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# 1 DESCRIPCIÓN

El propósito de este proyecto es el diseño estructural de las cajas para válvula mariposa de 20", purga de 4" y ventosa de 3" para el proyecto de redes de conducción de la ciudad de IBAGUE.

De acuerdo a la implantación, geometría, diseño hidráulico y estudio de suelos suministrada por IEH GRUCON, las estructuras a diseñar, son cajas de diferentes alturas dependiendo de uso, en concreto reforzado; se definió el espesor de la placa inferior de 30 cm, placa superior de 30cm de espesor y muros de 30cm de espesor, la base se encuentra a una profundad entre 2.3 y 2.8 m, con carencia de nivel freático a las profundidades exploradas.

Para el diseño se tuvo en cuenta las recomendaciones consignadas en el estudio de suelos suministrado por el contratista.

En el presente informe y en los planos básicos que se entregaran se encuentran desarrollados todos los aspectos referentes al proyecto.

Por la variación geométrica que presenta cada uno de los elementos diseñados y las diferentes cargas que se generan sobre ellos, se realizaron varios modelos que permiten analizar de forma individual el comportamiento por separado.

# 2 CARACTERISTICAS SUELO

Peso específico de suelo $\gamma$= 2 ton/m³.
Coeficiente de Presión activa Ka = 0.36
Nivel freático de diseño= No Presenta

# 3 MATERIALES

Se utilizaron las siguientes resistencias:
Muro: f'c= 35,0 Mpa
Refuerzo de esfuerzo: 3/8": fy = 420 Mpa
½" y mayores: fy = 420 Mpa.
Acero estructural: ASTM A-36 fy = 2.530 Kg/cm²

# 4 NORMAS UTILIZADAS

El diseño de la estructura y todos sus elementos constitutivos, fue realizado cumpliendo con los requerimientos establecidos por las normas:

1. Como las estructuras están sometidas a cargas vehiculares se adopta el Código Colombiano de Diseño Sísmico de Puentes 1995 y se empleará como carga viva el camión C40-95 definido por éste.

2. Para el refuerzo mínimo de retracción y temperatura se acogen las prescripciones del Código ACI 350. "Environmental Concrete Structures" (2001).

**_____**
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**MP. 252026-1474 CND.**

# 5 ANALISIS ESTRUCTURAL

Se realizaron los modelos en SAP-2000 con las siguientes características:

Para la modelación se utilizaron elementos Shell para las placas y muros, para los muros se tomaron Shell con espesor de 30 cm, para la placa superior Shell con espesor de 30 cm y para la placa de fondo Shell con espesor de 30. Para los diseños se trabaja con d=25.

Las cargas verticales y las cargas laterales constantes que se colocaron sobre la placa superior y los muros son Uniform loads, las cargas triangulares son presiones con joint patterns (tierra).

En la placa inferior se modelaron resortes de área (spring), que corresponde al Ks tomadas por el estudio de suelos.

Caso de carga utilizados:

Las cargas de diseño incluyen:

1. **Peso propio (MUERTA)**: Peso propio. El peso del concreto se toma como 2.4 $t/m^3$.

2. **Carga viva vehicular (VIVA)**: Como vehículo de diseño se consideró el camión C-40-95.

3. **Impacto (I)**: Se consideró así, teniendo en cuenta el espesor del relleno:

| | |
|---|---|
| h < 0.3 m | I = 0.30 |
| 0.3 < h < 0.6 m | I = 0.20 |
| 0.6 < h < 0.9 m | I = 0.10 |
| h > 1.2 m | I = 0 |

4. **Sobrecarga por carga viva (VIVA)**: Se considera una sobrecarga correspondiente a una altura de relleno de 0.70 m actuando como presión lateral.

5. **Empuje de tierra (TIERRA)**: Se considera el empuje horizontal del suelo. Se utilizará un $\gamma = 2\ t/m^3$ y un coeficiente de presión en reposo $K_a = 0.36$. considerando que el nivel freático no está presente a la profundidad de las cajas, éste no se incluirá en la evaluación del empuje horizontal.

**Casos de carga:**

| | | |
|---|---|---|
| I | Peso propio | (MUERTA) |
| II | Empuje de tierras (sin/con NF) | (TIERRA LATERAL/ AGUA) |
| III | Carga viva (vehicular) | (VIVA) |
| IV | Sobrecarga viva | (VIVA) |

Las secciones transversales de máximo momento positivo y negativo de las placas y muros que trabajen en una dirección, se dimensionarán de tal manera que el parámetro z no exceda en valor indicado para cado uno de los casos. Este parámetro se calcula con la siguiente expresión:

$$z = f_s \sqrt[3]{d_c A}$$

Separación máxima del refuerzo debe ser de 25 cm

Dónde:

- **fs:** esfuerzo en el acero de refuerzo al nivel de cargas de servicio (kg/cm2), puede tomarse como 0.45 fy según la norma NS-002 de la EAAB.

- **dc:** espesor del recubrimiento de concreto medido desde la fibra extrema sometida a tracción hasta el centro de la barra o alambre localizado más cerca a dicha fibra (cm). Los valores de z fueron establecidos para recubrimiento que no exceda 5 cm y se trabaja con este valor, el recubrimiento adicional se trata como simple protección.

- **A:** área efectiva, por barra, del concreto sometido a tracción que circunda el refuerzo de flexión a tracción.

# 6 CUANTIAS

La cuantía mínima para retracción y temperatura es función de la separación entre juntas de retracción o contracción en la dirección del refuerzo. Se adoptaron las siguientes cuantías mínimas, según el ACI 350-01 Cap.7.12.2.1

| Separación entre juntas de retracción, o contracción, en metros. | $f_y$ = 4200 Kg/cm$^2$ |
|---|---|
| <= 6 | 0.003 |
| 6 - 9 | 0.003 |
| 9 -12 | 0.004 |
| >12 | 0.005 |

El máximo espaciamiento del refuerzo será de 0.30 m.

La cuantía mínima por flexión se determinará de acuerdo con el numeral A.7.9 del Código Colombiano de Diseño Sísmico de Puentes.

Así mismo, la resistencia a cortante se establecerá de acuerdo con el numeral A.7.8.13 de dicha norma.

# 7 COMBINACIONES DE CARGA

**COMBO 1**
MUERTA 1.60

**COMBO 2**

MUERTA 1.20
VIVA 1.60
VERTICAL TIERRAS 1.60

# 8 DISEÑO

Para le revisión de los momentos y esfuerzos sobre las paredes y placas se tiene en cuenta la localización de los ejes para cada uno de los Shell.

A continuación se dan los resultados de momentos y de esfuerzo cortante, todos los datos están dados en:

- Momentos: t.m
- Esfuerzos: Kg/cm2

## *8.1 VALVULA MARIPOSA 20”*

**TUBERIA DE Φ20" CON VÁLVULA MARIPOSA DE Φ20"**

**REFUERZO PLACA INFERIOR**

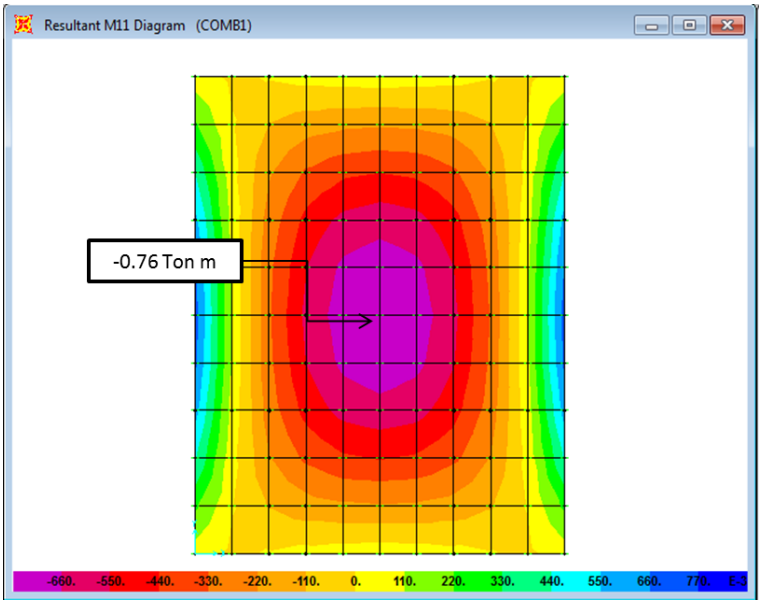
| | | | | | |
|---|---|---|---|---|---|
| | b = 100 cm | | fy = | 4200 | kg/cm2 |
| H = 30 cm | d = 25.0 cm | | fc= | 280 | kg/cm2 |

| *Chequeo a flexión MOMENTO M11* | | | | *Chequeo a flexión MOMENTO M22* | | | |
|---|---|---|---|---|---|---|---|
| Coef. Durab. | ϕ = | 1.00 | | | ϕ = | 1.00 | |
| | Mu = | 0.76 | T-m | | Mu = | 0.56 | T-m |
| | ϕMu = | 0.76 | T-m | | ϕMu = | 0.56 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | ρ = | 0.000323 | | | ρ = | 0.000237 | |
| | $\rho_{min}$ = | 0.002000 | | | $\rho_{min}$ = | 0.002000 | |
| Por lo tanto | As = | 5.00 | $cm^2/m$ | Por lo tanto | As = | 5.00 | $cm^2/m$ |
| | #3/cada = | 0.142 | m | | #3/cada = | 0.142 | m |
| | #4/cada = | 0.254 | m | | #4/cada = | 0.254 | m |
| | #5/cada = | 0.398 | m | | #5/cada = | 0.398 | m |
| | #6/cada = | 0.568 | m | | #6/cada = | 0.568 | m |
| | #7/cada = | 0.774 | m | | #7/cada = | 0.774 | m |
| | #8/cada = | 1.020 | m | | #8/cada = | 1.020 | m |

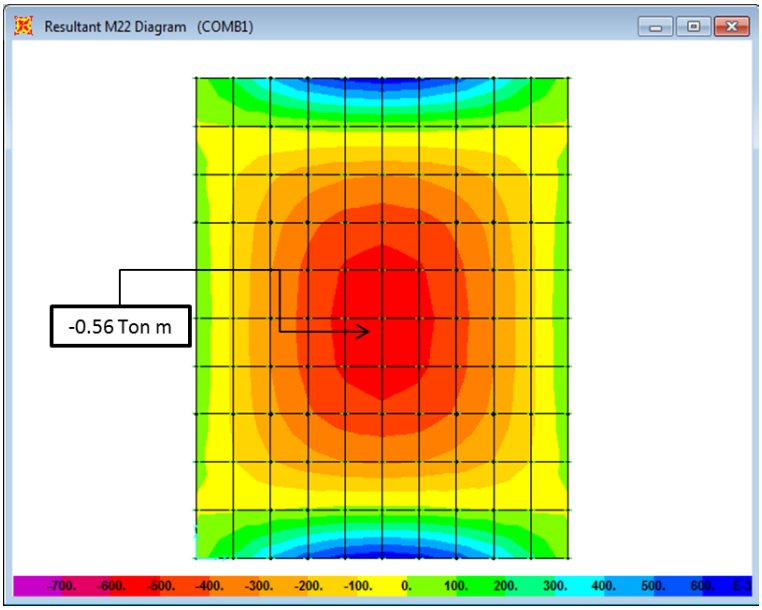
| **CORTANTE V13** | | | **CORTANTE V23** | | |
|---|---|---|---|---|---|
| vu (ton)= | 3.60 | | vu (ton)= | 3.17 | |
| Øvc (ton)= | 18.85 | | Øvc (ton)= | 18.85 | |
| | CUMPLE | | | CUMPLE | |
| Varilla = | # 4 | | Varilla = | # 4 | |
| Area varilla= | 1.29 | cm² | Area varilla= | 1.29 | cm² |
| Sep. Varilla= | 25 | cm | Sep. Varilla= | 25 | cm |
| Es = | 2040000.00 | kg/cm² | Es = | 2040000.00 | kg/cm² |
| Ec = | 209165.01 | kg/cm² | Ec = | 209165.01 | kg/cm² |
| n = | 9.75 | | n = | 9.75 | |
| Ms = | 0.54 | T-m | Ms = | 0.40 | T-m |
| As = | 5.16 | cm²/m | As = | 5.16 | cm²/m |
| ρ = | 0.002064 | | ρ = | 0.002064 | |
| k = | 0.18 | | k = | 0.18 | |
| j = | 0.94 | | j = | 0.94 | |
| jd = | 23.49 | cm² | jd = | 23.49 | cm² |
| fs = | 447.92 | kg/cm² | fs = | 330.05 | kg/cm² |
| 0.45fy = | 1890.00 | kg/cm² | 0.45fy = | 1890.00 | kg/cm² |
| z = | 4825.10 | kg-cm cumple | z = | 3555.34 | kg-cm cumple |
| **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | | **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | |

| *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | | *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | |
|---|---|---|---|---|---|---|---|
| | Mcr = | 1.01 | T-m | | Mcr = | 0.74 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | $\rho_{cr}$ = | 0.000429 | | | $\rho_{cr}$ = | 0.000316 | |
| Por lo tanto | $As_{cr}$ = | 1.07 | $cm^2/m$ | Por lo tanto | $As_{cr}$ = | 0.79 | $cm^2/m$ |
| | | cumple | | | | cumple | |
| | #3/cada = | 0.662 | m | | #3/cada = | 0.899 | m |
| | #4/cada = | 1.183 | m | | #4/cada = | 1.607 | m |
| | #5/cada = | 1.854 | m | | #5/cada = | 2.519 | m |
| | #6/cada = | 2.646 | m | | #6/cada = | 3.594 | m |
| | #7/cada = | 3.606 | m | | #7/cada = | 4.898 | m |
| | #8/cada = | 4.752 | m | | #8/cada = | 6.455 | m |

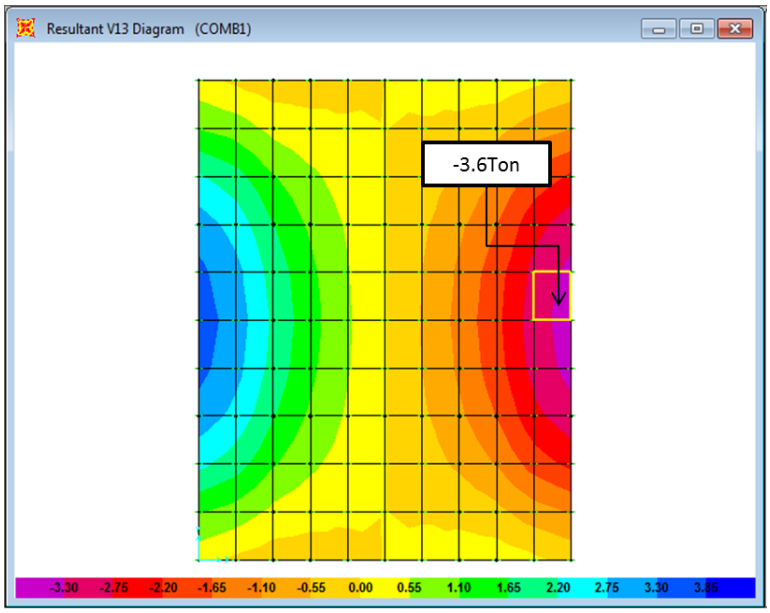
## M11


Resultant M11 Diagram (COMB1)
-0.76 Ton m
-660. -550. -440. -330. -220. -110. 0. 110. 220. 330. 440. 550. 660. 770. E-3

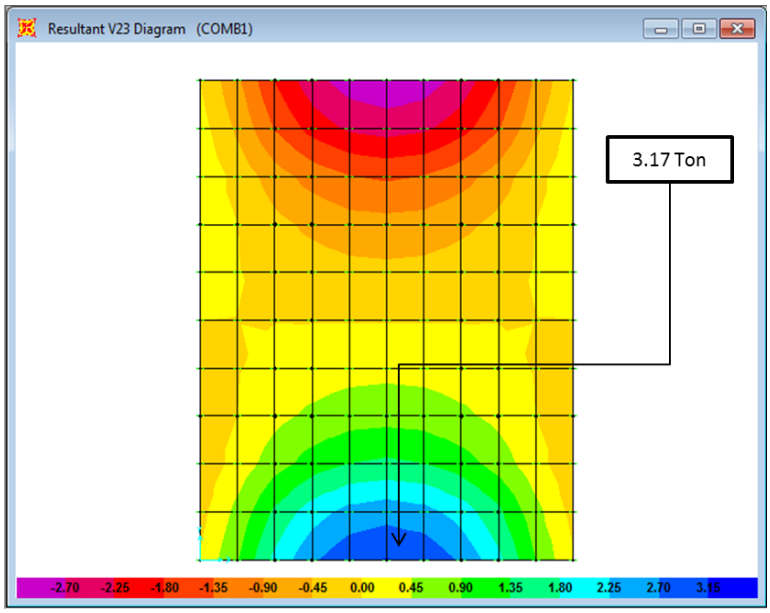
## M22


Resultant M22 Diagram (COMB1)
-0.56 Ton m
-700. -600. -500. -400. -300. -200. -100. 0. 100. 200. 300. 400. 500. 600. E-3

## V13


Resultant V13 Diagram (COMB1)
-3.6Ton
-3.30 -2.75 -2.20 -1.65 -1.10 -0.55 0.00 0.55 1.10 1.65 2.20 2.75 3.30 3.85

## V23


Resultant V23 Diagram (COMB1)
3.17 Ton
-2.70 -2.25 -1.80 -1.35 -0.90 -0.45 0.00 0.45 0.90 1.35 1.80 2.25 2.70 3.15

**TUBERIA DE Φ20" CON VÁLVULA MARIPOSA DE Φ20"**

**REFUERZO PLACA SUPERIOR**

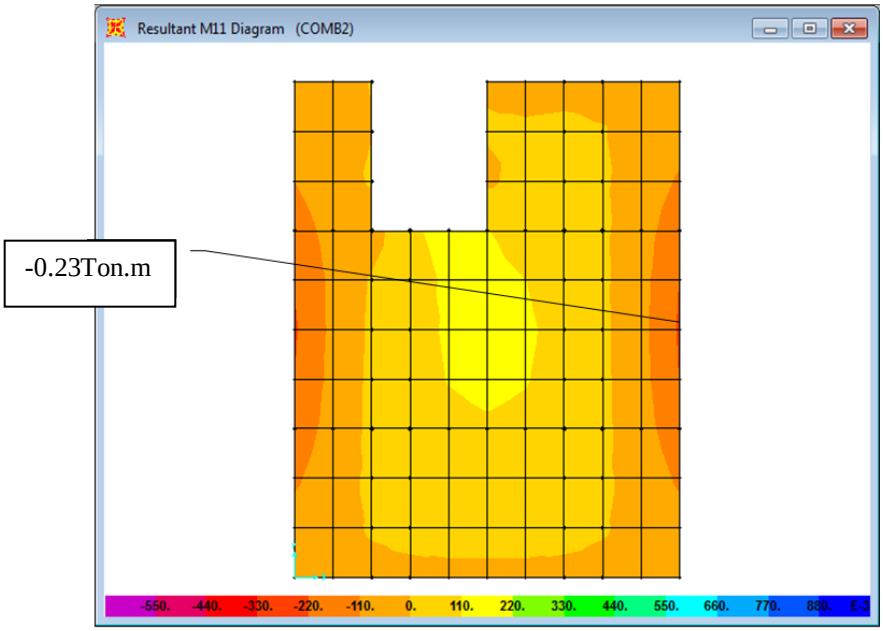
b = 100 cm | fy = 4200 kg/cm2
H = 30 cm | d = 25.0 cm | fc= 280 kg/cm2

| *Chequeo a flexión MOMENTO M11* | | | | *Chequeo a flexión MOMENTO M22* | | | |
|---|---|---|---|---|---|---|---|
| Coef. Durab. | ϕ = | 1.00 | | | ϕ = | 1.00 | |
| | Mu = | 0.23 | T-m | | Mu = | 0.28 | T-m |
| | ϕMu = | 0.23 | T-m | | ϕMu = | 0.28 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | ρ = | 0.000097 | | | ρ = | 0.000119 | |
| | $\rho_{min}$ = | 0.002000 | | | $\rho_{min}$ = | 0.002000 | |
| Por lo tanto | As = | 5.00 | $cm^2/m$ | Por lo tanto | As = | 5.00 | $cm^2/m$ |
| | #3/cada = | 0.142 | m | | #3/cada = | 0.142 | m |
| | #4/cada = | 0.254 | m | | #4/cada = | 0.254 | m |
| | #5/cada = | 0.398 | m | | #5/cada = | 0.398 | m |
| | #6/cada = | 0.568 | m | | #6/cada = | 0.568 | m |
| | #7/cada = | 0.774 | m | | #7/cada = | 0.774 | m |
| | #8/cada = | 1.020 | m | | #8/cada = | 1.020 | m |

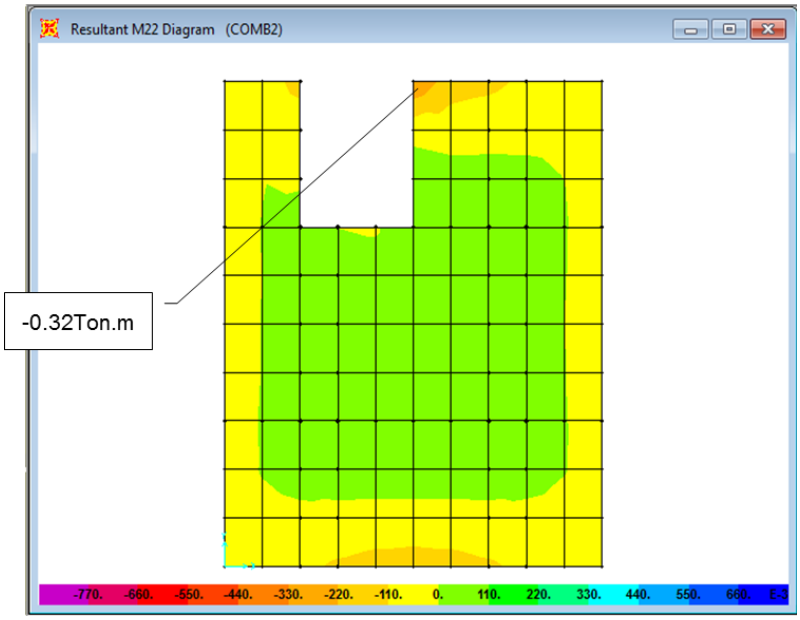
| **CORTANTE V13** | | | **CORTANTE V23** | | |
|---|---|---|---|---|---|
| vu (ton)= | 0.87 | | vu (ton)= | 1.33 | |
| Øvc (ton)= | 18.85 | | Øvc (ton)= | 18.85 | |
| | CUMPLE | | | CUMPLE | |
| Varilla = | # 4 | | Varilla = | # 4 | |
| Area varilla= | 1.29 | $cm^2$ | Area varilla= | 1.29 | $cm^2$ |
| Sep. Varilla= | 25 | cm | Sep. Varilla= | 25 | cm |
| Es = | 2040000.00 | $kg/cm^2$ | Es = | 2040000.00 | $kg/cm^2$ |
| Ec = | 209165.01 | $kg/cm^2$ | Ec = | 209165.01 | $kg/cm^2$ |
| n = | 9.75 | | n = | 9.75 | |
| Ms = | 0.16 | T-m | Ms = | 0.20 | T-m |
| As = | 5.16 | $cm^2/m$ | As = | 5.16 | $cm^2/m$ |
| ρ = | 0.002064 | | ρ = | 0.002064 | |
| k = | 0.18 | | k = | 0.18 | |
| j = | 0.94 | | j = | 0.94 | |
| jd = | 23.49 | $cm^2$ | jd = | 23.49 | $cm^2$ |
| fs = | 135.56 | $kg/cm^2$ | fs = | 165.02 | $kg/cm^2$ |
| 0.45fy = | 1890.00 | $kg/cm^2$ | 0.45fy = | 1890.00 | $kg/cm^2$ |
| z = | 1460.23 | kg-cm cumple | z = | 1777.67 | kg-cm cumple |
| **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | | **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | |

| *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | | *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | |
|---|---|---|---|---|---|---|---|
| | Mcr = | 0.31 | T-m | | Mcr = | 0.37 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | $\rho_{cr}$ = | 0.000130 | | | $\rho_{cr}$ = | 0.000158 | |
| Por lo tanto | $As_{cr}$ = | 0.32 | $cm^2/m$ | Por lo tanto | $As_{cr}$ = | 0.39 | $cm^2/m$ |
| | cumple | | | | cumple | | |
| | #3/cada = | 2.191 | m | | #3/cada = | 1.799 | m |
| | #4/cada = | 3.919 | m | | #4/cada = | 3.219 | m |
| | #5/cada = | 6.141 | m | | #5/cada = | 5.043 | m |
| | #6/cada = | 8.764 | m | | #6/cada = | 7.198 | m |
| | #7/cada = | 11.943 | m | | #7/cada = | 9.808 | m |
| | #8/cada = | 15.739 | m | | #8/cada = | 12.925 | m |

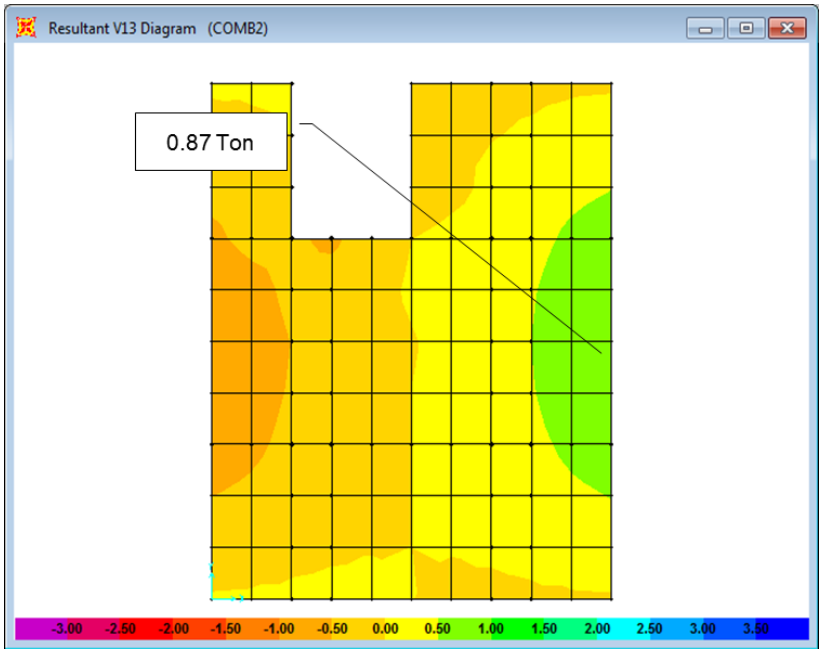
**M11**


Resultant M11 Diagram (COMB2)
-0.23Ton.m
-550. -440. -330. -220. -110. 0. 110. 220. 330. 440. 550. 660. 770. 880.

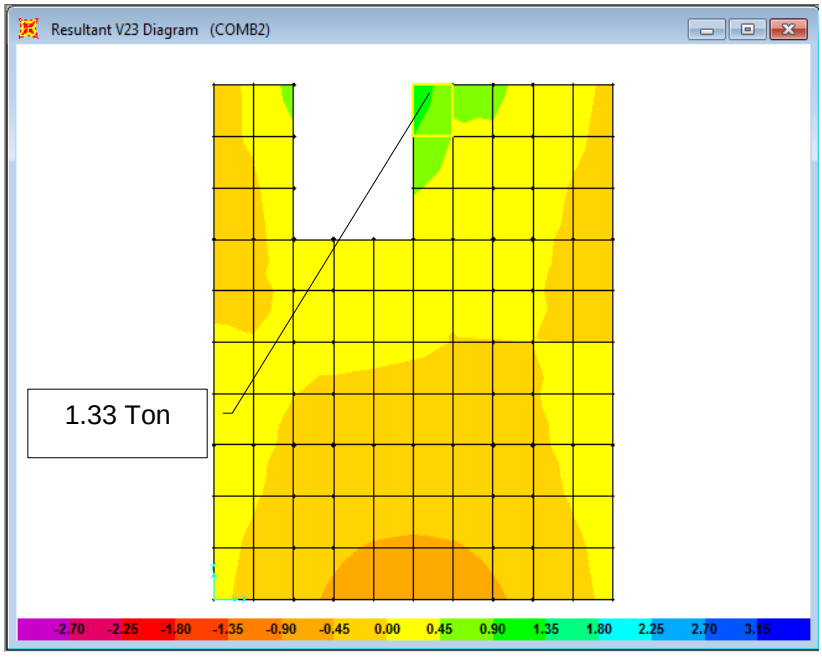
**M22**


Resultant M22 Diagram (COMB2)
-0.32Ton.m
-770. -660. -550. -440. -330. -220. -110. 0. 110. 220. 330. 440. 550. 660.

## V13


Resultant V13 Diagram (COMB2)
0.87 Ton
-3.00 -2.50 -2.00 -1.50 -1.00 -0.50 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50

## V23


Resultant V23 Diagram (COMB2)
1.33 Ton
-2.70 -2.25 -1.80 -1.35 -0.90 -0.45 0.00 0.45 0.90 1.35 1.80 2.25 2.70 3.15

**TUBERIA DE Φ20" CON VÁLVULA MARIPOSA DE Φ20"**

**REFUERZO MUROS**

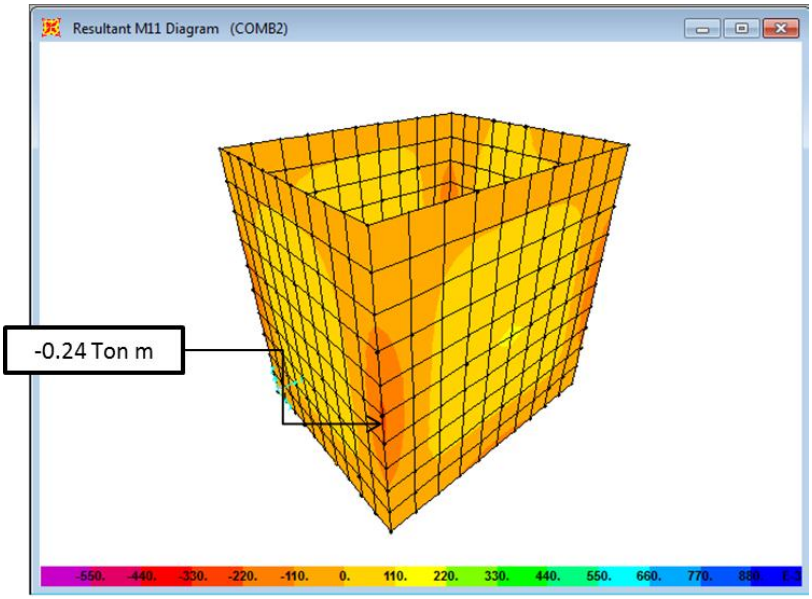
| | | | | | |
|---|---|---|---|---|---|
| | b = 100 cm | | fy = | 4200 | kg/cm2 |
| H = 30 cm | d = 25.0 cm | | f'c= | 280 | kg/cm2 |

| *Chequeo a flexión MOMENTO M11* | | | | *Chequeo a flexión MOMENTO M22* | | | |
|---|---|---|---|---|---|---|---|
| Coef. Durab. | ϕ = | 1.00 | | | ϕ = | 1.00 | |
| | Mu = | 0.24 | T-m | | Mu = | 0.81 | T-m |
| | ϕMu = | 0.24 | T-m | | ϕMu = | 0.81 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | ρ = | 0.000102 | | | ρ = | 0.000344 | |
| | $\rho_{min}$ = | 0.002000 | | | $\rho_{min}$ = | 0.002000 | |
| Por lo tanto | As = | 5.00 | $cm^2/m$ | Por lo tanto | As = | 5.00 | $cm^2/m$ |
| | #3/cada = | 0.142 | m | | #3/cada = | 0.142 | m |
| | #4/cada = | 0.254 | m | | #4/cada = | 0.254 | m |
| | #5/cada = | 0.398 | m | | #5/cada = | 0.398 | m |
| | #6/cada = | 0.568 | m | | #6/cada = | 0.568 | m |
| | #7/cada = | 0.774 | m | | #7/cada = | 0.774 | m |
| | #8/cada = | 1.020 | m | | #8/cada = | 1.020 | m |

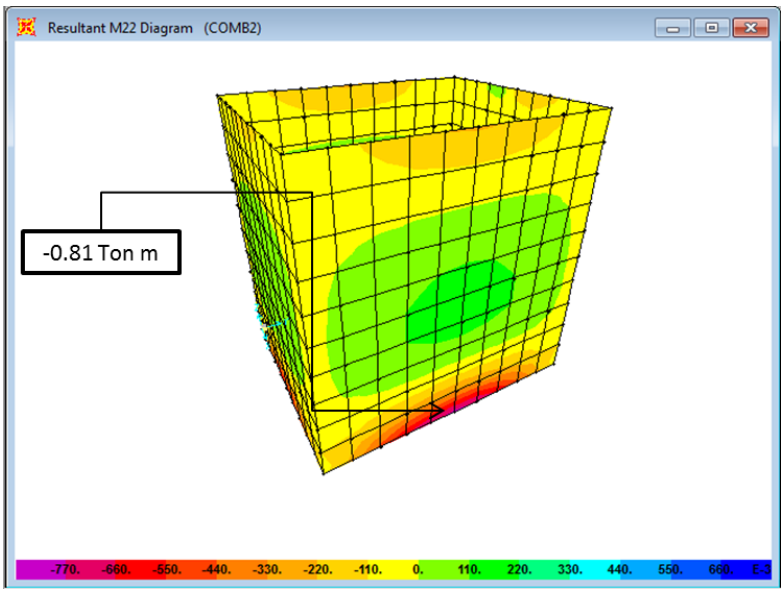
| **CORTANTE V13** | | | **CORTANTE V23** | | |
|---|---|---|---|---|---|
| vu (ton)= | 0.75 | | vu (ton)= | 2.04 | |
| Øvc (ton)= | 18.85 | | Øvc (ton)= | 18.85 | |
| | CUMPLE | | | CUMPLE | |
| Varilla = | # 4 | | Varilla = | # 4 | |
| Area varilla= | 1.29 | cm² | Area varilla= | 1.29 | cm² |
| Sep. Varilla= | 25 | cm | Sep. Varilla= | 25 | cm |
| Es = | 2040000.00 | kg/cm² | Es = | 2040000.00 | kg/cm² |
| Ec = | 209165.01 | kg/cm² | Ec = | 209165.01 | kg/cm² |
| n = | 9.75 | | n = | 9.75 | |
| Ms = | 0.17 | T-m | Ms = | 0.58 | T-m |
| As = | 5.16 | cm²/m | As = | 5.16 | cm²/m |
| ρ = | 0.002064 | | ρ = | 0.002064 | |
| k = | 0.18 | | k = | 0.18 | |
| j = | 0.94 | | j = | 0.94 | |
| jd = | 23.49 | cm² | jd = | 23.49 | cm² |
| fs = | 141.45 | kg/cm² | fs = | 477.39 | kg/cm² |
| 0.45fy = | 1890.00 | kg/cm² | 0.45fy = | 1890.00 | kg/cm² |
| z = | 1523.72 | kg-cm cumple | z = | 5142.54 | kg-cm cumple |
| **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | | **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | |

| *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | | *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | |
|---|---|---|---|---|---|---|---|
| | Mcr = | 0.32 | T-m | | Mcr = | 1.08 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | $\rho_{cr}$ = | 0.000135 | | | $\rho_{cr}$ = | 0.000458 | |
| Por lo tanto | $As_{cr}$ = | 0.34 | $cm^2/m$ | Por lo tanto | $As_{cr}$ = | 1.14 | $cm^2/m$ |
| | cumple | | | | cumple | | |
| | #3/cada = | 2.100 | m | | #3/cada = | 0.621 | m |
| | #4/cada = | 3.756 | m | | #4/cada = | 1.110 | m |
| | #5/cada = | 5.885 | m | | #5/cada = | 1.739 | m |
| | #6/cada = | 8.399 | m | | #6/cada = | 2.482 | m |
| | #7/cada = | 11.445 | m | | #7/cada = | 3.382 | m |
| | #8/cada = | 15.082 | m | | #8/cada = | 4.457 | m |

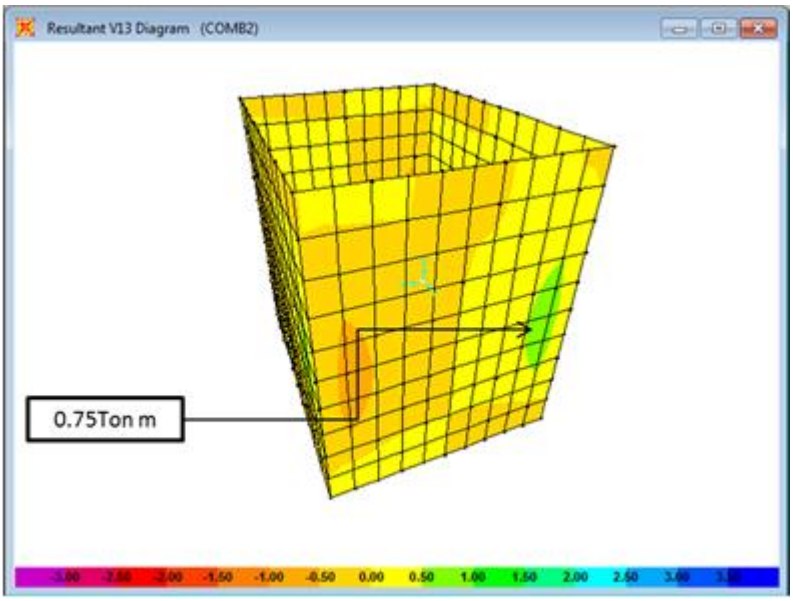
## M11


Resultant M11 Diagram (COMB2)
-0.24 Ton m
-550. -440. -330. -220. -110. 0. 110. 220. 330. 440. 550. 660. 770. 880.

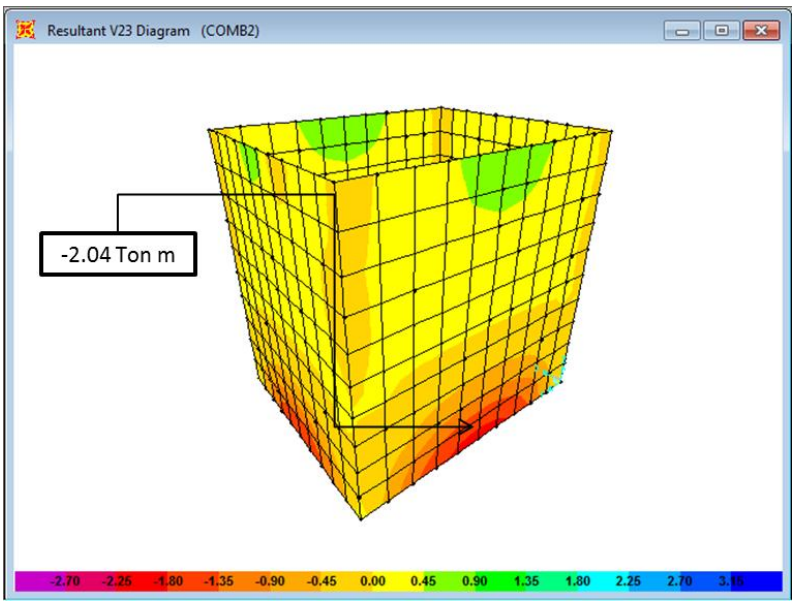
## M22


Resultant M22 Diagram (COMB2)
-0.81 Ton m
-770. -660. -550. -440. -330. -220. -110. 0. 110. 220. 330. 440. 550. 660.

## V13


Resultant V13 Diagram (COMB2)
0.75Ton m

## V23


Resultant V23 Diagram (COMB2)
-2.04 Ton m
-2.70 -2.25 -1.80 -1.35 -0.90 -0.45 0.00 0.45 0.90 1.35 1.80 2.25 2.70 3.15

## *8.2 PURGA 4”*

**TUBERIA DE Φ20" CON PURGA DE Φ4"**

**REFUERZO PLACA INFERIOR**

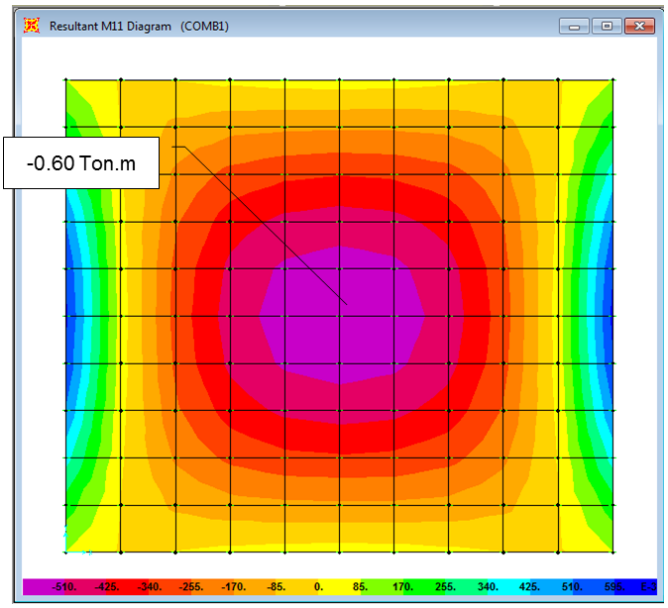
| | | | | | |
|---|---|---|---|---|---|
| | b = 100 cm | | fy = | 4200 | kg/cm2 |
| H = 30 cm | d = 25.0 cm | | f'c= | 280 | kg/cm2 |

| *Chequeo a flexión MOMENTO M11* | | | | *Chequeo a flexión MOMENTO M22* | | | |
|---|---|---|---|---|---|---|---|
| Coef. Durab. | ϕ = | 1.00 | | | ϕ = | 1.00 | |
| | Mu = | 0.60 | T-m | | Mu = | 0.70 | T-m |
| | ϕMu = | 0.60 | T-m | | ϕMu = | 0.70 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | ρ = | 0.000254 | | | ρ = | 0.000297 | |
| | $\rho_{min}$ = | 0.002000 | | | $\rho_{min}$ = | 0.002000 | |
| Por lo tanto | As = | 5.00 | $cm^2/m$ | Por lo tanto | As = | 5.00 | $cm^2/m$ |
| | #3/cada = | 0.142 | m | | #3/cada = | 0.142 | m |
| | #4/cada = | 0.254 | m | | #4/cada = | 0.254 | m |
| | #5/cada = | 0.398 | m | | #5/cada = | 0.398 | m |
| | #6/cada = | 0.568 | m | | #6/cada = | 0.568 | m |
| | #7/cada = | 0.774 | m | | #7/cada = | 0.774 | m |
| | #8/cada = | 1.020 | m | | #8/cada = | 1.020 | m |

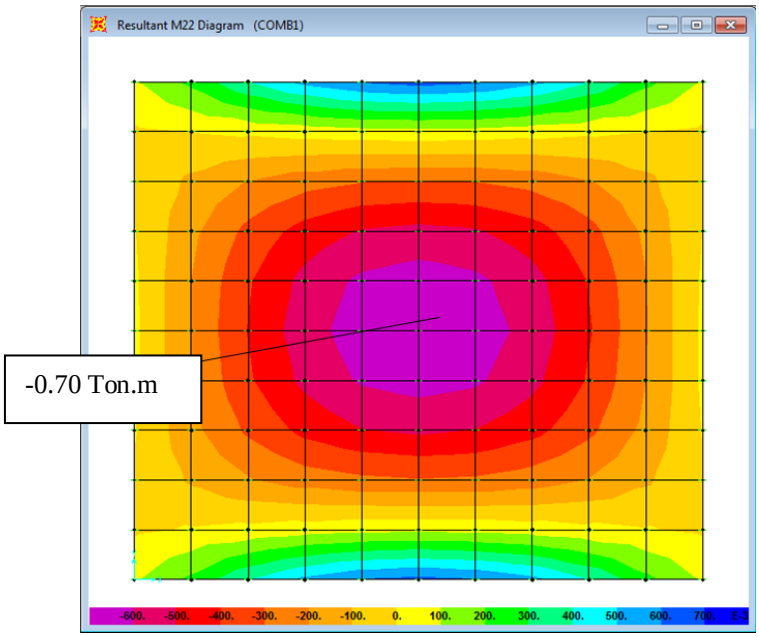
| **CORTANTE V13** | | | **CORTANTE V23** | | |
|---|---|---|---|---|---|
| vu (ton)= | 3.70 | | vu (ton)= | 4.10 | |
| Øvc (ton)= | 18.85 | | Øvc (ton)= | 18.85 | |
| | CUMPLE | | | CUMPLE | |
| Varilla = | # 4 | | Varilla = | # 4 | |
| Area varilla= | 1.29 | cm² | Area varilla= | 1.29 | cm² |
| Sep. Varilla= | 25 | cm | Sep. Varilla= | 25 | cm |
| Es = | 2040000.00 | kg/cm² | Es = | 2040000.00 | kg/cm² |
| Ec = | 209165.01 | kg/cm² | Ec = | 209165.01 | kg/cm² |
| n = | 9.75 | | n = | 9.75 | |
| Ms = | 0.43 | T-m | Ms = | 0.50 | T-m |
| As = | 5.16 | cm²/m | As = | 5.16 | cm²/m |
| ρ = | 0.002064 | | ρ = | 0.002064 | |
| k = | 0.18 | | k = | 0.18 | |
| j = | 0.94 | | j = | 0.94 | |
| jd = | 23.49 | cm² | jd = | 23.49 | cm² |
| fs = | 353.62 | kg/cm² | fs = | 412.56 | kg/cm² |
| 0.45fy = | 1890.00 | kg/cm² | 0.45fy = | 1890.00 | kg/cm² |
| z = | 3809.29 | kg-cm cumple | z = | 4444.17 | kg-cm cumple |
| **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | | **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | |

| *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | | *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | |
|---|---|---|---|---|---|---|---|
| | Mcr = | 0.80 | T-m | | Mcr = | 0.93 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | $\rho_{cr}$ = | 0.000339 | | | $\rho_{cr}$ = | 0.000395 | |
| Por lo tanto | $As_{cr}$ = | 0.85 | $cm^2/m$ | Por lo tanto | $As_{cr}$ = | 0.99 | $cm^2/m$ |
| | cumple | | | | cumple | | |
| | #3/cada = | 0.839 | m | | #3/cada = | 0.718 | m |
| | #4/cada = | 1.500 | m | | #4/cada = | 1.285 | m |
| | #5/cada = | 2.350 | m | | #5/cada = | 2.014 | m |
| | #6/cada = | 3.354 | m | | #6/cada = | 2.874 | m |
| | #7/cada = | 4.571 | m | | #7/cada = | 3.916 | m |
| | #8/cada = | 6.023 | m | | #8/cada = | 5.160 | m |

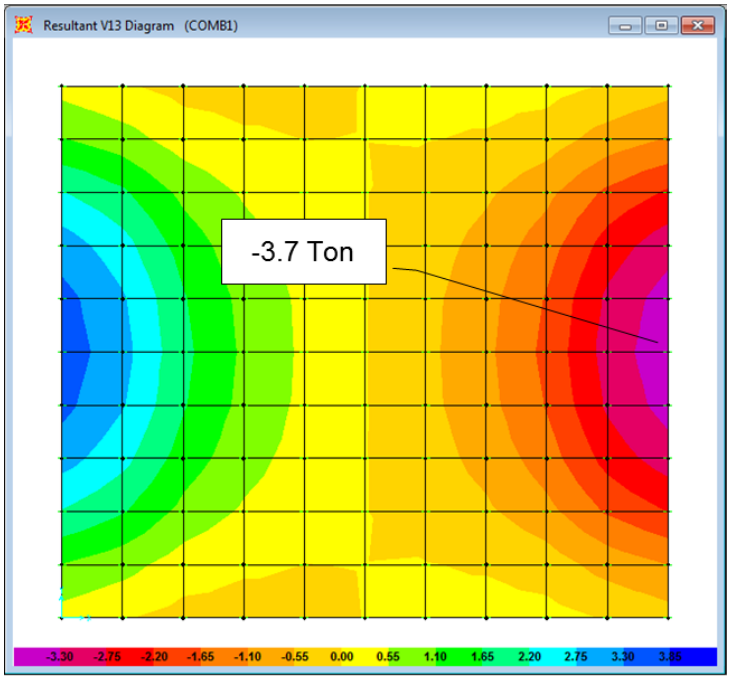
## M11


Resultant M11 Diagram (COMB1)
-0.60 Ton.m
-510. -425. -340. -255. -170. -85. 0. 85. 170. 255. 340. 425. 510.

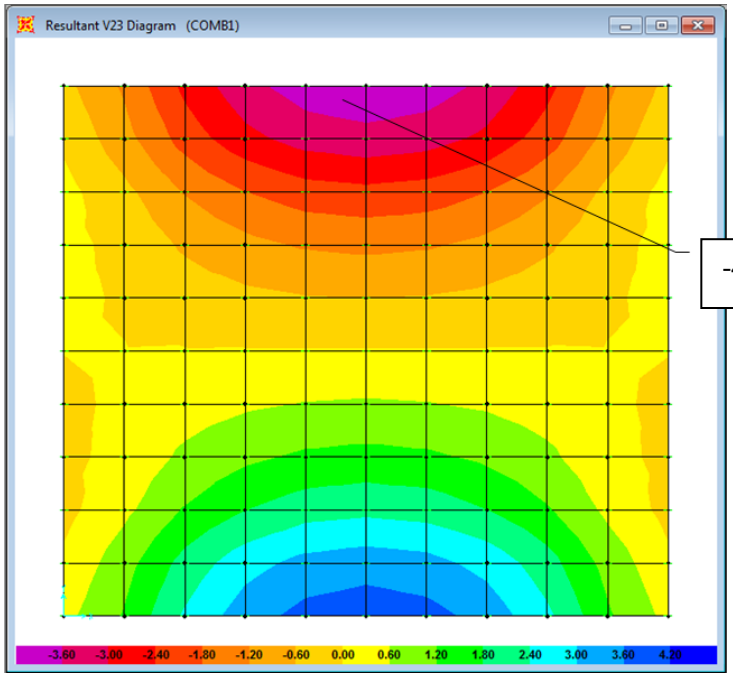
## M22


Resultant M22 Diagram (COMB1)
-0.70 Ton.m
-600. -500. -400. -300. -200. -100. 0. 100. 200. 300. 400. 500. 600. 700.

## V13


Resultant V13 Diagram (COMB1)
-3.7 Ton
-3.30 -2.75 -2.20 -1.65 -1.10 -0.55 0.00 0.55 1.10 1.65 2.20 2.75 3.30 3.85

## V23


Resultant V23 Diagram (COMB1)
-4.10 Ton
-3.60 -3.00 -2.40 -1.80 -1.20 -0.60 0.00 0.60 1.20 1.80 2.40 3.00 3.60 4.20

**TUBERIA DE Φ20" CON PURGA DE Φ4"**

**REFUERZO PLACA SUPERIOR**

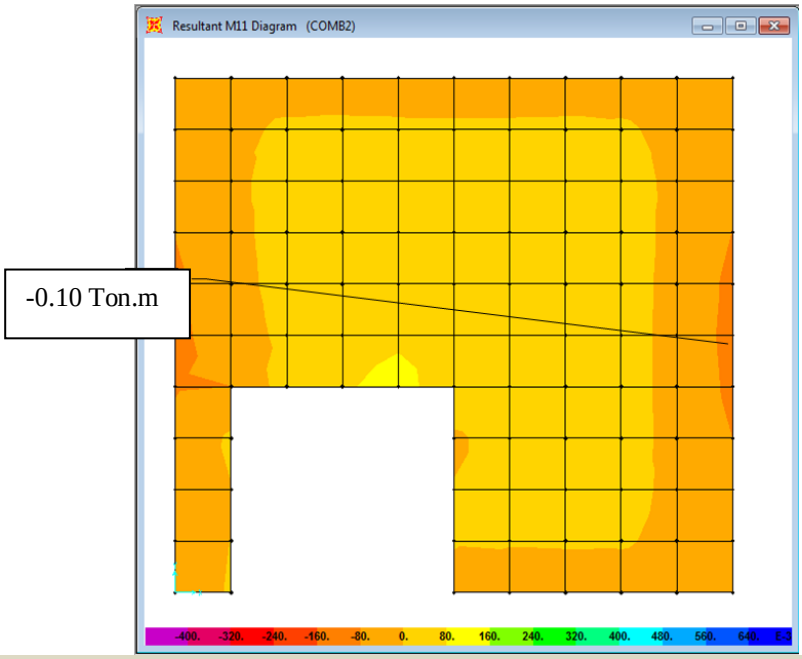
b = 100 cm | fy = 4200 kg/cm2
H = 30 cm | d = 25.0 cm | fc= 280 kg/cm2

| *Chequeo a flexión MOMENTO M11* | | | | *Chequeo a flexión MOMENTO M22* | | | |
|---|---|---|---|---|---|---|---|
| Coef. Durab. | ϕ = | 1.00 | | | ϕ = | 1.00 | |
| | Mu = | 0.10 | T-m | | Mu = | 0.12 | T-m |
| | ϕMu = | 0.10 | T-m | | ϕMu = | 0.12 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | ρ = | 0.000042 | | | ρ = | 0.000051 | |
| | $\rho_{min}$ = | 0.002000 | | | $\rho_{min}$ = | 0.002000 | |
| Por lo tanto | As = | 5.00 | $cm^2/m$ | Por lo tanto | As = | 5.00 | $cm^2/m$ |
| | #3/cada = | 0.142 | m | | #3/cada = | 0.142 | m |
| | #4/cada = | 0.254 | m | | #4/cada = | 0.254 | m |
| | #5/cada = | 0.398 | m | | #5/cada = | 0.398 | m |
| | #6/cada = | 0.568 | m | | #6/cada = | 0.568 | m |
| | #7/cada = | 0.774 | m | | #7/cada = | 0.774 | m |
| | #8/cada = | 1.020 | m | | #8/cada = | 1.020 | m |

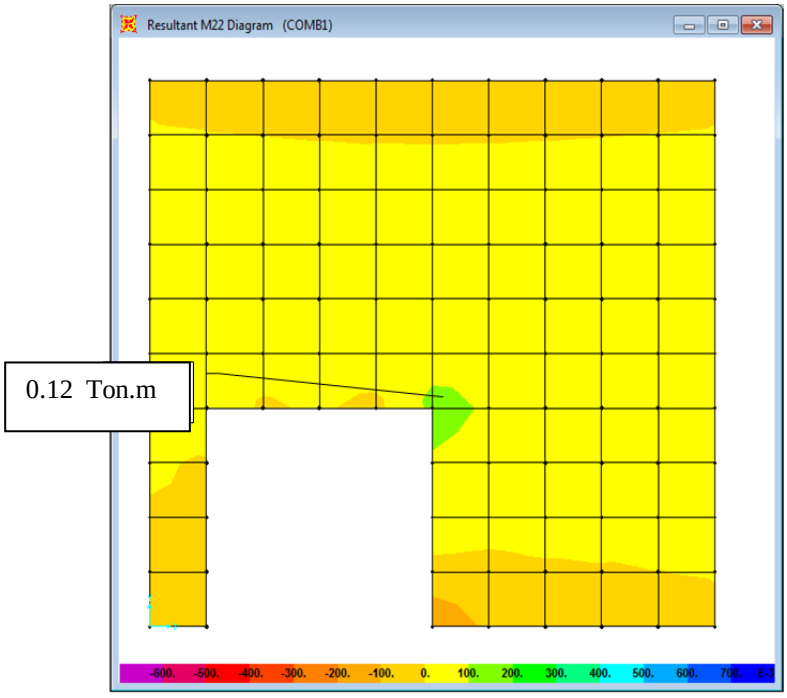
| **CORTANTE V13** | | | **CORTANTE V23** | | |
|---|---|---|---|---|---|
| vu (ton)= | 0.56 | | vu (ton)= | 1.55 | |
| Øvc (ton)= | 18.85 | | Øvc (ton)= | 18.85 | |
| | CUMPLE | | | CUMPLE | |
| Varilla = | # 4 | | Varilla = | # 4 | |
| Area varilla= | 1.29 | cm² | Area varilla= | 1.29 | cm² |
| Sep. Varilla= | 25 | cm | Sep. Varilla= | 25 | cm |
| Es = | 2040000.00 | kg/cm² | Es = | 2040000.00 | kg/cm² |
| Ec = | 209165.01 | kg/cm² | Ec = | 209165.01 | kg/cm² |
| n = | 9.75 | | n = | 9.75 | |
| Ms = | 0.07 | T-m | Ms = | 0.09 | T-m |
| As = | 5.16 | cm²/m | As = | 5.16 | cm²/m |
| ρ = | 0.002064 | | ρ = | 0.002064 | |
| k = | 0.18 | | k = | 0.18 | |
| j = | 0.94 | | j = | 0.94 | |
| jd = | 23.49 | cm² | jd = | 23.49 | cm² |
| fs = | 58.94 | kg/cm² | fs = | 70.72 | kg/cm² |
| 0.45fy = | 1890.00 | kg/cm² | 0.45fy = | 1890.00 | kg/cm² |
| z = | 634.88 | kg-cm cumple | z = | 761.86 | kg-cm cumple |
| **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | | **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | |

| *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | | *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | |
|---|---|---|---|---|---|---|---|
| | Mcr = | 0.13 | T-m | | Mcr = | 0.16 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | $\rho_{cr}$ = | 0.000056 | | | $\rho_{cr}$ = | 0.000068 | |
| Por lo tanto | $As_{cr}$ = | 0.14 | $cm^2/m$ | Por lo tanto | $As_{cr}$ = | 0.17 | $cm^2/m$ |
| | | cumple | | | | cumple | |
| | #3/cada = | 5.042 | m | | #3/cada = | 4.202 | m |
| | #4/cada = | 9.020 | m | | #4/cada = | 7.516 | m |
| | #5/cada = | 14.133 | m | | #5/cada = | 11.777 | m |
| | #6/cada = | 20.170 | m | | #6/cada = | 16.807 | m |
| | #7/cada = | 27.485 | m | | #7/cada = | 22.902 | m |
| | #8/cada = | 36.221 | m | | #8/cada = | 30.181 | m |

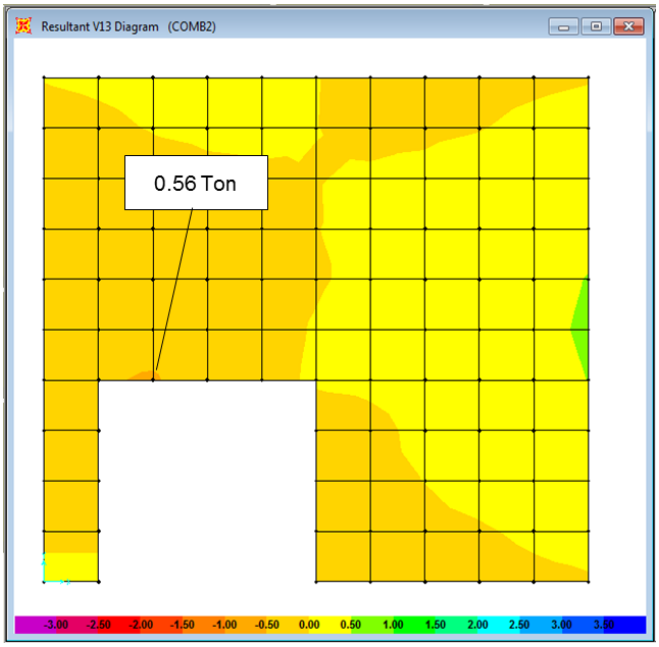
**M11**


Resultant M11 Diagram (COMB2)
-0.10 Ton.m
-400. -320. -240. -160. -80. 0. 80. 160. 240. 320. 400. 480. 560. 640.

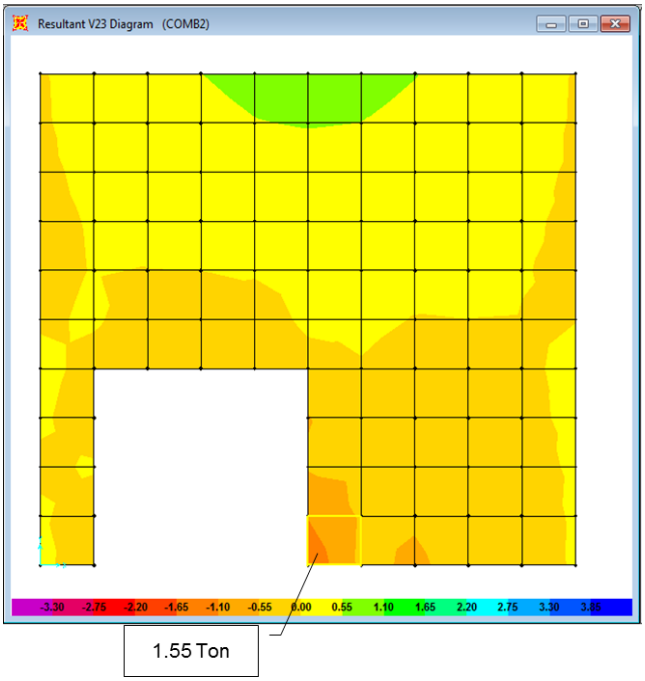
**M22**


Resultant M22 Diagram (COMB1)
0.12 Ton.m
-600. -500. -400. -300. -200. -100. 0. 100. 200. 300. 400. 500. 600. 700.

## V13


Resultant V13 Diagram (COMB2)
0.56 Ton
-3.00 -2.50 -2.00 -1.50 -1.00 -0.50 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50

## V23


Resultant V23 Diagram (COMB2)
-3.30 -2.75 -2.20 -1.65 -1.10 -0.55 0.00 0.55 1.10 1.65 2.20 2.75 3.30 3.85
1.55 Ton

**TUBERIA DE Φ20" CON PURGA DE Φ4"**

**REFUERZO MUROS**

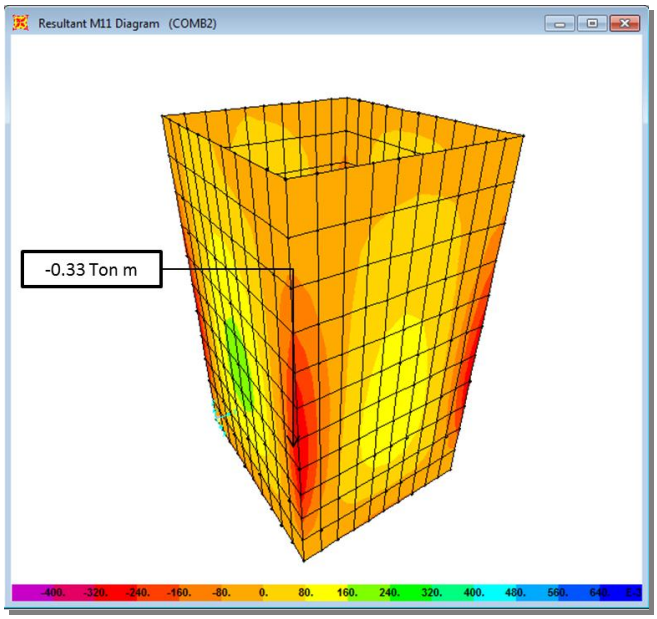
b = 100 cm | fy = 4200 kg/cm2
H = 30 cm | d = 25.0 cm | fc= 280 kg/cm2

| *Chequeo a flexión MOMENTO M11* | | | | *Chequeo a flexión MOMENTO M22* | | | |
|---|---|---|---|---|---|---|---|
| Coef. Durab. | ϕ = | 1.00 | | | ϕ = | 1.00 | |
| | Mu = | 0.33 | T-m | | Mu = | 0.71 | T-m |
| | ϕMu = | 0.33 | T-m | | ϕMu = | 0.71 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | ρ = | 0.000140 | | | ρ = | 0.000301 | |
| | $\rho_{min}$ = | 0.002000 | | | $\rho_{min}$ = | 0.002000 | |
| Por lo tanto | As = | 5.00 | $cm^2/m$ | Por lo tanto | As = | 5.00 | $cm^2/m$ |
| | #3/cada = | 0.142 | m | | #3/cada = | 0.142 | m |
| | #4/cada = | 0.254 | m | | #4/cada = | 0.254 | m |
| | #5/cada = | 0.398 | m | | #5/cada = | 0.398 | m |
| | #6/cada = | 0.568 | m | | #6/cada = | 0.568 | m |
| | #7/cada = | 0.774 | m | | #7/cada = | 0.774 | m |
| | #8/cada = | 1.020 | m | | #8/cada = | 1.020 | m |

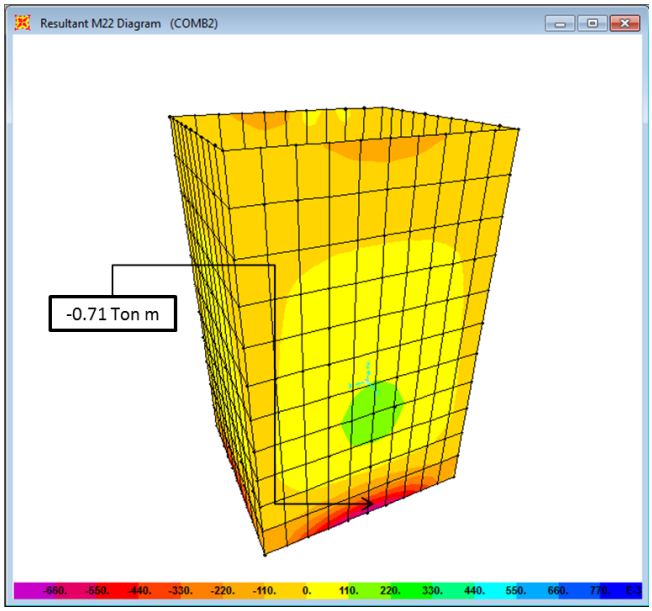
| **CORTANTE V13** | | | **CORTANTE V23** | | |
|---|---|---|---|---|---|
| vu (ton)= | 1.09 | | vu (ton)= | 2.00 | |
| Øvc (ton)= | 18.85 | | Øvc (ton)= | 18.85 | |
| | CUMPLE | | | CUMPLE | |
| Varilla = | # 4 | | Varilla = | # 4 | |
| Area varilla= | 1.29 | $cm^2$ | Area varilla= | 1.29 | $cm^2$ |
| Sep. Varilla= | 25 | cm | Sep. Varilla= | 25 | cm |
| Es = | 2040000.00 | $kg/cm^2$ | Es = | 2040000.00 | $kg/cm^2$ |
| Ec = | 209165.01 | $kg/cm^2$ | Ec = | 209165.01 | $kg/cm^2$ |
| n = | 9.75 | | n = | 9.75 | |
| Ms = | 0.24 | T-m | Ms = | 0.51 | T-m |
| As = | 5.16 | $cm^2/m$ | As = | 5.16 | $cm^2/m$ |
| ρ = | 0.002064 | | ρ = | 0.002064 | |
| k = | 0.18 | | k = | 0.18 | |
| j = | 0.94 | | j = | 0.94 | |
| jd = | 23.49 | $cm^2$ | jd = | 23.49 | $cm^2$ |
| fs = | 194.49 | $kg/cm^2$ | fs = | 418.45 | $kg/cm^2$ |
| 0.45fy = | 1890.00 | $kg/cm^2$ | 0.45fy = | 1890.00 | $kg/cm^2$ |
| z = | 2095.11 | kg-cm cumple | z = | 4507.66 | kg-cm cumple |
| **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | | **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | |

| *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | | *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | |
|---|---|---|---|---|---|---|---|
| | Mcr = | 0.44 | T-m | | Mcr = | 0.94 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | $\rho_{cr}$ = | 0.000186 | | | $\rho_{cr}$ = | 0.000401 | |
| Por lo tanto | $As_{cr}$ = | 0.47 | $cm^2/m$ | Por lo tanto | $As_{cr}$ = | 1.00 | $cm^2/m$ |
| | cumple | | | | cumple | | |
| | #3/cada = | 1.526 | m | | #3/cada = | 0.708 | m |
| | #4/cada = | 2.730 | m | | #4/cada = | 1.267 | m |
| | #5/cada = | 4.278 | m | | #5/cada = | 1.985 | m |
| | #6/cada = | 6.106 | m | | #6/cada = | 2.833 | m |
| | #7/cada = | 8.320 | m | | #7/cada = | 3.860 | m |
| | #8/cada = | 10.965 | m | | #8/cada = | 5.087 | m |

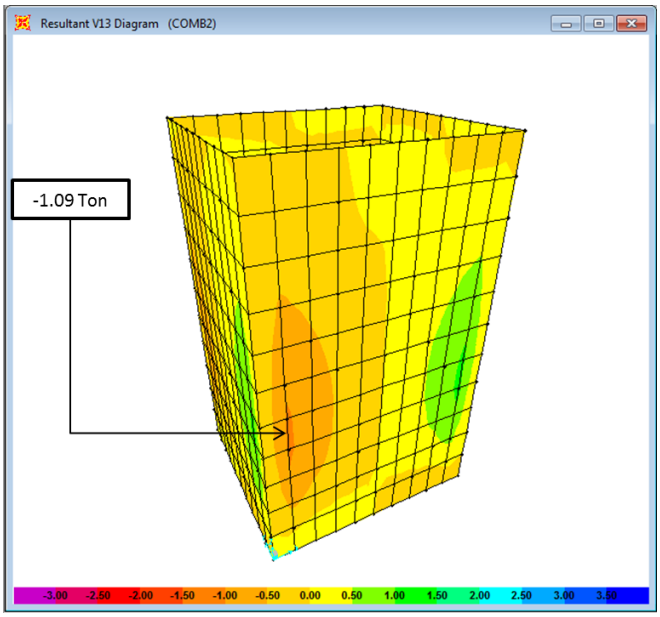
**M11**


Resultant M11 Diagram (COMB2)
-0.33 Ton m
-400. -320. -240. -160. -80. 0. 80. 160. 240. 320. 400. 480. 560. 640.

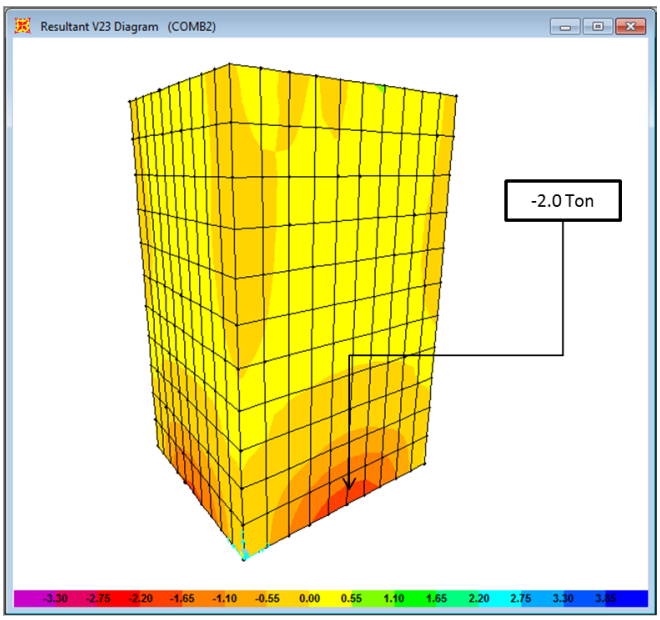
**M22**


Resultant M22 Diagram (COMB2)
-0.71 Ton m
-660. -550. -440. -330. -220. -110. 0. 110. 220. 330. 440. 550. 660. 770.

## V13


Resultant V13 Diagram (COMB2)
-1.09 Ton
-3.00 -2.50 -2.00 -1.50 -1.00 -0.50 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50

## V23


Resultant V23 Diagram (COMB2)
-2.0 Ton
-3.30 -2.75 -2.20 -1.65 -1.10 -0.55 0.00 0.55 1.10 1.65 2.20 2.75 3.30 3.85

## *8.3 VENTOSA 3”*

**TUBERIA DE Φ20" CON VENTOSA DE Φ3"**

**REFUERZO PLACA INFERIOR**

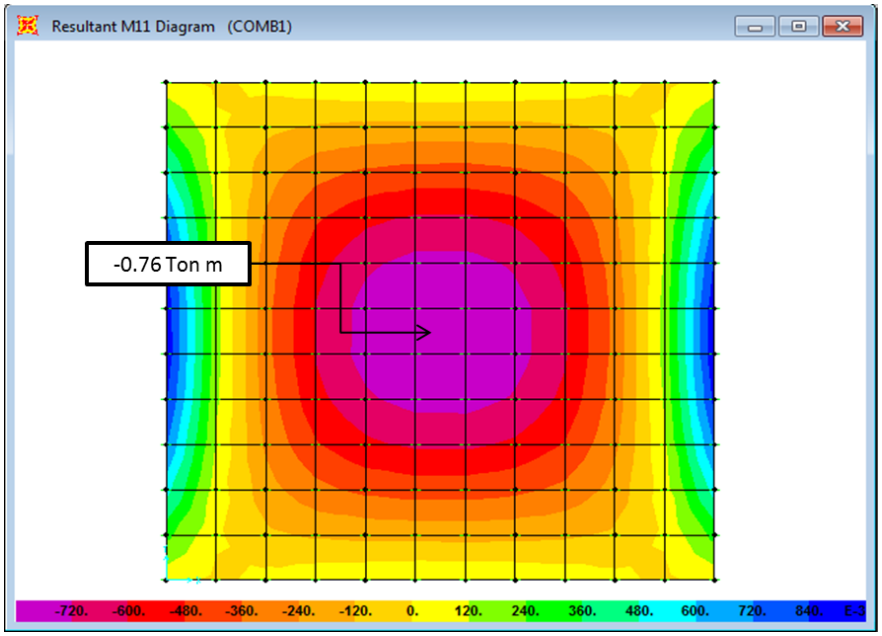
b = 100 cm | fy = 4200 kg/cm2
H = 30 cm | d = 25.0 cm | fc= 280 kg/cm2

| *Chequeo a flexión MOMENTO M11* | | | | *Chequeo a flexión MOMENTO M22* | | | |
|---|---|---|---|---|---|---|---|
| Coef. Durab. | ϕ = | 1.00 | | | ϕ = | 1.00 | |
| | Mu = | 0.84 | T-m | | Mu = | 0.90 | T-m |
| | ϕMu = | 0.84 | T-m | | ϕMu = | 0.90 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | ρ = | 0.000357 | | | ρ = | 0.000382 | |
| | $\rho_{min}$ = | 0.002000 | | | $\rho_{min}$ = | 0.002000 | |
| Por lo tanto | As = | 5.00 | $cm^2/m$ | Por lo tanto | As = | 5.00 | $cm^2/m$ |
| | #3/cada = | 0.142 | m | | #3/cada = | 0.142 | m |
| | #4/cada = | 0.254 | m | | #4/cada = | 0.254 | m |
| | #5/cada = | 0.398 | m | | #5/cada = | 0.398 | m |
| | #6/cada = | 0.568 | m | | #6/cada = | 0.568 | m |
| | #7/cada = | 0.774 | m | | #7/cada = | 0.774 | m |
| | #8/cada = | 1.020 | m | | #8/cada = | 1.020 | m |

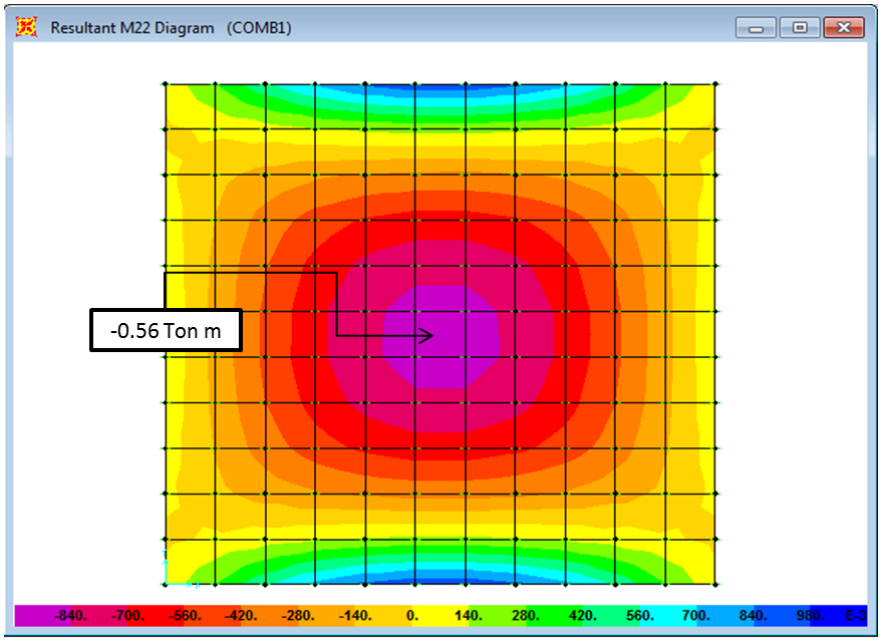
| **CORTANTE V13** | | | **CORTANTE V23** | | |
|---|---|---|---|---|---|
| vu (ton)= | 3.98 | | vu (ton)= | 4.12 | |
| Øvc (ton)= | 18.85 | | Øvc (ton)= | 18.85 | |
| | CUMPLE | | | CUMPLE | |
| Varilla = | # 4 | | Varilla = | # 4 | |
| Area varilla= | 1.29 | cm² | Area varilla= | 1.29 | cm² |
| Sep. Varilla= | 25 | cm | Sep. Varilla= | 25 | cm |
| Es = | 2040000.00 | kg/cm² | Es = | 2040000.00 | kg/cm² |
| Ec = | 209165.01 | kg/cm² | Ec = | 209165.01 | kg/cm² |
| n = | 9.75 | | n = | 9.75 | |
| Ms = | 0.60 | T-m | Ms = | 0.64 | T-m |
| As = | 5.16 | cm²/m | As = | 5.16 | cm²/m |
| ρ = | 0.002064 | | ρ = | 0.002064 | |
| k = | 0.18 | | k = | 0.18 | |
| j = | 0.94 | | j = | 0.94 | |
| jd = | 23.49 | cm² | jd = | 23.49 | cm² |
| fs = | 495.07 | kg/cm² | fs = | 530.44 | kg/cm² |
| 0.45fy = | 1890.00 | kg/cm² | 0.45fy = | 1890.00 | kg/cm² |
| z = | 5333.01 | kg-cm cumple | z = | 5713.94 | kg-cm cumple |
| **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | | **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | |

| *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | | *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | |
|---|---|---|---|---|---|---|---|
| | Mcr = | 1.12 | T-m | | Mcr = | 1.20 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | $\rho_{cr}$ = | 0.000475 | | | $\rho_{cr}$ = | 0.000509 | |
| Por lo tanto | $As_{cr}$ = | 1.19 | $cm^2/m$ | Por lo tanto | $As_{cr}$ = | 1.27 | $cm^2/m$ |
| | cumple | | | | cumple | | |
| | #3/cada = | 0.598 | m | | #3/cada = | 0.558 | m |
| | #4/cada = | 1.070 | m | | #4/cada = | 0.999 | m |
| | #5/cada = | 1.677 | m | | #5/cada = | 1.565 | m |
| | #6/cada = | 2.393 | m | | #6/cada = | 2.233 | m |
| | #7/cada = | 3.261 | m | | #7/cada = | 3.043 | m |
| | #8/cada = | 4.298 | m | | #8/cada = | 4.010 | m |

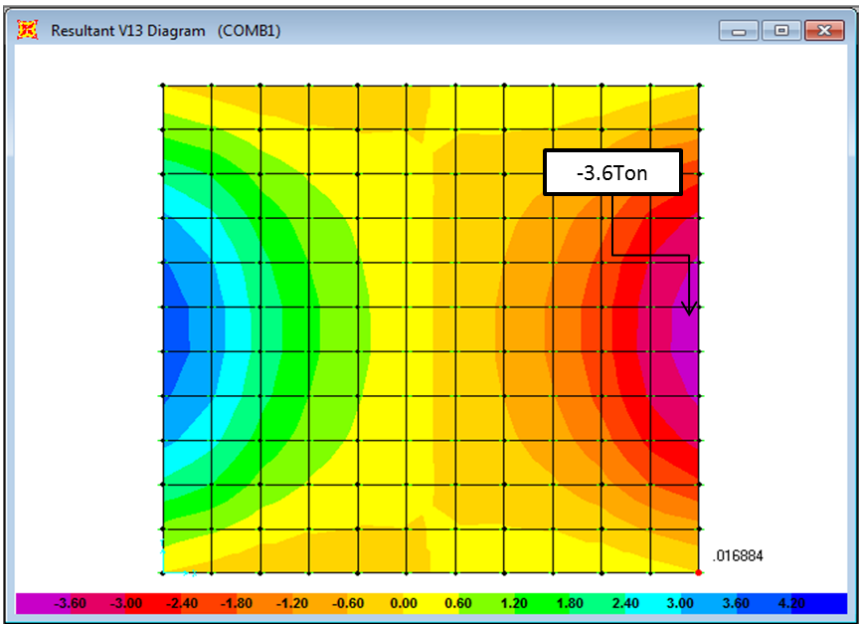
## M11


Resultant M11 Diagram (COMB1)
-0.76 Ton m
-720. -600. -480. -360. -240. -120. 0. 120. 240. 360. 480. 600. 720. 840. E-3

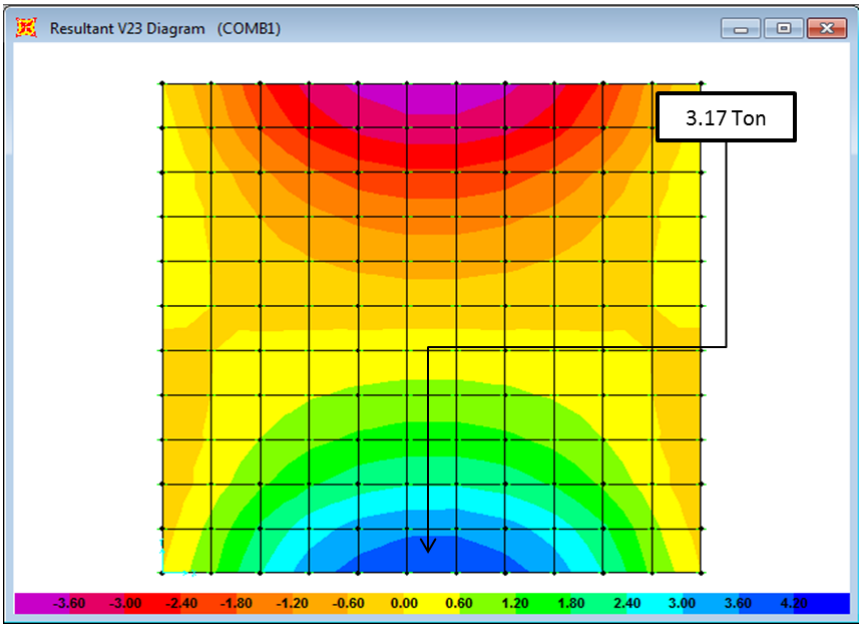
## M22


Resultant M22 Diagram (COMB1)
-0.56 Ton m
-840. -700. -560. -420. -280. -140. 0. 140. 280. 420. 560. 700. 840. 980. E-3

## V13


Resultant V13 Diagram (COMB1)
-3.6Ton
.016884
-3.60 -3.00 -2.40 -1.80 -1.20 -0.60 0.00 0.60 1.20 1.80 2.40 3.00 3.60 4.20

## V23


Resultant V23 Diagram (COMB1)
3.17 Ton
-3.60 -3.00 -2.40 -1.80 -1.20 -0.60 0.00 0.60 1.20 1.80 2.40 3.00 3.60 4.20

**TUBERIA DE Φ20" CON VENTOSA DE Φ3"**

**REFUERZO PLACA SUPERIOR**

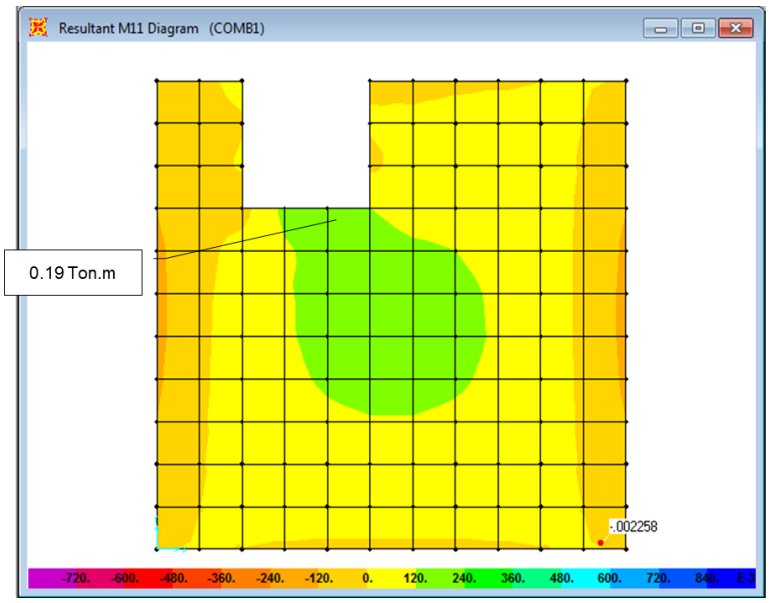
b = 100 cm | fy = 4200 kg/cm2
H = 30 cm | d = 25.0 cm | fc= 280 kg/cm2

| *Chequeo a flexión MOMENTO M11* | | | | *Chequeo a flexión MOMENTO M22* | | | |
|---|---|---|---|---|---|---|---|
| Coef. Durab. | ϕ = | 1.00 | | | ϕ = | 1.00 | |
| | Mu = | 0.19 | T-m | | Mu = | 0.20 | T-m |
| | ϕMu = | 0.19 | T-m | | ϕMu = | 0.20 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | ρ = | 0.000080 | | | ρ = | 0.000085 | |
| | $\rho_{min}$ = | 0.002000 | | | $\rho_{min}$ = | 0.002000 | |
| Por lo tanto | As = | 5.00 | $cm^2/m$ | Por lo tanto | As = | 5.00 | $cm^2/m$ |
| | #3/cada = | 0.142 | m | | #3/cada = | 0.142 | m |
| | #4/cada = | 0.254 | m | | #4/cada = | 0.254 | m |
| | #5/cada = | 0.398 | m | | #5/cada = | 0.398 | m |
| | #6/cada = | 0.568 | m | | #6/cada = | 0.568 | m |
| | #7/cada = | 0.774 | m | | #7/cada = | 0.774 | m |
| | #8/cada = | 1.020 | m | | #8/cada = | 1.020 | m |

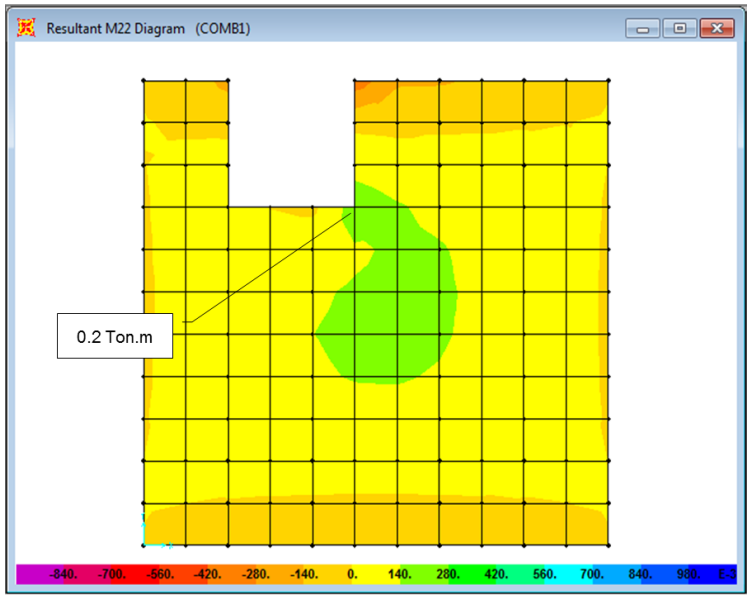
| **CORTANTE V13** | | | **CORTANTE V23** | | |
|---|---|---|---|---|---|
| vu (ton)= | 0.90 | | vu (ton)= | 2.06 | |
| Øvc (ton)= | 18.85 | | Øvc (ton)= | 18.85 | |
| | CUMPLE | | | CUMPLE | |
| Varilla = | # 4 | | Varilla = | # 4 | |
| Area varilla= | 1.29 | $cm^2$ | Area varilla= | 1.29 | $cm^2$ |
| Sep. Varilla= | 25 | cm | Sep. Varilla= | 25 | cm |
| Es = | 2040000.00 | $kg/cm^2$ | Es = | 2040000.00 | $kg/cm^2$ |
| Ec = | 209165.01 | $kg/cm^2$ | Ec = | 209165.01 | $kg/cm^2$ |
| n = | 9.75 | | n = | 9.75 | |
| Ms = | 0.14 | T-m | Ms = | 0.14 | T-m |
| As = | 5.16 | $cm^2/m$ | As = | 5.16 | $cm^2/m$ |
| ρ = | 0.002064 | | ρ = | 0.002064 | |
| k = | 0.18 | | k = | 0.18 | |
| j = | 0.94 | | j = | 0.94 | |
| jd = | 23.49 | $cm^2$ | jd = | 23.49 | $cm^2$ |
| fs = | 111.98 | $kg/cm^2$ | fs = | 117.87 | $kg/cm^2$ |
| 0.45fy = | 1890.00 | $kg/cm^2$ | 0.45fy = | 1890.00 | $kg/cm^2$ |
| z = | 1206.28 | kg-cm cumple | z = | 1269.76 | kg-cm cumple |
| **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | | **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | |

| *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | | *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | |
|---|---|---|---|---|---|---|---|
| | Mcr = | 0.25 | T-m | | Mcr = | 0.27 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | $\rho_{cr}$ = | 0.000107 | | | $\rho_{cr}$ = | 0.000113 | |
| Por lo tanto | $As_{cr}$ = | 0.27 | $cm^2/m$ | Por lo tanto | $As_{cr}$ = | 0.28 | $cm^2/m$ |
| | cumple | | | | cumple | | |
| | #3/cada = | 2.653 | m | | #3/cada = | 2.520 | m |
| | #4/cada = | 4.745 | m | | #4/cada = | 4.508 | m |
| | #5/cada = | 7.435 | m | | #5/cada = | 7.063 | m |
| | #6/cada = | 10.611 | m | | #6/cada = | 10.080 | m |
| | #7/cada = | 14.460 | m | | #7/cada = | 13.736 | m |
| | #8/cada = | 19.056 | m | | #8/cada = | 18.102 | m |

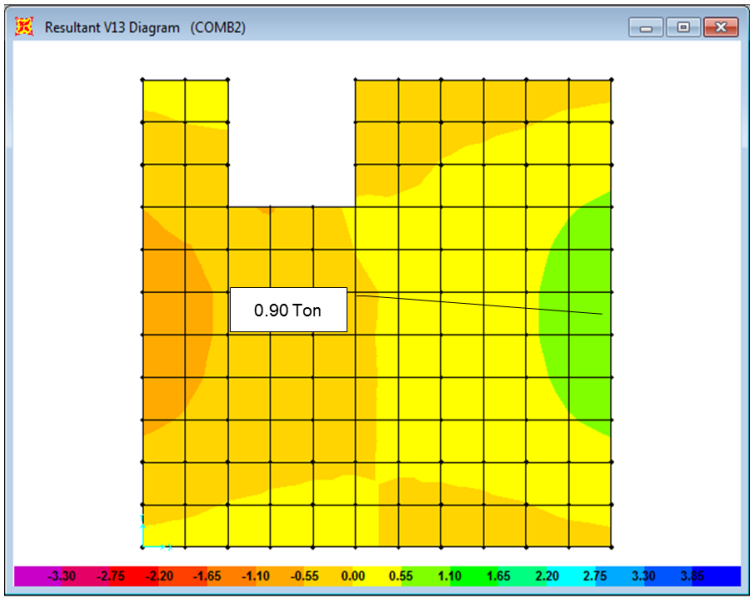
## M11


Resultant M11 Diagram (COMB1)
0.19 Ton.m
-.002258
-720. -600. -480. -360. -240. -120. 0. 120. 240. 360. 480. 600. 720. 840.

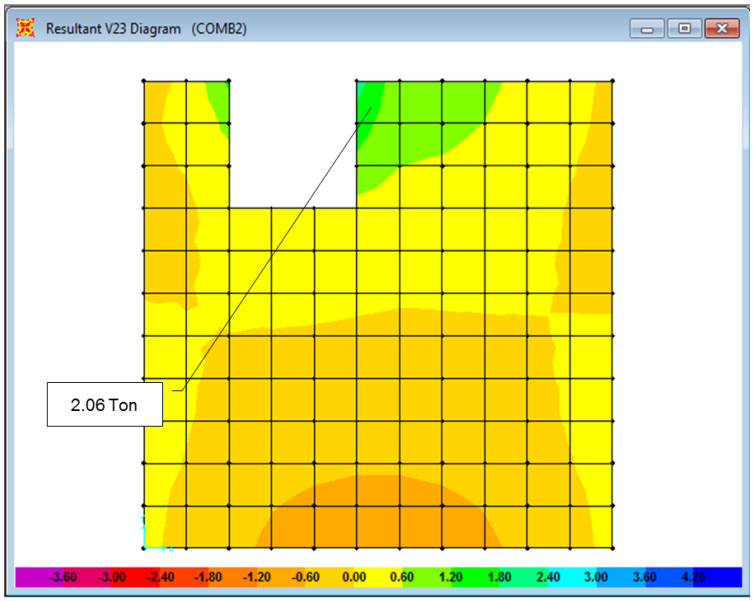
## M22


Resultant M22 Diagram (COMB1)
0.2 Ton.m
-840. -700. -560. -420. -280. -140. 0. 140. 280. 420. 560. 700. 840. 980.

## V13


Resultant V13 Diagram (COMB2)
0.90 Ton
-3.30 -2.75 -2.20 -1.65 -1.10 -0.55 0.00 0.55 1.10 1.65 2.20 2.75 3.30 3.85

## V23


Resultant V23 Diagram (COMB2)
2.06 Ton
-3.60 -3.00 -2.40 -1.80 -1.20 -0.60 0.00 0.60 1.20 1.80 2.40 3.00 3.60 4.20

**TUBERIA DE Φ20" CON VENTOSA DE Φ3"**

**REFUERZO MUROS**

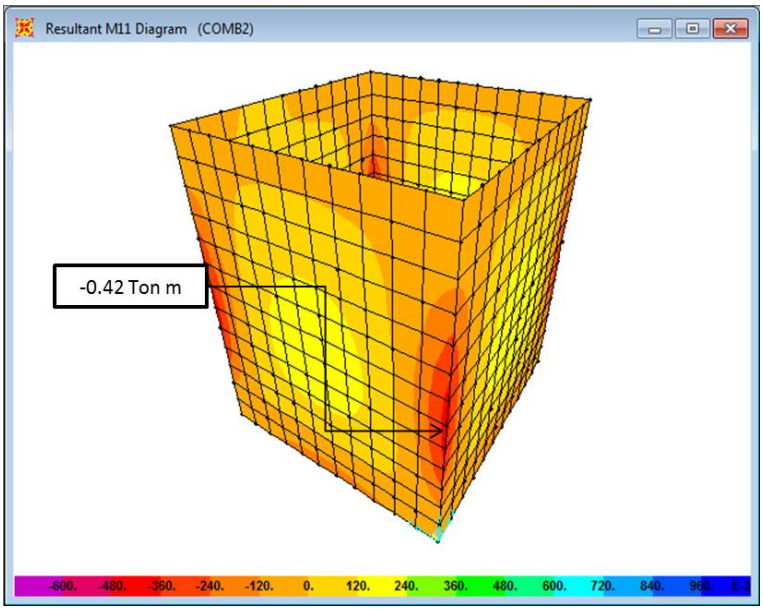
b = 100 cm | fy = 4200 kg/cm2
H = 30 cm | d = 25.0 cm | fc= 280 kg/cm2

| *Chequeo a flexión MOMENTO M11* | | | | *Chequeo a flexión MOMENTO M22* | | | |
|---|---|---|---|---|---|---|---|
| Coef. Durab. | ϕ = | 1.00 | | | ϕ = | 1.00 | |
| | Mu = | 0.42 | T-m | | Mu = | 1.06 | T-m |
| | ϕMu = | 0.42 | T-m | | ϕMu = | 1.06 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | ρ = | 0.000178 | | | ρ = | 0.000450 | |
| | $\rho_{min}$ = | 0.002000 | | | $\rho_{min}$ = | 0.002000 | |
| Por lo tanto | As = | 5.00 | $cm^2/m$ | Por lo tanto | As = | 5.00 | $cm^2/m$ |
| | #3/cada = | 0.142 | m | | #3/cada = | 0.142 | m |
| | #4/cada = | 0.254 | m | | #4/cada = | 0.254 | m |
| | #5/cada = | 0.398 | m | | #5/cada = | 0.398 | m |
| | #6/cada = | 0.568 | m | | #6/cada = | 0.568 | m |
| | #7/cada = | 0.774 | m | | #7/cada = | 0.774 | m |
| | #8/cada = | 1.020 | m | | #8/cada = | 1.020 | m |

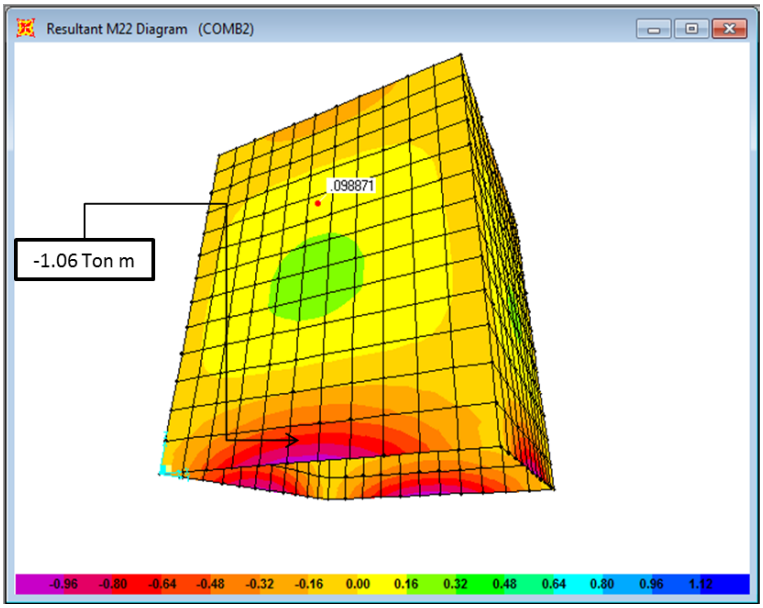
| **CORTANTE V13** | | | **CORTANTE V23** | | |
|---|---|---|---|---|---|
| vu (ton)= | 1.11 | | vu (ton)= | 2.63 | |
| Øvc (ton)= | 18.85 | | Øvc (ton)= | 18.85 | |
| | CUMPLE | | | CUMPLE | |
| Varilla = | # 4 | | Varilla = | # 4 | |
| Area varilla= | 1.29 | cm² | Area varilla= | 1.29 | cm² |
| Sep. Varilla= | 25 | cm | Sep. Varilla= | 25 | cm |
| Es = | 2040000.00 | kg/cm² | Es = | 2040000.00 | kg/cm² |
| Ec = | 209165.01 | kg/cm² | Ec = | 209165.01 | kg/cm² |
| n = | 9.75 | | n = | 9.75 | |
| Ms = | 0.30 | T-m | Ms = | 0.76 | T-m |
| As = | 5.16 | cm²/m | As = | 5.16 | cm²/m |
| ρ = | 0.002064 | | ρ = | 0.002064 | |
| k = | 0.18 | | k = | 0.18 | |
| j = | 0.94 | | j = | 0.94 | |
| jd = | 23.49 | cm² | jd = | 23.49 | cm² |
| fs = | 247.54 | kg/cm² | fs = | 624.73 | kg/cm² |
| 0.45fy = | 1890.00 | kg/cm² | 0.45fy = | 1890.00 | kg/cm² |
| z = | 2666.50 | kg-cm cumple | z = | 6729.75 | kg-cm cumple |
| **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | | **SE COLOCARA REFUERZO #4 C/ 0.25 m** | | |

| *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | | *MOMENTO DE AGRIETAMIENTO POR FLEXION* | | | |
|---|---|---|---|---|---|---|---|
| | Mcr = | 0.56 | T-m | | Mcr = | 1.41 | T-m |
| Por lo tanto: | | | | Por lo tanto: | | | |
| | $\rho_{cr}$ = | 0.000237 | | | $\rho_{cr}$ = | 0.000600 | |
| Por lo tanto | $As_{cr}$ = | 0.59 | $cm^2/m$ | Por lo tanto | $As_{cr}$ = | 1.50 | $cm^2/m$ |
| | | cumple | | | | cumple | |
| | #3/cada = | 1.199 | m | | #3/cada = | 0.474 | m |
| | #4/cada = | 2.144 | m | | #4/cada = | 0.847 | m |
| | #5/cada = | 3.360 | m | | #5/cada = | 1.328 | m |
| | #6/cada = | 4.795 | m | | #6/cada = | 1.895 | m |
| | #7/cada = | 6.535 | m | | #7/cada = | 2.582 | m |
| | #8/cada = | 8.612 | m | | #8/cada = | 3.402 | m |

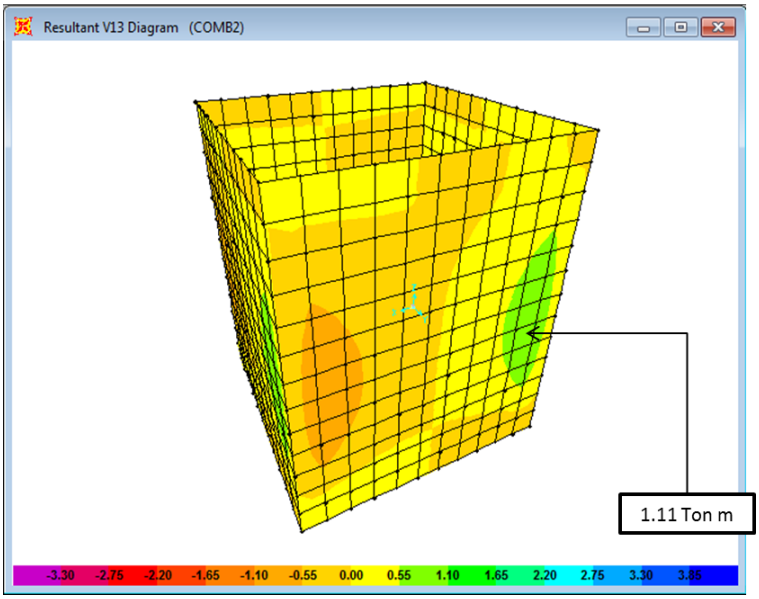
## M11


Resultant M11 Diagram (COMB2)
-0.42 Ton m
-600. -480. -360. -240. -120. 0. 120. 240. 360. 480. 600. 720. 840. 960.

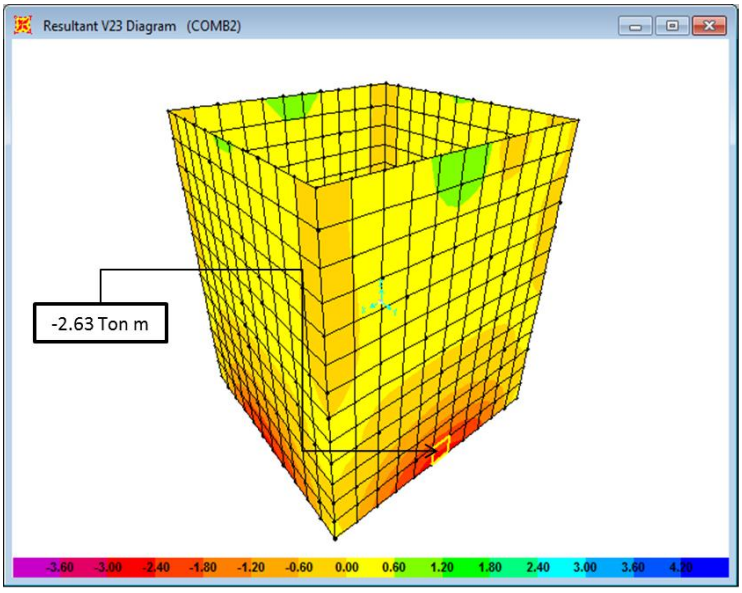
## M22


Resultant M22 Diagram (COMB2)
.098871
-1.06 Ton m
-0.96 -0.80 -0.64 -0.48 -0.32 -0.16 0.00 0.16 0.32 0.48 0.64 0.80 0.96 1.12

## V13

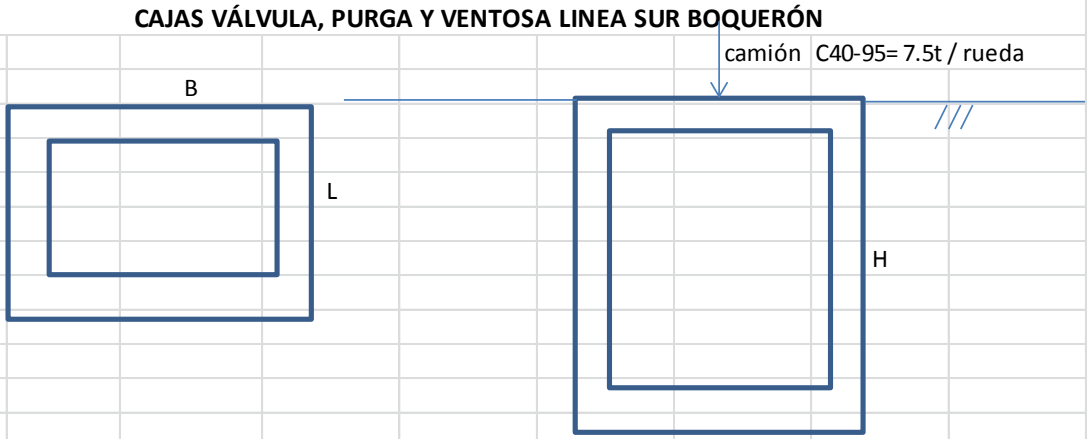

Resultant V13 Diagram (COMB2)
1.11 Ton m
-3.30 -2.75 -2.20 -1.65 -1.10 -0.55 0.00 0.55 1.10 1.65 2.20 2.75 3.30 3.85

## V23


Resultant V23 Diagram (COMB2)
-2.63 Ton m
-3.60 -3.00 -2.40 -1.80 -1.20 -0.60 0.00 0.60 1.20 1.80 2.40 3.00 3.60 4.20

# *9. REVISIÓN DE SUPRESIONES*

**CAJAS VÁLVULA, PURGA Y VENTOSA LINEA SUR BOQUERÓN**




**No se encontro nivel freatico**

| Caja | Area | | Altura Caja | Espesor Pared | Peso Valvula | Peso Propio | Peso Total | Esfuerzo Sobre Suelo |
|---|---|---|---|---|---|---|---|---|
| | (m) | (m) | (m) | (m) | (Ton) | (Ton) | (Ton) | (Ton/m2) |
| **Valvula Mariposa 20"** | 1.80 | 2.22 | 2.30 | 0.30 | 0.50 | 17.08 | 17.58 | 4.40 |
| **Purga de 4"** | 1.70 | 1.51 | 2.82 | 0.30 | 0.50 | 14.30 | 14.80 | 5.76 |
| **Ventosa de 3"** | 2.30 | 2.20 | 2.70 | 0.30 | 0.50 | 22.45 | 22.95 | 4.54 |