

COLEGIO PABLO VI
RAMPA DE ACCESO
NARIÑO

MEMORIAS DE CÁLCULO ESTRUCTURAL

Análisis y diseño:
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Noviembre de 2016

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1.1 Introducción

Las presentes memorias de cálculo resumen las labores adelantadas para el análisis y diseño de la estructura de la rampa de acceso para el colegio Pablo VI en el municipio de Taminango en el Departamento de Nariño.

La estructura de la rampa se constituye en pórticos en concreto reforzado. Las secciones de las columnas son de 50x50cm que tienen en una altura máxima de 3.20 metros. De las vigas sale la placa de la rampa la cual trabaja en voladizo y transcurren con la pendiente con que se diseñó arquitectónicamente la rampa; estas vigas tienen secciones de 40x50cm.

La cimentación de la rampa se constituye en zapatas aisladas.

1.2 Normas de diseño

Se utilizó como guía para el análisis y diseño la Norma para Construcciones Sismo Resistentes – NSR 10.

1.3 Materiales

Concreto de limpieza: $f'c=14$ MPa

Concreto para columnas, vigas y placa: $f'c=28$ MPa

Acero de refuerzo $f_y = 4200$ Kg/cm², para $\varnothing \geq 3/8"$

1.4 Evaluación de Cargas

Carga permanente (CM)

| | | |
|---------------|--|----------------------|
| Peso Propio* | | |
| Peso acabados | | 0 Kg./m ² |
| Peso barandas | | 100 Kg./m |
| | | |

*El peso propio es calculado directamente por el programa.

Carga Viva sobre cubierta (L)

Se toma 500 Kg/m², para uso de corredores y escaleras para edificios institucionales según B.4.2.1 del NSR-10

Carga de Granizo (G)

NO APLICA

Carga de Viento (W)

NO APLICA

Carga de Sismo (SPEC)

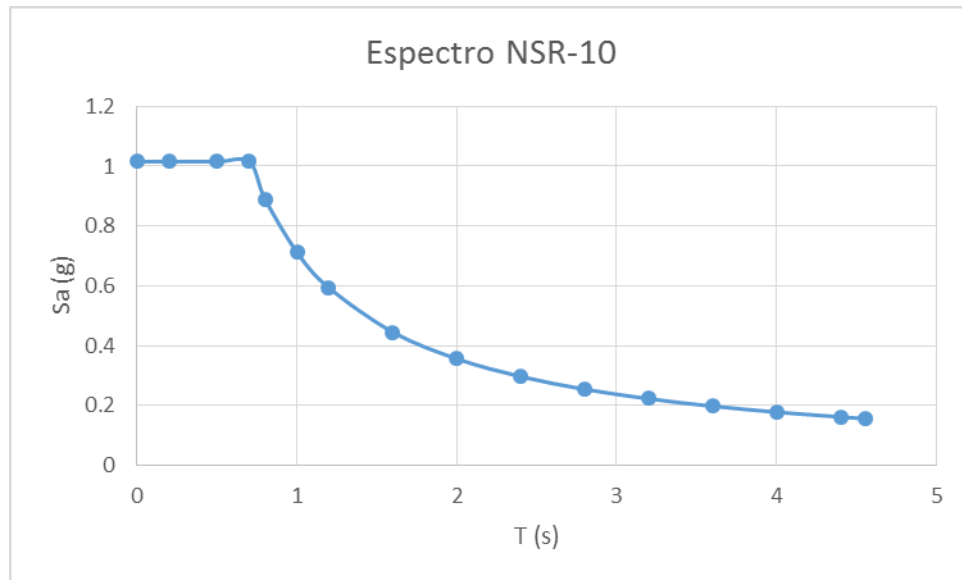
La carga de sismo se representa a través de los coeficientes de diseño que genera una curva para zona de respuesta sísmica ALTA de acuerdo al reglamento de construcciones sismo-resistentes de Colombia NSR-10.

Coeficientes de Diseño y curva para un amortiguamientos de 5% con respecto al crítico.

| Municipio | | | | Grupo de uso | Perfil de suelo | |
|-------------------------|------------------------------------|-----------------------------|---------------------------|--------------------------------|-----------------|-----|
| Taminango | | | | III | D | |
| Zona de amenaza sísmica | Capacidad de disipación de energía | Aceleración horizontal (Aa) | Velocidad Horizontal (Av) | Coeficiente de Importancia (I) | Fa | Fv |
| ALTA | DES | 0.35 | 0.35 | 1.25 | 1.05 | 2.6 |

| Datos | |
|-------|----------|
| Aa | 0.25 |
| Av | 0.25 |
| Fa | 1.3 |
| Fv | 1.9 |
| I | 1.25 |
| T0 | 0.146154 |
| Tc | 0.701538 |
| TI | 4.56 |
| Sa | 1.015625 |

| T (s) | Sa (g) |
|----------|----------|
| 0 | 1.015625 |
| 0.2 | 1.015625 |
| 0.5 | 1.015625 |
| 0.701538 | 1.015625 |
| 0.8 | 0.890625 |
| 1 | 0.7125 |
| 1.2 | 0.59375 |
| 1.6 | 0.445313 |
| 2 | 0.35625 |
| 2.4 | 0.296875 |
| 2.8 | 0.254464 |
| 3.2 | 0.222656 |
| 3.6 | 0.197917 |
| 4 | 0.178125 |
| 4.4 | 0.161932 |
| 4.56 | 0.15625 |



1.5 Modelo

Se implementó un modelo estructural en tres dimensiones en el programa de análisis SAP 2000 V.15. Se utilizaron elementos tipo frame para simular vigas y columnas y tipo Shell para las placas de la rampa.

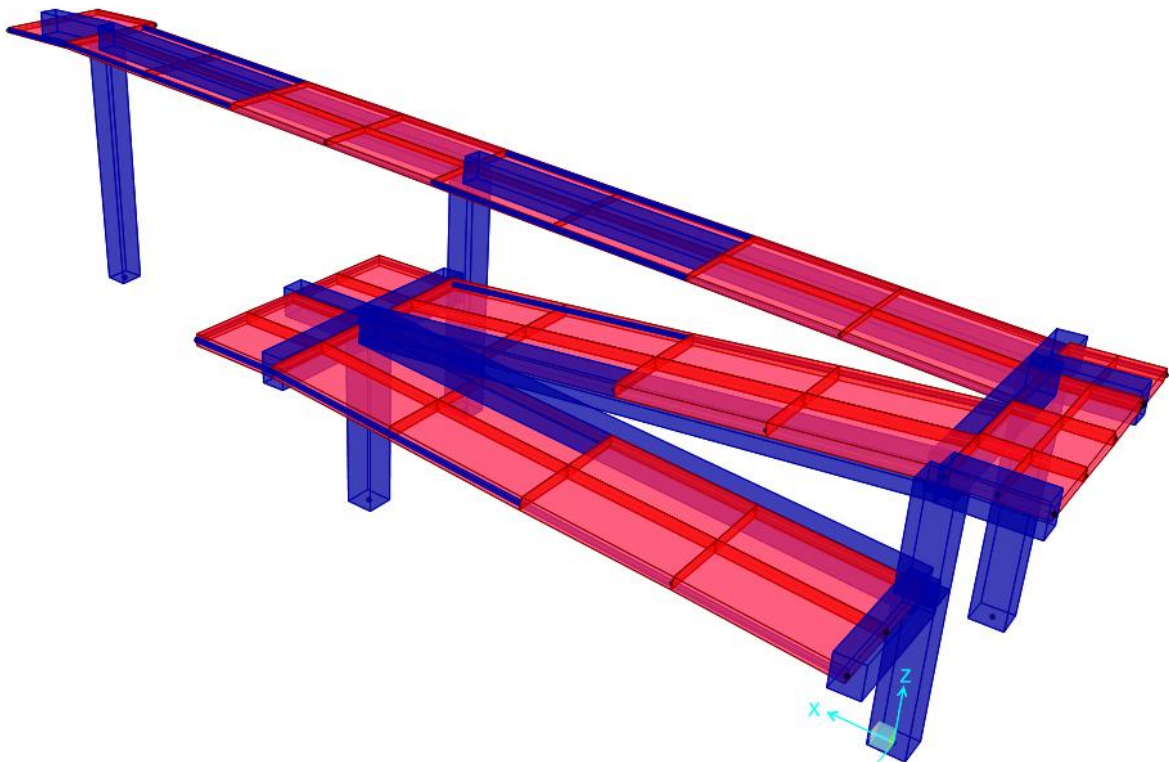


FIGURA 1. VISTA ESTRUCTURA RAMPA.

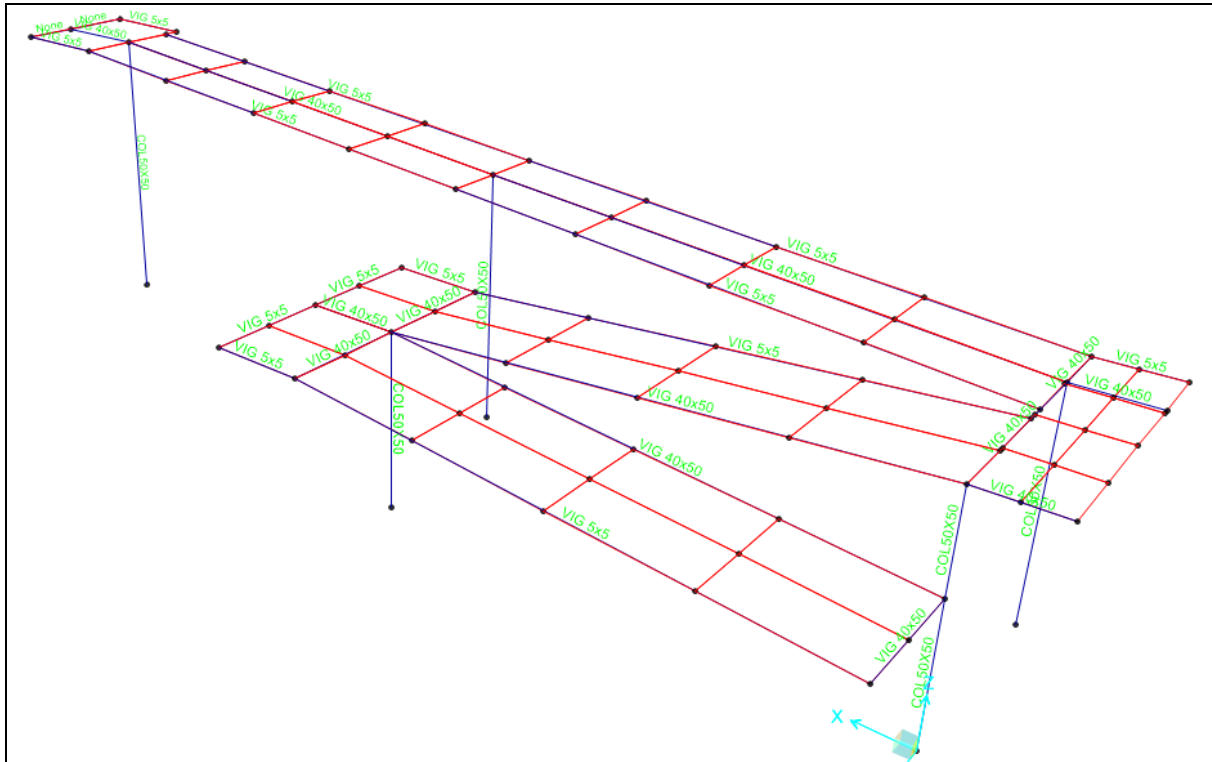


FIGURA 2. SECCIONES DE ELEMENTOS

TABLE: Frame Section Properties 01 - General

| SectionName | Material | Shape | t3 | t2 | Area | TorsConst | I33 | I22 |
|-------------|----------|-------------|------|------|--------|-----------|-----------|-----------|
| Text | Text | Text | m | m | m2 | m4 | m4 | m4 |
| COL50X50 | 4000Psi | Rectangular | 0.5 | 0.5 | 0.25 | 0.008802 | 0.005208 | 0.005208 |
| VIG 40x50 | 4000Psi | Rectangular | 0.5 | 0.4 | 0.2 | 0.005474 | 0.004167 | 0.002667 |
| VIG 5x5 | 4000Psi | Rectangular | 0.05 | 0.05 | 0.0025 | 8.802E-07 | 5.208E-07 | 5.208E-07 |

TABLE: Area Section Properties

| Section | Material | MatAngle | AreaType | Type | DrillDOF | Thickness | BendThick |
|-------------|----------|----------|----------|------------|----------|-----------|-----------|
| Text | Text | Degrees | Text | Text | Yes/No | m | m |
| PLACA RAMPA | 4000Psi | 0 | Shell | Shell-Thin | No | 0.2 | 0.2 |
| PLRAMPAPINT | 4000Psi | 0 | Shell | Shell-Thin | No | 0.12 | 0.12 |

Condiciones Modelo

- Se utilizan elementos tipo frame con seis grados de libertad por nudo.
- Condiciones de frontera: Empotramiento en la base.

- Entrepiso como diafragma rígido.
- Se realiza análisis Sísmico por Método Modal Espectral, **Rox= 7.0**
- Se realiza análisis Sísmico por Método Modal Espectral, **Roy= 2.0**

1.6 Combinaciones de Carga

Según la norma NSR-10 CAP B.2 sección B.2.4.2

Combinación: Combo 1, 1.0 CM + 1.0 L
 Combo 2, 1.2 CM+ 1.6 L
 Combo 3, 1.2 CM + S X/R + 0.3 SY/R
 Combo 4, 1.2 CM + S Y /R + 0.3 SX/R
 Sobre Resistencia: Combo 5, 1.2 CM + 1.0 L+ SX/R + 0.3 SY/R
 Combo 6, 0.9 CM + SX/R + 0.3 SY/R

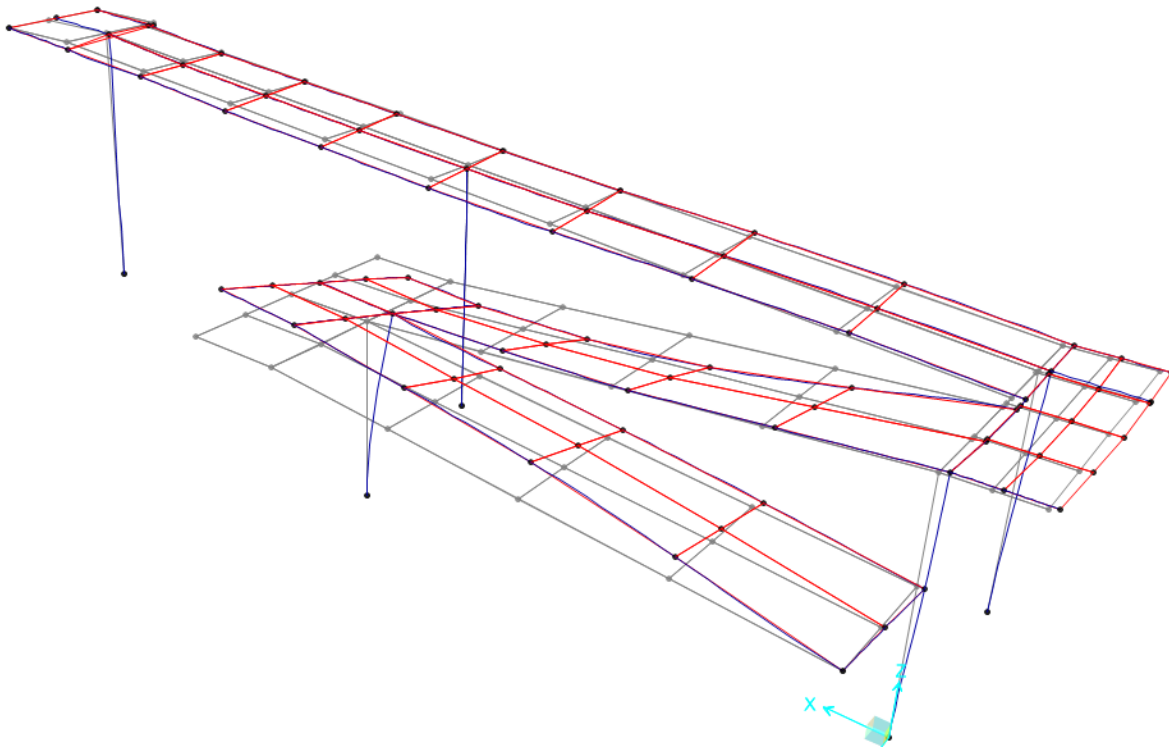
CM: Carga Muerta

L: Carga Viva

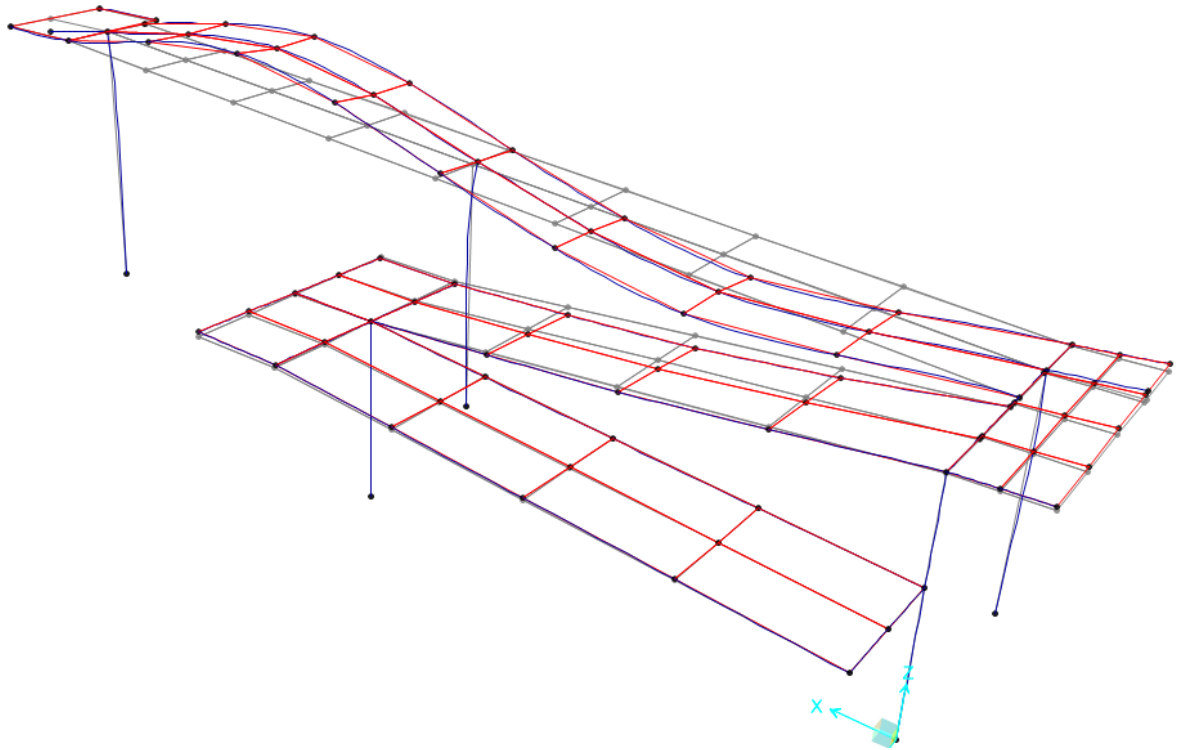
SX: (sismo en x)

SY: (sismo en y)

MODOS DE VIBRACIÓN SENTIDO X (T=0.15433)



SENTIDO Y (T=0.12552)



Parámetros dinámicos del modelo Matemático

| TABLE: Modal Participating Mass Ratios | | | | | | | | |
|--|----------|----------|----------|----------|-------------|-------------|----------|----------|
| OutputCase | StepType | StepNum | Period | UX | UY | UZ | SumUX | SumUY |
| Text | Text | Unitless | Sec | Unitless | Unitless | Unitless | Unitless | Unitless |
| MODAL | Mode | 1 | 0.15433 | 0.103988 | 0.13162 | 0.000422 | 0.103988 | 0.13162 |
| MODAL | Mode | 2 | 0.133275 | 0.000539 | 0.023369 | 0.000004172 | 0.104527 | 0.154989 |
| MODAL | Mode | 3 | 0.1313 | 0.007211 | 0.393201 | 0.004857 | 0.111738 | 0.54819 |
| MODAL | Mode | 4 | 0.119217 | 0.000524 | 0.005179 | 0.29077 | 0.112263 | 0.553369 |
| MODAL | Mode | 5 | 0.110587 | 0.004783 | 0.007068 | 0.142933 | 0.117046 | 0.560437 |
| MODAL | Mode | 6 | 0.104292 | 0.001377 | 0.004388 | 0.010599 | 0.118423 | 0.564825 |
| MODAL | Mode | 7 | 0.102187 | 0.013836 | 0.135954 | 0.005322 | 0.132259 | 0.700779 |
| MODAL | Mode | 8 | 0.073101 | 0.000359 | 0.00923 | 0.000091 | 0.132618 | 0.710009 |
| MODAL | Mode | 9 | 0.071305 | 0.123034 | 0.00751 | 0.000001442 | 0.255651 | 0.717519 |
| MODAL | Mode | 10 | 0.067516 | 0.025589 | 0.088406 | 0.000476 | 0.281241 | 0.805925 |
| MODAL | Mode | 11 | 0.06583 | 0.007094 | 0.001751 | 0.000045 | 0.288335 | 0.807676 |
| MODAL | Mode | 12 | 0.058048 | 0.000851 | 6.985E-07 | 0.009899 | 0.289186 | 0.807677 |
| MODAL | Mode | 13 | 0.056595 | 0.198462 | 0.009299 | 0.000824 | 0.487648 | 0.816976 |
| MODAL | Mode | 14 | 0.051601 | 0.05261 | 0.002372 | 0.000341 | 0.540258 | 0.819348 |
| MODAL | Mode | 15 | 0.050226 | 0.001582 | 0.000105 | 0.030895 | 0.541839 | 0.819453 |
| MODAL | Mode | 16 | 0.049194 | 0.002966 | 0.000978 | 0.005546 | 0.544805 | 0.820431 |
| MODAL | Mode | 17 | 0.047989 | 0.00006 | 0.00000809 | 0.012333 | 0.544865 | 0.820439 |
| MODAL | Mode | 18 | 0.046049 | 0.000193 | 0.000073 | 0.051236 | 0.545058 | 0.820512 |
| MODAL | Mode | 19 | 0.045548 | 0.017768 | 0.000009803 | 0.006199 | 0.562826 | 0.820522 |
| MODAL | Mode | 20 | 0.043713 | 0.005109 | 0.001287 | 0.004961 | 0.567936 | 0.821809 |
| MODAL | Mode | 21 | 0.043247 | 0.004565 | 0.000544 | 0.000017 | 0.572501 | 0.822353 |
| MODAL | Mode | 22 | 0.042248 | 0.040942 | 0.000615 | 0.005945 | 0.613443 | 0.822968 |
| MODAL | Mode | 23 | 0.041272 | 0.305547 | 0.000106 | 0.000131 | 0.918989 | 0.823074 |
| MODAL | Mode | 24 | 0.038668 | 0.000049 | 0.000014 | 0.000257 | 0.919039 | 0.823089 |

Ajuste de Resultados

- (b) Cuando el valor del cortante dinámico total en la base, V_{tj} , obtenido después de realizar la combinación modal, para cualquiera de las direcciones de análisis, j , sea menor que el 80 por ciento para estructuras regulares, o que el 90 por ciento para estructura irregulares, del cortante sísmico en la base, V_s , calculado como se indicó en (a), todos los parámetros de la respuesta dinámica, tales como deflexiones, derivas, fuerzas en los pisos, cortantes de piso, cortante en la base y fuerzas en los elementos de la correspondiente dirección j deben multiplicarse por el siguiente factor de modificación:

$$0.80 \frac{V_s}{V_{tj}} \quad \text{para estructuras regulares} \quad (\text{A.5.4-4})$$

A-70

NSR-10 — Capítulo A.5 — Método del análisis dinámico

$$0.90 \frac{V_s}{V_{tj}} \quad \text{para estructuras irregulares} \quad (\text{A.5.4-5})$$

- (c) Cuando el cortante sísmico en la base, V_{tj} , obtenido después de realizar la combinación modal, para cualquiera de las direcciones principales, excede los valores prescritos en (a), todos los parámetros de la respuesta dinámica total, tales como deflexiones, derivas, fuerzas en los pisos, cortantes de piso, cortante en la base y fuerzas en los elementos, pueden reducirse proporcionalmente, a juicio del diseñador.

| TA+A1:I12BLE: Joint Reactions | | | | | | | | |
|-------------------------------|------------|-----------|---------|---------|---------|----------|----------|----------|
| Joint | OutputCase | CaseType | F1 | F2 | F3 | M1 | M2 | M3 |
| Text | Text | Text | Tonf | Tonf | Tonf | Tonf-m | Tonf-m | Tonf-m |
| 15 | DEAD | LinStatic | -0.4664 | -0.0451 | 0.0755 | 0 | 0 | 0 |
| 15 | PERMANENTE | LinStatic | -0.1828 | -0.0149 | 0.0119 | 0 | 0 | 0 |
| 17 | DEAD | LinStatic | 0.1073 | -0.0845 | 0.5584 | 0 | 0 | 0 |
| 17 | PERMANENTE | LinStatic | 0.0332 | -0.0246 | 0.154 | 0 | 0 | 0 |
| 21 | DEAD | LinStatic | 3.1725 | 0.2086 | 15.2922 | -0.14437 | 2.63091 | 0.13174 |
| 21 | PERMANENTE | LinStatic | 0.4219 | 0.0371 | 1.159 | -0.0262 | 0.35226 | 0.01922 |
| 22 | DEAD | LinStatic | 0.9288 | -0.7511 | 2.4647 | 0 | 0 | 0 |
| 22 | PERMANENTE | LinStatic | 0.0748 | -0.0724 | 0.3841 | 0 | 0 | 0 |
| 23 | DEAD | LinStatic | 2.0995 | 0.5275 | 12.7389 | -0.80824 | 2.69858 | 0.0273 |
| 23 | PERMANENTE | LinStatic | 0.4253 | 0.0338 | 1.356 | -0.05761 | 0.55081 | 0.00616 |
| 28 | DEAD | LinStatic | -1.3348 | 0.1043 | 9.8666 | -0.18674 | -2.42124 | -0.0134 |
| 28 | PERMANENTE | LinStatic | -0.2735 | 0.0301 | 1.0876 | -0.05363 | -0.49314 | -0.00448 |
| 29 | DEAD | LinStatic | 0.0412 | 0.0638 | 14.2952 | -0.1887 | 0.06772 | -0.00949 |
| 29 | PERMANENTE | LinStatic | 0.0141 | 0.0122 | 2.1025 | -0.04123 | 0.0261 | -0.00106 |
| 30 | DEAD | LinStatic | -4.5481 | -0.0236 | 22.3893 | -0.12093 | -4.70935 | -0.02504 |
| 30 | PERMANENTE | LinStatic | -0.5129 | -0.0014 | 2.6722 | -0.01939 | -0.53236 | -0.00062 |
| | | | | | 86.6081 | Tn | | |

| TABLE: Base Reactions | | | |
|-----------------------|------------|-----------|----------|
| OutputCase | GlobalFX | GlobalFY | GlobalFZ |
| Text | Tonf | Tonf | Tonf |
| DEAD | -4.374E-14 | 5.252E-13 | 77.6808 |
| PERMANENTE | -2.817E-15 | 6.115E-14 | 8.9273 |
| SPECX | 67.6947 | 30.8249 | 5.917 |
| SPECY | 22.2125 | 56.6928 | 6.1171 |

| Ajuste | |
|------------|-----------------|
| Wdead | 77.6808 |
| Wperm | 8.9273 |
| Wt (ton) | 86.6081 |
| V (Sa*W) | 87.96135 |
| SPECX | 67.6947 |
| SPECY | 56.6928 |
| 0.8*V | 70.36908 |
| Fax | 1.039507 |
| Fay | 1.241235 |

1.6.1 Distribución de cargas

Carga Permanente: 100 Kg/m²:

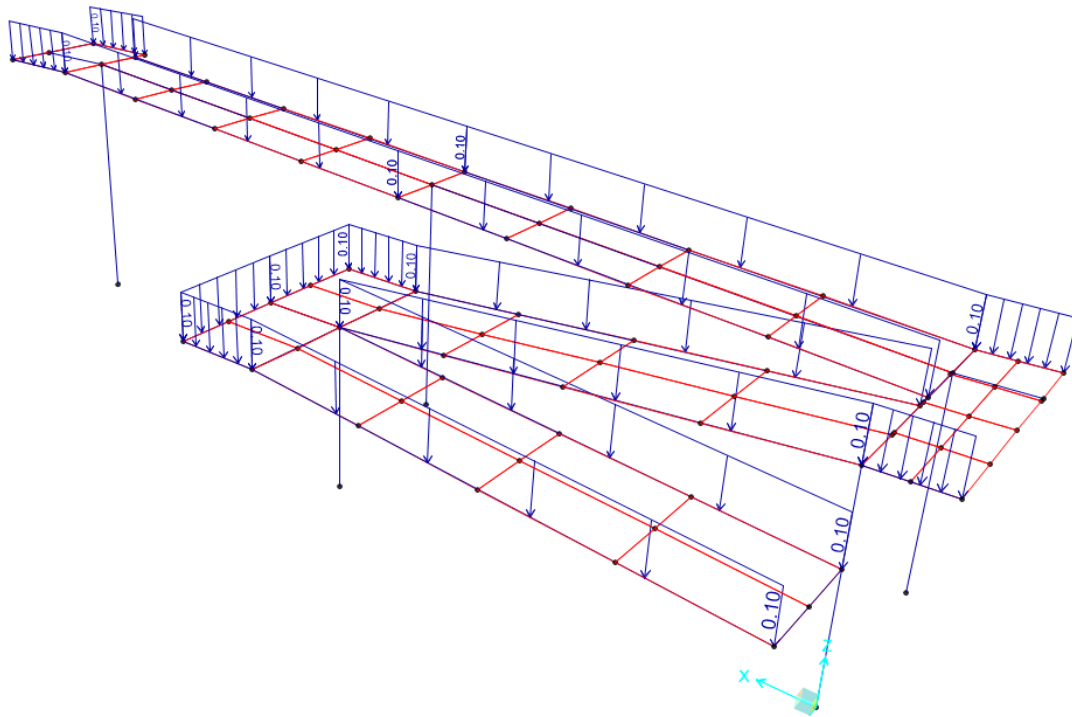


FIGURA 4. DISTRIBUCIÓN DE CARGA PERMANENTE

Carga Viva: 500 Kg/m²:

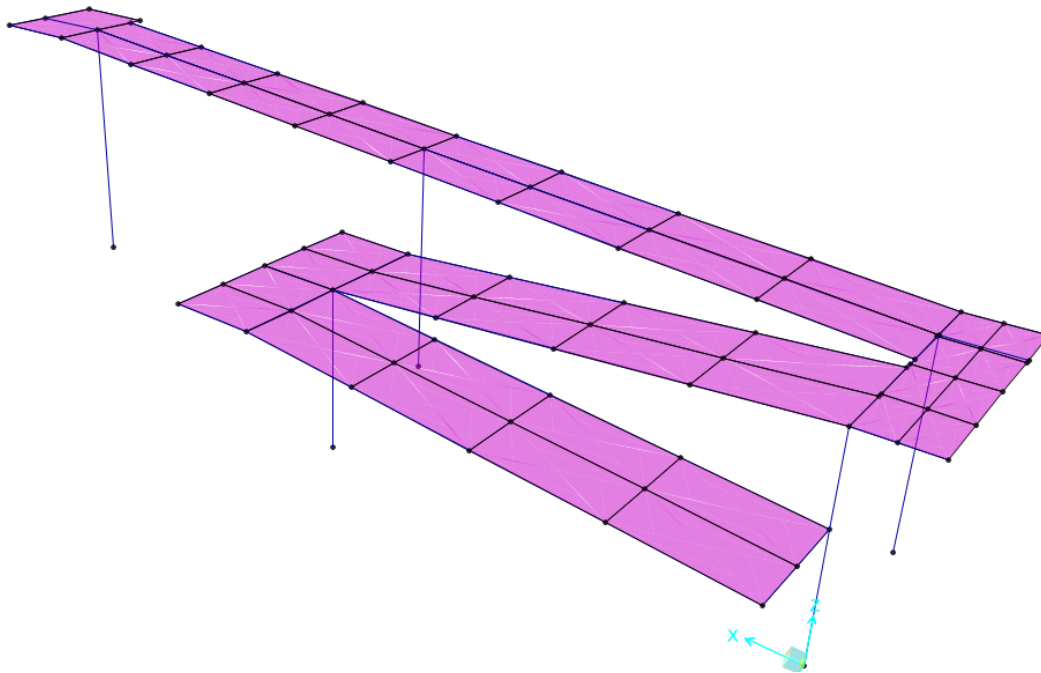


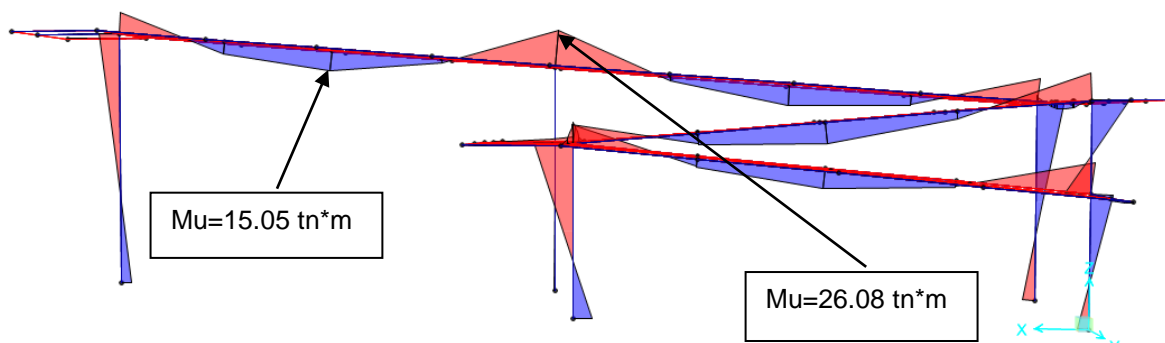
FIGURA 5. DISTRIBUCION DE CARGA VIVA

1.7 Resultados

Teniendo en cuenta las cargas se obtuvieron los siguientes resultados:

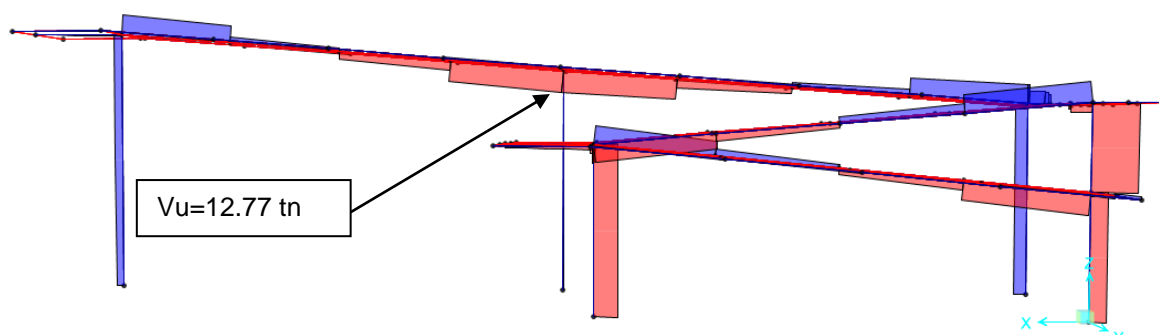
1.7.1 Axiales, Momentos y Cortantes

Diagrama de Momentos M33 Combo 2



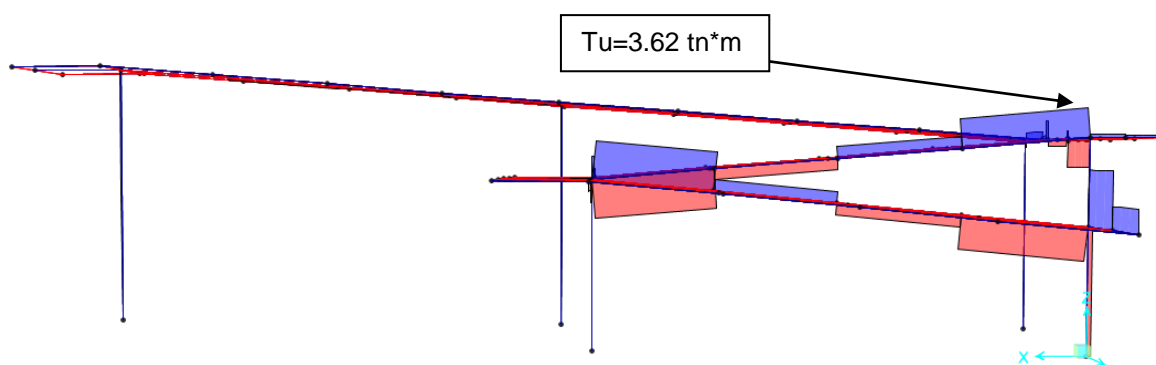
FÍGURA 6. DIAGRAMA DE MOMENTO M33 (COMBO 2)

Diagrama de Cortante V22 Combo 2

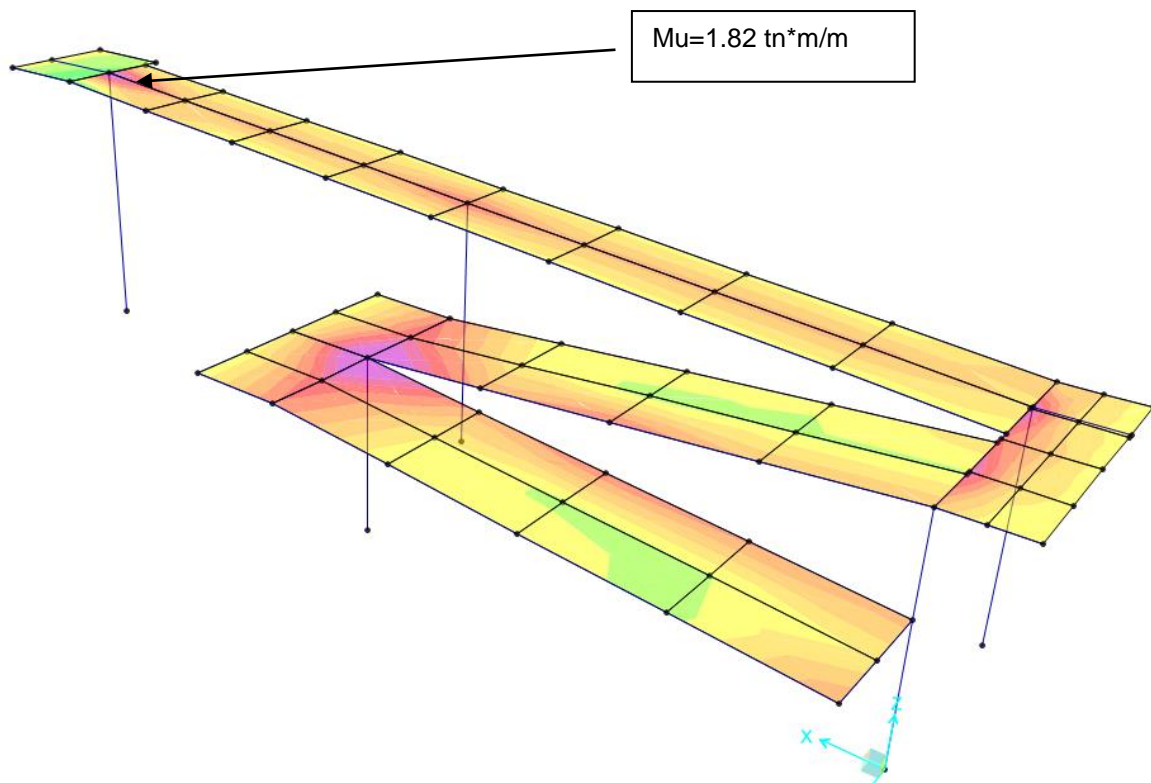


FÍGURA 7. DIAGRAMA DE CORTANTE V22 (COMBO 2)

Diagrama de Torsiones Combo 2



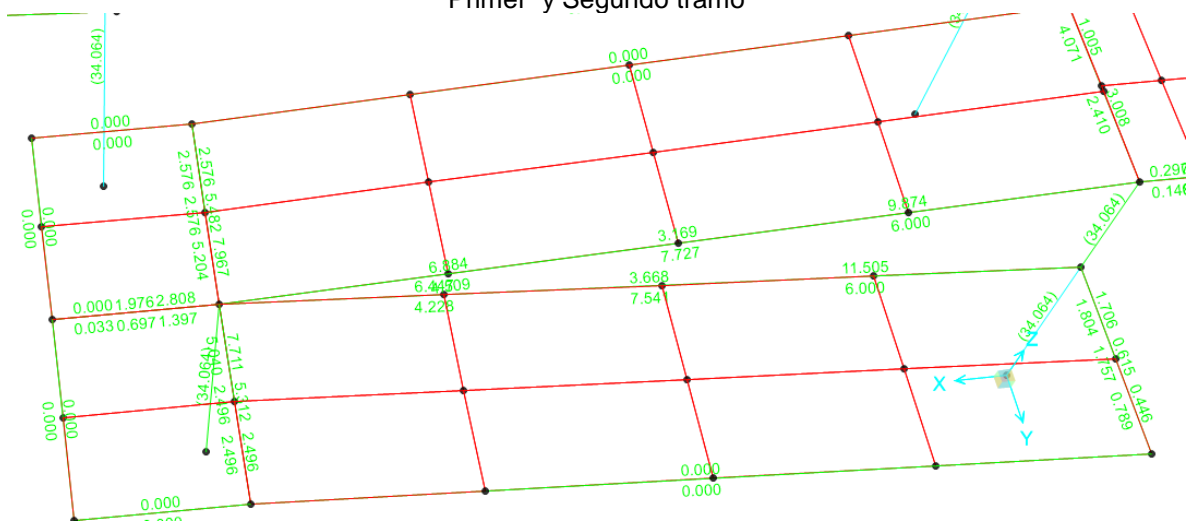
FÍGURA 8. DIAGRAMA DE TORSORES T (COMBO 2)

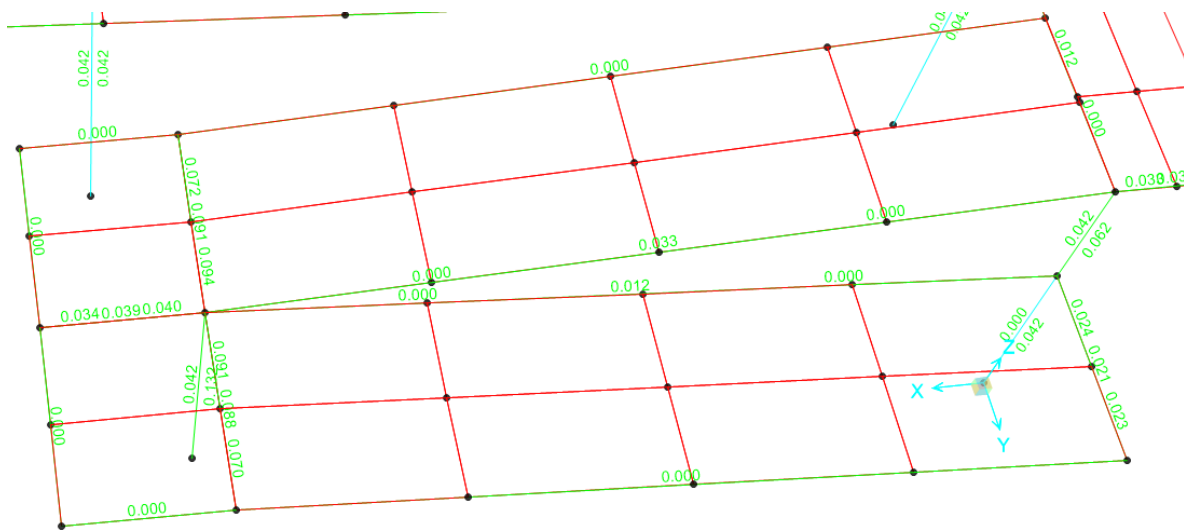


FÍGURA 11. DIAGRAMA M11 (COMBO 2)

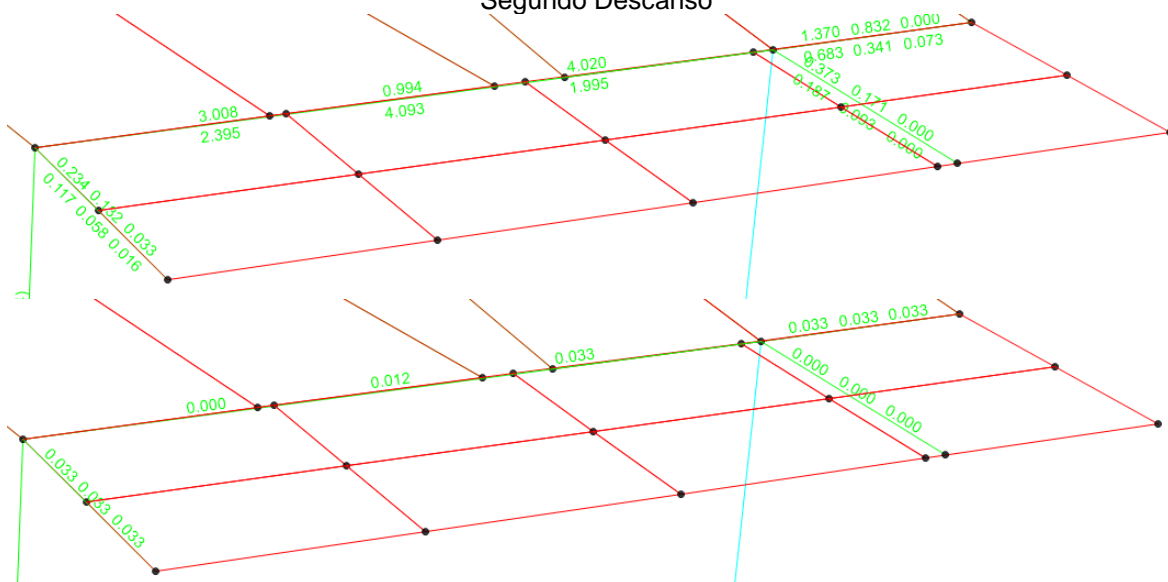
1.8 Diseño de los Elementos

Primer y Segundo tramo

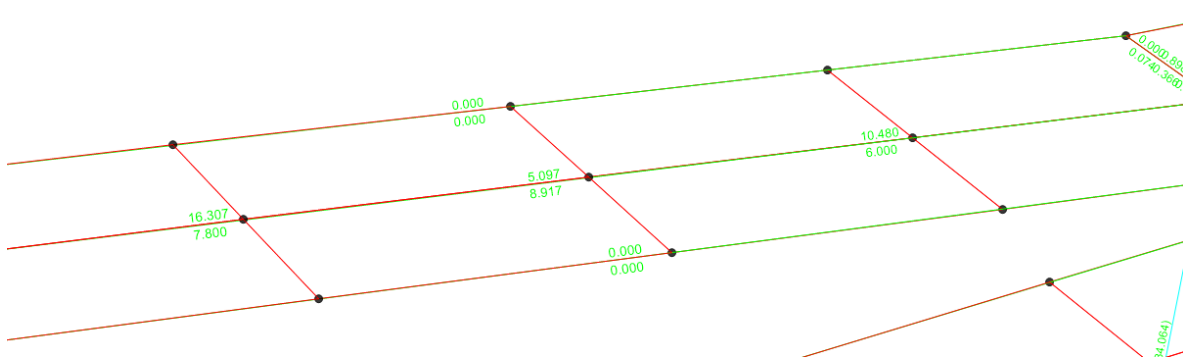


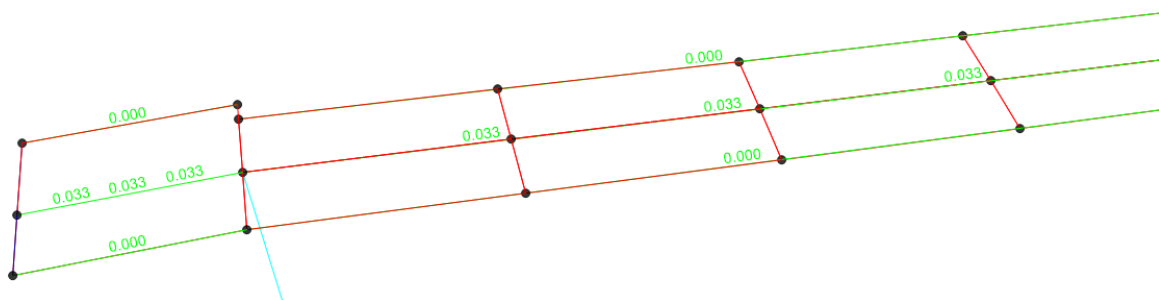
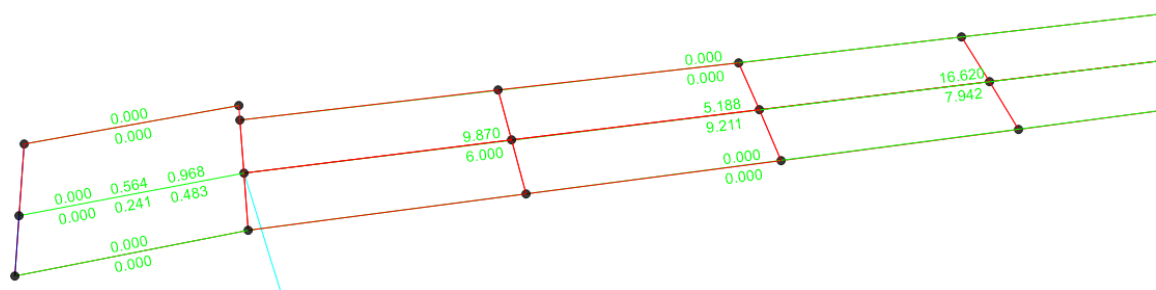
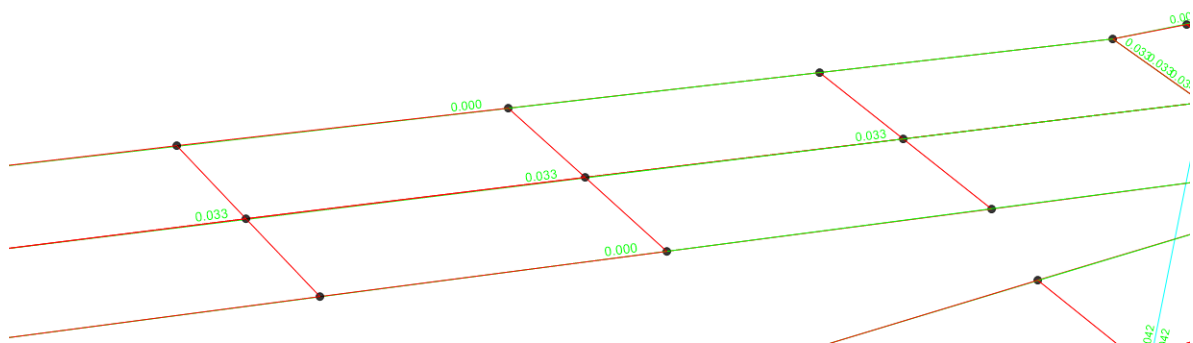


Segundo Descanso



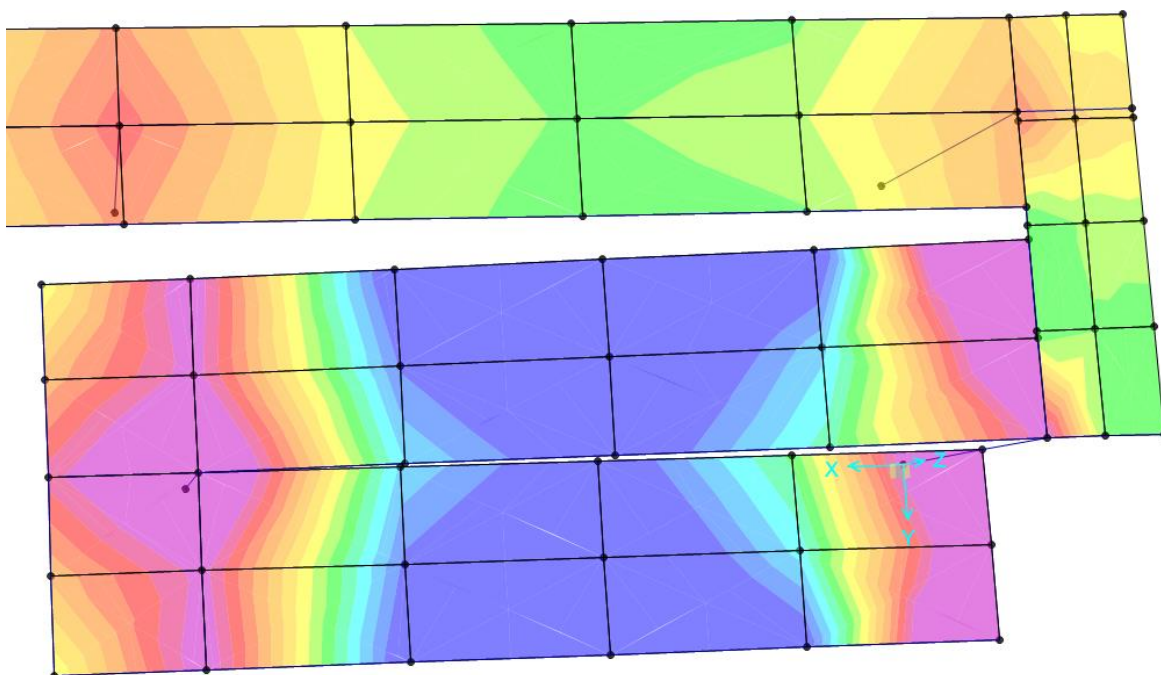
Tercer, Cuarto, Quinto y Sexto tramo; Descanso intermedio





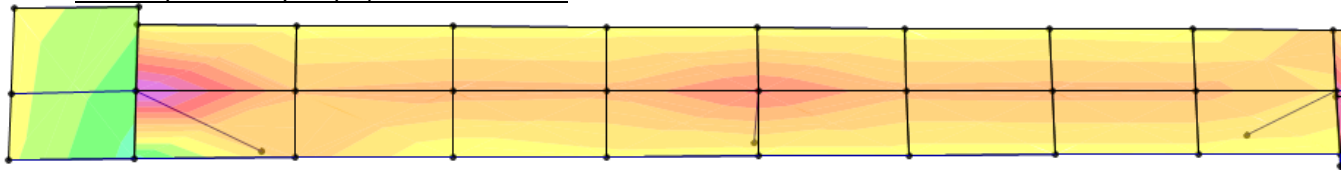
| TABLE: Concrete Design 1 - Column Summary Data - ACI 318-08/IBC2009 | | | | | |
|---|------------|-----------------|-----------|-----------------|-----------|
| Frame | DesignSect | VMajCombo | VMajRebar | VMinCombo | VMinRebar |
| Text | Text | Text | cm2/cm | Text | cm2/cm |
| 21 | COL50X50 | COMB4(ELU) | 0 | COMB4(ELU) (Sp) | 0.0417 |
| 21 | COL50X50 | COMB4(ELU) | 0 | COMB4(ELU) (Sp) | 0.0417 |
| 21 | COL50X50 | COMB4(ELU) | 0 | COMB4(ELU) (Sp) | 0.0417 |
| 27 | COL50X50 | COMB4(ELU) (Sp) | 0.0417 | COMB4(ELU) (Sp) | 0.0417 |
| 27 | COL50X50 | COMB4(ELU) (Sp) | 0.0417 | COMB4(ELU) (Sp) | 0.0417 |
| 27 | COL50X50 | COMB4(ELU) (Sp) | 0.0417 | COMB4(ELU) (Sp) | 0.0417 |
| 34 | COL50X50 | COMB4(ELU) (Sp) | 0.0417 | COMB4(ELU) | 0.0417 |
| 34 | COL50X50 | COMB4(ELU) (Sp) | 0.0417 | COMB4(ELU) | 0.0417 |
| 34 | COL50X50 | COMB4(ELU) (Sp) | 0.0417 | COMB4(ELU) | 0.0417 |
| 39 | COL50X50 | COMB4(ELU) | 0.0417 | COMB4(ELU) (Sp) | 0.1319 |
| 39 | COL50X50 | COMB4(ELU) | 0.0417 | COMB4(ELU) (Sp) | 0.1319 |
| 39 | COL50X50 | COMB4(ELU) | 0.0417 | COMB4(ELU) (Sp) | 0.1319 |
| 42 | COL50X50 | COMB4(ELU) | 0.0417 | COMB4(ELU) | 0.0417 |
| 42 | COL50X50 | COMB4(ELU) | 0.0417 | COMB4(ELU) | 0.0417 |
| 42 | COL50X50 | COMB4(ELU) | 0.0417 | COMB4(ELU) | 0.0417 |
| 3 | COL50X50 | COMB4(ELU) | 0.0417 | COMB4(ELU) (Sp) | 0.062 |
| 3 | COL50X50 | COMB4(ELU) | 0.0417 | COMB4(ELU) (Sp) | 0.062 |
| 3 | COL50X50 | COMB4(ELU) | 0.0417 | COMB4(ELU) (Sp) | 0.062 |

Diseño placa rampa apoyada en un extremo



| DATOS DE ENTRADA | | | |
|----------------------|------------|----------------------|-----------|
| MATERIALES | | SECCIÓN | |
| Fy = | 420 Mpa | base = | 1.00 m |
| F'c = | 28 Mpa | altura = | 0.20 m |
| FUERZAS | | rec. vertical = | 0.050 m |
| Momento último = | 2.92 Ton.m | d = | 0.150 m |
| Cortante apoyo = | 4.45 Ton | Base apoyo viga = | 0.20 m |
| | | | |
| REFUERZO | | | |
| A FLEXIÓN | | A CORTANTE | |
| DISEÑO | | Dist. donde (V=0) = | 4.52 m |
| Varilla a utilizar = | No. 4 | FLEJES CONSTRUCTIVOS | |
| No. Varillas = | 5 | Fleje a utilizar = | No. 3 |
| rec. lateral = | 3.00 cm | Fy fleje = | 420 Mpa |
| bmin = | 15.00 cm | # Ramas = | 2 |
| | | Separación = | -11.73 cm |
| | | S sugerida = | 7.50 cm |

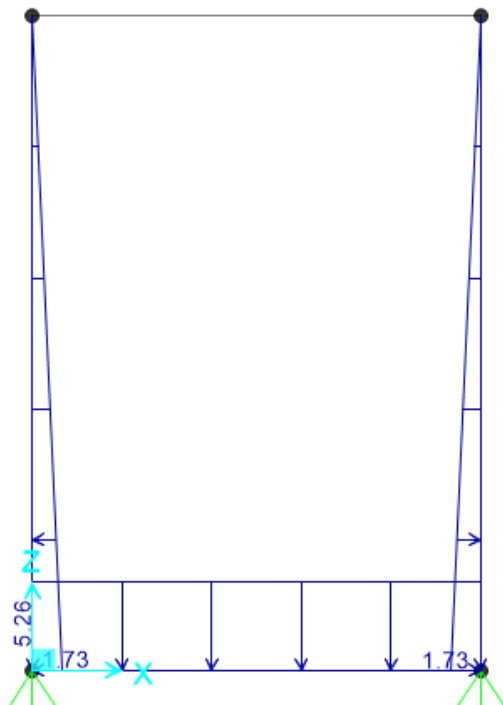
Diseño placa rampa apoyada en el medio



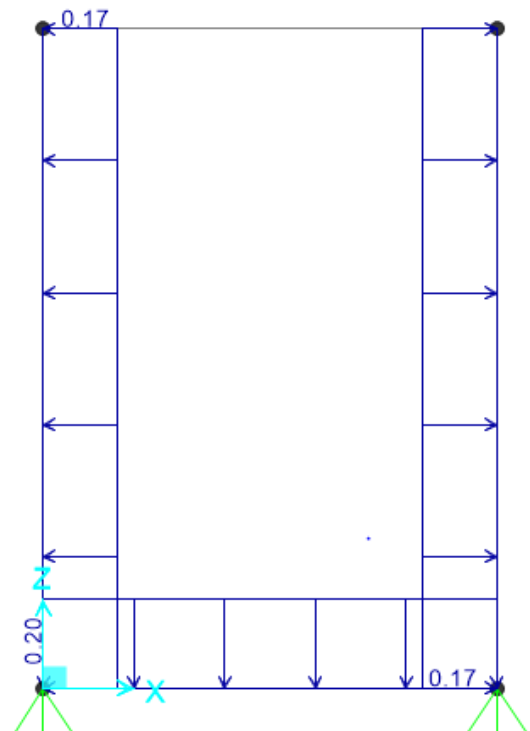
| DATOS DE ENTRADA | | | |
|----------------------|------------|----------------------|-----------|
| MATERIALES | | SECCIÓN | |
| Fy = | 420 Mpa | base = | 1.00 m |
| F'c = | 28 Mpa | altura = | 0.20 m |
| FUERZAS | | rec. vertical = | 0.050 m |
| Momento último = | 1.82 Ton.m | d = | 0.150 m |
| Cortante apoyo = | 4.83 Ton | Base apoyo viga = | 0.20 m |
| | | | |
| REFUERZO | | | |
| A FLEXIÓN | | A CORTANTE | |
| DISEÑO | | Dist. donde (V=0) = | 4.89 m |
| | | FLEJES CONSTRUCTIVOS | |
| Varilla a utilizar = | No. 4 | Fleje a utilizar = | No. 3 |
| No. Varillas = | 4 | Fy fleje = | 420 Mpa |
| rec. lateral = | 3.00 cm | # Ramas = | 2 |
| bmin = | 25.00 cm | Separación = | -12.57 cm |
| | | S sugerida = | 7.50 cm |

DISEÑO DE COJONES PARA RAMPA.

- Carga presión de tierras



- Carga viva



MOMENTOS ULTIMOS

| | B | E |
|---------------------------|-------------|-------------|
| Mu (Ton-m) | 5.06 | 0.34 |
| Factor de Durabilidad Sd | 0.85 | 1.47 |
| Mu *Sd | 4.28 | 0.50 |
| Mn(Ton-m) | 4.75 | 0.56 |
| Mcr=(fr*I)/c | 2.99 | 2.99 |
| Espesor(H) (cm) | 25 | 25 |
| Inercia (cm4) | 130208 | 130208 |
| Eje Neutro (cm) | 12.5 | 12.5 |
| Recubrimiento (d' cm) | 5.0 | 5.0 |
| d (cm) | 20 | 20 |
| Rn (Kg/cm2) | 11.88 | 1.39 |
| Rn(max) (kg/cm2) | 54.73 | 54.73 |
| Rn(max)<Rn | simple armd | simple armd |
| Cuantía sección | 0.002930 | 0.000333 |
| pmax>p>pmin | CUMPLE | FALSO |
| Cuantía de diseño | 0.00422 | 0.00422 |
| As requerido (cm2) | 5.86 | 0.67 |
| Número de Varilla | 4 | 4 |
| Diámetro de varilla (cm) | 1.27 | 1.27 |
| As varilla (cm2) | 1.27 | 1.27 |
| Cantidad | 4.63 | 0.53 |
| Separación calculada (cm) | 22 | 190 |
| Separación colocada (cm) | 15 | 15 |
| As suministrado (cm2) | 8.45 | 8.45 |
| a (cm) | 1.99 | 1.99 |
| φMn (res) (Ton-m) | 6.07 | 6.07 |
| 1.2*Mcr (Ton-m) | 3.59 | 3.59 |
| φMn (res) >= 1.2 Mcr | CUMPLE | CUMPLE |

Cortante (Ton)

$$V_c = 0.75 * 0.53 * \text{Raiz}(210) * b * d =$$

$$V_u = \begin{matrix} \text{B-B} \\ 11.52 \\ 9.45 \\ \text{CUMPLE} \end{matrix}$$

DISEÑO POR FISURACIÓN

0.45 f_c (Kg/cm²)
 f_s de Diseño (kg/cm²)
 Cuantía suministrada
 Módulo Elástico Concreto E_c (kg/cm²)
 Módulo Elástico Acero E_s (kg/cm²)
 Relación Modular n
 k
 j
 Momento de servicio Res. (Ton-m)
 Momento de servicio Aplicado. (Ton-m)
 M (Res) $\geq M$ (Aplicado)

| B | E |
|---------------|---------------|
| 94.5 | 94.5 |
| 2792.5 | 2792.5 |
| 0.00422 | 0.00422 |
| 178720.5 | 178720.5 |
| 2040000 | 2040000 |
| 11 | 11 |
| 0.27 | 0.27 |
| 0.91 | 0.91 |
| 4.30 | 4.30 |
| 3.16 | 0.37 |
| CUMPLE | CUMPLE |

TIPO DE EXPOSICIÓN AMBIENTAL

NORMAL

COEFICIENTE DE DURABILIDAD AMBIENTAL (CÓDIGO ACI 350-06)

$S_d = (\phi f_y) / \gamma \cdot f_s \geq 1.0$

γ = Carga Mayorada / Carga No Mayorada

| | | |
|----------|------------|------------|
| ϕ | 0.9 | 0.9 |
| γ | 1.60 | 0.92 |
| S_d | 0.85 | 1.47 |

DISEÑO POR FISURACIÓN (CÓDIGO ACI 350-06)

Factor de Amplificación
 Diámetro de la varilla (cm)
 Separación (cm)
 f_s (max) kg/cm²=
 f_s (max) kg/cm² $\leq 0.60 f_y$
 f_s de Diseño

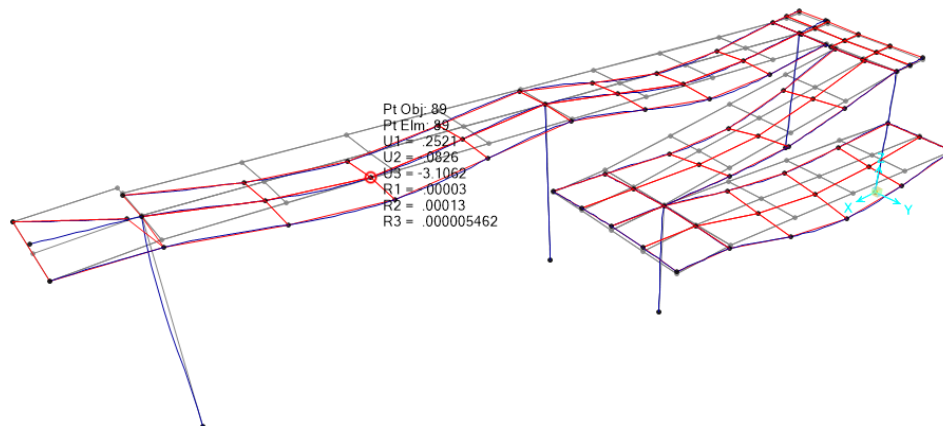
| | | |
|--|---------------|---------------|
| β | 1.35 | 1.35 |
| d_b | 1.27 | 1.27 |
| s | 15 | 15 |
| f_s (max) kg/cm ² | 2792.5 | 2792.5 |
| f_s (max) kg/cm ² $\leq 0.60 f_y$ | 2520 | 2520 |
| f_s de Diseño | 2052.9 | 240.4 |
| f_s (kg/cm ²) | CUMPLE | CUMPLE |

1.9 Control de deflexiones

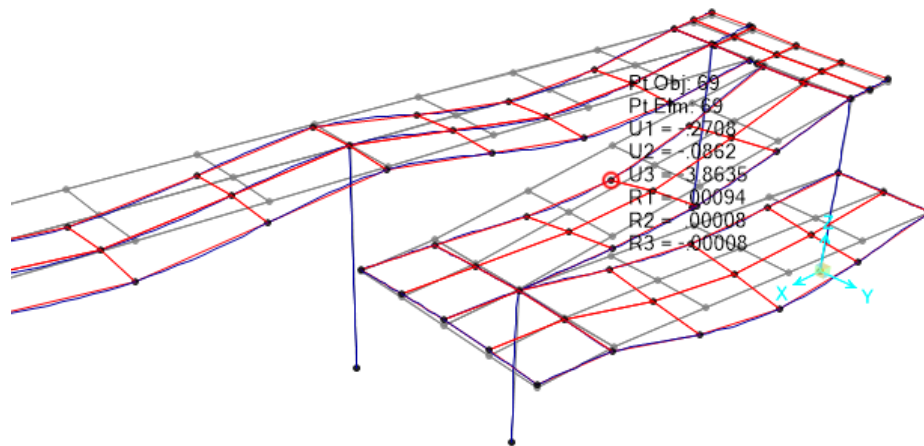
Deflexión activa=3.61 mm

Límite= $L/240 = 9780/240 = 40.75$ mm

Luego o.k!!



Deflexión activa=3.86 mm
 Límite= $L/240=2430/240=10.13\text{mm}$
Luego o.k!!



1.10 Diseño de cimentación

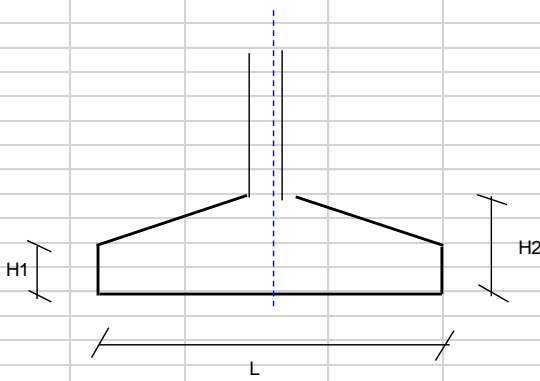
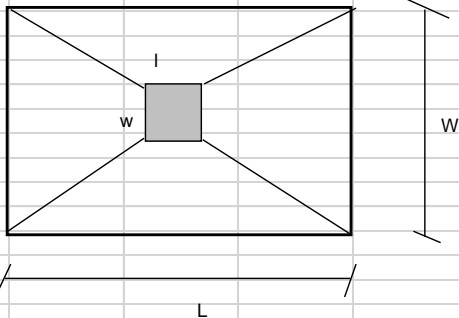
Reacciones en la base

| TABLE: Joint Reactions | | | | | | | | |
|------------------------|------------|-------------|----------|---------|---------|----------|----------|----------|
| Joint | OutputCase | CaseType | F1 | F2 | F3 | M1 | M2 | M3 |
| Text | Text | Text | Tonf | Tonf | Tonf | Tonf-m | Tonf-m | Tonf-m |
| 15 | CIM | Combination | -2.9655 | -0.2569 | 0.2509 | 0 | 0 | 0 |
| 17 | CIM | Combination | 0.5211 | -0.3834 | 1.6813 | 0 | 0 | 0 |
| 21 | CIM | Combination | 14.6086 | 1.9499 | 23.2975 | -0.01493 | 2.7038 | 0.20139 |
| 22 | CIM | Combination | 0.6674 | -3.0874 | 4.6194 | 0 | 0 | 0 |
| 23 | CIM | Combination | 7.6578 | 1.7691 | 21.5872 | -1.74053 | 5.59916 | -0.01563 |
| 28 | CIM | Combination | -4.4908 | 0.3817 | 15.7984 | -0.46306 | -5.88573 | -0.05951 |
| 29 | CIM | Combination | 0.1117 | 0.1787 | 26.1875 | -0.3912 | 0.04045 | 0.00984 |
| 30 | CIM | Combination | -17.8716 | -0.5516 | 37.24 | 0.10235 | -8.52111 | 0.03466 |

ZAPATA Z-1

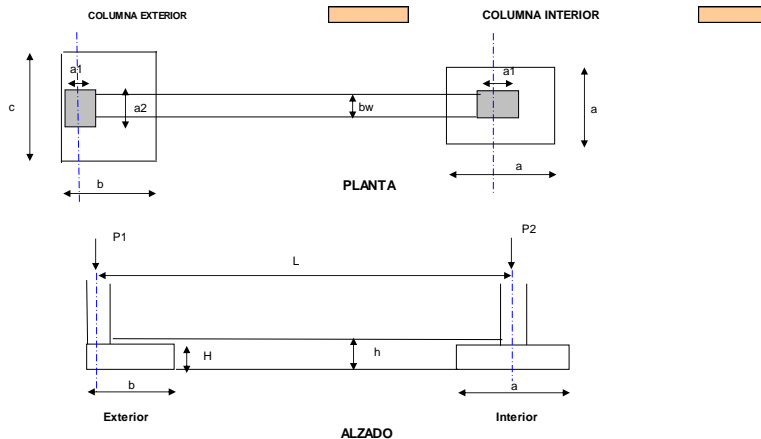
| DATOS DE ENTRADA | | | | | |
|--|--------|---------------|--|--|--|
| Capacidad portante suelo σ (Ton/m²)= | 15.1 | | | | |
| Carga P1 exterior (Tn)= | 37.24 | (SIN MAYORAR) | | | |
| P. propio cimiento (Tn)= | 3.724 | | | | |
| Σ P1 (Ton)= | 40.964 | | | | |
| Factor de Mayoración | 1.5 | | | | |
| | | | | | |
| Columna | | | | | |
| w (m)= | 0.50 | | | | |
| l (m)= | 0.50 | | | | |
| | | | | | |
| Calibre de la varilla longitudinal de la columna No | Nº 7 | | | | |
| Area (m2)= | 2.71 | | | | |
| | | | | | |
| Valores recomendados para W, L, H1 y H2 | | | | | |
| W (m) | 1.65 | | | | |
| L (m) | 1.65 | | | | |
| H1 (m) | 0.15 | | | | |
| H2 (m) | 0.58 | | | | |
| | | | | | |
| Tomar: | | | | | |
| W (m) | 2 | | | | |
| L (m) | 2 | | | | |
| H1 (m) | 0.25 | | | | |
| H2 (m) | 0.5 | | | | |
| Area real (m ²)= | 4 | | | | |
| | | | | | |
| Reaccion zapata | | | | | |
| | | | | | |
| σ_{neta} (Tn/m2)= | 10.24 | | | | |
| σ_{ultima} (Tn/m2)= | 14.01 | | | | |
| | | | | | |

| DISEÑO | | | | |
|--------------------------------|-------------|------------------------------|------|---------------|
| Sentido Corto | | | | Sentido Largo |
| Zapata: | | | | |
| M ultimo borde columna (T*m) | 7.881 | | | 7.881 |
| d sugerido (cms) | 50.92 | | | 50.92 |
| Tomar d (cms)= | 43 | | | 43 |
| REVISION DE CORTANTE | | | | |
| Punzonamiento | | | | |
| Vu(d/2) (Ton)= | 43.74 | | | 43.74 |
| vu (d/2) (Kg/cm ²) | 3.28 | ✓ | | 3.28 ✓ |
| Como Viga Ancha | | | | |
| Vu (d) (Ton)= | 8.97 | | | 15.97 |
| vu (d) (Kg/cm ²) | 1.04 | ✓ | | 1.04 ✓ |
| FLEXION | | | | |
| Refuerzo | | | | |
| ρ calculada | 0.00057 | | | 0.00057 |
| ρ agrietamiento | 0.00210 | $M_{cr}= f_r I_g / Y_t$ | | 0.00210 |
| ρ usada | 0.00180 | $f_r= 1.98 * (f'c)^{0.5}$ | | 0.00180 |
| As (cm ²)= | 15.48 | $f_r= 28.69 \text{ kg/cm}^2$ | | 15.48 |
| Usar zapata | | | | |
| L (mts)= | | 2 | | |
| W(mts)= | | 2 | | |
| H1 (mts)= | | 0.25 | | |
| H2 (mts)= | | 0.5 | | |
| Se sugiere usar | | | | |
| para refuerzo sentido corto: | | | | |
| | 8 barras No | 5 | cada | 27 cms |
| para refuerzo sentido largo: | | | | |
| | 8 barras No | 5 | cada | 27 cms |

ZAPATA Z-3 (SIN ACARTELAMIENTO) Y ZAPATA Z-2 (ZAPATA EXCÉNTRICA Y SIN ACARTELAMIENTO)

CALCULO DE ZAPATAS MEDIANERAS CON VIGAS DE ENLACE
PROYECTO: RAMPA COLEGIO PABLO VI
ZAPATA Z2



DATOS DE ENTRADA

Capacidad portante suelo σ (Ton/m²)=

14.5

COLUMNA EXTERIOR

Carga P1 exterior (Tn)=

23.298 (SIN MAYORAR)

P.propio cimiento (Tn)=

2.3298

Σ P1 (Ton)=

25.6278

Factor de Mayoración

1.5

Columna

a1 (m)=

0.50

a2 (m)=

0.50

exce (mt)=

0.25 0.75

Area (m²)=

1.77

Valores recomendados para b y c

b (m)=

1.00

c (m)=

1.82

Tomar:

b (m)=

2.00

c (m)=

2.00

d (m)=

0.43

Area real (m²)=

4.00

Reaccion zapata exterior

ΔR (Ton)

2.13

σ_{neta} (Tn/m²)=

6.36

σ ultima (Tn/m²)=

7.63

Especificaciones:

f'c (kg/cm²)=

210

f'y (kg/cm²)=

4200

fy (flejes) =

2400

Long. entre zapatas (L)

9.78 m

COLUMNA INTERIOR

Carga P2 Interior (Tn)=

37.24 (SIN MAYORAR)

P.propio cimiento (Tn)=

3.724

Σ P2 (Ton)=

40.964

Factor de Mayoración

1.5

Columna

a1 (m)=

0.50

a1 (m)=

0.50

Area (m²)=

2.87

Valores recomendados para a

a (m)=

1.69 (minimo se debe tomar 1 metro)

Tomar:

a (m)=

2

d (m)=

0.43

Area real (m²)=

4

Reaccion zapata interior

ΔR (Ton)

2.13

σ_{neta} (Tn/m²)=

9.7

σ ultima (Tn/m²)=

12.66

DISEÑO

Zapata:

M ultimo borde

columna (T·m)

4.29

d sugerido

(cms)

17.00

Tomar d (cms)=

40

REVISION DE CORTANTE

Punzonamiento

V(d/2) (Ton)=

20.90

v_u (d/2) (Kg/cm²)

2.27

Como Viga Ancha

V_u (d) (Ton)=

16.78

v_u (d) (Kg/cm²)

2.10

FLEXION

Refuerzo

ρ calculada

0.00036

ρ agrietamiento

0.00244

ρ usada

0.00180

As (cm²)=

14.40

Acero de Reparticion

ρ ret y temperatura

0.001

As (cm²)=

10

M_{cr} =

$f_r I_g / Y_i$

f_r =

$1.98 * (f'c)^{0.5}$

f_r =

28.69 kg/cm²

DISEÑO

Zapata:

M ultimo borde

columna (T·m)

7.12

d sugerido

(cms)

21.90

Tomar d (cms)=

40

REVISION DE CORTANTE

Punzonamiento

V(d/2) (Ton)=

10.09

v_u (d/2) (Kg/cm²)

2.80

Como Viga Ancha

V_u (d) (Ton)=

20.25

v_u (d) (Kg/cm²)

2.53

FLEXION

Refuerzo

ρ calculada

0.00059

ρ agrietamiento

0.00244

ρ usada

0.00100

As (cm²)=

8.00

Acero de Reparticion

ρ ret y temperatura

0.001

As (cm²)=

10

Usar zapata

| | |
|----------|----|
| b (mts)= | 2 |
| c (mts)= | 2 |
| H (cms)= | 50 |

Se sugiere usar

para refuerzo principal:

| | | | |
|--------------|---|------|--------|
| 12 barras No | 4 | cada | 17 cms |
|--------------|---|------|--------|

para refuerzo de repartición:

| | | | |
|--------------|---|------|--------|
| 15 barras No | 3 | cada | 14 cms |
|--------------|---|------|--------|

Usar zapata

| | |
|----------|----|
| a (mts)= | 2 |
| H (cms)= | 50 |

Se sugiere usar

para refuerzo principal:

| | | | |
|-------------|---|------|--------------------------|
| 8 barras No | 4 | cada | 27 cms en ambos sentidos |
|-------------|---|------|--------------------------|

Viga de enlace:
Mud (T^m)= 26.44

dimensiones de b y d sugeridas:

b (cm)= 30
d (cm)= 85.14

tomar:

| | |
|---------|----|
| b (cm)= | 40 |
| d (cm)= | 45 |

Refuerzo:

| | |
|-------------|-------------|
| ρ calculada | 0.009753545 |
| ρ min | 0.003333333 |
| ρ max | 0.016079826 |

ρ usada 0.009753545
As (cm2)= 17.56

Cortante:

Vub (Ton)= 15.67

vub (Kg/cm²)= 8.71

Usar viga

| | | |
|------------------------------|-------|--------|
| b (cm)= | 40 | |
| h (cm)= | 50 | |
| As (cm2)= | 17.56 | Arriba |
| flejes sencillos ϕ 3/8" cada | 34 | cms |
| flejes dobles ϕ 3/8" cada | 67 | cms |
| separacion maxima | 22.5 | cms |

VIGAS DE CIMENTACIÓN

DISEÑO VIGAS DE AMARRE

COLEGIO PABLO VI

VCIM01

Criterio de diseño: La viga debe ser capaz de trasladar al apoyo adyacente, entre el 5 y el 10% de la carga total que baja por la columna

COLUMNA MAS CARGADA

P= 26.2 Tn

%P 2.6 Tn

L 9.78 m

Factor de Mayoración

1.5

DIAGRAMA DE MOMENTO

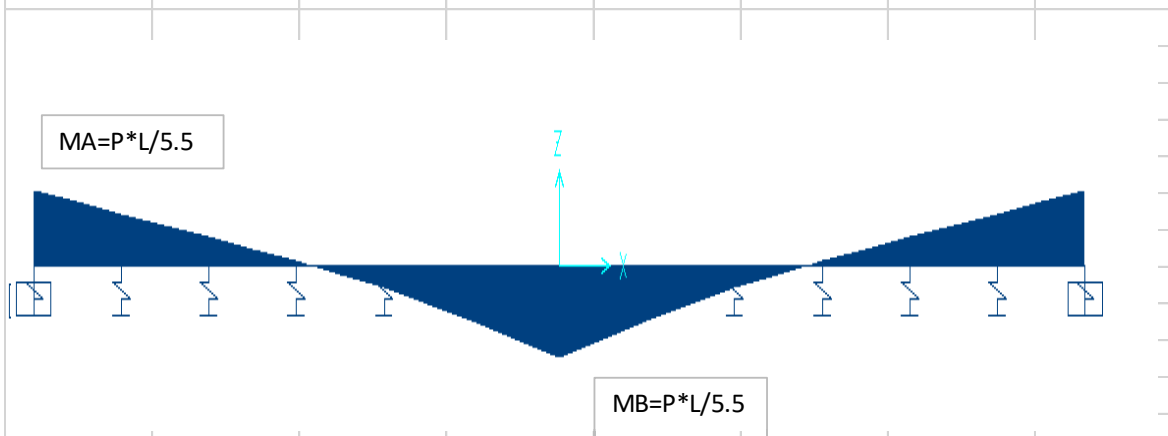
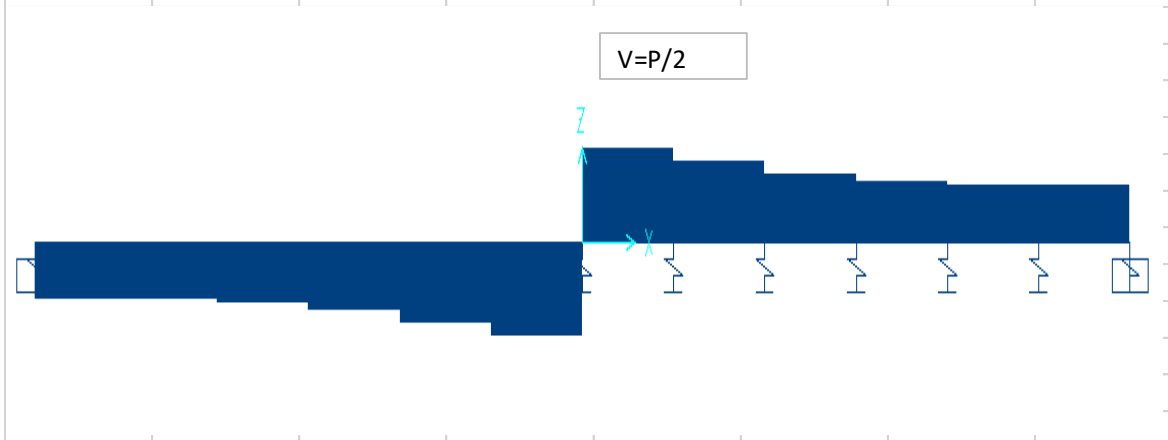


DIAGRAMA DE CORTANTE



| | | | | | | |
|-------------------|---------|------|----------|---------------|------|--|
| b | 40 | cm | | | | |
| h | 50 | cm | | | | |
| d | 43 | cm | | | | |
| Mu max | 7.0 | Tn*m | Estático | | | |
| Mu max | 7.8 | Tn*m | Sismo | | | |
| Vu max | 1.96425 | Tn | | Especificaci | | |
| | | | | f'c (kg/cm²)= | 210 | |
| | | | | f'y (kg/cm²)= | 4200 | |
| DISEÑO A CORTANTE | | | | | | |
| φ Vc | 2400 | Tn | | | | |
| fy Estribo | 4200 | | | | | |
| No Estribo | Nº 3 | | | | | |
| Usar cada | 21.5 | cm | | | | |

| | | | | | | | | | |
|------------------------------|---------|-----------|-------------------------|---------|-------------|----------|---|----------|----------|
| DISEÑO A FI (Falla Tracción) | | | (REFUERZO LONGITUDINAL) | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | ρ min | 0.0033 | | | | | | | |
| | ρ max | 0.0160 | | | | | | | |
| | ρ tracc | 0.0135 | | | | | | | |
| | Punto | Mu (Tn*m) | Mu/φbd² | ρ | ρ utilizado | As (cm²) | φ | Cantidad | |
| | A | 7.80 | 11.72 | 0.00289 | 0.00330 | 5.68 | 5 | 3 | Ref. Inf |
| | B | 7.80 | 11.72 | 0.00289 | 0.00330 | 5.68 | 5 | 3 | Ref. Sup |

DISEÑO VIGAS DE AMARRE

COLEGIO PABLO VI

VCIM02

Criterio de diseño: La viga debe ser capaz de trasladar al apoyo adyacente, entre el 5 y el 10% de la carga total que baja por la columna

COLUMNA MAS CARGADA

| | | |
|----------------------|------|----|
| P= | 23.3 | Tn |
| %P | 2.3 | Tn |
| L | 3.55 | m |
| Factor de Mayoración | 1.5 | |

DIAGRAMA DE MOMENTO

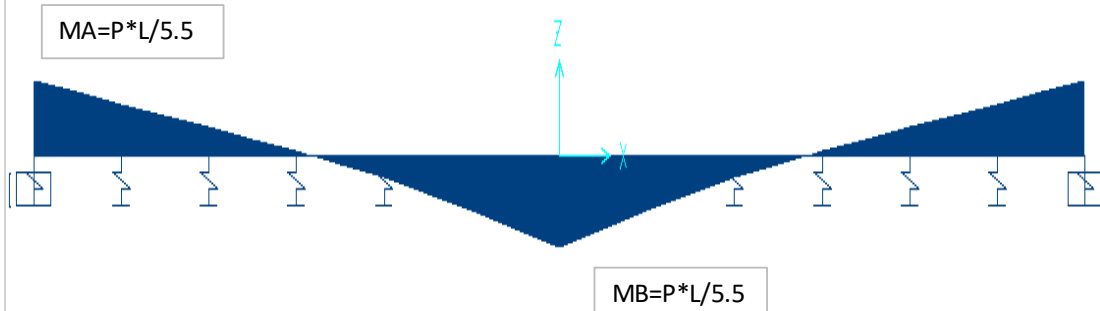
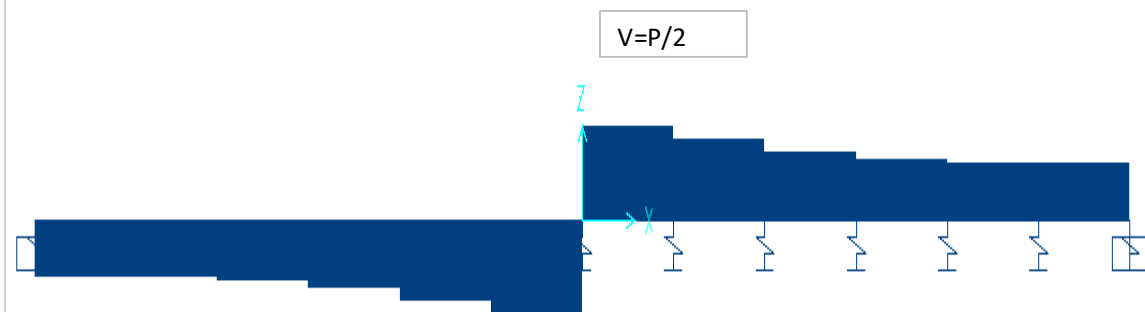


DIAGRAMA DE CORTANTE



| | | | | | | | |
|---|---------|-----------|----------|---------------|-------------|----------|----------|
| b | 40 | cm | | | | | |
| h | 50 | cm | | | | | |
| d | 43 | cm | | | | | |
| Mu max | 2.3 | Tn*m | Estático | | | | |
| Mu max | 6.5 | Tn*m | Sismo | | | | |
| Vu max | 1.74735 | Tn | | Especificaci | | | |
| | | | | f'c (kg/cm²)= | 210 | | |
| | | | | f'y (kg/cm²)= | 4200 | | |
| DISEÑO A CORTANTE | | | | | | | |
| φ Vc | 2400 | | Tn | | | | |
| fy Estribo | 4200 | | | | | | |
| No Estribo | Nº 3 | | | | | | |
| Usar cada | 21.5 | cm | | | | | |
| DISEÑO A FI (Falla Tracción) (REFUERZO LONGITUDINAL) | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | ρ min | 0.0033 | | | | | |
| | ρ max | 0.0160 | | | | | |
| | ρ tracc | 0.0135 | | | | | |
| | Punto | Mu (Tn*m) | Mu/φbd² | ρ | ρ utilizado | As (cm²) | φ |
| | A | 6.50 | 9.77 | 0.00239 | 0.00330 | 5.68 | 5 |
| | B | 6.50 | 9.77 | 0.00239 | 0.00330 | 5.68 | 5 |
| | | | | | | | Cantidad |
| | | | | | | | 3 |
| | | | | | | | 3 |
| | | | | | | | Ref. Inf |
| | | | | | | | Ref. Sup |

DISEÑO VIGAS DE AMARRE

COLEGIO PABLO VI

VCIM03

Criterio de diseño: La viga debe ser capaz de trasladar al apoyo adyacente, entre el 5 y el 10% de la carga total que baja por la columna

COLUMNA MAS CARGADA

| | | |
|----------------------|------|----|
| P= | 37.2 | Tn |
| %P | 3.7 | Tn |
| L | 9 | m |
| Factor de Mayoración | 1.5 | |

DIAGRAMA DE MOMENTO

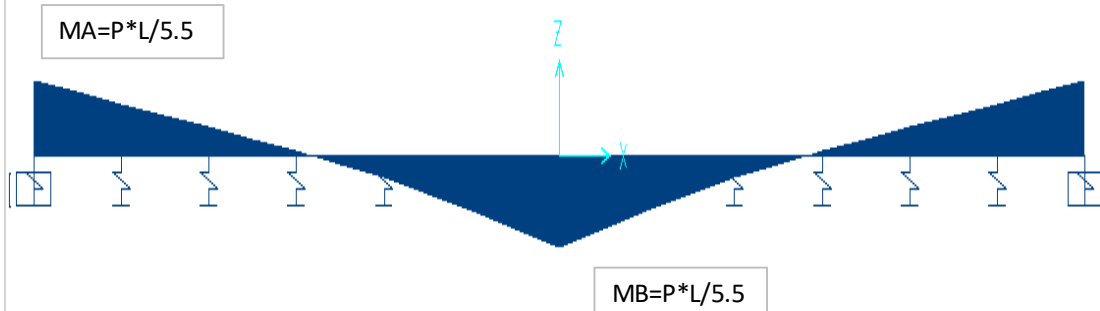
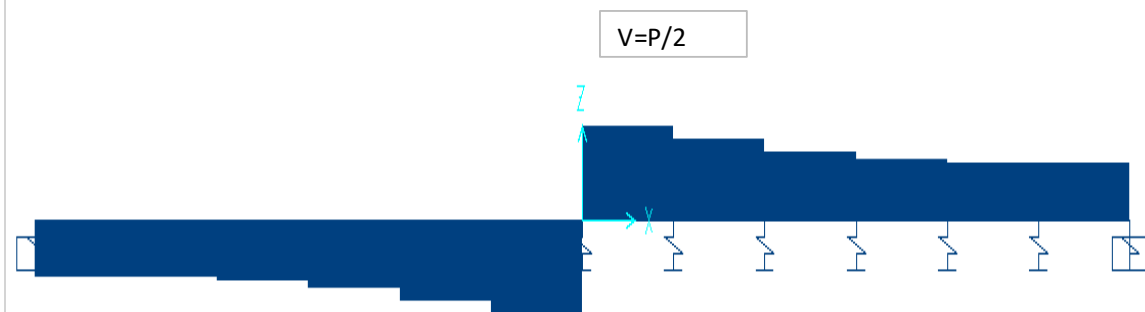


DIAGRAMA DE CORTANTE



| | | | | | | |
|-------------------|-------|------|----------|---------------|------|--|
| b | 40 | cm | | | | |
| h | 50 | cm | | | | |
| d | 43 | cm | | | | |
| Mu max | 9.1 | Tn*m | Estático | | | |
| Mu max | 6.5 | Tn*m | Sismo | | | |
| Vu max | 2.793 | Tn | | Especificaci | | |
| | | | | f'c (kg/cm²)= | 210 | |
| | | | | f'y (kg/cm²)= | 4200 | |
| DISEÑO A CORTANTE | | | | | | |
| φ Vc | 2400 | ▼ | Tn | | | |
| fy Estribo | 4200 | ▼ | | | | |
| No Estribo | Nº 3 | ▼ | | | | |
| Usar cada | 21.5 | cm | | | | |

| | | | | | | | | | |
|------------------------------|---------|-----------|-------------------------|---------|-------------|----------|---|----------|----------|
| DISEÑO A FI (Falla Tracción) | | | (REFUERZO LONGITUDINAL) | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | ρ min | 0.0033 | | | | | | | |
| | ρ max | 0.0160 | | | | | | | |
| | ρ tracc | 0.0135 | | | | | | | |
| | Punto | Mu (Tn*m) | Mu/φbd² | ρ | ρ utilizado | As (cm²) | φ | Cantidad | |
| | A | 9.14 | 13.73 | 0.00341 | 0.00341 | 5.86 | 5 | 3 | Ref. Inf |
| | B | 9.14 | 13.73 | 0.00341 | 0.00341 | 5.86 | 5 | 3 | Ref. Sup |