.61   | 2975.24            | 0.55        | 2.26         | 0.41         | 5.00 |
| 0.25               |       |          |                    |             |              |              |      |
| 10 90%             | 36.60 | 930.30   | 2975.24            | 0.68        | 2.26         | 0.41         | 5.00 |
| 0.31               |       |          |                    |             |              |              |      |




|  |                    |  |  |  |  |      |                        |            |
|--|--------------------|--|--|--|--|------|------------------------|------------|
|   | TIPO DE DOCUMENTO: |  |  |  |  |      | CÓDIGO DEL DOCUMENTO:  |            |
|  | MEMORIA DE CÁLCULO |  |  |  |  |      | IPE-2025-2977-S-MC-011 |            |
|  | TÍTULO:            |  |  |  |  |      | HOJA:                  | 118 de 140 |
| MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |                    |  |  |  |  | REV: |                        |            |
|  |                    |  |  |  |  | A    |                        |            |

|      |      |       |         |         |      |      |      |      |
|------|------|-------|---------|---------|------|------|------|------|
| 11   | 100% | 36.60 | 1079.24 | 2975.24 | 0.79 | 2.26 | 0.41 | 5.00 |
| 0.36 |      |       |         |         |      |      |      |      |

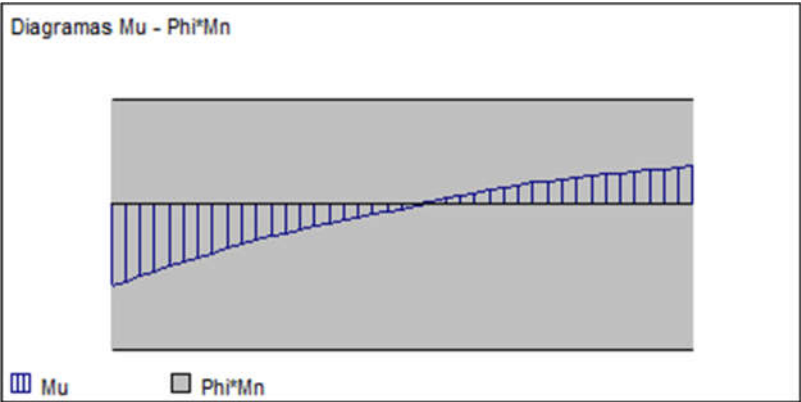
|      |    |       |      |         |      |      |      |      |
|------|----|-------|------|---------|------|------|------|------|
| C    | 0% | 36.60 | 0.00 | 2975.24 | 0.00 | 2.26 | 0.41 | 5.00 |
| 0.56 |    |       |      |         |      |      |      |      |

**Momentos flectores negativos**

| Estación         | d[cm] | Mu[Kg*m] | $\phi$ *Mn[Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%)sb | [cm] |
|------------------|-------|----------|------------------|-------------|--------------|--------------|------|
| Mu/( $\phi$ *Mn) |       |          |                  |             |              |              |      |
| No. Dist         |       |          |                  |             |              |              |      |
| 1                | 0%    | 35.35    | -2357.86         | -4189.54    | 1.84         | 3.39         | 0.64 |
| 0.56             |       |          |                  |             |              |              | 5.00 |
| 2                | 10%   | 35.35    | -1811.36         | -4189.54    | 1.40         | 3.39         | 0.64 |
| 0.43             |       |          |                  |             |              |              | 5.00 |
| 3                | 20%   | 35.35    | -1288.60         | -4189.54    | 0.99         | 3.39         | 0.64 |
| 0.31             |       |          |                  |             |              |              | 5.00 |
| 4                | 30%   | 35.35    | -847.85          | -4189.54    | 0.64         | 3.39         | 0.64 |
| 0.20             |       |          |                  |             |              |              | 5.00 |
| 5                | 40%   | 35.35    | -467.51          | -4189.54    | 0.35         | 3.39         | 0.64 |
| 0.11             |       |          |                  |             |              |              | 5.00 |
| 6                | 50%   | 35.35    | -145.53          | -4189.54    | 0.11         | 3.39         | 0.64 |
| 0.03             |       |          |                  |             |              |              | 5.00 |
| 7                | 60%   | 35.35    | 0.00             | -4189.54    | 0.00         | 3.39         | 0.64 |
| 0.08             |       |          |                  |             |              |              | 5.00 |
| 8                | 70%   | 35.35    | 0.00             | -4189.54    | 0.00         | 3.39         | 0.64 |
| 0.18             |       |          |                  |             |              |              | 5.00 |
| 9                | 80%   | 35.35    | 0.00             | -4189.54    | 0.00         | 3.39         | 0.64 |
| 0.25             |       |          |                  |             |              |              | 5.00 |

|   |  |  |  |  |  |                        |  |  |
|---|--|--|--|--|--|------------------------|--|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  | IPE-2025-2977-S-MC-011 |  |  |
|   | TÍTULO:  |  |  |  |  | HOJA:                  |  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE H°A° Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  | 119 de 140             |  |  |
|   |  |  |  |  |  | REV:                   |  |  |
|   |  |  |  |  |  | A                      |  |  |

|      |      |       |          |          |      |      |      |      |
|------|------|-------|----------|----------|------|------|------|------|
| 10   | 90%  | 35.35 | 0.00     | -4189.54 | 0.00 | 3.39 | 0.64 | 5.00 |
| 0.31 |      |       |          |          |      |      |      |      |
| 11   | 100% | 35.35 | 0.00     | -4189.54 | 0.00 | 3.39 | 0.64 | 5.00 |
| 0.36 |      |       |          |          |      |      |      |      |
|      |      |       |          |          |      |      |      |      |
| C    | 0%   | 35.35 | -2357.86 | -4189.54 | 1.84 | 3.39 | 0.64 | 5.00 |
| 0.56 |      |       |          |          |      |      |      |      |




Tramo: 4-5                      Miembro No: 61

|  |                         |                         |
|--|-------------------------|-------------------------|
| Porcentaje de redistribución de momentos:      | Apoyo A = 0.00%         | Apoyo B = 0.00%         |
| Cuantía geométrica máxima:                     | $\rho_{maxsup}$ = 1.55% | $\rho_{maxinf}$ = 1.55% |
| Separación límite entre barras por fisuración: | sb lim = 30.61 [cm]     |                         |

Momentos flectores positivos


| Estación         | d[cm] | Mu[Kg*m] | $\phi*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%)sb | [cm] |
|------------------|-------|----------|------------------|-------------|--------------|--------------|------|
| Mu/( $\phi*Mn$ ) |       |          |                  |             |              |              |      |
| No. Dist         |       |          |                  |             |              |              |      |

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 120 de 140                    |
|   |   | REV:                          |
|   |   | <b>A</b>                      |

|    |      |       |         |         |      |      |      |      |
|----|------|-------|---------|---------|------|------|------|------|
| 1  | 0%   | 36.60 | 1075.20 | 2975.24 | 0.79 | 2.26 | 0.41 | 5.00 |
|    |      | 0.36  |         |         |      |      |      |      |
| 2  | 10%  | 36.60 | 1140.82 | 2975.24 | 0.84 | 2.26 | 0.41 | 5.00 |
|    |      | 0.38  |         |         |      |      |      |      |
| 3  | 20%  | 36.60 | 1138.51 | 2975.24 | 0.84 | 2.26 | 0.41 | 5.00 |
|    |      | 0.38  |         |         |      |      |      |      |
| 4  | 30%  | 36.60 | 1030.61 | 2975.24 | 0.76 | 2.26 | 0.41 | 5.00 |
|    |      | 0.35  |         |         |      |      |      |      |
| 5  | 40%  | 36.60 | 890.34  | 2975.24 | 0.65 | 2.26 | 0.41 | 5.00 |
|    |      | 0.30  |         |         |      |      |      |      |
| 6  | 50%  | 36.60 | 714.60  | 2975.24 | 0.52 | 2.26 | 0.41 | 5.00 |
|    |      | 0.24  |         |         |      |      |      |      |
| 7  | 60%  | 36.60 | 467.03  | 2975.24 | 0.34 | 2.26 | 0.41 | 5.00 |
|    |      | 0.16  |         |         |      |      |      |      |
| 8  | 70%  | 36.60 | 132.59  | 2975.24 | 0.10 | 2.26 | 0.41 | 5.00 |
|    |      | 0.04  |         |         |      |      |      |      |
| 9  | 80%  | 36.60 | 0.00    | 2975.24 | 0.00 | 2.26 | 0.41 | 5.00 |
|    |      | 0.10  |         |         |      |      |      |      |
| 10 | 90%  | 36.60 | 0.00    | 2975.24 | 0.00 | 2.26 | 0.41 | 5.00 |
|    |      | 0.20  |         |         |      |      |      |      |
| 11 | 100% | 36.60 | 0.00    | 2975.24 | 0.00 | 2.26 | 0.41 | 5.00 |
|    |      | 0.31  |         |         |      |      |      |      |
| C  | 15%  | 36.60 | 1161.49 | 2975.24 | 0.86 | 2.26 | 0.41 | 5.00 |
|    |      | 0.39  |         |         |      |      |      |      |


#### Momentos flectores negativos

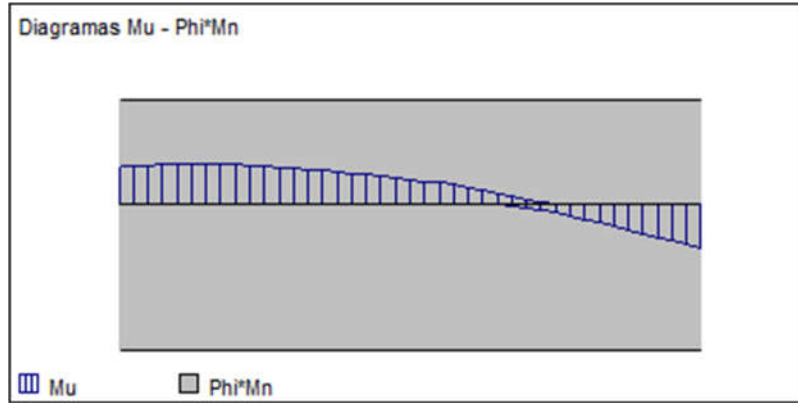
| Estación          | d[cm] | Mu[Kg*m] | $\phi^*Mn$ [Kg*m] | Asreq [cm2] | Asprov [cm2] | $\rho$ (%)sb | [cm] |
|-------------------|-------|----------|-------------------|-------------|--------------|--------------|------|
| Mu/( $\phi^*Mn$ ) |       |          |                   |             |              |              |      |

|   |  |  |  |  |  |                        |  |  |
|---|--|--|--|--|--|------------------------|--|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  | IPE-2025-2977-S-MC-011 |  |  |
|   | TÍTULO:  |  |  |  |  | HOJA:                  |  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  | 121 de 140             |  |  |
|   |  |  |  |  |  | REV:                   |  |  |
|   |  |  |  |  |  | A                      |  |  |

No. Dist

|    |      |       |          |          |      |      |      |      |
|----|------|-------|----------|----------|------|------|------|------|
| 1  | 0%   | 35.35 | 0.00     | -4189.54 | 0.00 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.36 |
| 2  | 10%  | 35.35 | 0.00     | -4189.54 | 0.00 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.38 |
| 3  | 20%  | 35.35 | 0.00     | -4189.54 | 0.00 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.38 |
| 4  | 30%  | 35.35 | 0.00     | -4189.54 | 0.00 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.35 |
| 5  | 40%  | 35.35 | 0.00     | -4189.54 | 0.00 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.30 |
| 6  | 50%  | 35.35 | 0.00     | -4189.54 | 0.00 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.24 |
| 7  | 60%  | 35.35 | 0.00     | -4189.54 | 0.00 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.16 |
| 8  | 70%  | 35.35 | -104.88  | -4189.54 | 0.08 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.04 |
| 9  | 80%  | 35.35 | -436.84  | -4189.54 | 0.33 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.10 |
| 10 | 90%  | 35.35 | -846.48  | -4189.54 | 0.64 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.20 |
| 11 | 100% | 35.35 | -1293.75 | -4189.54 | 0.99 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.31 |
| C  | 15%  | 35.35 | 0.00     | -4189.54 | 0.00 | 3.39 | 0.64 | 5.00 |
|    |      |       |          |          |      |      |      | 0.39 |

|   |  |                               |
|---|--|-------------------------------|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:         |
|   | MEMORIA DE CÁLCULO   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:  | HOJA: 122 de 140              |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | REV: <b>A</b>                 |



## Corte y Torsión

Tramo: 1-2

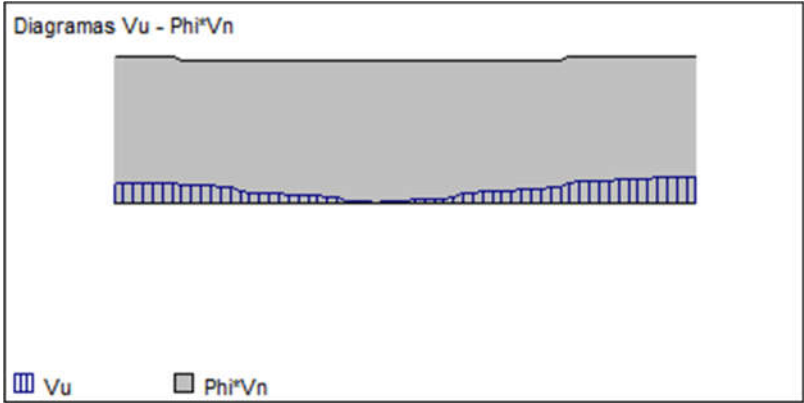
Miembro No: 46

| Estación                   | Estribos | Spc prov | Spc lim | Tu    | $\phi^*T_n$ | Al     | Vu      | Vs    | Vc      |          |           |
|----------------------------|----------|----------|---------|-------|-------------|--------|---------|-------|---------|----------|-----------|
| $\phi^*V_nV_u/(\phi^*V_n)$ |          |          |         |       |             |        |         |       |         |          |           |
| No.                        | Dist     | Diám     | VCT     | [cm]  | [cm]        | [Kg*m] | [Kg*m]  | [cm2] | [Kg]    | [Kg]     | [Kg] [Kg] |
| 1                          | 0%       | 8mm      | VT      | 12.00 | 12.60       | 986.58 | 1200.97 | 3.47  | 1758.51 | 12886.86 | 3750.64   |
| 12478.120.14               |          |          |         |       |             |        |         |       |         |          |           |
| 2                          | 10%      | 8mm      | VT      | 12.00 | 12.60       | 782.04 | 1200.97 | 2.75  | 1656.78 | 12886.86 | 3750.64   |
| 12478.120.13               |          |          |         |       |             |        |         |       |         |          |           |
| 3                          | 20%      | 8mm      | VT      | 12.00 | 12.60       | 782.04 | 1200.97 | 2.75  | 1376.89 | 12886.86 | 3276.48   |
| 12122.510.11               |          |          |         |       |             |        |         |       |         |          |           |
| 4                          | 30%      | 8mm      | T       | 12.00 | 12.60       | 430.08 | 1200.97 | 2.15  | 746.72  | 12886.86 | 3276.48   |
| 12122.510.06               |          |          |         |       |             |        |         |       |         |          |           |
| 5                          | 40%      | 8mm      |         | 12.00 | 18.30       | 34.88  | 1200.97 | 0.00  | 187.11  | 12886.86 | 3276.48   |
| 12122.510.02               |          |          |         |       |             |        |         |       |         |          |           |
| 6                          | 50%      | 8mm      |         | 12.00 | 18.30       | 34.88  | 1200.97 | 0.00  | 223.68  | 12886.86 | 3276.48   |
| 12122.510.02               |          |          |         |       |             |        |         |       |         |          |           |

|  |  |  |                        |  |
|--|--|--|------------------------|--|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |  |
|  | MEMORIA DE CÁLCULO   |  | IPE-2025-2977-S-MC-011 |  |
|  | TÍTULO:  |  | HOJA:                  |  |
|  | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 123 de 140             |  |
|  |  |  | REV:                   |  |
|  |  |  | A                      |  |

|              |      |     |    |       |       |         |         |      |         |          |         |
|--------------|------|-----|----|-------|-------|---------|---------|------|---------|----------|---------|
| 7            | 60%  | 8mm | T  | 12.00 | 12.60 | 359.51  | 1200.97 | 2.39 | 867.84  | 12886.86 | 3276.48 |
| 12122.510.07 |      |     |    |       |       |         |         |      |         |          |         |
| 8            | 70%  | 8mm | T  | 12.00 | 12.60 | 359.51  | 1200.97 | 2.39 | 1147.72 | 12886.86 | 3276.48 |
| 12122.510.09 |      |     |    |       |       |         |         |      |         |          |         |
| 9            | 80%  | 8mm | VT | 12.00 | 12.60 | 746.62  | 1200.97 | 2.63 | 1808.33 | 12886.86 | 3750.64 |
| 12478.120.14 |      |     |    |       |       |         |         |      |         |          |         |
| 10           | 90%  | 8mm | VT | 12.00 | 12.60 | 746.62  | 1200.97 | 2.63 | 2088.22 | 12886.86 | 3750.64 |
| 12478.120.17 |      |     |    |       |       |         |         |      |         |          |         |
| 11           | 100% | 8mm | VT | 12.00 | 12.60 | 1130.47 | 1200.97 | 3.98 | 2189.95 | 12886.86 | 3750.64 |
| 12478.120.18 |      |     |    |       |       |         |         |      |         |          |         |

|              |     |     |    |       |       |        |         |      |         |          |         |
|--------------|-----|-----|----|-------|-------|--------|---------|------|---------|----------|---------|
| C            | 95% | 8mm | VT | 12.00 | 12.60 | 746.62 | 1200.97 | 2.63 | 2189.95 | 12886.86 | 3750.64 |
| 12478.120.18 |     |     |    |       |       |        |         |      |         |          |         |



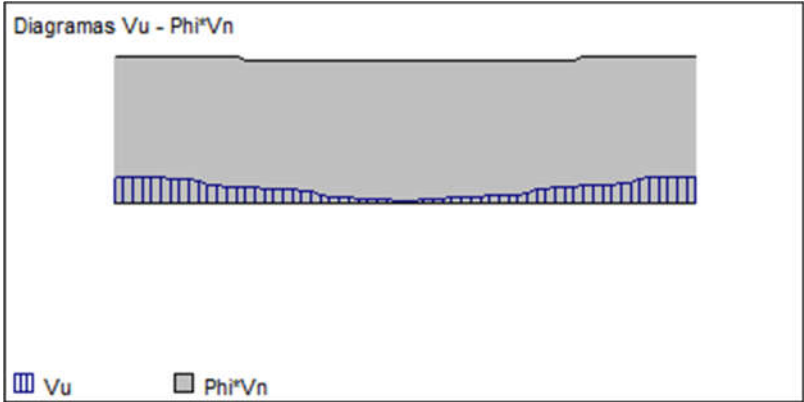
Tramo: 2-3                      Miembro No: 44


| Estación                   |      | Estribos |     | Spc prov | Spc lim | Tu     | $\phi^*T_n$ | Al    | Vu      | Vs       | Vc        |
|----------------------------|------|----------|-----|----------|---------|--------|-------------|-------|---------|----------|-----------|
| $\phi^*V_nV_u/(\phi^*V_n)$ |      |          |     |          |         |        |             |       |         |          |           |
| No.                        | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m]      | [cm2] | [Kg]    | [Kg]     | [Kg] [Kg] |
| <hr/>                      |      |          |     |          |         |        |             |       |         |          |           |
| 1                          | 0%   | 8mm      | VT  | 12.00    | 12.60   | 893.88 | 1200.97     | 3.14  | 2214.96 | 12886.86 | 3750.64   |
| 12478.120.18               |      |          |     |          |         |        |             |       |         |          |           |

|  |  |  |                        |  |
|--|--|--|------------------------|--|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |  |
|  | MEMORIA DE CÁLCULO   |  | IPE-2025-2977-S-MC-011 |  |
|  | TÍTULO:  |  | HOJA:                  |  |
|  | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 124 de 140             |  |
|  |  |  | REV:                   |  |
|  |  |  | A                      |  |

|              |      |     |    |       |       |         |         |      |         |          |         |
|--------------|------|-----|----|-------|-------|---------|---------|------|---------|----------|---------|
| 2            | 10%  | 8mm | VT | 12.00 | 12.60 | 893.88  | 1200.97 | 3.14 | 2099.74 | 12886.86 | 3750.64 |
| 12478.120.17 |      |     |    |       |       |         |         |      |         |          |         |
| 3            | 20%  | 8mm | VT | 12.00 | 12.60 | 510.44  | 1200.97 | 1.86 | 1430.63 | 12886.86 | 3750.64 |
| 12478.120.11 |      |     |    |       |       |         |         |      |         |          |         |
| 4            | 30%  | 8mm | T  | 12.00 | 12.60 | 510.44  | 1200.97 | 1.86 | 1138.99 | 12886.86 | 3276.48 |
| 12122.510.09 |      |     |    |       |       |         |         |      |         |          |         |
| 5            | 40%  | 8mm |    | 12.00 | 18.30 | 126.73  | 1200.97 | 0.00 | 469.64  | 12886.86 | 3276.48 |
| 12122.510.04 |      |     |    |       |       |         |         |      |         |          |         |
| 6            | 50%  | 8mm |    | 12.00 | 18.30 | 126.73  | 1200.97 | 0.00 | 177.99  | 12886.86 | 3276.48 |
| 12122.510.01 |      |     |    |       |       |         |         |      |         |          |         |
| 7            | 60%  | 8mm | T  | 12.00 | 12.60 | 256.98  | 1200.97 | 2.76 | 491.35  | 12886.86 | 3276.48 |
| 12122.510.04 |      |     |    |       |       |         |         |      |         |          |         |
| 8            | 70%  | 8mm | T  | 12.00 | 12.60 | 256.98  | 1200.97 | 2.76 | 783.00  | 12886.86 | 3276.48 |
| 12122.510.06 |      |     |    |       |       |         |         |      |         |          |         |
| 9            | 80%  | 8mm | VT | 12.00 | 12.60 | 640.43  | 1200.97 | 2.25 | 1452.11 | 12886.86 | 3560.97 |
| 12335.880.12 |      |     |    |       |       |         |         |      |         |          |         |
| 10           | 90%  | 8mm | VT | 12.00 | 12.60 | 947.47  | 1200.97 | 3.33 | 2045.98 | 12886.86 | 3750.64 |
| 12478.120.16 |      |     |    |       |       |         |         |      |         |          |         |
| 11           | 100% | 8mm | VT | 12.00 | 12.60 | 1024.23 | 1200.97 | 3.60 | 2236.75 | 12886.86 | 3750.64 |
| 12478.120.18 |      |     |    |       |       |         |         |      |         |          |         |

|              |     |     |    |       |       |         |         |      |         |          |         |
|--------------|-----|-----|----|-------|-------|---------|---------|------|---------|----------|---------|
| C            | 95% | 8mm | VT | 12.00 | 12.60 | 1024.23 | 1200.97 | 3.60 | 2236.75 | 12886.86 | 3750.64 |
| 12478.120.18 |     |     |    |       |       |         |         |      |         |          |         |




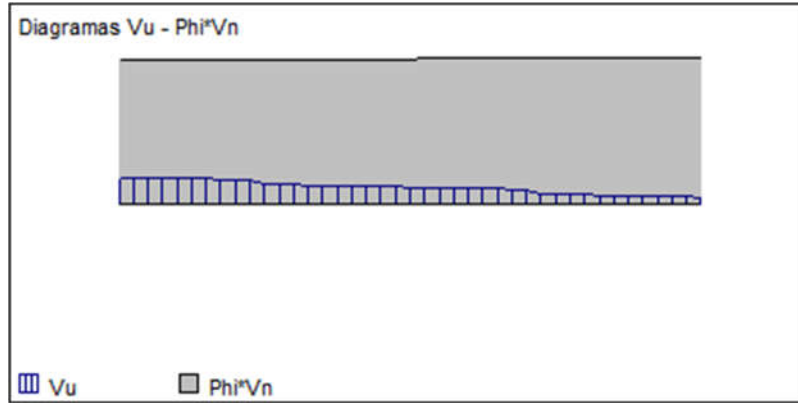
|   |  |                                       |
|---|--|---------------------------------------|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:                 |
|   | MEMORIA DE CÁLCULO   | <b>IP-2025-2977-S-MC-011</b><br>HOJA: |
|   | TÍTULO:<br><b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 125 de 140<br>REV:<br><b>A</b>        |

Tramo: 3-4
 Miembro No: 58

| Estación     |      | Estribos |     | Spc prov | Spc lim | Tu     | ϕ*Tn   | Al    | Vu      | Vs       | Vc        |
|--------------|------|----------|-----|----------|---------|--------|--------|-------|---------|----------|-----------|
| ϕ*Vu/(ϕ*Vn)  |      |          |     |          |         |        |        |       |         |          |           |
| No.          | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m] | [cm2] | [Kg]    | [Kg]     | [Kg] [Kg] |
|              |      |          |     |          |         |        |        |       |         |          |           |
| 1            | 0%   | 8mm      | VT  | 11.00    | 11.35   | 414.20 | 652.25 | 1.96  | 2172.09 | 13579.54 | 3025.37   |
| 12453.680.17 |      |          |     |          |         |        |        |       |         |          |           |
| 2            | 10%  | 8mm      | VT  | 11.00    | 11.35   | 414.20 | 652.25 | 1.96  | 2172.09 | 13579.54 | 3025.37   |
| 12453.680.17 |      |          |     |          |         |        |        |       |         |          |           |
| 3            | 20%  | 8mm      | VT  | 11.00    | 11.35   | 414.20 | 652.53 | 1.96  | 2130.07 | 13579.54 | 3025.37   |
| 12453.680.17 |      |          |     |          |         |        |        |       |         |          |           |
| 4            | 30%  | 8mm      | V   | 11.00    | 17.68   | 27.27  | 655.40 | 0.00  | 1650.53 | 13579.54 | 3025.37   |
| 12453.680.13 |      |          |     |          |         |        |        |       |         |          |           |
| 5            | 40%  | 8mm      | V   | 11.00    | 17.68   | 27.27  | 655.90 | 0.00  | 1551.54 | 13579.54 | 3025.37   |
| 12453.680.12 |      |          |     |          |         |        |        |       |         |          |           |
| 6            | 50%  | 8mm      | V   | 11.00    | 17.68   | 27.27  | 656.37 | 0.00  | 1452.55 | 13579.54 | 3025.37   |
| 12453.680.12 |      |          |     |          |         |        |        |       |         |          |           |
| 7            | 60%  | 8mm      | V   | 11.00    | 18.30   | 27.27  | 642.86 | 0.00  | 1353.56 | 14058.39 | 2704.68   |
| 12572.300.11 |      |          |     |          |         |        |        |       |         |          |           |
| 8            | 70%  | 8mm      | V   | 11.00    | 18.30   | 27.27  | 643.24 | 0.00  | 1254.57 | 14058.39 | 2704.68   |
| 12572.300.10 |      |          |     |          |         |        |        |       |         |          |           |
| 9            | 80%  | 8mm      | T   | 11.00    | 11.35   | 366.85 | 644.69 | 1.73  | 782.33  | 14058.39 | 2704.68   |
| 12572.300.06 |      |          |     |          |         |        |        |       |         |          |           |
| 10           | 90%  | 8mm      | T   | 11.00    | 11.35   | 366.85 | 644.90 | 1.73  | 683.34  | 14058.39 | 2704.68   |
| 12572.300.05 |      |          |     |          |         |        |        |       |         |          |           |
| 11           | 100% | 8mm      | T   | 11.00    | 11.35   | 366.85 | 645.09 | 1.73  | 584.35  | 14058.39 | 2704.68   |
| 12572.300.05 |      |          |     |          |         |        |        |       |         |          |           |
|              |      |          |     |          |         |        |        |       |         |          |           |
| C            | 0%   | 8mm      | VT  | 11.00    | 11.35   | 414.20 | 652.25 | 1.96  | 2172.09 | 13579.54 | 3025.37   |
| 12453.680.17 |      |          |     |          |         |        |        |       |         |          |           |
|              |      |          |     |          |         |        |        |       |         |          |           |




|   |  |                        |
|---|--|------------------------|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:  |
|   | MEMORIA DE CÁLCULO   | IPE-2025-2977-S-MC-011 |
|   | TÍTULO:  | HOJA: 126 de 140       |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | REV: A                 |



Tramo: 4-5

Miembro No: 61

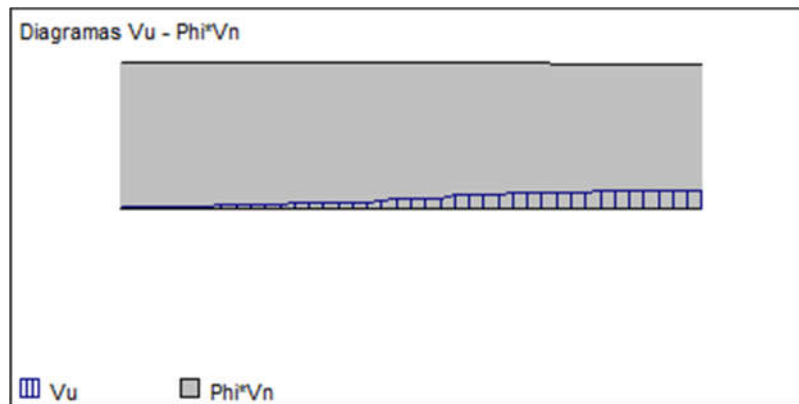
| Estación                   |      | Estribos |     | Spc prov | Spc lim | Tu     | $\phi^*T_n$ | Al    | Vu      | Vs       | Vc        |
|----------------------------|------|----------|-----|----------|---------|--------|-------------|-------|---------|----------|-----------|
| $\phi^*V_nV_u/(\phi^*V_n)$ |      |          |     |          |         |        |             |       |         |          |           |
| No.                        | Dist | Diám     | VCT | [cm]     | [cm]    | [Kg*m] | [Kg*m]      | [cm2] | [Kg]    | [Kg]     | [Kg] [Kg] |
| <hr/>                      |      |          |     |          |         |        |             |       |         |          |           |
| 1                          | 0%   | 8mm      | T   | 11.00    | 11.35   | 247.98 | 645.56      | 1.57  | 170.34  | 14058.39 | 2704.68   |
| 12572.300.01               |      |          |     |          |         |        |             |       |         |          |           |
| 2                          | 10%  | 8mm      | T   | 11.00    | 11.35   | 247.98 | 645.56      | 1.57  | 170.34  | 14058.39 | 2704.68   |
| 12572.300.01               |      |          |     |          |         |        |             |       |         |          |           |
| 3                          | 20%  | 8mm      | T   | 11.00    | 11.35   | 147.45 | 645.44      | 2.05  | 327.00  | 14058.39 | 2704.68   |
| 12572.300.03               |      |          |     |          |         |        |             |       |         |          |           |
| 4                          | 30%  | 8mm      | T   | 11.00    | 11.35   | 147.45 | 645.31      | 2.05  | 442.58  | 14058.39 | 2704.68   |
| 12572.300.04               |      |          |     |          |         |        |             |       |         |          |           |
| 5                          | 40%  | 8mm      | T   | 11.00    | 11.35   | 147.45 | 645.14      | 2.05  | 558.17  | 14058.39 | 2704.68   |
| 12572.300.04               |      |          |     |          |         |        |             |       |         |          |           |
| 6                          | 50%  | 8mm      | T   | 11.00    | 11.35   | 287.08 | 644.60      | 1.39  | 818.25  | 14058.39 | 2704.68   |
| 12572.300.07               |      |          |     |          |         |        |             |       |         |          |           |
| 7                          | 60%  | 8mm      | V   | 11.00    | 18.30   | 68.31  | 643.39      | 0.00  | 1216.08 | 14058.39 | 2704.68   |
| 12572.300.10               |      |          |     |          |         |        |             |       |         |          |           |
| 8                          | 70%  | 8mm      | V   | 11.00    | 18.30   | 68.31  | 642.94      | 0.00  | 1331.66 | 14058.39 | 2704.68   |
| 12572.300.11               |      |          |     |          |         |        |             |       |         |          |           |
| 9                          | 80%  | 8mm      | V   | 11.00    | 17.68   | 68.31  | 656.40      | 0.00  | 1447.25 | 13579.54 | 3025.37   |
| 12453.680.12               |      |          |     |          |         |        |             |       |         |          |           |

|   |  |  |                        |  |
|---|--|--|------------------------|--|
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|   | TÍTULO:  |  | HOJA:                  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 127 de 140             |  |
|   |  |  | REV:                   |  |
|   |  |  | A                      |  |

10 90% 8mm V 11.00 17.68 68.31 656.06 0.00 1518.78 13579.54 3025.37  
12453.680.12

11 100% 8mm VT 11.00 11.35 276.54 656.06 1.44 1518.78 13579.54 3025.37  
12453.680.12

C 88% 8mm V 11.00 17.68 68.31 656.06 0.00 1518.78 13579.54 3025.37  
12453.680.12



Armadura longitudinal distribuidos uniformemente

Superior 3 Ø 12 mm.

Inferior 2 Ø 12 mm.

Estribos Ø 8 mm c/12 cm para armadura transversal TRAMO (1-2).


Estribos Ø 8 mm c/12 cm para armadura transversal TRAMO (2-3).

Estribos Ø 8 mm c/11 cm para armadura transversal TRAMO (3-5).

### 8.3.3. VIGA VS-02 TRAMO (4-5), VS-04 TRAMO (A-B) Y VIGA VS-05/ VS-06/ VS-07/VS-08/ VS-09 TRAMO (A-B)

Para el cálculo de las demás vigas al ser las menos solicitadas se realizó el resumen de diseño:

**Figura 27.** Resumen de diseño (Vigas de encadenado).

|   |  |   |
|---|--|---|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:                             |
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|   | TÍTULO:<br><b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | REV: <b>A</b>                                     |


| Vigas |                 |          |          |          |          |       |                    |       |       |       |   |
|-------|-----------------|----------|----------|----------|----------|-------|--------------------|-------|-------|-------|---|
| VIGA  | A. izq          | A. cent  | A. der   | P.I. izq | P.I. der | PIEL  | Sep. Estribos [cm] |       |       | TIPO  |   |
| ID    | Mmin/max        | V [Kg]   | Longitud | [m]      | [m]      | [cm2] | Barra              | IZQ.  | CENT. | DER.  |   |
|       | [cm2]           | T [Kg/m] | [cm2]    |          |          |       |                    |       |       |       |   |
|       | [Kg/m]          |          | [m]      |          |          |       |                    |       |       |       |   |
| 47    | RcBeamM 20x40cm |          |          |          |          |       |                    |       |       |       |   |
| SUP:  | 0.00            | 0.00     | 0.00     | 0.00     | 0.00     | 0.00  | T8                 | 17.50 | 17.50 | 17.50 | U |
|       | 519.40          | 483.10   | 3.80     |          |          |       |                    |       |       |       |   |
| INF:  | 0.00            | 0.00     | 0.00     | 0.00     | 0.00     |       |                    |       |       |       |   |
|       | -481.10         | 18.08    |          |          |          |       |                    |       |       |       |   |
| 45    | RcBeamM 15X40   |          |          |          |          |       |                    |       |       |       |   |
| SUP:  | 0.00            | 0.00     | 1.88     | 0.00     | 0.00     | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|       | 751.80          | 550.20   | 3.80     |          |          |       |                    |       |       |       |   |
| INF:  | 0.00            | 0.00     | 1.88     | 0.00     | 0.00     |       |                    |       |       |       |   |
|       | -828.90         | 5.45     |          |          |          |       |                    |       |       |       |   |
| 36    | RcBeamM 15X40   |          |          |          |          |       |                    |       |       |       |   |
| SUP:  | 0.00            | 0.00     | 0.00     | 0.70     | 2.84     | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|       | 449.10          | 317.80   | 2.85     |          |          |       |                    |       |       |       |   |
| INF:  | 0.00            | 0.00     | 0.00     | 0.00     | 0.00     |       |                    |       |       |       |   |
|       | -121.70         | 6.20     |          |          |          |       |                    |       |       |       |   |
| 37    | RcBeamM 15X40   |          |          |          |          |       |                    |       |       |       |   |
| SUP:  | 0.00            | 0.00     | 0.00     | 0.00     | 2.78     | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|       | 435.80          | 379.60   | 2.80     |          |          |       |                    |       |       |       |   |
| INF:  | 0.00            | 0.00     | 0.00     | 2.79     | 0.00     |       |                    |       |       |       |   |
|       | -12.48          | 16.35    |          |          |          |       |                    |       |       |       |   |
| 41    | RcBeamM 15X40   |          |          |          |          |       |                    |       |       |       |   |
| SUP:  | 0.00            | 0.00     | 0.00     | 0.91     | 0.00     | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|       | 711.10          | 588.40   | 1.15     |          |          |       |                    |       |       |       |   |
| INF:  | 0.00            | 0.00     | 1.88     | 0.00     | 0.00     |       |                    |       |       |       |   |
|       | -438.30         | 11.88    |          |          |          |       |                    |       |       |       |   |
| 43    | RcBeamM 15X40   |          |          |          |          |       |                    |       |       |       |   |
| SUP:  | 0.00            | 0.00     | 1.88     | 0.00     | 0.00     | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|       | 707.70          | 618.70   | 3.80     |          |          |       |                    |       |       |       |   |
| INF:  | 0.00            | 0.00     | 1.88     | 0.00     | 0.00     |       |                    |       |       |       |   |
|       | -873.80         | 3.70     |          |          |          |       |                    |       |       |       |   |
| 49    | RcBeamM 15X40   |          |          |          |          |       |                    |       |       |       |   |
| SUP:  | 0.00            | 0.00     | 1.88     | 0.00     | 0.00     | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|       | 783.10          | 808.80   | 1.15     |          |          |       |                    |       |       |       |   |
| INF:  | 0.00            | 0.00     | 1.88     | 0.02     | 0.00     |       |                    |       |       |       |   |
|       | -782.80         | 3.54     |          |          |          |       |                    |       |       |       |   |
| 59    | RcBeamM 15X40   |          |          |          |          |       |                    |       |       |       |   |
| SUP:  | 0.00            | 0.00     | 0.00     | 0.21     | 1.97     | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|       | 839.60          | 338.40   | 2.85     |          |          |       |                    |       |       |       |   |
| INF:  | 0.00            | 0.00     | 1.88     | 0.00     | 0.00     |       |                    |       |       |       |   |
|       | -180.80         | 4.04     |          |          |          |       |                    |       |       |       |   |
| 60    | RcBeamM 15X40   |          |          |          |          |       |                    |       |       |       |   |
| SUP:  | 0.00            | 0.00     | 1.88     | 0.93     | 0.00     | 0.00  | T8                 | 18.80 | 18.80 | 18.80 | U |
|       | 711.50          | 579.70   | 2.85     |          |          |       |                    |       |       |       |   |
| INF:  | 1.88            | 0.00     | 0.00     | 2.19     | 0.00     |       |                    |       |       |       |   |
|       | -557.20         | 3.99     |          |          |          |       |                    |       |       |       |   |

Armado de vigas:

Viga VS-02 TRAMO (4-5) y VS-05/VS-06 /VS-07/VS-08/VS-09 TRAMO (A-B)

Sección de la viga 15 cm x 40 cm

Armadura Longitudinal: 4 Ø 10 mm  $A_s = 3.14 \text{ cm}^2$

|   |  |   |
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Armadura Transversal: Ø 8 mm c/17 cm

Viga VS-04 TRAMO (A-B)

Sección de la viga 20 cm x 40 cm

Armadura Longitudinal: 4 Ø 10 mm  $A_s = 3.14 \text{ cm}^2$

Armadura Transversal: Ø 8 mm c/17 cm

## 9. CÁLCULO DE FUNDACIONES

# Resultados de Diseño Zapatas de Hormigón Armado

## Datos Generales

Estatus global : **Bien**  
 Código de diseño : ACI 318-2019  
 Tipo de zapata : Aislada  
 Tipo de columna : Concreto


### Materiales

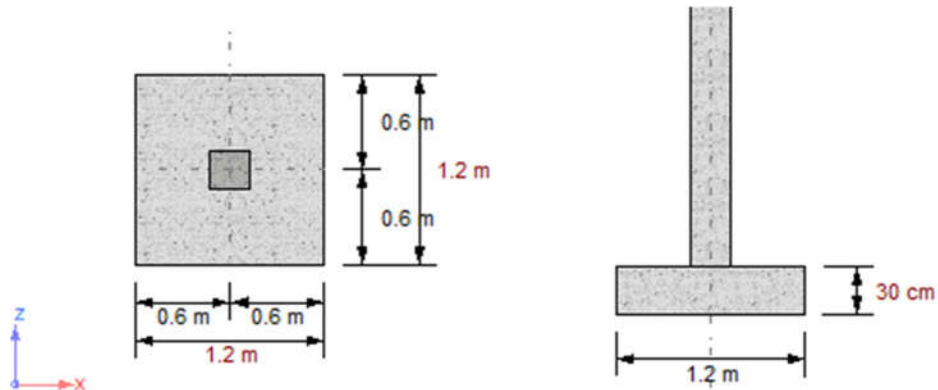
|                                |                      |                             |                  |
|--------------------------------|----------------------|-----------------------------|------------------|
| Hormigón, $f_c$                | : 2100000.00 [Kg...] | Acero, $f_y$                | : 4.2E07 [Kg/m2] |
| Tipo de concreto               | : Normal             | Recubrimiento epóxico       | : No             |
| Módulo de elasticidad hormigón | : 2.14E09 [Kg/m2]    | Módulo de elasticidad acero | : 2.9E11 [Kg/m2] |
| Peso unitario                  | : 2400.00 [Kg/m3]    |                             |                  |

### Suelo

Coeficiente de balasto : 3150000.00 [Kg...]  
 Peso unitario (húmedo) : 1860.00 [Kg/m3]

## Geometría

|   |   |                               |
|---|---|-------------------------------|
|  | TIPO DE DOCUMENTO:  | CÓDIGO DEL DOCUMENTO:         |
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|   |   | <b>A</b>                      |



|                        |   |                        |
|------------------------|---|------------------------|
| Longitud               | : | 1.20 [m]               |
| Ancho                  | : | 1.20 [m]               |
| Espesor                | : | 0.30 [m]               |
| Profundidad de la base | : | 1.20 [m]               |
| Área de la base        | : | 1.44 [m <sup>2</sup> ] |
| Volumen de la zapata   | : | 0.43 [m <sup>3</sup> ] |

|  |   |            |
|--|---|------------|
| Longitud de la columna                               | : | 25.00 [cm] |
| Ancho de la columna                                  | : | 25.00 [cm] |
| Posición de la columna respecto al c.g. de la zapata | : | Centrada   |

## Reinforcement

### Armadura longitudinal

|  |   |                           |
|--|---|---------------------------|
| Recubrimiento libre                              | : | 8.00 [cm]                 |
| Relación máxima permitida entre Rho/Rho balanceo | : | 0.75                      |
| Armadura // a L (xx) inferior                    | : | 7-R12 c/ 17.00cm          |
| Armadura // a L (xx) superior                    | : | 7-R12 c/ 17.00cm          |
| Armadura // a B (zz) inferior                    | : | 7-R12 c/ 17.00cm (Zona 1) |
| Armadura // a B (zz) superior                    | : | 7-R12 c/ 17.00cm          |


### Armadura de espera

|                              |   |               |
|------------------------------|---|---------------|
| Armadura 1                   | : | 6-R12         |
| Recubrimiento libre          | : | 2.50 [cm]     |
| Longitud de anclaje calcular | : | a tracción    |
| Número de barras // al eje x | : | 2             |
| Número de barras // al eje z | : | 3             |
| Estribos                     | : | R8 c/ 15.00cm |
| Número de ramas // al eje x  | : | 2             |
| Número de ramas // al eje z  | : | 2             |

## Condiciones de carga

### Servicio:


|    |   |     |
|----|---|-----|
| S1 | : | _S1 |
| S2 | : | _S2 |
| S3 | : | _S3 |
| S4 | : | _S4 |

|   |   |                               |
|---|---|-------------------------------|
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|     |   |      |
|-----|---|------|
| S5  | : | _S5  |
| S6  | : | _S6  |
| S7  | : | _S7  |
| S8  | : | _S8  |
| S9  | : | _S9  |
| S10 | : | _S10 |
| S11 | : | _S11 |
| S12 | : | _S12 |
| S13 | : | _S13 |
| S14 | : | _S14 |
| S15 | : | _S15 |
| S16 | : | _S16 |
| S17 | : | _S17 |
| S18 | : | _S18 |
| S19 | : | _S19 |
| S20 | : | _S20 |
| S21 | : | _S21 |
| S22 | : | _S22 |
| S23 | : | _S23 |
| S24 | : | _S24 |
| S25 | : | _S25 |
| S26 | : | _S26 |
| S27 | : | _S27 |
| S28 | : | _S28 |
| S29 | : | _S29 |
| S30 | : | _S30 |
| S31 | : | _S31 |
| S32 | : | _S32 |
| S33 | : | _S33 |
| S34 | : | _S34 |
| S35 | : | _S35 |
| S36 | : | _S36 |
| S37 | : | _S37 |
| S38 | : | _S38 |
| S39 | : | _S39 |
| S40 | : | _S40 |
| S41 | : | _S41 |

**Límite ultimo:**


|     |   |      |
|-----|---|------|
| D1  | : | _D1  |
| D2  | : | _D2  |
| D3  | : | _D3  |
| D4  | : | _D4  |
| D5  | : | _D5  |
| D6  | : | _D6  |
| D7  | : | _D7  |
| D8  | : | _D8  |
| D9  | : | _D9  |
| D10 | : | _D10 |
| D11 | : | _D11 |
| D12 | : | _D12 |
| D13 | : | _D13 |
| D14 | : | _D14 |
| D15 | : | _D15 |
| D16 | : | _D16 |
| D17 | : | _D17 |
| D18 | : | _D18 |
| D19 | : | _D19 |
| D20 | : | _D20 |
| D21 | : | _D21 |

|   |  |  |                        |
|---|--|--|------------------------|
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D22 : \_D22  
D23 : \_D23  
D24 : \_D24  
D25 : \_D25  
D26 : \_D26  
D27 : \_D27  
D28 : \_D28  
D29 : \_D29  
D30 : \_D30  
D31 : \_D31  
D32 : \_D32  
D33 : \_D33  
D34 : \_D34  
D35 : \_D35  
D36 : \_D36  
D37 : \_D37  
D38 : \_D38


#### Cargas

| Estado     | Zapata | Nudo | Axial<br>[Kg] | Mxx<br>[Kg*m] | Mzz<br>[Kg*m] | Vx<br>[Kg] | Vz<br>[Kg] |
|------------|--------|------|---------------|---------------|---------------|------------|------------|
| CM         | 1      | 2    | 4699.66       | 101.30        | 88.90         | -586.89    | -301.47    |
| VxCASO...  | 1      | 2    | -502.00       | -59.59        | 319.77        | 291.03     | 60.12      |
| VxCASO...  | 1      | 2    | -353.37       | -38.20        | 268.72        | 250.69     | 38.90      |
| VzCASO...  | 1      | 2    | -79.79        | 141.99        | 89.53         | 71.31      | -164.85    |
| VzCASO...  | 1      | 2    | 69.41         | 166.66        | 42.63         | 32.86      | -189.17    |
| EQx        | 1      | 2    | 289.74        | 103.22        | -390.06       | 285.63     | -98.22     |
| EQz        | 1      | 2    | 289.74        | 103.22        | -390.06       | 285.63     | -98.22     |
| CV         | 1      | 2    | 270.26        | -1.19         | 34.22         | 31.66      | 14.00      |
| VzCASOB... | 1      | 2    | -59.60        | 0.23          | -7.44         | -6.68      | -3.00      |
| VzCASOB... | 1      | 2    | 0.00          | 0.00          | 0.00          | 0.00       | 0.00       |
| EQxCUB     | 1      | 2    | 24.60         | 9.58          | -1.12         | -0.81      | -8.53      |
| EQzCUB     | 1      | 2    | 24.60         | 9.58          | -1.12         | -0.81      | -8.53      |
| _D1        | 1      | 2    | 6578.14       | 141.86        | 125.91        | -821.37    | -422.11    |
| _D2        | 1      | 2    | 5387.34       | 91.77         | 268.08        | -558.63    | -331.92    |
| _D3        | 1      | 2    | 5461.74       | 102.46        | 242.44        | -578.77    | -342.46    |
| _D4        | 1      | 2    | 5601.32       | 192.98        | 152.38        | -668.37    | -444.65    |
| _D5        | 1      | 2    | 5676.44       | 205.39        | 128.90        | -687.56    | -456.90    |
| _D6        | 1      | 2    | 5135.83       | 61.97         | 428.81        | -413.08    | -302.06    |
| _D7        | 1      | 2    | 5284.56       | 83.35         | 377.55        | -453.37    | -323.13    |
| _D8        | 1      | 2    | 5563.59       | 264.37        | 197.44        | -632.60    | -527.53    |
| _D9        | 1      | 2    | 5713.85       | 289.19        | 150.48        | -670.99    | -552.01    |
| _D10       | 1      | 2    | 3727.41       | 31.66         | 400.71        | -237.41    | -211.62    |
| _D11       | 1      | 2    | 3876.00       | 53.00         | 349.54        | -277.66    | -232.69    |
| _D12       | 1      | 2    | 4154.11       | 233.75        | 169.88        | -456.69    | -436.96    |
| _D13       | 1      | 2    | 4304.23       | 258.53        | 123.00        | -495.03    | -461.43    |
| _D14       | 1      | 2    | 5928.74       | 224.80        | -282.76       | -418.52    | -460.00    |
| _D15       | 1      | 2    | 5928.74       | 224.80        | -282.76       | -418.52    | -460.00    |
| _D16       | 1      | 2    | 4519.65       | 194.39        | -310.28       | -242.61    | -369.52    |
| _D17       | 1      | 2    | 4519.65       | 194.39        | -310.28       | -242.61    | -369.52    |
| _D18       | 1      | 2    | 6073.00       | 119.81        | 163.32        | -654.64    | -339.65    |
| _D19       | 1      | 2    | 5609.45       | 121.70        | 103.50        | -707.52    | -363.29    |
| _D20       | 1      | 2    | 5639.00       | 121.58        | 107.30        | -704.15    | -361.79    |
| _D21       | 1      | 2    | 5579.89       | 121.81        | 99.69         | -710.90    | -364.79    |
| _D22       | 1      | 2    | 5639.00       | 121.58        | 107.30        | -704.15    | -361.79    |
| _D23       | 1      | 2    | 5406.49       | 60.79         | 464.08        | -382.03    | -288.20    |
| _D24       | 1      | 2    | 5555.36       | 82.19         | 412.76        | -422.35    | -309.28    |
| _D25       | 1      | 2    | 5835.29       | 263.34        | 232.38        | -601.68    | -513.70    |

|   |  |  |                        |  |
|---|--|--|------------------------|--|
|  | TIPO DE DOCUMENTO:   |  | CÓDIGO DEL DOCUMENTO:  |  |
|   | MEMORIA DE CÁLCULO   |  | IPE-2025-2977-S-MC-011 |  |
|   | TÍTULO:  |  | HOJA:                  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 133 de 140             |  |
|   |  |  | REV:                   |  |
|   |  |  | A                      |  |

|           |   |   |         |         |         |         |         |
|-----------|---|---|---------|---------|---------|---------|---------|
| _D26      | 1 | 2 | 5985.71 | 288.19  | 185.38  | -640.09 | -538.19 |
| _D27      | 1 | 2 | 5851.24 | 120.70  | 134.64  | -679.95 | -350.95 |
| _D28      | 1 | 2 | 5910.30 | 120.47  | 142.27  | -673.20 | -347.95 |
| _D29      | 1 | 2 | 4170.75 | 91.40   | 72.21   | -534.99 | -274.31 |
| _D30      | 1 | 2 | 4229.91 | 91.17   | 79.78   | -528.24 | -271.31 |
| _D31      | 1 | 2 | 5664.16 | 131.22  | 106.23  | -704.96 | -370.38 |
| _D32      | 1 | 2 | 5664.16 | 131.22  | 106.23  | -704.96 | -370.38 |
| _D33      | 1 | 2 | 6200.04 | 223.69  | -247.79 | -387.57 | -446.16 |
| _D34      | 1 | 2 | 6200.04 | 223.69  | -247.79 | -387.57 | -446.16 |
| _D35      | 1 | 2 | 5935.52 | 130.11  | 141.20  | -674.02 | -356.54 |
| _D36      | 1 | 2 | 5935.52 | 130.11  | 141.20  | -674.02 | -356.54 |
| _D37      | 1 | 2 | 4255.02 | 100.79  | 78.72   | -529.05 | -279.90 |
| _D38      | 1 | 2 | 4255.02 | 100.79  | 78.72   | -529.05 | -279.90 |
| _S1       | 1 | 2 | 4699.66 | 101.30  | 88.90   | -586.89 | -301.47 |
| _S2       | 1 | 2 | 4397.96 | 65.57   | 281.60  | -412.36 | -265.65 |
| _S3       | 1 | 2 | 4487.17 | 78.39   | 250.86  | -436.51 | -278.29 |
| _S4       | 1 | 2 | 4654.27 | 186.90  | 142.98  | -543.95 | -400.87 |
| _S5       | 1 | 2 | 4744.37 | 201.78  | 114.83  | -566.96 | -415.56 |
| _S6       | 1 | 2 | 4902.47 | 173.56  | -184.14 | -386.95 | -370.22 |
| _S7       | 1 | 2 | 4902.47 | 173.56  | -184.14 | -386.95 | -370.22 |
| _S8       | 1 | 2 | 2519.21 | 25.11   | 244.96  | -177.91 | -145.07 |
| _S9       | 1 | 2 | 2608.31 | 37.90   | 214.30  | -202.02 | -157.70 |
| _S10      | 1 | 2 | 2774.69 | 146.20  | 106.77  | -309.31 | -280.19 |
| _S11      | 1 | 2 | 2864.67 | 161.04  | 78.69   | -332.28 | -294.86 |
| _S12      | 1 | 2 | 4989.39 | 204.52  | -301.16 | -301.26 | -399.68 |
| _S13      | 1 | 2 | 4989.39 | 204.52  | -301.16 | -301.26 | -399.68 |
| _S14      | 1 | 2 | 4851.77 | 155.49  | -115.88 | -436.93 | -353.03 |
| _S15      | 1 | 2 | 4851.77 | 155.49  | -115.88 | -436.93 | -353.03 |
| _S16      | 1 | 2 | 3023.20 | 133.02  | -220.32 | -152.31 | -249.60 |
| _S17      | 1 | 2 | 3023.20 | 133.02  | -220.32 | -152.31 | -249.60 |
| _S18      | 1 | 2 | 4971.14 | 100.19  | 123.74  | -555.95 | -287.63 |
| _S19      | 1 | 2 | 4903.29 | 100.46  | 115.02  | -563.69 | -291.09 |
| _S20      | 1 | 2 | 4664.17 | 101.44  | 84.35   | -590.93 | -303.27 |
| _S21      | 1 | 2 | 4699.66 | 101.30  | 88.90   | -586.89 | -301.47 |
| _S22      | 1 | 2 | 4717.25 | 108.04  | 88.16   | -587.45 | -307.48 |
| _S23      | 1 | 2 | 4717.25 | 108.04  | 88.16   | -587.45 | -307.48 |
| _S24      | 1 | 2 | 4676.77 | 73.64   | 259.65  | -432.76 | -264.22 |
| _S25      | 1 | 2 | 4743.74 | 83.26   | 236.58  | -450.88 | -273.70 |
| _S26      | 1 | 2 | 4869.39 | 164.69  | 155.58  | -531.49 | -365.64 |
| _S27      | 1 | 2 | 4937.01 | 175.86  | 134.45  | -548.76 | -376.66 |
| _S28      | 1 | 2 | 4876.69 | 100.57  | 111.60  | -566.72 | -292.44 |
| _S29      | 1 | 2 | 4903.29 | 100.46  | 115.02  | -563.69 | -291.09 |
| _S30      | 1 | 2 | 2784.85 | 60.91   | 48.21   | -356.29 | -182.65 |
| _S31      | 1 | 2 | 2820.38 | 60.77   | 52.72   | -352.25 | -180.85 |
| _S32      | 1 | 2 | 4724.78 | 110.93  | 87.84   | -587.69 | -310.06 |
| _S33      | 1 | 2 | 4724.78 | 110.93  | 87.84   | -587.69 | -310.06 |
| _S34      | 1 | 2 | 5055.40 | 154.65  | -89.76  | -413.73 | -342.65 |
| _S35      | 1 | 2 | 5055.40 | 154.65  | -89.76  | -413.73 | -342.65 |
| _S36      | 1 | 2 | 4916.50 | 105.52  | 114.46  | -564.11 | -295.60 |
| _S37      | 1 | 2 | 4916.50 | 105.52  | 114.46  | -564.11 | -295.60 |
| _S38      | 1 | 2 | 4712.85 | 106.36  | 88.34   | -587.31 | -305.98 |
| _S39      | 1 | 2 | 4712.85 | 106.36  | 88.34   | -587.31 | -305.98 |
| _S40      | 1 | 2 | 2837.92 | 67.49   | 51.99   | -352.81 | -186.86 |
| _S41      | 1 | 2 | 2837.92 | 67.49   | 51.99   | -352.81 | -186.86 |
| CM        | 2 | 3 | 5857.96 | -114.76 | 299.80  | -471.36 | 270.16  |
| VxCASO... | 2 | 3 | -394.79 | -75.88  | 400.14  | 336.78  | 104.08  |
| VxCASO... | 2 | 3 | -271.42 | -47.56  | 356.53  | 316.95  | 64.68   |
| VzCASO... | 2 | 3 | -565.74 | 161.18  | 286.66  | 252.80  | -213.59 |
| VzCASO... | 2 | 3 | -432.93 | 193.73  | 190.68  | 169.38  | -258.64 |
| EQx       | 2 | 3 | 240.95  | 127.53  | -481.23 | 316.38  | -161.70 |




|   |  |  |  |  |  |                        |            |
|---|--|--|--|--|--|------------------------|------------|
|  | TIPO DE DOCUMENTO:   |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |            |
|   | MEMORIA DE CÁLCULO   |  |  |  |  | IPE-2025-2977-S-MC-011 |            |
|   | TÍTULO:  |  |  |  |  | HOJA:                  | 134 de 140 |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  | REV:                   | A          |


|            |   |   |         |         |         |         |         |
|------------|---|---|---------|---------|---------|---------|---------|
| EQz        | 2 | 3 | 240.95  | 127.53  | -481.23 | 316.38  | -161.70 |
| CV         | 2 | 3 | 443.70  | 16.00   | -60.36  | -73.47  | -32.50  |
| VzCASOB... | 2 | 3 | -98.27  | -3.51   | 12.98   | 16.24   | 7.13    |
| VzCASOB... | 2 | 3 | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    |
| EQxCUB     | 2 | 3 | -5.81   | 12.06   | 1.69    | 1.56    | -15.09  |
| EQzCUB     | 2 | 3 | -5.81   | 12.06   | 1.69    | 1.56    | -15.09  |
| _D1        | 2 | 3 | 8199.82 | -160.74 | 421.28  | -660.04 | 378.30  |
| _D2        | 2 | 3 | 6830.56 | -175.97 | 561.58  | -397.33 | 376.74  |
| _D3        | 2 | 3 | 6892.54 | -161.71 | 539.66  | -407.22 | 356.89  |
| _D4        | 2 | 3 | 6746.20 | -56.99  | 504.50  | -439.52 | 217.72  |
| _D5        | 2 | 3 | 6813.01 | -40.67  | 456.40  | -481.34 | 195.19  |
| _D6        | 2 | 3 | 6632.17 | -214.17 | 762.67  | -228.90 | 429.25  |
| _D7        | 2 | 3 | 6756.11 | -185.67 | 718.86  | -248.70 | 389.54  |
| _D8        | 2 | 3 | 6463.30 | 23.72   | 648.51  | -313.31 | 111.26  |
| _D9        | 2 | 3 | 6596.80 | 56.37   | 552.37  | -396.94 | 66.20   |
| _D10       | 2 | 3 | 4875.69 | -179.58 | 671.22  | -87.46  | 348.09  |
| _D11       | 2 | 3 | 4999.66 | -151.12 | 627.46  | -107.28 | 308.40  |
| _D12       | 2 | 3 | 4706.80 | 57.94   | 557.30  | -171.88 | 30.36   |
| _D13       | 2 | 3 | 4840.34 | 90.54   | 461.25  | -255.53 | -14.67  |
| _D14       | 2 | 3 | 7269.94 | -10.21  | -120.81 | -249.31 | 162.53  |
| _D15       | 2 | 3 | 7269.94 | -10.21  | -120.81 | -249.31 | 162.53  |
| _D16       | 2 | 3 | 5513.33 | 24.26   | -211.67 | -107.83 | 81.43   |
| _D17       | 2 | 3 | 5513.33 | 24.26   | -211.67 | -107.83 | 81.43   |
| _D18       | 2 | 3 | 7747.86 | -111.99 | 265.82  | -685.21 | 271.94  |
| _D19       | 2 | 3 | 6980.03 | -139.50 | 366.87  | -557.55 | 327.78  |
| _D20       | 2 | 3 | 7028.99 | -137.74 | 360.43  | -565.69 | 324.22  |
| _D21       | 2 | 3 | 6931.07 | -141.26 | 373.32  | -549.42 | 331.35  |
| _D22       | 2 | 3 | 7028.99 | -137.74 | 360.43  | -565.69 | 324.22  |
| _D23       | 2 | 3 | 7081.44 | -198.20 | 704.06  | -303.39 | 396.70  |
| _D24       | 2 | 3 | 7205.38 | -169.66 | 660.19  | -323.22 | 356.95  |
| _D25       | 2 | 3 | 6912.79 | 39.95   | 589.63  | -387.94 | 78.44   |
| _D26       | 2 | 3 | 7046.30 | 72.65   | 493.41  | -471.60 | 33.34   |
| _D27       | 2 | 3 | 7380.67 | -125.17 | 314.15  | -624.12 | 298.67  |
| _D28       | 2 | 3 | 7478.50 | -121.65 | 301.27  | -640.39 | 291.54  |
| _D29       | 2 | 3 | 5174.40 | -106.78 | 282.49  | -407.94 | 250.25  |
| _D30       | 2 | 3 | 5272.38 | -103.27 | 269.57  | -424.21 | 243.13  |
| _D31       | 2 | 3 | 7023.49 | -125.66 | 362.21  | -564.25 | 309.19  |
| _D32       | 2 | 3 | 7023.49 | -125.66 | 362.21  | -564.25 | 309.19  |
| _D33       | 2 | 3 | 7719.45 | 5.88    | -179.96 | -324.02 | 129.84  |
| _D34       | 2 | 3 | 7719.45 | 5.88    | -179.96 | -324.02 | 129.84  |
| _D35       | 2 | 3 | 7472.97 | -109.56 | 303.06  | -638.95 | 276.50  |
| _D36       | 2 | 3 | 7472.97 | -109.56 | 303.06  | -638.95 | 276.50  |
| _D37       | 2 | 3 | 5266.91 | -91.21  | 271.35  | -422.77 | 228.12  |
| _D38       | 2 | 3 | 5266.91 | -91.21  | 271.35  | -422.77 | 228.12  |
| _S1        | 2 | 3 | 5857.96 | -114.76 | 299.80  | -471.36 | 270.16  |
| _S2        | 2 | 3 | 5619.91 | -160.58 | 540.93  | -269.34 | 333.15  |
| _S3        | 2 | 3 | 5694.29 | -143.49 | 514.66  | -281.21 | 309.33  |
| _S4        | 2 | 3 | 5518.70 | -17.96  | 472.53  | -319.98 | 142.44  |
| _S5        | 2 | 3 | 5598.87 | 1.61    | 414.86  | -370.16 | 115.41  |
| _S6        | 2 | 3 | 6026.63 | -25.49  | -37.07  | -249.90 | 156.97  |
| _S7        | 2 | 3 | 6026.63 | -25.49  | -37.07  | -249.90 | 156.97  |
| _S8        | 2 | 3 | 3277.40 | -114.55 | 419.88  | -80.77  | 225.00  |
| _S9        | 2 | 3 | 3351.79 | -97.49  | 393.64  | -92.66  | 201.20  |
| _S10       | 2 | 3 | 3176.17 | 27.77   | 351.67  | -131.42 | 34.50   |
| _S11       | 2 | 3 | 3256.33 | 47.30   | 294.07  | -181.61 | 7.50    |
| _S12       | 2 | 3 | 6098.91 | 12.77   | -181.44 | -154.99 | 108.46  |
| _S13       | 2 | 3 | 6098.91 | 12.77   | -181.44 | -154.99 | 108.46  |
| _S14       | 2 | 3 | 5984.46 | -47.80  | 47.15   | -305.27 | 185.27  |
| _S15       | 2 | 3 | 5984.46 | -47.80  | 47.15   | -305.27 | 185.27  |
| _S16       | 2 | 3 | 3684.01 | 20.45   | -157.65 | -61.30  | 48.88   |

|  |  |                        |
|--|--|------------------------|
|  | TIPO DE DOCUMENTO:   | CÓDIGO DEL DOCUMENTO:  |
|  | MEMORIA DE CÁLCULO   | IPE-2025-2977-S-MC-011 |
|  | TÍTULO:  | HOJA:                  |
|  | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO | 135 de 140             |
|  |  | REV:                   |
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|            |   |   |         |         |         |         |         |
|------------|---|---|---------|---------|---------|---------|---------|
| _S17       | 2 | 3 | 3684.01 | 20.45   | -157.65 | -61.30  | 48.88   |
| _S18       | 2 | 3 | 6307.62 | -98.68  | 240.57  | -546.05 | 237.49  |
| _S19       | 2 | 3 | 6195.28 | -102.70 | 255.37  | -527.38 | 245.65  |
| _S20       | 2 | 3 | 5799.19 | -116.86 | 307.54  | -461.60 | 274.43  |
| _S21       | 2 | 3 | 5857.96 | -114.76 | 299.80  | -471.36 | 270.16  |
| _S22       | 2 | 3 | 5854.13 | -106.31 | 301.04  | -470.36 | 259.64  |
| _S23       | 2 | 3 | 5854.13 | -106.31 | 301.04  | -470.36 | 259.64  |
| _S24       | 2 | 3 | 6016.67 | -137.10 | 436.41  | -375.80 | 292.94  |
| _S25       | 2 | 3 | 6072.45 | -124.27 | 416.68  | -384.71 | 275.06  |
| _S26       | 2 | 3 | 5940.92 | -30.05  | 385.02  | -413.82 | 149.80  |
| _S27       | 2 | 3 | 6001.04 | -15.35  | 341.74  | -451.46 | 129.52  |
| _S28       | 2 | 3 | 6151.23 | -104.28 | 261.17  | -520.06 | 248.86  |
| _S29       | 2 | 3 | 6195.28 | -102.70 | 255.37  | -527.38 | 245.65  |
| _S30       | 2 | 3 | 3456.52 | -70.92  | 186.98  | -273.01 | 166.33  |
| _S31       | 2 | 3 | 3515.34 | -68.82  | 179.21  | -282.76 | 162.06  |
| _S32       | 2 | 3 | 5852.48 | -102.69 | 301.58  | -469.93 | 255.14  |
| _S33       | 2 | 3 | 5852.48 | -102.69 | 301.58  | -469.93 | 255.14  |
| _S34       | 2 | 3 | 6321.77 | -35.74  | 2.72    | -361.28 | 160.76  |
| _S35       | 2 | 3 | 6321.77 | -35.74  | 2.72    | -361.28 | 160.76  |
| _S36       | 2 | 3 | 6192.39 | -96.36  | 256.30  | -526.62 | 237.76  |
| _S37       | 2 | 3 | 6192.39 | -96.36  | 256.30  | -526.62 | 237.76  |
| _S38       | 2 | 3 | 5855.09 | -108.42 | 300.73  | -470.61 | 262.27  |
| _S39       | 2 | 3 | 5855.09 | -108.42 | 300.73  | -470.61 | 262.27  |
| _S40       | 2 | 3 | 3511.53 | -60.39  | 180.45  | -281.76 | 151.56  |
| _S41       | 2 | 3 | 3511.53 | -60.39  | 180.45  | -281.76 | 151.56  |
| CM         | 3 | 6 | 2923.13 | -5.37   | -230.29 | -618.57 | 1.28    |
| VxCASO...  | 3 | 6 | -186.50 | -71.62  | 226.28  | 214.46  | 74.27   |
| VxCASO...  | 3 | 6 | -37.72  | -44.30  | 94.90   | 93.30   | 45.57   |
| VzCASO...  | 3 | 6 | -550.77 | 150.72  | 227.94  | 227.89  | -169.53 |
| VzCASO...  | 3 | 6 | -459.28 | 181.34  | 129.41  | 135.97  | -201.55 |
| EQx        | 3 | 6 | 410.70  | 108.66  | -156.18 | 152.04  | -108.60 |
| EQz        | 3 | 6 | 410.70  | 108.66  | -156.18 | 152.04  | -108.60 |
| CV         | 3 | 6 | 46.89   | 2.43    | 54.48   | 109.78  | 0.01    |
| VzCASOB... | 3 | 6 | -11.80  | -0.54   | -11.44  | -22.86  | 0.02    |
| VzCASOB... | 3 | 6 | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    |
| EQxCUB     | 3 | 6 | -31.78  | 10.09   | 3.71    | 3.53    | -9.66   |
| EQzCUB     | 3 | 6 | -31.78  | 10.09   | 3.71    | 3.53    | -9.66   |
| _D1        | 3 | 6 | 4092.35 | -7.53   | -322.52 | -866.17 | 1.81    |
| _D2        | 3 | 6 | 3415.42 | -42.30  | -163.40 | -636.07 | 38.62   |
| _D3        | 3 | 6 | 3489.35 | -28.63  | -228.98 | -696.00 | 24.30   |
| _D4        | 3 | 6 | 3232.16 | 69.18   | -162.65 | -629.61 | -83.30  |
| _D5        | 3 | 6 | 3277.65 | 84.53   | -211.87 | -675.15 | -99.33  |
| _D6        | 3 | 6 | 3322.85 | -78.13  | -50.38  | -529.74 | 75.67   |
| _D7        | 3 | 6 | 3470.87 | -50.81  | -181.55 | -649.64 | 47.05   |
| _D8        | 3 | 6 | 2956.67 | 144.79  | -48.94  | -516.85 | -168.18 |
| _D9        | 3 | 6 | 3047.53 | 175.52  | -147.35 | -607.93 | -200.26 |
| _D10       | 3 | 6 | 2445.90 | -76.40  | 18.57   | -344.12 | 75.20   |
| _D11       | 3 | 6 | 2593.85 | -49.12  | -112.47 | -463.98 | 46.61   |
| _D12       | 3 | 6 | 2080.54 | 146.20  | 19.95   | -331.29 | -168.43 |
| _D13       | 3 | 6 | 2171.37 | 176.88  | -78.36  | -422.35 | -200.48 |
| _D14       | 3 | 6 | 3918.45 | 102.21  | -432.57 | -590.31 | -107.05 |
| _D15       | 3 | 6 | 3918.45 | 102.21  | -432.57 | -590.31 | -107.05 |
| _D16       | 3 | 6 | 3041.53 | 103.83  | -363.42 | -404.64 | -107.45 |
| _D17       | 3 | 6 | 3041.53 | 103.83  | -363.42 | -404.64 | -107.45 |
| _D18       | 3 | 6 | 3593.82 | -2.47   | -191.82 | -573.83 | 1.46    |
| _D19       | 3 | 6 | 3501.88 | -6.72   | -282.14 | -753.81 | 1.55    |
| _D20       | 3 | 6 | 3507.74 | -6.45   | -276.39 | -742.35 | 1.55    |
| _D21       | 3 | 6 | 3496.02 | -6.99   | -287.89 | -765.27 | 1.56    |
| _D22       | 3 | 6 | 3507.74 | -6.45   | -276.39 | -742.35 | 1.55    |
| _D23       | 3 | 6 | 3376.84 | -75.74  | 2.58    | -424.35 | 75.69   |

|   |  |  |  |  |  |                        |  |
|---|--|--|--|--|--|------------------------|--|
|  | TIPO DE DOCUMENTO:   |  |  |  |  | CÓDIGO DEL DOCUMENTO:  |  |
|   | MEMORIA DE CÁLCULO   |  |  |  |  | IPE-2025-2977-S-MC-011 |  |
|   | TÍTULO:  |  |  |  |  | HOJA:                  |  |
|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  |  |  |  | 136 de 140             |  |
|   |  |  |  |  |  | REV:                   |  |
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|           |   |    |         |         |         |         |         |
|-----------|---|----|---------|---------|---------|---------|---------|
| _D24      | 3 | 6  | 3524.89 | -48.39  | -128.65 | -544.29 | 47.05   |
| _D25      | 3 | 6  | 3009.72 | 147.37  | 4.02    | -411.47 | -168.29 |
| _D26      | 3 | 6  | 3100.54 | 178.13  | -94.43  | -502.57 | -200.39 |
| _D27      | 3 | 6  | 3549.91 | -4.52   | -235.07 | -659.99 | 1.52    |
| _D28      | 3 | 6  | 3561.60 | -3.97   | -223.56 | -637.05 | 1.50    |
| _D29      | 3 | 6  | 2619.08 | -5.37   | -218.72 | -579.59 | 1.17    |
| _D30      | 3 | 6  | 2630.82 | -4.83   | -207.24 | -556.68 | 1.15    |
| _D31      | 3 | 6  | 3475.86 | 3.67    | -272.70 | -738.87 | -8.11   |
| _D32      | 3 | 6  | 3475.86 | 3.67    | -272.70 | -738.87 | -8.11   |
| _D33      | 3 | 6  | 3972.30 | 104.68  | -379.73 | -485.01 | -107.11 |
| _D34      | 3 | 6  | 3972.30 | 104.68  | -379.73 | -485.01 | -107.11 |
| _D35      | 3 | 6  | 3529.65 | 6.16    | -219.86 | -633.57 | -8.17   |
| _D36      | 3 | 6  | 3529.65 | 6.16    | -219.86 | -633.57 | -8.17   |
| _D37      | 3 | 6  | 2599.00 | 5.27    | -203.55 | -553.21 | -8.50   |
| _D38      | 3 | 6  | 2599.00 | 5.27    | -203.55 | -553.21 | -8.50   |
| _S1       | 3 | 6  | 2923.13 | -5.37   | -230.29 | -618.57 | 1.28    |
| _S2       | 3 | 6  | 2812.29 | -48.34  | -94.77  | -491.04 | 45.74   |
| _S3       | 3 | 6  | 2901.02 | -31.96  | -173.42 | -562.95 | 28.57   |
| _S4       | 3 | 6  | 2592.77 | 85.29   | -93.91  | -483.32 | -100.47 |
| _S5       | 3 | 6  | 2647.33 | 103.71  | -152.92 | -537.95 | -119.70 |
| _S6       | 3 | 6  | 3210.62 | 70.69   | -339.61 | -512.14 | -74.74  |
| _S7       | 3 | 6  | 3210.62 | 70.69   | -339.61 | -512.14 | -74.74  |
| _S8       | 3 | 6  | 1643.04 | -46.11  | -2.77   | -243.58 | 45.16   |
| _S9       | 3 | 6  | 1731.70 | -29.76  | -81.31  | -315.46 | 28.01   |
| _S10      | 3 | 6  | 1424.17 | 87.27   | -1.96   | -235.91 | -100.88 |
| _S11      | 3 | 6  | 1478.68 | 105.65  | -60.89  | -290.52 | -120.09 |
| _S12      | 3 | 6  | 3333.83 | 103.29  | -386.47 | -466.52 | -107.32 |
| _S13      | 3 | 6  | 3333.83 | 103.29  | -386.47 | -466.52 | -107.32 |
| _S14      | 3 | 6  | 3138.75 | 51.68   | -312.28 | -538.74 | -55.73  |
| _S15      | 3 | 6  | 3138.75 | 51.68   | -312.28 | -538.74 | -55.73  |
| _S16      | 3 | 6  | 2041.39 | 72.84   | -247.45 | -264.64 | -75.25  |
| _S17      | 3 | 6  | 2041.39 | 72.84   | -247.45 | -264.64 | -75.25  |
| _S18      | 3 | 6  | 2977.03 | -2.90   | -177.49 | -513.31 | 1.24    |
| _S19      | 3 | 6  | 2963.58 | -3.52   | -190.70 | -539.63 | 1.25    |
| _S20      | 3 | 6  | 2916.09 | -5.69   | -237.18 | -632.31 | 1.29    |
| _S21      | 3 | 6  | 2923.13 | -5.37   | -230.29 | -618.57 | 1.28    |
| _S22      | 3 | 6  | 2900.84 | 1.71    | -227.70 | -616.13 | -5.47   |
| _S23      | 3 | 6  | 2900.84 | 1.71    | -227.70 | -616.13 | -5.47   |
| _S24      | 3 | 6  | 2880.53 | -35.78  | -89.02  | -443.96 | 34.62   |
| _S25      | 3 | 6  | 2947.05 | -23.49  | -148.02 | -497.90 | 21.74   |
| _S26      | 3 | 6  | 2715.52 | 64.51   | -88.37  | -438.17 | -75.08  |
| _S27      | 3 | 6  | 2756.44 | 78.33   | -132.64 | -479.15 | -89.51  |
| _S28      | 3 | 6  | 2958.31 | -3.77   | -195.87 | -549.95 | 1.26    |
| _S29      | 3 | 6  | 2963.58 | -3.52   | -190.70 | -539.63 | 1.25    |
| _S30      | 3 | 6  | 1746.84 | -3.54   | -145.01 | -384.80 | 0.77    |
| _S31      | 3 | 6  | 1753.89 | -3.21   | -138.13 | -371.07 | 0.77    |
| _S32      | 3 | 6  | 2891.29 | 4.74    | -226.59 | -615.09 | -8.37   |
| _S33      | 3 | 6  | 2891.29 | 4.74    | -226.59 | -615.09 | -8.37   |
| _S34      | 3 | 6  | 3179.20 | 53.53   | -272.69 | -459.81 | -55.76  |
| _S35      | 3 | 6  | 3179.20 | 53.53   | -272.69 | -459.81 | -55.76  |
| _S36      | 3 | 6  | 2946.83 | 1.79    | -188.76 | -537.80 | -3.82   |
| _S37      | 3 | 6  | 2946.83 | 1.79    | -188.76 | -537.80 | -3.82   |
| _S38      | 3 | 6  | 2906.42 | -0.06   | -228.35 | -616.74 | -3.78   |
| _S39      | 3 | 6  | 2906.42 | -0.06   | -228.35 | -616.74 | -3.78   |
| _S40      | 3 | 6  | 1731.66 | 3.85    | -135.55 | -368.64 | -5.98   |
| _S41      | 3 | 6  | 1731.66 | 3.85    | -135.55 | -368.64 | -5.98   |
| CM        | 4 | 10 | 5530.80 | -423.68 | 235.76  | 616.60  | 1043.32 |
| VxCASO... | 4 | 10 | 85.41   | -95.40  | 255.10  | 291.19  | 91.73   |
| VxCASO... | 4 | 10 | -4.14   | -52.38  | 112.18  | 140.14  | 50.36   |
| VzCASO... | 4 | 10 | 3.18    | 229.45  | 236.17  | 246.91  | -189.35 |

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|   | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |  | 137 de 140             |  |
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|------------|---|----|---------|---------|---------|---------|---------|
| VzCASO...  | 4 | 10 | -36.64  | 268.48  | 126.40  | 125.94  | -230.75 |
| EQx        | 4 | 10 | 180.06  | 186.02  | -159.04 | 161.00  | -114.65 |
| EQz        | 4 | 10 | 180.06  | 186.02  | -159.04 | 161.00  | -114.65 |
| CV         | 4 | 10 | 484.83  | 11.56   | -22.89  | -103.15 | -61.35  |
| VzCASOB... | 4 | 10 | -109.66 | -2.15   | 4.62    | 21.42   | 12.07   |
| VzCASOB... | 4 | 10 | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    |
| EQxCUB     | 4 | 10 | -4.79   | 14.03   | 3.63    | 3.32    | -9.33   |
| EQzCUB     | 4 | 10 | -4.79   | 14.03   | 3.63    | 3.32    | -9.33   |
| _D1        | 4 | 10 | 7743.05 | -593.73 | 330.18  | 863.37  | 1461.10 |
| _D2        | 4 | 10 | 6690.15 | -557.04 | 411.14  | 886.50  | 1300.49 |
| _D3        | 4 | 10 | 6639.63 | -535.21 | 339.26  | 810.30  | 1278.68 |
| _D4        | 4 | 10 | 6643.78 | -394.86 | 401.81  | 864.74  | 1159.87 |
| _D5        | 4 | 10 | 6621.82 | -375.74 | 346.62  | 803.79  | 1139.85 |
| _D6        | 4 | 10 | 6743.36 | -605.41 | 539.33  | 1033.03 | 1348.80 |
| _D7        | 4 | 10 | 6642.34 | -561.75 | 395.56  | 880.64  | 1305.18 |
| _D8        | 4 | 10 | 6650.65 | -281.12 | 520.63  | 989.47  | 1067.57 |
| _D9        | 4 | 10 | 6606.74 | -242.84 | 410.26  | 867.59  | 1027.52 |
| _D10       | 4 | 10 | 5083.71 | -477.79 | 468.33  | 848.02  | 1035.53 |
| _D11       | 4 | 10 | 4982.95 | -434.22 | 324.69  | 695.60  | 991.92  |
| _D12       | 4 | 10 | 4991.50 | -154.18 | 449.59  | 804.44  | 754.34  |
| _D13       | 4 | 10 | 4947.79 | -115.97 | 339.31  | 682.54  | 714.30  |
| _D14       | 4 | 10 | 6816.99 | -322.64 | 123.92  | 900.98  | 1137.53 |
| _D15       | 4 | 10 | 6816.99 | -322.64 | 123.92  | 900.98  | 1137.53 |
| _D16       | 4 | 10 | 5157.79 | -195.20 | 53.12   | 715.92  | 824.27  |
| _D17       | 4 | 10 | 5157.79 | -195.20 | 53.12   | 715.92  | 824.27  |
| _D18       | 4 | 10 | 7443.18 | -493.12 | 249.10  | 582.12  | 1163.43 |
| _D19       | 4 | 10 | 6582.05 | -509.72 | 285.27  | 750.72  | 1258.21 |
| _D20       | 4 | 10 | 6636.93 | -508.67 | 282.96  | 739.98  | 1252.18 |
| _D21       | 4 | 10 | 6527.17 | -510.77 | 287.58  | 761.46  | 1264.24 |
| _D22       | 4 | 10 | 6636.93 | -508.67 | 282.96  | 739.98  | 1252.18 |
| _D23       | 4 | 10 | 7247.62 | -595.75 | 518.29  | 934.42  | 1293.29 |
| _D24       | 4 | 10 | 7146.37 | -552.05 | 374.45  | 782.02  | 1249.69 |
| _D25       | 4 | 10 | 7154.40 | -271.12 | 499.59  | 890.87  | 1012.20 |
| _D26       | 4 | 10 | 7110.34 | -232.82 | 389.17  | 768.98  | 972.16  |
| _D27       | 4 | 10 | 7031.03 | -501.05 | 266.40  | 662.82  | 1208.80 |
| _D28       | 4 | 10 | 7140.81 | -498.95 | 261.79  | 641.33  | 1196.72 |
| _D29       | 4 | 10 | 4868.00 | -383.33 | 216.78  | 576.38  | 950.97  |
| _D30       | 4 | 10 | 4977.73 | -381.22 | 212.16  | 554.92  | 938.92  |
| _D31       | 4 | 10 | 6632.34 | -494.91 | 286.62  | 743.35  | 1243.38 |
| _D32       | 4 | 10 | 6632.34 | -494.91 | 286.62  | 743.35  | 1243.38 |
| _D33       | 4 | 10 | 7320.87 | -312.93 | 102.75  | 802.33  | 1082.08 |
| _D34       | 4 | 10 | 7320.87 | -312.93 | 102.75  | 802.33  | 1082.08 |
| _D35       | 4 | 10 | 7136.19 | -485.17 | 265.45  | 644.71  | 1187.94 |
| _D36       | 4 | 10 | 7136.19 | -485.17 | 265.45  | 644.71  | 1187.94 |
| _D37       | 4 | 10 | 4973.17 | -367.50 | 215.82  | 558.30  | 930.11  |
| _D38       | 4 | 10 | 4973.17 | -367.50 | 215.82  | 558.30  | 930.11  |
| _S1        | 4 | 10 | 5530.80 | -423.68 | 235.76  | 616.60  | 1043.32 |
| _S2        | 4 | 10 | 5594.49 | -481.66 | 389.49  | 792.45  | 1101.29 |
| _S3        | 4 | 10 | 5533.97 | -455.50 | 303.28  | 701.00  | 1075.12 |
| _S4        | 4 | 10 | 5539.04 | -287.33 | 378.28  | 766.32  | 932.57  |
| _S5        | 4 | 10 | 5512.77 | -264.40 | 312.08  | 693.18  | 908.54  |
| _S6        | 4 | 10 | 5656.84 | -293.47 | 124.43  | 729.30  | 963.07  |
| _S7        | 4 | 10 | 5656.84 | -293.47 | 124.43  | 729.30  | 963.07  |
| _S8        | 4 | 10 | 3381.83 | -311.81 | 294.97  | 545.79  | 683.76  |
| _S9        | 4 | 10 | 3321.53 | -285.71 | 208.87  | 454.32  | 657.60  |
| _S10       | 4 | 10 | 3326.79 | -118.01 | 283.74  | 519.65  | 515.08  |
| _S11       | 4 | 10 | 3300.68 | -95.13  | 217.61  | 446.48  | 491.06  |
| _S12       | 4 | 10 | 5710.86 | -237.66 | 76.72   | 777.60  | 928.67  |
| _S13       | 4 | 10 | 5710.86 | -237.66 | 76.72   | 777.60  | 928.67  |
| _S14       | 4 | 10 | 5625.33 | -326.02 | 152.26  | 701.13  | 983.13  |

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|   |                    | MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO |                        | 138 de 140 |
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|------|---|----|---------|---------|--------|--------|---------|
| _S15 | 4 | 10 | 5625.33 | -326.02 | 152.26 | 701.13 | 983.13  |
| _S16 | 4 | 10 | 3444.55 | -123.75 | 30.08  | 482.61 | 545.55  |
| _S17 | 4 | 10 | 3444.55 | -123.75 | 30.08  | 482.61 | 545.55  |
| _S18 | 4 | 10 | 6034.61 | -413.96 | 214.58 | 518.00 | 987.91  |
| _S19 | 4 | 10 | 5908.65 | -416.39 | 219.87 | 542.65 | 1001.77 |
| _S20 | 4 | 10 | 5464.96 | -424.95 | 238.53 | 629.48 | 1050.55 |
| _S21 | 4 | 10 | 5530.80 | -423.68 | 235.76 | 616.60 | 1043.32 |
| _S22 | 4 | 10 | 5527.60 | -414.07 | 238.32 | 618.96 | 1037.16 |
| _S23 | 4 | 10 | 5527.60 | -414.07 | 238.32 | 618.96 | 1037.16 |
| _S24 | 4 | 10 | 5956.54 | -459.89 | 335.22 | 674.55 | 1045.22 |
| _S25 | 4 | 10 | 5911.08 | -440.25 | 270.54 | 605.96 | 1025.60 |
| _S26 | 4 | 10 | 5914.79 | -314.02 | 326.82 | 654.97 | 918.73  |
| _S27 | 4 | 10 | 5895.03 | -296.82 | 277.15 | 600.10 | 900.72  |
| _S28 | 4 | 10 | 5859.26 | -417.33 | 221.95 | 552.32 | 1007.20 |
| _S29 | 4 | 10 | 5908.65 | -416.39 | 219.87 | 542.65 | 1001.77 |
| _S30 | 4 | 10 | 3252.69 | -255.23 | 144.17 | 382.77 | 633.02  |
| _S31 | 4 | 10 | 3318.51 | -253.97 | 141.40 | 369.91 | 625.80  |
| _S32 | 4 | 10 | 5526.23 | -409.95 | 239.41 | 619.98 | 1034.52 |
| _S33 | 4 | 10 | 5526.23 | -409.95 | 239.41 | 619.98 | 1034.52 |
| _S34 | 4 | 10 | 6003.18 | -318.73 | 136.38 | 627.18 | 941.58  |
| _S35 | 4 | 10 | 6003.18 | -318.73 | 136.38 | 627.18 | 941.58  |
| _S36 | 4 | 10 | 5906.24 | -409.17 | 221.80 | 544.43 | 997.15  |
| _S37 | 4 | 10 | 5906.24 | -409.17 | 221.80 | 544.43 | 997.15  |
| _S38 | 4 | 10 | 5528.40 | -416.47 | 237.68 | 618.37 | 1038.70 |
| _S39 | 4 | 10 | 5528.40 | -416.47 | 237.68 | 618.37 | 1038.70 |
| _S40 | 4 | 10 | 3315.34 | -244.39 | 143.96 | 372.27 | 619.63  |
| _S41 | 4 | 10 | 3315.34 | -244.39 | 143.96 | 372.27 | 619.63  |

## Diseño

Estatus : Bien

### Interacción suelo - fundación

Presión admisible : 1.5E04 [Kg/m2]  
Factor de seguridad min. para deslizamiento : 1.50  
Factor de seguridad min. a vuelco : 1.50

Estado gobernante : S2 - 4


| Estado | qprom   | qmax    | Δmax  | Área en compresión |     | Volteo |      | FS      |
|--------|---------|---------|-------|--------------------|-----|--------|------|---------|
| Zapata | [Kg/m2] | [Kg/m2] | [cm]  | [m2]               | (%) | FSx    | FSz  | desliz. |
| S2 - 4 | 6.28E03 | 1.13E04 | 0.358 | 1.44               | 100 | 6.68   | 8.65 | 4.55    |

### Flexión

Factor  $\phi$  : 0.90  
Cuantía mínima : 0.00200

Longitud de desarrollo

| Eje | Pos. | ld   | lhd  | Dist1 | Dist2 |
|-----|------|------|------|-------|-------|
|     |      | [cm] | [cm] | [cm]  | [cm]  |

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|---|--|---|
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|   | TÍTULO:<br><b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | REV: <b>A</b>                                     |

|   |      |       |       |       |       |
|---|------|-------|-------|-------|-------|
| z | Inf. | 47.76 | 16.72 | 39.50 | 39.50 |
| x | Inf. | 47.76 | 16.72 | 39.50 | 39.50 |
| z | Sup. | 30.48 | 15.24 | 39.50 | 39.50 |
| x | Sup. | 30.48 | 15.24 | 39.50 | 39.50 |

| Eje | Pos. | Estado Zapata | Mu [Kg*m] | $\phi$ *Mn [Kg*m] | Asreq [cm2] | Asprov [cm2] | Asreq/Asprov | Mu/( $\phi$ *Mn) |
|-----|------|---------------|-----------|-------------------|-------------|--------------|--------------|------------------|
| zz  | Sup. | D1 - 1        | 0.00      | 0.00              | 0.00        | 7.91         | 0.000        | 0.000            |
| zz  | Inf. | D23 - 4       | 957.68    | 6166.69           | 7.20        | 7.91         | 0.910        | 0.155            |
| xx  | Sup. | D1 - 1        | 0.00      | 0.00              | 0.00        | 7.91         | 0.000        | 0.000            |
| xx  | Inf. | D1 - 4        | 1085.03   | 5807.89           | 7.20        | 7.91         | 0.910        | 0.187            |

### Cortantes


|                        |   |           |
|------------------------|---|-----------|
| Factor $\phi$          | : | 0.75      |
| Área de corte plano zz | : | 0.26 [m2] |
| Área de corte plano xx | : | 0.24 [m2] |

| Plano | Estado Zapata | Vu [Kg] | Vc [Kg]  | Vu/( $\phi$ *Vn) |
|-------|---------------|---------|----------|------------------|
| xy    | D1 - 4        | 2668.43 | 11052.10 | 0.322            |
| yz    | D23 - 4       | 2255.95 | 11485.59 | 0.262            |

### Corte por punzonamiento

|                           |   |           |
|---------------------------|---|-----------|
| Factor $\phi$             | : | 0.75      |
| Perímetro de corte (bo 1) | : | 1.83 [m]  |
| Área de punzonamiento     | : | 0.38 [m2] |

| Columna   | Estado Zapata | Vu [Kg] | Vc [Kg]  | Vu/( $\phi$ *Vn) |
|-----------|---------------|---------|----------|------------------|
| columna 1 | D1 - 2        | 7005.36 | 58567.47 | 0.159            |

|   |   |                               |
|---|---|-------------------------------|
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|   | <b>MEMORIA DE CÁLCULO</b>   | <b>IPE-2025-2977-S-MC-011</b> |
|   | TÍTULO:   | HOJA:                         |
|   | <b>MEMORIA DE CÁLCULO ESTRUCTURA DE HºAº Y CUBIERTA METÁLICA ALMACENES, TALLER Y BAÑO</b> | 140 de 140                    |
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## 10. CONCLUSIONES Y RECOMENDACIONES

El análisis demuestra que las dimensiones propuestas para la sección de la columna, viga superior e inferior y zapatas de fundación, resisten satisfactoriamente todas las solicitaciones a la que estará sometida.

La tensión producida en la zona de contacto de la fundación con el suelo es de 1.34 kg/cm<sup>2</sup> inferior a la tensión admisible del suelo de 1.5 kg/cm<sup>2</sup>.

El análisis demuestra que las secciones propuestas para la cubierta metálica cumplen satisfactoriamente todas las solicitaciones que estará sometida.

Se deberá realizar un mejoramiento del suelo con un espesor de 0.60 m por debajo de la fundación y un sobreancho de 0.30 m a los lados del área de vaciado como se indica en el plano. Para el suelo mejorado se utilizará materiales granulares desde gw hasta gp-gm o arenas limosas con gravas desde sp-sm hasta sm. esta camada deberá ser debidamente compactada al 95% de la densidad máxima según Proctor T-180 modificado, en capas de 0.20 m hasta el nivel de cota de fundación con la finalidad de uniformizar la compacidad del suelo.

Para la construcción se debe verificar la buena calidad de los materiales, los recubrimientos especificados, las resistencias del hormigón, del acero corrugado y todos aquellos factores que puedan influir en la calidad de la obra.