

# Nota de Lanzamiento



Fecha de Lanzamiento: Julio 2018

Version del software : Civil 2019 (v1.1)

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## DISEÑO DE ESTRUCTURAS CIVILES

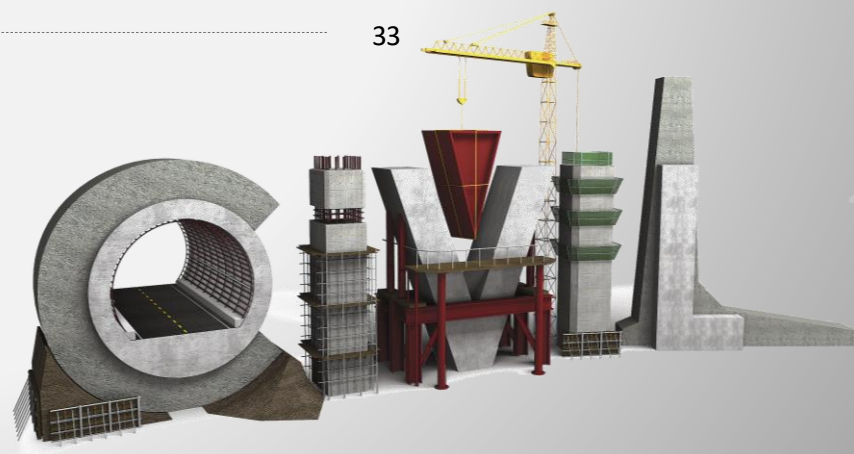
# Mejoras

## ■ Análisis & Diseño

|    |   |    |
|----|---|----|
| 1. | Modelos de carga de tráfico para Turquía                  | 3  |
| 2. | Optimización de cargas móviles para Australia             | 5  |
| 3. | Normas de puentes IRS de la India: cargas ferroviarias    | 6  |
| 4. | Links elásticos no lineales para análisis Pushover        | 7  |
| 5. | GSD - Cálculo del ancho de fisuración según IRC 112: 2011 | 8  |
| 6. | Actualización AASHTO LRFD 2016                            | 9  |
| 7. | Diseño de Shell   | 11 |

## ■ Pre & Post - Procesamiento

|    |   |    |
|----|---|----|
| 1. | Gráfico de resultados de energía para el análisis tiempo historia                     | 24 |
| 2. | Resultados de deformación para el análisis no lineal de materiales                    | 28 |
| 3. | Función multi-lineal de fuerza-deformación para Point Spring Support y Elastic Link   | 30 |
| 4. | Informe de análisis de la vía férrea con la configuración de la unidad estadounidense | 31 |
| 5. | Interfaz de datos con midas GTS NX  | 32 |
| 6. | Interfaz Tekla Structure 2018   | 33 |



## 1. Modelos de carga de tráfico para Turquía

- Se implementaron cinco modelos turcos de carga viva en midas Civil. KGM-45, H30-S24, H30-S24L, H20-S16, H20-S16L
- Estos vehículos se pueden encontrar a partir del código estándar AASHTO LRFD / AASHTO.

### Load/Moving Load Analysis Data > Vehicles

**Define Standard Vehicular Load**

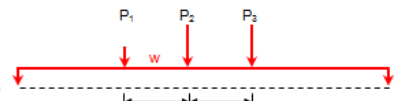
Standard Name: Turkey

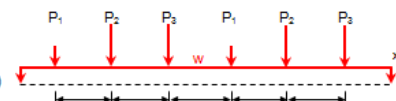
Vehicular Load Properties

Vehicular Load Name: KGM-45

Vehicular Load Type: KGM-45

Dynamic Load Allowance: 0 %

(a) 

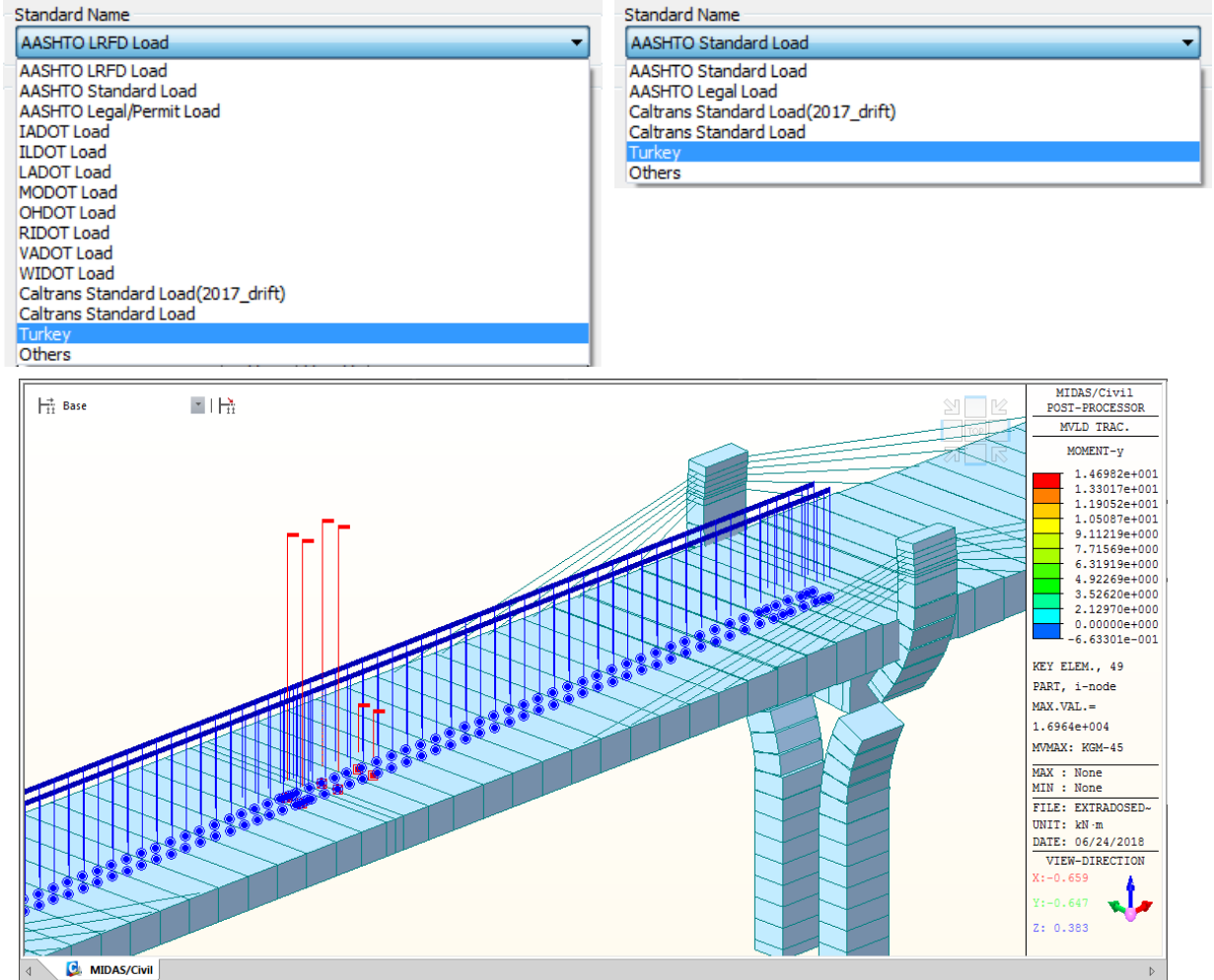
(b) 

| Lane Support-Neg. Moment/ Reaction | Application |
|------------------------------------|-------------|
| Not assigned                       | a           |
| Assigned                           | a, b        |

| No | Load(kN) | Spacing(m) | W     | 10 | kN/m |
|----|----------|------------|-------|----|------|
| 1  | 50       | 4.25       | r     | 90 | %    |
| 2  | 200      | 4.25       | Dist. | 15 | m    |
| 3  | 200      | 9          |       |    |      |

OK Cancel Apply

Carga Vehicular Estándar KGM-45



Trazador de Carga Móvil, KGM-45

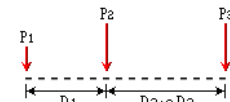
## 1. Modelos de carga de tráfico para Turquía

### ▪ Load/Moving Load Analysis Data > Vehicles

Define Standard Vehicular Load

Standard Name  
Turkey

Vehicular Load Properties  
Vehicular Load Name : H30-S24  
Vehicular Load Type : H30-S24



| No | Load(kN) | Spacing(m) | W  |
|----|----------|------------|----|
| 1  | 60       | 4.25       | Ps |
| 2  | 240      | 4.25       | Pm |
| 3  | 240      | 9          |    |

dW1 0  
dD1 0  
dW2 0  
dD2 0

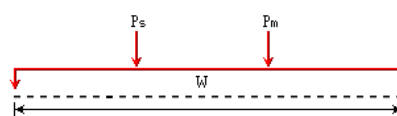
OK Cancel

Carga Vehicular Estándar, H30-S24

Define Standard Vehicular Load

Standard Name  
Turkey

Vehicular Load Properties  
Vehicular Load Name : H30-S24L  
Vehicular Load Type : H30-S24L



| No | Load(kN) | Spacing(m) | W         |
|----|----------|------------|-----------|
|    |          |            | 15 kN/m   |
|    |          |            | Ps 195 kN |
|    |          |            | Pm 135 kN |

dW1 0 kN/m  
dD1 0 m  
dW2 0 kN/m  
dD2 0 m

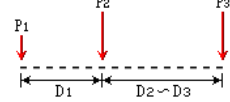
OK Cancel Apply

Carga Vehicular Estándar , H30-S24L

Define Standard Vehicular Load

Standard Name  
Turkey

Vehicular Load Properties  
Vehicular Load Name : H20-S16  
Vehicular Load Type : H20-S16



| No | Load(kN) | Spacing(m) | W  |
|----|----------|------------|----|
| 1  | 40       | 4.25       | Ps |
| 2  | 160      | 4.25       | Pm |
| 3  | 160      | 9          |    |

dW1 0  
dD1 0  
dW2 0  
dD2 0

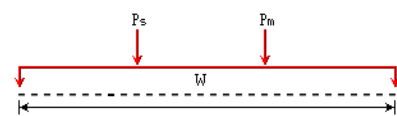
OK Cancel

Carga Vehicular Estándar, H20-S16

Define Standard Vehicular Load

Standard Name  
Turkey

Vehicular Load Properties  
Vehicular Load Name : H20-S16L  
Vehicular Load Type : H20-S16L



| No | Load(kN) | Spacing(m) | W         |
|----|----------|------------|-----------|
|    |          |            | 10 kN/m   |
|    |          |            | Ps 135 kN |
|    |          |            | Pm 90 kN  |

dW1 0 kN/m  
dD1 0 m  
dW2 0 kN/m  
dD2 0 m

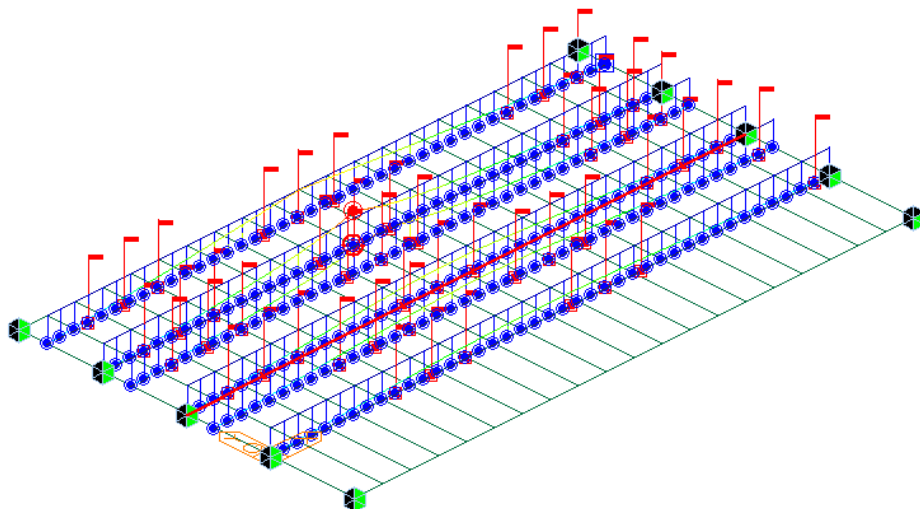
OK Cancel Apply

Carga Vehicular Estándar, H20-S16L

## 2. Optimización de Carga Móvil para Australia

- Ahora, la función de optimización de la carga móvil se puede aplicar también con el código de Australia.
- La optimización de carga móvil amplía las capacidades del análisis de carga móvil y ayuda a simplificar significativamente la evaluación de ubicaciones críticas de vehículos. Las ubicaciones críticas de los vehículos se pueden identificar en la dirección transversal así como en la dirección longitudinal de acuerdo con la disposición del código.

- Load > Moving Load > Traffic Line/Surface Lane > Moving Load Optimization**
- Load > Moving Load > Moving Load Cases**



Resultados Optimizados para Vigas Exteriores por S1600

**Moving Load Optimization**

Lane Name : LO

Traffic Lane Optimization Properties

**a : Eccentricity**

|                   |    |   |
|-------------------|----|---|
| Optimization Lane | 11 | m |
| Lane Width        | 3  | m |
| Anal. Lane Offset | 1  | m |
| Wheel Spacing     | 2  | m |
| Margin            | 0  | m |
| Eccentricity      | 0  | m |

Vehicular Load Distribution

☐ Lane Element ☒ Cross Beam

Cross Beam Group

Cross Beam

Skew

Start 0 End 0 [deg]

Moving Direction

☐ Forward ☐ Backward ☒ Both

Selection by

☒ 2 Points ☐ Picking ☐ Number

0, 0, 0 m

0, 0, 0 m

Operations

Add Insert Delete

| No | Elem | Eccen. (m) | Span Start                          |
|----|------|------------|-------------------------------------|
| 1  | 11   | 0          | <input checked="" type="checkbox"/> |
| 2  | 12   | 0          | <input type="checkbox"/>            |
| 3  | 13   | 0          | <input type="checkbox"/>            |

OK Cancel Apply

Optimización de Línea de Tráfico

**Define Moving Load Case**

Load Case Name : MO

Description :

☐ Load Case for Permit Vehicle

☒ **Moving Load Optimization**

☐ Accompanying Lane Factor

| Num of Loaded Lanes | Scale Factor |
|---------------------|--------------|
| 1                   | 1            |
| 2                   | 0.8          |
| 3 or more           | 0.4          |

Optimization

Min. Vehicle Distance 1 m

Load Case Data

Loaded Lane LO

Min. Number of Vehicle 0

Max. Number of Vehicle 4

Loading Effect

☐ Combined ☒ Independent

Assignment Vehicle

Selected Vehicle VL:S1600

Scale Factor 1.0

| Vehicle class | Scale |
|---------------|-------|
| VL:S1600      | 1     |

Add Modify Delete

OK Cancel Apply

Caso de Carga Móvil

### 3. Normas para puentes IRS India: cargas ferroviarias

- Todas las cargas ferroviarias aplicables ahora podrían aplicarse directamente a cualquier estructura. La carga de tracción y de frenado de la locomotora y del vagón se consideraría automáticamente.

- Loads > Moving Load > India > Vehicles > IRS Bridge Rules**
- Analysis > Moving Load Analysis Control > Railway Bridge Information**

Bridge Type for Impact/CDA Calculation

☐ Steel ☒ RC

Railway Bridge Information

Tracks Single

Longitudinal Load Dispersion

Sleeper Width Type 2 0 m

Depth of fill(d) 0.3 m

Define Standard Vehicular Load

Standard Name IRS: Bridge Rules

Vehicular Load Properties

Vehicular Load Name Heavy Mineral Loadings

Vehicular Load Type Heavy Mineral Loadings

Select Vehicle Heavy Mineral Loadings

**Gondola Wagon**

**Train Load**

Define Standard Vehicular Load

Standard Name IRS: Bridge Rules

Vehicular Load Properties

Vehicular Load Name Broad Gauge-1676mm

Vehicular Load Type Broad Gauge-1676mm

Select Vehicle Modified B.G. Loading 1987-1

**Modified B.G. Loading 1987-1**

**Modified B.G. Loading 1987-2**

**B.G. Standard Loading 1926-M.L.**

**B.G. Standard Loading 1926-B.L.**

**Revised B.G. Loading 1975-WG1+WG1**

**Revised B.G. Loading 1975-WAM4A+WAM4A**

**Revised B.G. Loading 1975-Bo-Bo+Bo-Bo**

**Revised B.G. Loading 1975-WAM4A**

**Revised B.G. Loading 1975-WAM4A+WAM4**

**Revised B.G. Loading 1975-WAM4A+WDM2**

**25t Loading-2008 Combination 1**

**25t Loading-2008 Combination 2**

**25t Loading-2008 Combination 3**

**25t Loading-2008 Combination 4**

**25t Loading-2008 Combination 5**

**DFC Loading Combination 1**

**DFC Loading Combination 2**

**DFC Loading Combination 3**

**DFC Loading Combination 4**

**DFC Loading Combination 5**

**2 LOCO**

| No | P(tonf) | D(m) |
|----|---------|------|
| 1  | 25      | 2.05 |
| 2  | 25      | 1.95 |
| 3  | 25      | 5.56 |
| 4  | 25      | 1.95 |
| 5  | 25      | 2.05 |
| 9  | 25      | 1.95 |
| 10 | 25      | 5.56 |
| 11 | 25      | 1.95 |
| 12 | 25      | 2.05 |

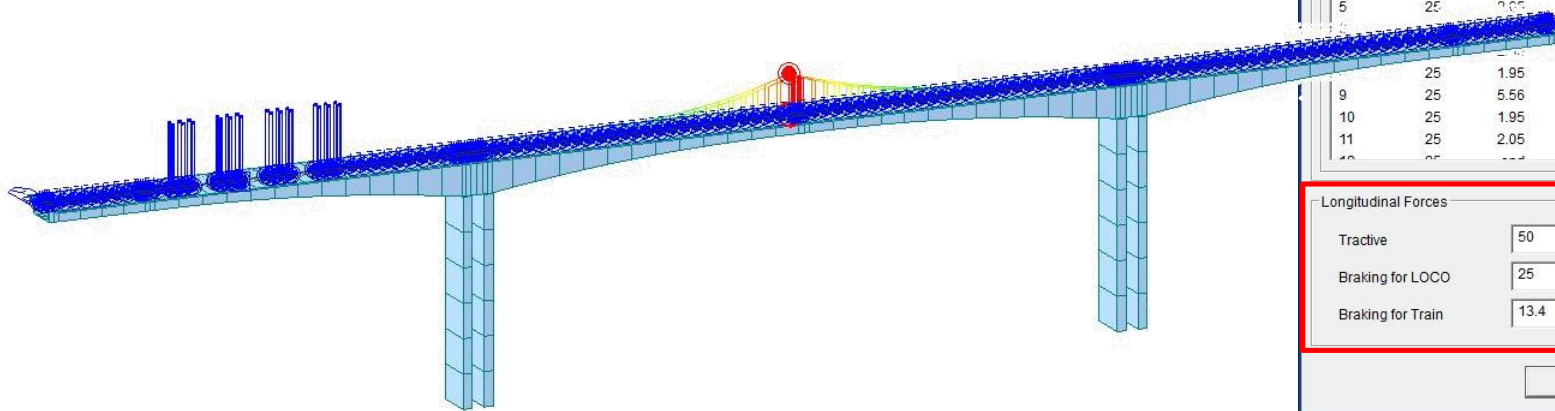
Longitudinal Forces

Tractive 50 tonf

Braking for LOCO 25 % of P

Braking for Train 13.4 % of W

OK Cancel Apply



## 4. Links Elásticos No Lineales para Análisis Pushover

- El comportamiento no lineal de los links elásticos, es decir, solo-comp., solo-tens., multi-linear se puede tener en cuenta en el análisis de pushover.
- Las fuerzas de links importadas desde el análisis estático o el análisis de etapas constructivas no se pueden especificar como cargas iniciales para el análisis de pushover.

### Pushover > Control > Global Control

**Pushover Global Control**

Geometric Nonlinearity Type  
☒ None ☐ Large Displacements

Initial Load  
☒ Perform Nonlinear Static Analysis for Initial Load  
☐ Import Static Analysis / Construction Stage Analysis Results  
 - When the boundary conditions are different between initial load and pushover load  
 - When the element forces in the last construction stage are used as an initial load

Load Case: LDC2 Scale Factor: 1

Static Load Case: Scale

Buttons: Add, Modify, Delete

Nonlinear Analysis Option  
☒ Permit Convergence Failure  
 Max. Number of Substeps: 10  
 Maximum Iteration: 10

Convergence Criteria  
☒ Displacement Norm: 0.001  
☐ Force Norm: 0.001  
☐ Energy Norm: 0.001

Analysis Stop  
☐ Shear Component Yield  
☒ Beam/Column  
☐ Axial Component Collapse/Buckling  
☒ Beam/Column  
☐ Support Uplifting/Collapse  
☐ Uplifting  
☐ Collapse

Pushover Hinge Data Option  
☒ Assign Hinge Properties to Member only for Moment-Rotation Beam/Column

Default Stiffness Reduction Ratio of Skeleton Curve  
 Trilinear / Slip Trilinear Type  
☒ Symmetric  

|            | (+)  | (-)  |
|------------|------|------|
| $\alpha_1$ | 0.1  | 0.1  |
| $\alpha_2$ | 0.05 | 0.05 |

 Bilinear / Slip Bilinear Type  
☒ Symmetric  

|            | (+)  | (-)  |
|------------|------|------|
| $\alpha_1$ | 0.05 | 0.05 |

Buttons: Remove Pushover Global Control, Misc..., OK, Cancel

Point Spring Support : Comp.-Only, Tens.-Only, Multilinear Type

☒ Apply the nonlinear properties defined in Point Spring Support for pushover analysis

☐ Assumed as linear spring support for pushover analysis

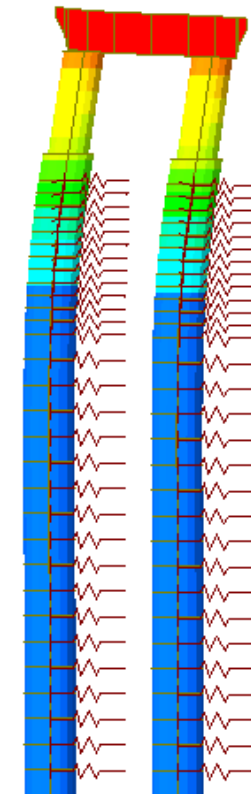
Note. In case when pushover hinges are assigned to Point Spring Support, the pushover hinge properties will be used for pushover analysis.

Elastic Link : Comp.-Only, Tens.-Only, Multilinear Type

☒ Apply the nonlinear properties defined in Elastic Link for pushover analysis

☐ Assumed as linear Elastic Link for pushover analysis

Buttons: OK, Cancel



Bi-linear Elastic Links representing soil resistance

Control Global de Pushover

Análisis Pushover para Pilas y Pilotes

## 5. GSD - Cálculo del ancho de fisuración según IRC 112: 2011

- Para cualquier sección irregular, el ancho de fisura elástico y fisurado-elástico pueden ser calculados según el código IRC 112: 2011.
- Se puede obtener un informe Excel del cálculo del esfuerzo y el ancho de la fisura

### GSD > Design Section > Crack width > Report

General Section Design

Works (Pre Mode)

- RC: 1
  - 1: Cvl\_M40 <Parabola-rectangl...
- Steel
  - Cvl\_Pier Column
  - Material
    - RC: Cvl\_M40 <Parabola-rect...
  - Rebar Material Property: Fe500
  - Shape
    - 1: 1200x2000 (RC)
  - Main Reinforcement
    - Point
    - Line
    - Arc
    - Rectangle
    - Perimeter
    - Perimeter1, Rebar Dia(P...
  - Load Combination
    - 1: SLS
    - 2: SLS 2

Section View: Cvl\_Pier Column | Interaction Curve | Moment-Curvature Curve | **Stress Contour**

Crack Status

☐ Elastic ☒ Cracked elastic ☐ Ultimate State

☐ User-defined Ratio of Modulus of Elasticity Apply

Rebar/Conc.: 6 Steel/Conc.: 6

Force and Stress in bars: Table

Concrete ☒ Stress ☐ Mesh ☒ Max/Min

Steel ☐ Stress ☐ Mesh

Rebar ☒ Stress ☐ ID

Coordinate ☒ Section ☐ Neutral Axis

Display ☒ Contour

Components ☐ Combined

Value Format ☒ Exponential

Decimal Point

MAX: 104.152

MIN: -72.800

Sig\_max = 104.152 at Y = 934 at Z = 534 Unit: N/mm²

Sig\_min = -72.7997 at Y = -934 at Z = -534

CW = 0.0678345 CW Lim= 0.3 CW OK

|    | A  | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q                 | R |
|----|--|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-------------------|---|
| 1  | Crack Width  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 2  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 3  | <b>1. Material</b>   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 4  | Name   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | M40               |   |
| 5  | fck  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 40.00 N/mm²       |   |
| 6  | fcm = fck+10(MPa)  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 50.00 N/mm²       |   |
| 7  | fctm = 0.259*fck^(2/3)   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 3.029282377 N/mm² |   |
| 8  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 9  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 10 | <b>2. Calculation of Effective Area</b>  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 11 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 12 | Overall Depth h  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 2032.72 mm        |   |
| 13 | Steel Centroid Depth d   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 1572.70 mm        |   |
| 14 | Neutral Axis Depth x   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 1204.28 mm        |   |
| 15 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 16 | Height of effective area hc,eff = min( 2.5 * (h - d) , (h - x) / 3, h/2)   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 276.15 mm         |   |
| 17 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 18 | Effective area Ac,eff  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 83144.34 mm²      |   |
| 19 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 20 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 21 | <b>3. Calculation of Crack Width</b>   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 22 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 23 | Stress in the bar $\sigma_s$   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 72.80 N/mm²       |   |
| 24 | Area of Tension steel within As  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 3216.99 mm²       |   |
| 25 | $\rho_{p,eff} = A_s / A_{c,eff}$   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0.04              |   |
| 26 | $E_{cm} = 22000 * \sqrt{f_{cm} / 12.5}^{1.5}$  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 20575.47 N/mm²    |   |
| 27 | $\alpha_e = E_s / E_{cm}$  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 5.9977632         |   |
| 28 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 29 | $(\epsilon_{s,sm} - \epsilon_{s,cm}) = (\sigma_s - k_1 * f_{ct,eff} / \rho_{p,eff} * (1 + \alpha_e * \rho_{p,eff})) / E_s$ |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0.000128          |   |
| 30 | < 0.6 * $\sigma_s$ / $E_s$   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0.0002184         |   |
| 31 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 32 | $(\epsilon_{s,sm} - \epsilon_{s,cm})$  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0.0002184         |   |
| 33 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 34 | Bond coefficient(k1)   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0.80              |   |
| 35 | Strain distribution coefficient(k2)  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0.50              |   |
| 36 | NAD Value (k3)   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 3.40              |   |
| 37 | NAD Value (k4)   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0.43              |   |
| 38 | Cover to the bar c   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 50.00 mm          |   |
| 39 | Equivalent Diameter $\phi$   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 32.00 mm          |   |
| 40 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 41 | $S_{r,max} = k_3 * c + k_1 * k_2 * k_4 * \phi / \rho_{p,eff}$  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 310.5988471 mm    |   |
| 42 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 43 | $w_k = S_{r,max} * (\epsilon_{s,sm} - \epsilon_{s,cm})$  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0.0678345 mm      |   |
| 44 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 45 | CW limit (taking from the input given in serviceability parameters)  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0.30 mm           |   |
| 46 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 47 | Crack Width Check  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | OK                |   |
| 48 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 49 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |
| 50 |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |                   |   |

Property | Stress | CrackWidth

Depth = 1204.28 mm

Report Close

## 6. Actualización AASHTO LRFD 2016

## ■ Combinación de Carga

| Load Combination Limit State    | DC<br>DD<br>DW<br>EH<br>EV<br>ES<br>EL<br>PS<br>CR<br>SH | LL<br>IM<br>CE<br>BR<br>PL<br>LS | WA   | WS  | WL   | FR   | TU        | TG            | SE            | Use One of These at a Time |      |      |      |      |
|---------------------------------|--|----------------------------------|------|-----|------|------|-----------|---------------|---------------|----------------------------|------|------|------|------|
|                                 |  |                                  |      |     |      |      |           |               |               | EQ                         | BL   | IC   | CT   | CV   |
| Strength I (unless noted)       | $\gamma_p$   | 1.75                             | 1.00 | —   | —    | 1.00 | 0.50/1.20 | $\gamma_{TG}$ | $\gamma_{SE}$ | —                          | —    | —    | —    | —    |
| Strength II                     | $\gamma_p$   | 1.35                             | 1.00 | —   | —    | 1.00 | 0.50/1.20 | $\gamma_{TG}$ | $\gamma_{SE}$ | —                          | —    | —    | —    | —    |
| Strength III                    | $\gamma_p$   | —                                | 1.00 | 1.0 | —    | 1.00 | 0.50/1.20 | $\gamma_{TG}$ | $\gamma_{SE}$ | —                          | —    | —    | —    | —    |
| Strength IV                     | $\gamma_p$   | —                                | 1.00 | —   | —    | 1.00 | 0.50/1.20 | —             | —             | —                          | —    | —    | —    | —    |
| Strength V                      | $\gamma_p$   | 1.35                             | 1.00 | 1.0 | 1.00 | 1.00 | 0.50/1.20 | $\gamma_{TG}$ | $\gamma_{SE}$ | —                          | —    | —    | —    | —    |
| Extreme Event I                 | 1.0  | $\gamma_{EQ}$                    | 1.00 | —   | —    | 1.00 | —         | —             | —             | 1.00                       | —    | —    | —    | —    |
| Extreme Event II                | $\gamma_p$   | 0.50                             | 1.00 | —   | —    | 1.00 | —         | —             | —             | —                          | 1.00 | 1.00 | 1.00 | 1.00 |
| Service I                       | 1.00   | 1.00                             | 1.00 | 1.0 | 1.00 | 1.00 | 1.00/1.20 | $\gamma_{TG}$ | $\gamma_{SE}$ | —                          | —    | —    | —    | —    |
| Service II                      | 1.00   | 1.30                             | 1.00 | —   | —    | 1.00 | 1.00/1.20 | —             | —             | —                          | —    | —    | —    | —    |
| Service III                     | 1.00   | $\gamma_{LL}$                    | 1.00 | —   | —    | 1.00 | 1.00/1.20 | $\gamma_{TG}$ | $\gamma_{SE}$ | —                          | —    | —    | —    | —    |
| Service IV                      | 1.00   | —                                | 1.00 | 1.0 | —    | 1.00 | 1.00/1.20 | —             | 1.00          | —                          | —    | —    | —    | —    |
| Fatigue I—<br>LL, IM & CE only  | —  | 1.50                             | —    | —   | —    | —    | —         | —             | —             | —                          | —    | —    | —    | —    |
| Fatigue II—<br>LL, IM & CE only | —  | 0.75                             | —    | —   | —    | —    | —         | —             | —             | —                          | —    | —    | —    | —    |

**Automatic Generation of Load Combinations**

Option  
☒ Add ☐ Replace ☒ Add Envelope

Code Selection  
☒ Steel ☐ Concrete ☐ SRC ☐ Steel Composite  
 Design Code : AASHTO-LRFD 16

Manipulation of Construction Stage Load Case  
☒ ST Only ☐ CS Only ☐ ST+CS  
 ST : Static Load Case CS : Construction Stage

Load Modifier : 1

☒ Load Factors for Permanent Loads ( $\gamma_p$ )

Load Factor for Settlement : 1

☐ Structural Plate Box Structures (Metal Box Culverts)

Live Load Factor for Service III : 0.8

Condition for Temperature  
☐ Deformation Check ☒ All Other Effects

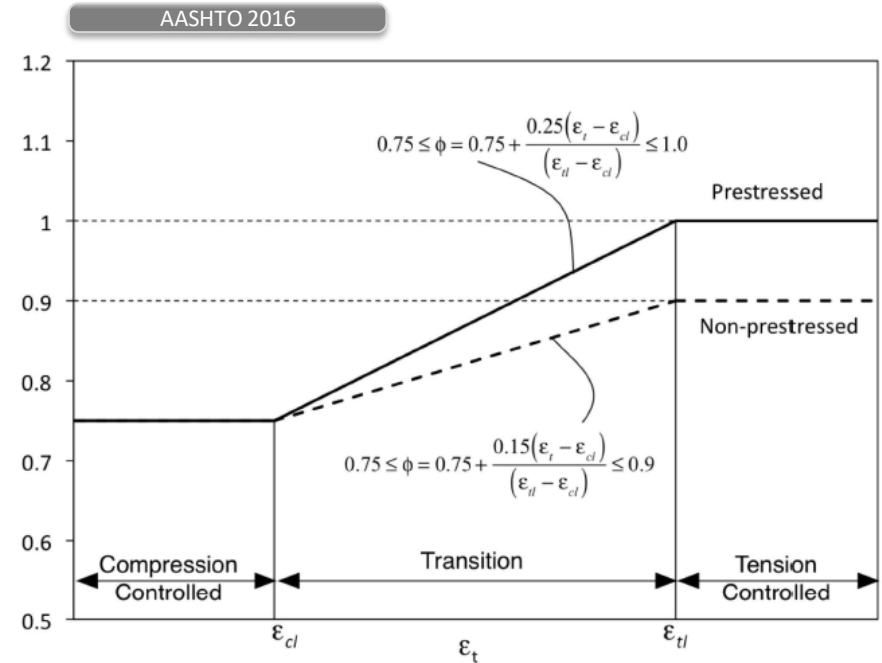
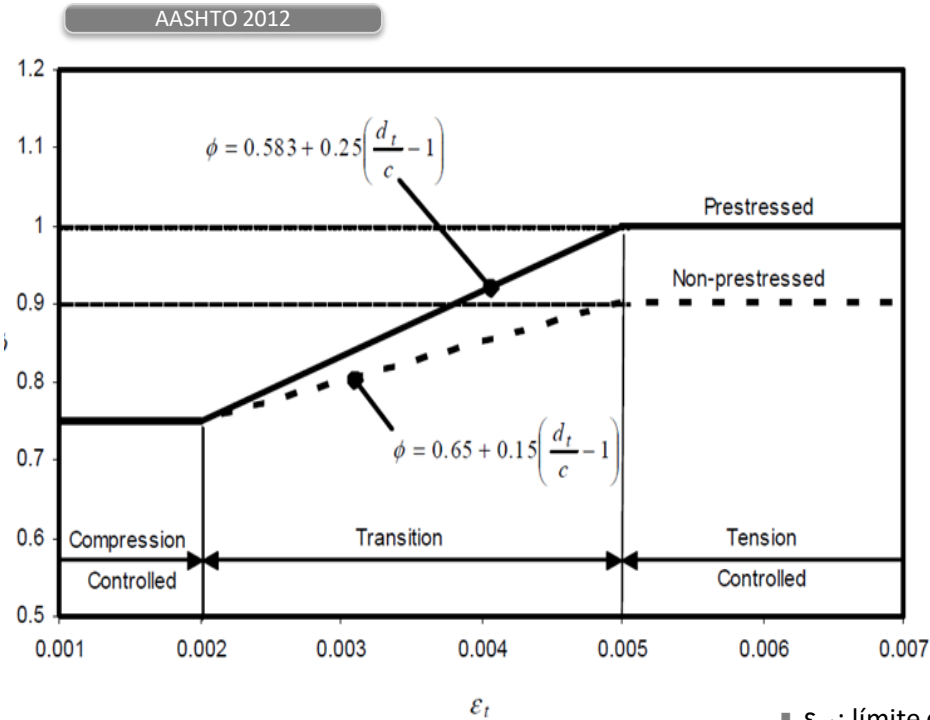
OK Cancel

Cuadro de Combinaciones de Carga

- Los factores de carga de WS para Resistencia III, Resistencia V, Servicio I, Servicio IV se cambiaron de 1.4 a 1.0, 0.4 a 1.0, 0.3 a 1.0, 0.7 a 1.0, respectivamente.
- El factor de carga de los efectos permanentes para el Evento Extremo I se cambió de  $\gamma_p$  a 1.0. AASHTO-LRFD 2012 usaba un valor para  $\gamma_p$  mayor que 1.0.

## 6. Actualización AASHTO LRFD 2016

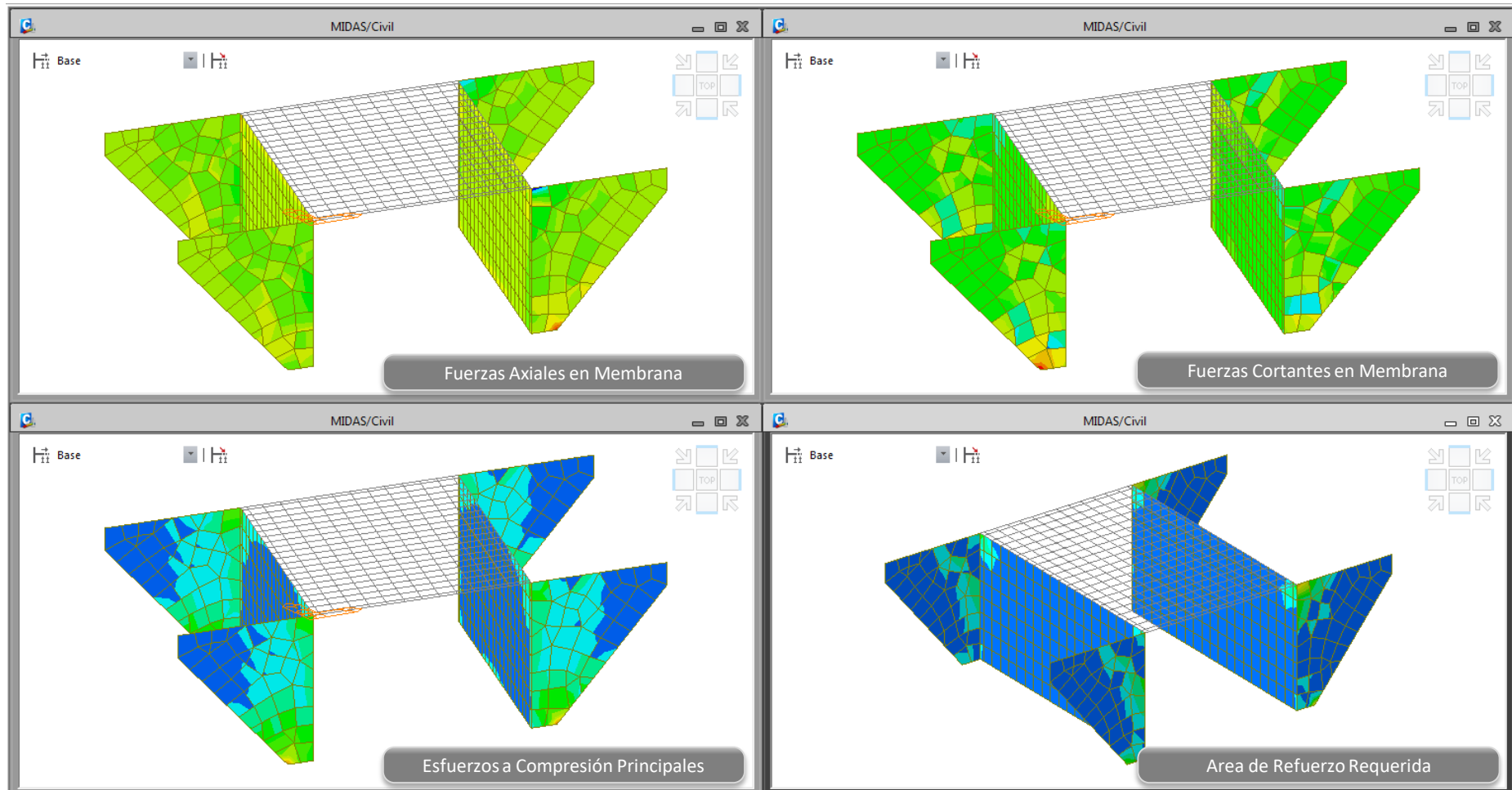
## Factor de Resistencia



- $\epsilon_{cl}$ : límite de deformación controlada por compresión en el extremo de acero a tensión
- $\epsilon_{tl}$ : límite de deformación controlada por tensión en el extremo de acero a tensión

## 7. Diseño de elementos tipo Shell

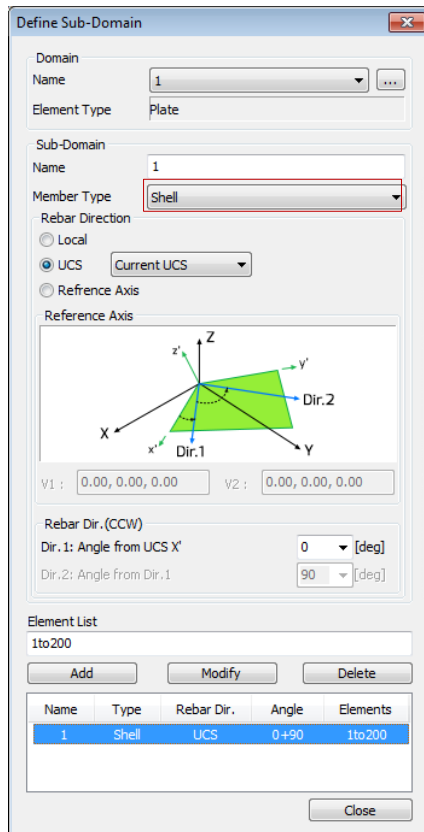
- Se implementó el diseño de los elementos tipo Shell de hormigón reforzado según el Anexo LL de EN 1992-2.
- El diseño de elementos tipo Shell considera tres fuerzas de membrana, dos momentos de flexión, momento de torsión y dos fuerzas de cortante transversal.
- Esta función de diseño se puede aplicar a la estructura tipo Shell de hormigón reforzado, muros de estribos / muros de ala, estructuras subterráneas.



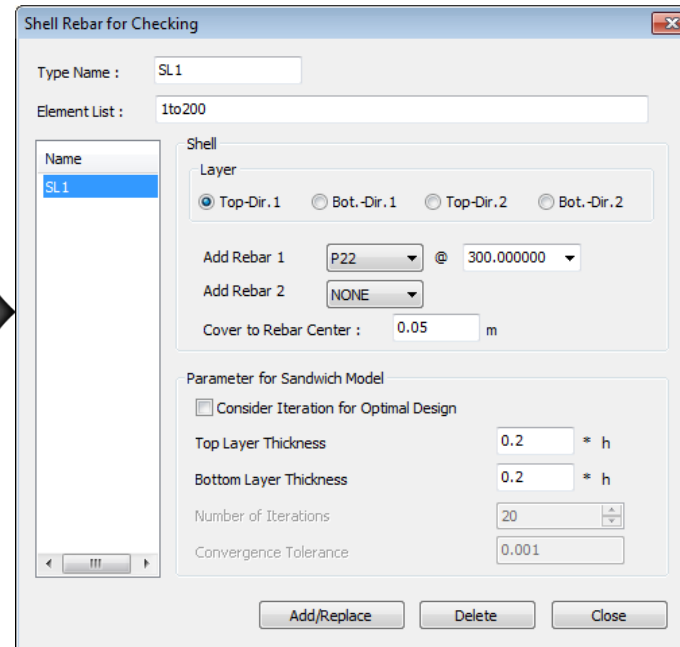
## 7. Diseño de elementos tipo Shell

### Diseño de Shell

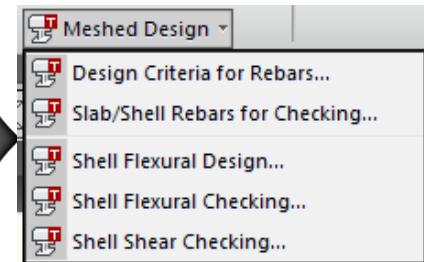
#### Step 1. Definición de miembro shell



#### Step 2. Definición de Datos de Refuerzo y Espesor de capa



#### Step 3. Ejecución del diseño y verificación de los Shells



## 7. Diseño de elementos tipo Shell

### Diseño/Verificación a Flexión de Shell

**Resultados de Barras de Refuerzo**

Shell Flexural Design

Load Cases/Combinations  
ALL COMBINATION

Design Force  
☒ Element ☐ Avg. Nodal

☒ Element ☐ Width 1 m

Display Option  
☐ Top ☐ Bottom ☒ Both

☒ Rebar (Dir. 1) ☐ Rebar (Dir. 2)

☐ Concrete

Type of Display  
☒ Contour ☒ Legend ☐ Values

Los siguientes resultados se pueden mostrar.

1. Fuerza Axial en Membrana
2. Fuerza Cortante en Membrana
3. Esfuerzo de barras
4. As\_req  
(área de refuerzo requerida)
5. Rho\_req  
(índice de refuerzo requerido)
6. Configuración de barras de refuerzo

**Resultados de Concreto**

Shell Flexural Design

Load Cases/Combinations  
ALL COMBINATION

Design Force  
☒ Element ☐ Avg. Nodal

☒ Element ☐ Width 1 m

Display Option  
☐ Top ☐ Bottom ☒ Both

☐ Rebar (Dir. 1) ☐ Rebar (Dir. 2)

☒ Concrete

Type of Display  
☒ Contour ☒ Legend ☐ Values

Los siguientes resultados se pueden mostrar.

1. Fuerza Axial en Membrana
2. Fuerza Cortante en Membrana
3. Esfuerzo Principal a Compression de Concreto

Tabla de Resultados

|   | Elem | Node | POS | CHK | Dir-1  |             |             |       | Dir-2  |             |             |       | Conc   |                |                  |       |
|---|------|------|-----|-----|--------|-------------|-------------|-------|--------|-------------|-------------|-------|--------|----------------|------------------|-------|
|   |      |      |     |     | Lcom   | ftd (kN/m²) | ftd (kN/m²) | Ratio | Lcom   | ftd (kN/m²) | ftd (kN/m²) | Ratio | Lcom   | Sig_cd (kN/m²) | sigcdlim (kN/m²) | Ratio |
| ▶ | 2    | 2    | TOP | NG  | LC3-st | 5720.27     | 808.63      | 7.07  | LC3-st | 1155.22     | 743.06      | 1.55  | LC3-st | 28.70          | 4000.00          | 0.01  |
|   | 2    | 2    | BOT | NG  | LC3-st | 139.52      | 771.16      | 0.18  | LC3-st | 28.18       | 721.21      | 0.04  | LC3-st | 5855.31        | 4000.00          | 1.46  |
|   | 2    | 3    | TOP | NG  | LC3-st | 5714.92     | 808.63      | 7.07  | LC3-st | 1148.37     | 743.06      | 1.55  | LC3-st | 13.97          | 4000.00          | 0.00  |
|   | 2    | 3    | BOT | NG  | LC3-st | 139.39      | 771.16      | 0.18  | LC3-st | 28.01       | 721.21      | 0.04  | LC3-st | 5856.79        | 4000.00          | 1.46  |
|   | 2    | 7    | TOP | NG  | LC3-st | 2992.12     | 808.63      | 3.70  | LC3-st | 524.62      | 743.06      | 0.71  | LC3-st | 69.89          | 4000.00          | 0.02  |
|   | 2    | 7    | BOT | OK  | LC3-st | 72.98       | 771.16      | 0.09  | LC3-st | 12.80       | 721.21      | 0.02  | LC3-st | 3040.47        | 4000.00          | 0.76  |
|   | 2    | 8    | TOP | NG  | LC3-st | 3092.07     | 808.63      | 3.82  | LC3-st | 630.71      | 743.06      | 0.85  | LC3-st | 27.22          | 4000.00          | 0.01  |
|   | 2    | 8    | BOT | OK  | LC3-st | 75.42       | 771.16      | 0.10  | LC3-st | 15.38       | 721.21      | 0.02  | LC3-st | 3163.41        | 4000.00          | 0.79  |

## 7. Diseño de elementos tipo Shell

### Verificación de Cortante en Shell

#### Resultado de Cortante

Shell Shear Checking ...

Load Cases/Combinations  
ALL COMBINATION ...

Design Force  
☒ Element ☐ Avg. Nodal  
☒ Element ☐ Width 1 m

Display Option  
 Type of Display  
☒ Contour ... ☒ Legend ...  
☐ Values ...

☒ V\_Edo  
☐ Shear Resistance  
☐ Resistance Ratio

Los siguientes resultados se pueden mostrar.

1. V\_Edo
2. Resistencia a Cortante del Concreto
3. Índice de Resistencia

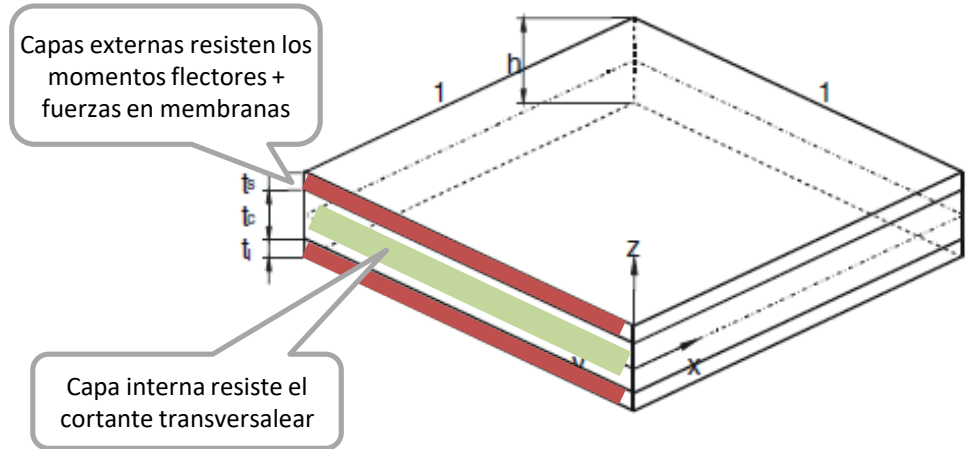
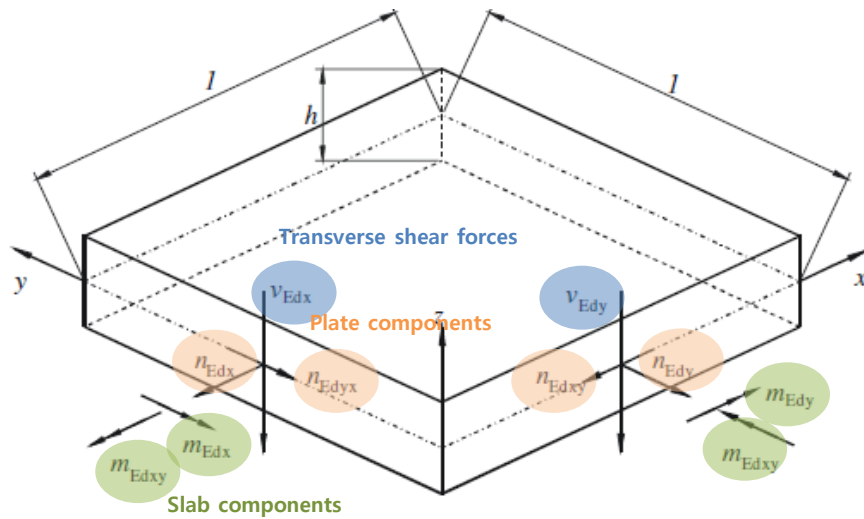
#### Tabla de Resultados

|   | Elem | Sub-Domain | Lcom    | Node | CHK | Shear Force     |                 |                 |       | Resistance      |                 |                              |
|---|------|------------|---------|------|-----|-----------------|-----------------|-----------------|-------|-----------------|-----------------|------------------------------|
|   |      |            |         |      |     | V_Edx<br>(kN/m) | V_Edy<br>(kN/m) | V_Edo<br>(kN/m) | phi_o | V_Rdc<br>(kN/m) | V_Rds<br>(kN/m) | Asw/s<br>(m <sup>2</sup> /m) |
| ▶ | 2    | L-B        | LC2-ser | 7    | OK  | -44.70          | 1.76            | 44.73           | -0.04 | 117.78          | 0.00            | 0.00                         |
|   | 2    | L-B        | LC2-ser | 8    | OK  | -43.10          | 1.76            | 43.14           | -0.04 | 117.78          | 0.00            | 0.00                         |
|   | 2    | L-B        | LC2-ser | 3    | OK  | -43.10          | 0.00            | 43.10           | -0.00 | 126.37          | 0.00            | 0.00                         |
|   | 2    | L-B        | LC2-ser | 2    | OK  | -44.70          | 0.00            | 44.70           | -0.00 | 126.37          | 0.00            | 0.00                         |

## 7. Diseño de elementos tipo Shell

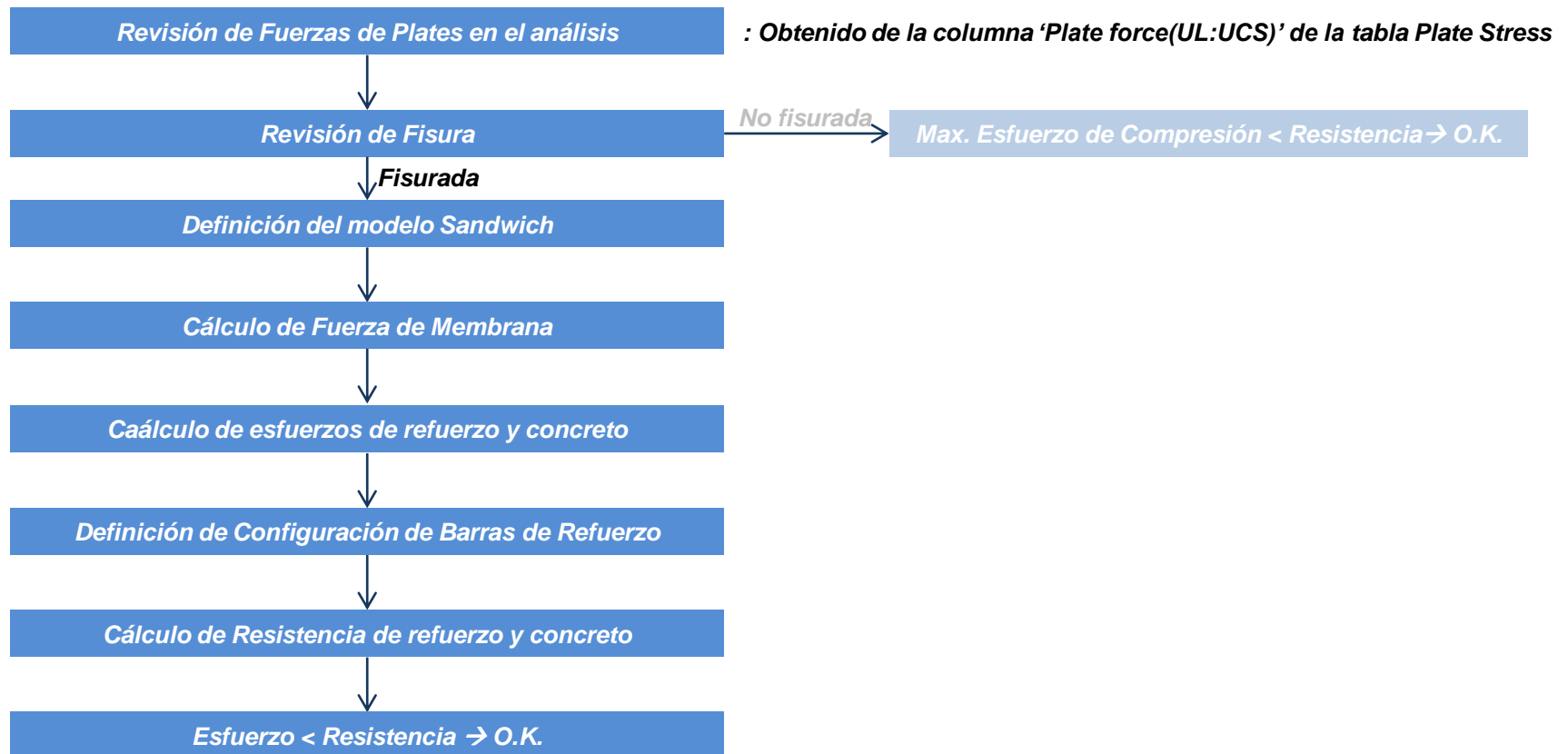
### Concepto de Diseño de Shell

- Shell o elemento de placa sometido a fuerzas de membrana  $N_x$ ,  $N_y$ ,  $N_{xy}$  + fuerzas de flexión  $M_x$ ,  $M_y$ ,  $M_{xy}$
- Resistido por las fuerzas de tensión resultantes del refuerzo + fuerzas de compresión resultantes del hormigón



## 7. Diseño de elementos tipo Shell

### Procedimiento para Diseño de Shell



## 7. Diseño de elementos tipo Shell

### Procedimiento para Diseño de Shell

#### Revisión de Fisura

$$\Phi = \alpha \frac{J_2}{f_{cm}^2} + \lambda \frac{\sqrt{J_2}}{f_{cm}} + \beta \frac{I_1}{f_{cm}} - 1 \leq 0 \quad \rightarrow \text{No Fisurada, If } \Phi > 0.0, \text{ Cracked}$$

where:

$$J_2 = \frac{1}{6} [(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2]$$

$$J_3 = (\sigma_1 - \sigma_m)(\sigma_2 - \sigma_m)(\sigma_3 - \sigma_m)$$

$$I_1 = \sigma_1 + \sigma_2 + \sigma_3$$

$$\sigma_m = (\sigma_1 + \sigma_2 + \sigma_3)/3$$

$$\alpha = \frac{1}{9k^{1.4}}$$

$$\sigma_1 = \text{Max. } [\sigma_x, \sigma_y] = \text{Max. } [F_{xx}, F_{yy}]$$

$$\sigma_2 = \text{Min. } [\sigma_x, \sigma_y] = \text{Min. } [F_{xx}, F_{yy}]$$

$$\sigma_3 = 0$$

$$\lambda = c_1 \cos \left[ \frac{1}{3} \arccos(C_2 \cos 3\theta) \right] \quad \text{for } \cos 3\theta \geq 0$$

$$\lambda = c_1 \cos \left[ \frac{\pi}{3} - \frac{1}{3} \arccos(-C_2 \cos 3\theta) \right] \quad \text{for } \cos 3\theta < 0$$

$$\beta = \frac{1}{3.7k^{1.1}}$$

$$\cos 3\theta = \frac{3\sqrt{3}}{2} \frac{J_3}{J_2^{3/2}}$$

$$c_1 = \frac{1}{0.7k^{0.9}}$$

$$c_2 = 1 - 6.8(k - 0.07)^2$$

$$k = \frac{f_{ctm}}{f_{cm}}$$

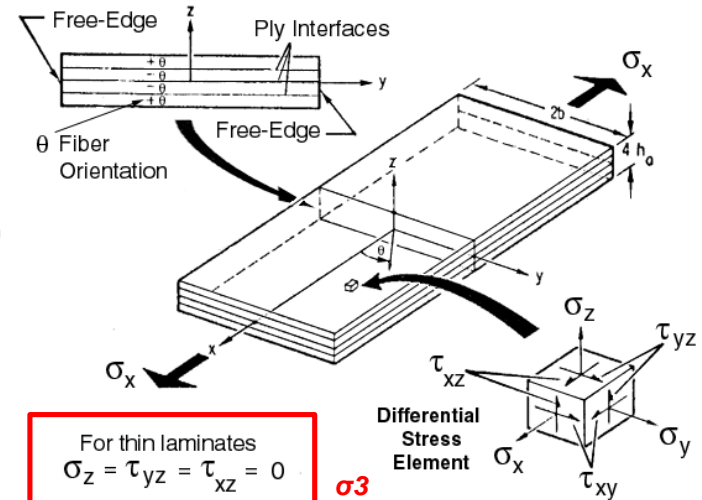


Tabla Plate Stress (UL : UCS)

|   | Elem | Load  | Node | Fxx<br>(kN/m) | Fyy<br>(kN/m) | Fxy<br>(kN/m) | Fmax<br>(kN/m) | Fmin<br>(kN/m) |
|---|------|-------|------|---------------|---------------|---------------|----------------|----------------|
| ▶ | 218  | cLCB1 | Cent | -17.633       | -1.408        | -0.083        | -1.408         | -17.634        |
|   | 218  | cLCB1 | 186  | -18.198       | -0.873        | -0.319        | -0.867         | -18.203        |
|   | 218  | cLCB1 | 238  | -17.152       | -0.873        | -0.275        | -0.869         | -17.157        |
|   | 218  | cLCB1 | 185  | -17.152       | -1.860        | 0.152         | -1.859         | -17.154        |
|   | 218  | cLCB1 | 150  | -18.198       | -1.860        | 0.108         | -1.859         | -18.198        |

◀ ▶ \ Plate Force(L) \ Plate Force(G) \ Plate Force(UL:Local) \ Plate Force(UL:UCS) \ F

## 7. Diseño de elementos tipo Shell

### Procedure of Shell Design

#### Definición de Modelo Sandwich

- Usa '0.2\*h' como valor por defecto.
- Si se selecciona "Consider Iteration for optimal design", el espesor de la capa se calcula automáticamente.

☐ Consider Iteration for Optimal Design

Top Layer Thickness : 0.2 \* h

Bottom Layer Thickness : 0.2 \* h

Number of Iterations : 20

Convergence Tolerance : 0.001

OK Close

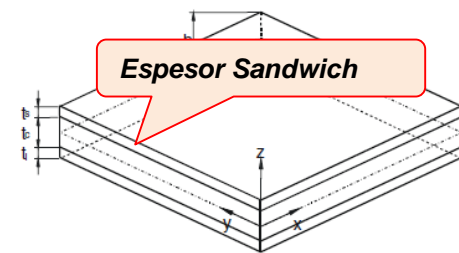
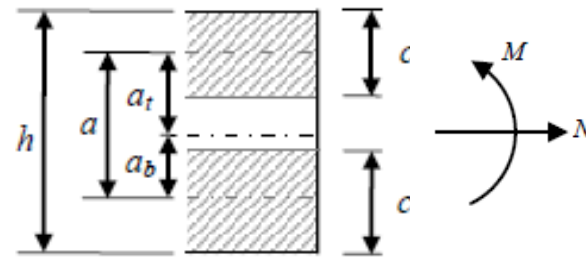


Figure LL.2 — The sandwich model

#### Cálculo de Fuerza en Membrana

- La geometría del elemento sandwich debe ser conocida para calcular las fuerzas de la membrana ( $N_{xk}$ ,  $N_{yk}$ ,  $N_{xyk}$ ).

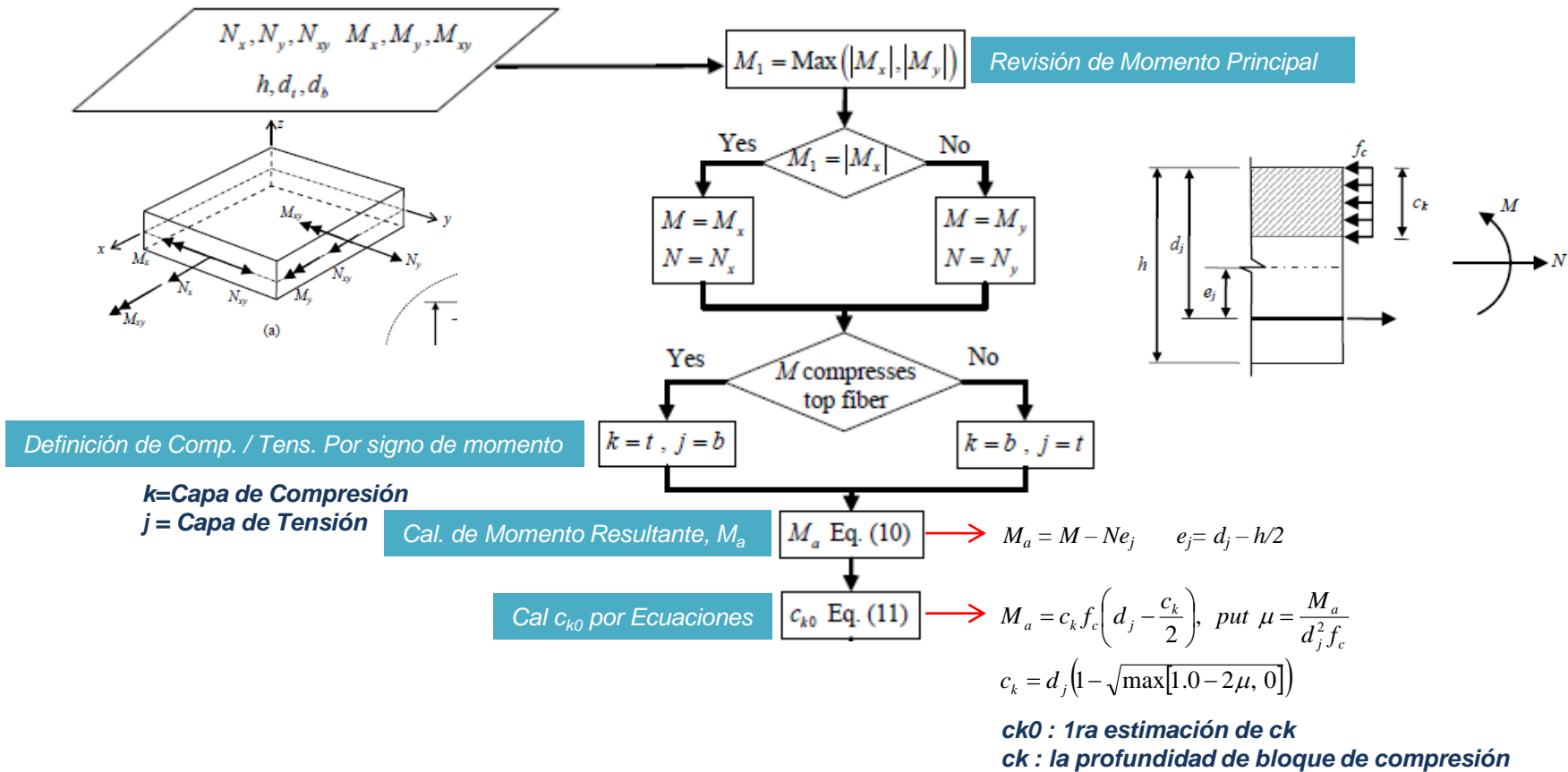
$$\begin{aligned} N_{xt} &= N_x \frac{a_b}{a} - \frac{M_x}{a} & N_{xb} &= N_x \frac{a_t}{a} + \frac{M_x}{a} \\ N_{yt} &= N_y \frac{a_b}{a} - \frac{M_y}{a} & N_{yb} &= N_y \frac{a_t}{a} + \frac{M_y}{a} \\ N_{xyt} &= N_{xy} \frac{a_b}{a} - \frac{M_{xy}}{a} & N_{xyb} &= N_{xy} \frac{a_t}{a} + \frac{M_{xy}}{a} \end{aligned}$$



## 7. Diseño de elementos tipo Shell

## Procedimiento para el Diseño de Shell

## Cálculo de Espesor de Sandwich para Diseño óptimo - 1



## 7. Diseño de elementos tipo Shell

### Procedimiento para Diseño de Shell

#### Cálculo de Espesor de Sandwich para Diseño óptimo - 2

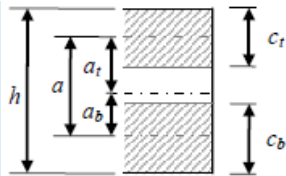
##### Fuerza de Membrana en Capa de Compresión.

$$a = d_j - \frac{c_k}{2}, \quad a_k = \frac{h - c_k}{2}, \quad a_j = a - a_k$$

$$N_{xk} = N_x \frac{a_j}{a} - \frac{M_x}{a}$$

$$N_{yk} = N_y \frac{a_j}{a} - \frac{M_y}{a}$$

$$N_{xyk} = N_{xy} \frac{a_j}{a} - \frac{M_{xy}}{a}$$



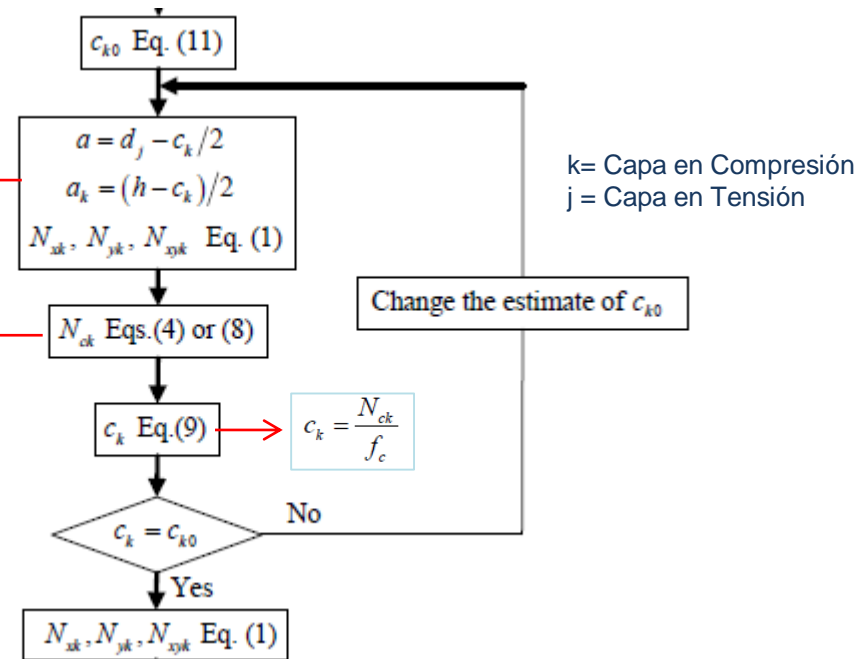
##### Fuerza de Compresión de Concreto.

**Cuando**  $N_{xk} < -|N_{xyk}|, N_{yk} < -|N_{xyk}|$

$$N_{ck} = \frac{1}{2}(N_{xk} + N_{yk}) - \frac{1}{2}\sqrt{(N_{xk} - N_{yk})^2 + 4N_{xyk}^2}$$

**Cuando se excluye**  $N_{xk} < -|N_{xyk}|, N_{yk} < -|N_{xyk}|$

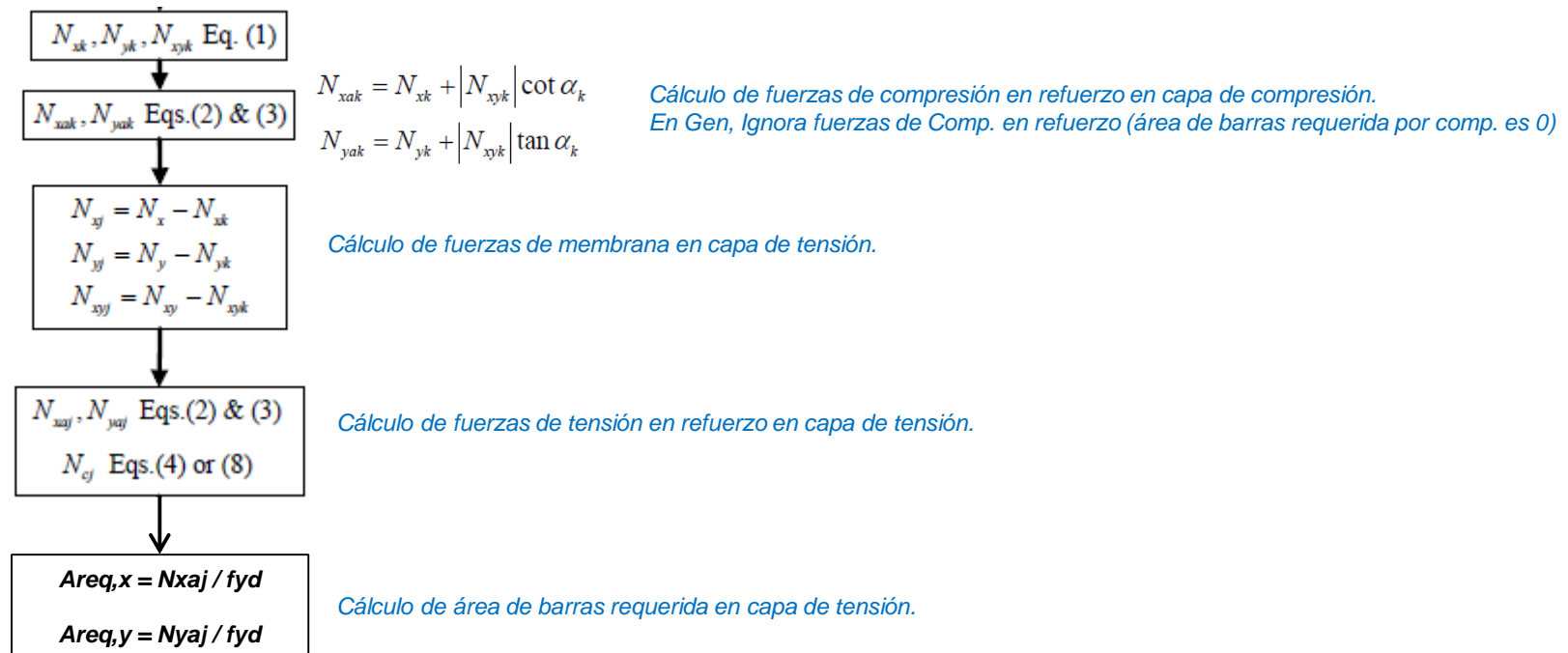
$$N_{ck} = |N_{xyk}|(\tan \alpha_k + \cot \alpha_k)$$



## 7. Diseño de elementos tipo Shell

### Procedimiento para Diseño de Shell

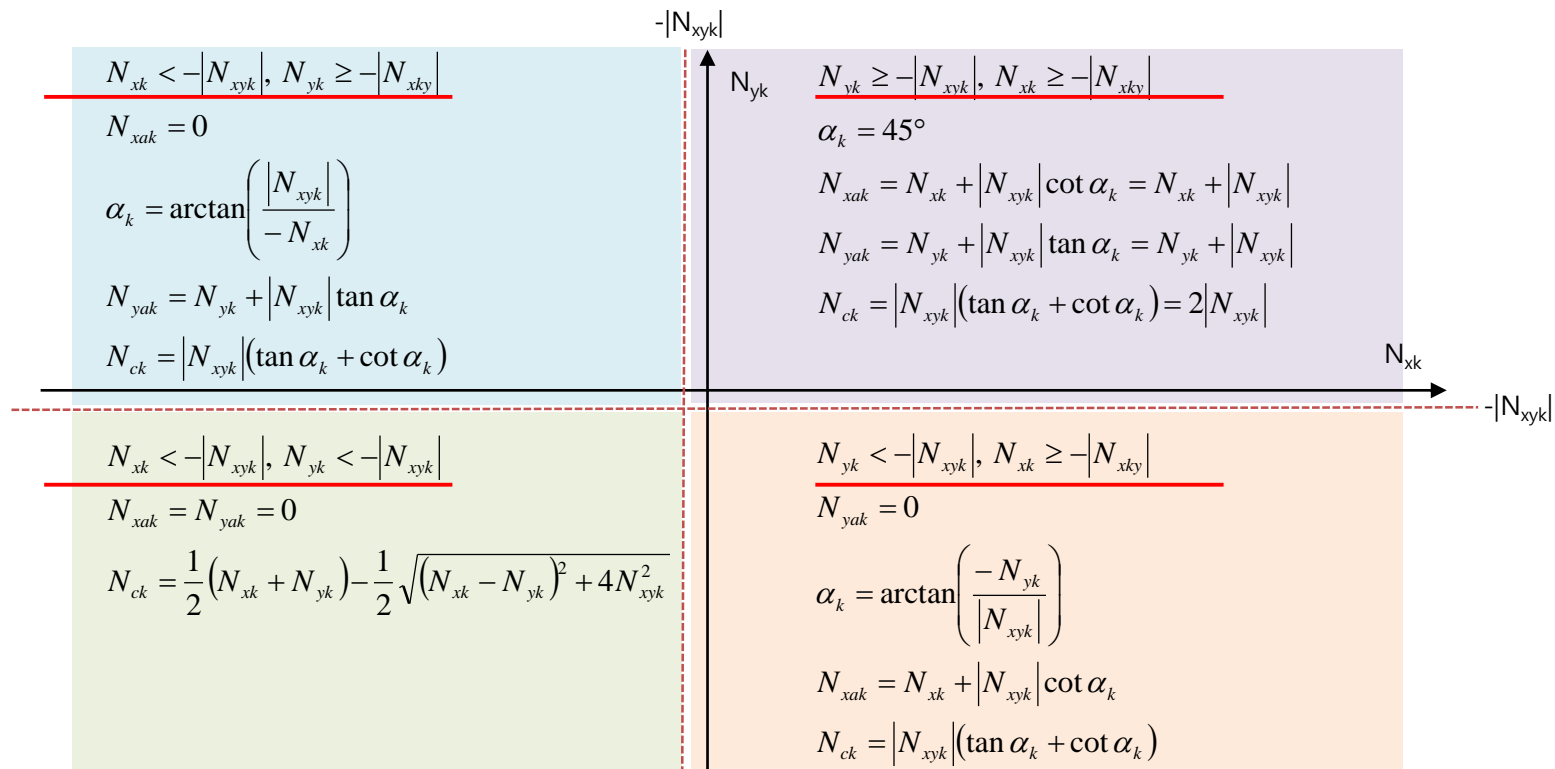
#### Cálculo de Fuerza de Membrana en capa de Tensión y área de barras requerida



## 7. Diseño de elementos tipo Shell

### Procedimiento para Diseño de Shell

#### Cálculo de fuerza de refuerzo (Capa de Tensión) y concreto (Capa de compresión)



$N_{xak}, N_{yak}$  : fuerzas de tensión en refuerzo colocadas en dirección  $x$  y  $y$  en capa  $k$

$N_{ck}$  : Fuerza de compresión de concreto en capa  $k$

## 7. Diseño de elementos tipo Shell

### Procedimiento para Diseño de Shell

#### Modificación de Fuerza de Tensión considerando la ubicación de las barras de refuerzo

Distancia desde el centro de la sección hasta el centro de la barra exteriora

Distancia desde el centro de la sección hasta el el centro del espesor de sandwich

$$z_{ya} = \frac{N_{yat} z_{yat} + N_{yab} z_{yab}}{\sum N_{ya}} = \frac{168.71 \cdot 67 + 229.47(-80)}{398.18} = -17.72 \text{ mm}$$

The actual positions of y reinforcement in top and bottom layer are  $z_{yat}^* = 53 \text{ mm}$  and

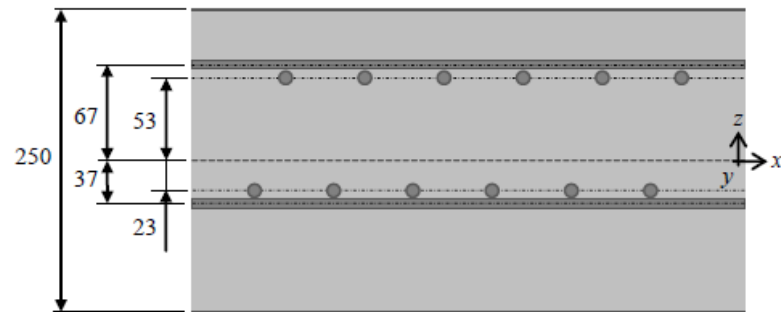
$z_{yab}^* = -23 \text{ mm}$ , the corresponding tension forces at those levels,  $N_{yat}^*$  and  $N_{yab}^*$ , can be

obtained from:

$$N_{yat}^* = \sum N_{ya} \frac{z_{ya} - z_{yab}^*}{z_{yat}^* - z_{yab}^*} = 398.18 \frac{-17.72 + 23}{53 + 23} = 27.68 \text{ N/mm}$$

$$N_{yab}^* = \sum N_{ya} \frac{z_{yat}^* - z_{ya}}{z_{yat}^* - z_{yab}^*} = 398.18 \frac{53 + 17.72}{53 + 23} = 370.50 \text{ N/mm}$$

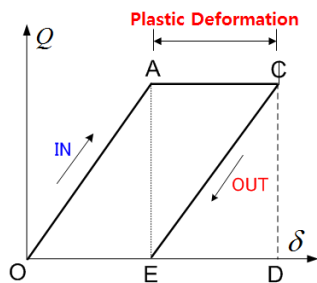
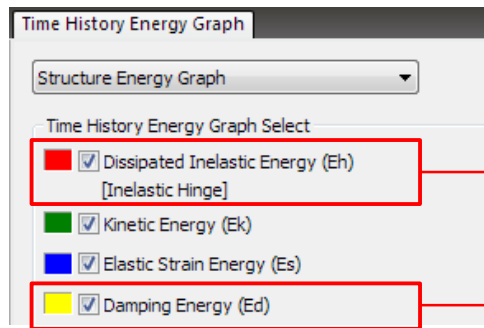
All the measurements in mm



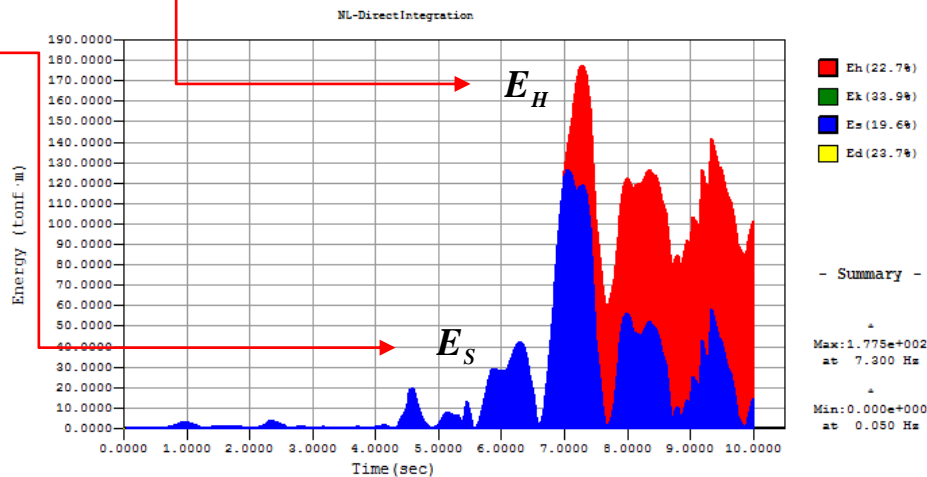
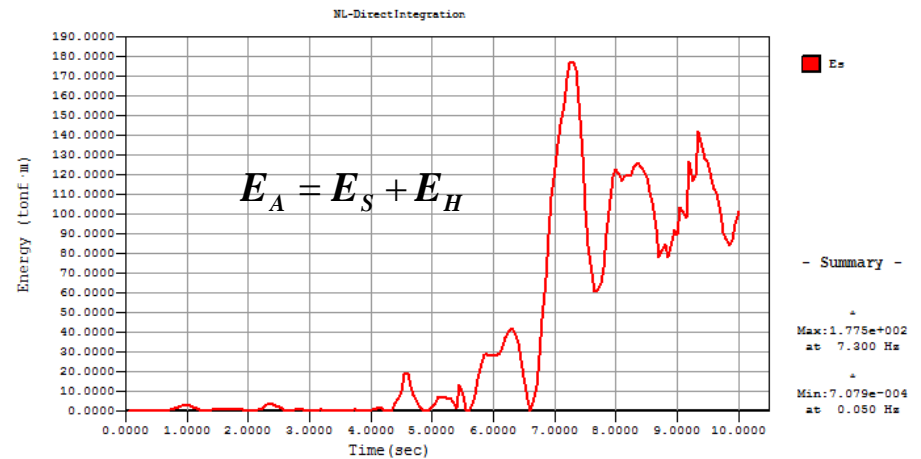
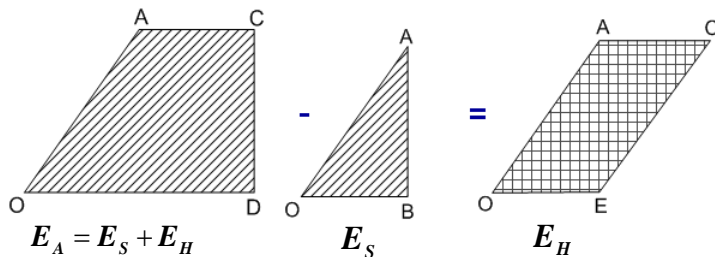
## 1. Gráfico de resultados de energía para el análisis tiempo historia

- Imprima el gráfico de resultados de energía para los dispositivos de control de vibración y aislamiento en el análisis tiempo historia no lineal.

### Result > T.H. Graph/Text > Time History Energy Graph

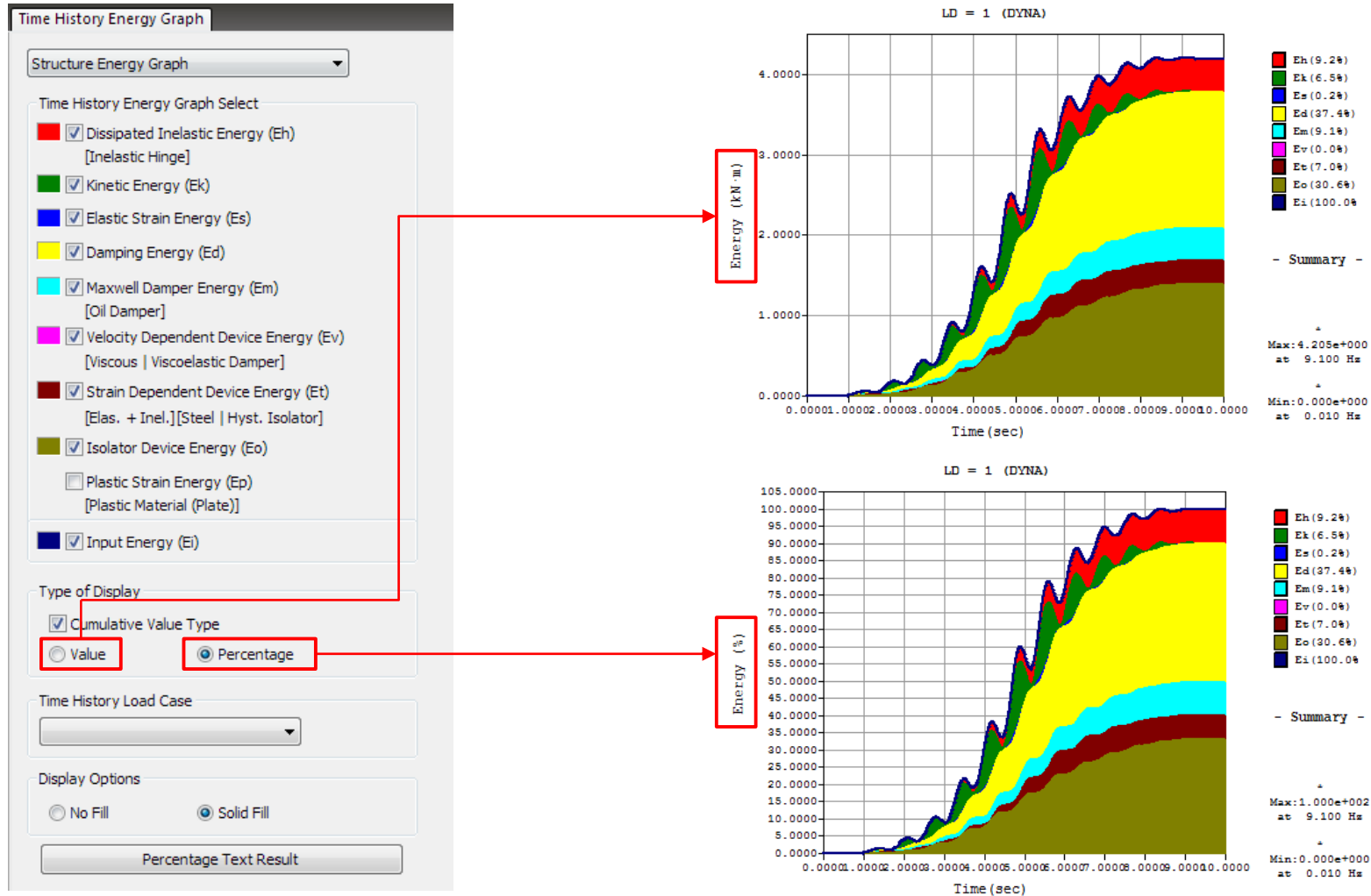


■ Input Energy   ■ Elastic Energy   ■ Dissipated Energy



## 1. Gráfico de resultados de energía para el análisis tiempo historia

### Result > T.H. Graph/Text > Time History Energy Graph



## 1. Gráfico de resultados de energía para el análisis tiempo historia

### Result > T.H. Graph/Text > Time History Energy Graph

Time History Energy Graph

Structure Energy Graph

Time History Energy Graph Select

☒ Dissipated Inelastic Energy (Eh)  
[Inelastic Hinge]

☒ Kinetic Energy (Ek)

☒ Elastic Strain Energy (Es)

☒ Damping Energy (Ed)

☒ Maxwell Damper Energy (Em)  
[Oil Damper]

☒ Velocity Dependent Device Energy (Ev)  
[Viscous | Viscoelastic Damper]

☒ Strain Dependent Device Energy (Et)  
[Elas. + Inel.] [Steel | Hyst. Isolator]

☒ Isolator Device Energy (Eo)

☐ Plastic Strain Energy (Ep)  
[Plastic Material (Plate)]

☒ Input Energy (Ei)

Type of Display

☒ Cumulative Value Type

☐ Value ☒ Percentage

Time History Load Case

Display Options

☐ No Fill ☒ Solid Fill

Percentage Text Result

< Resultado en texto de cada índice de energía >

MIDAS/Text Editor - [App4\_Time history analysis.spf]

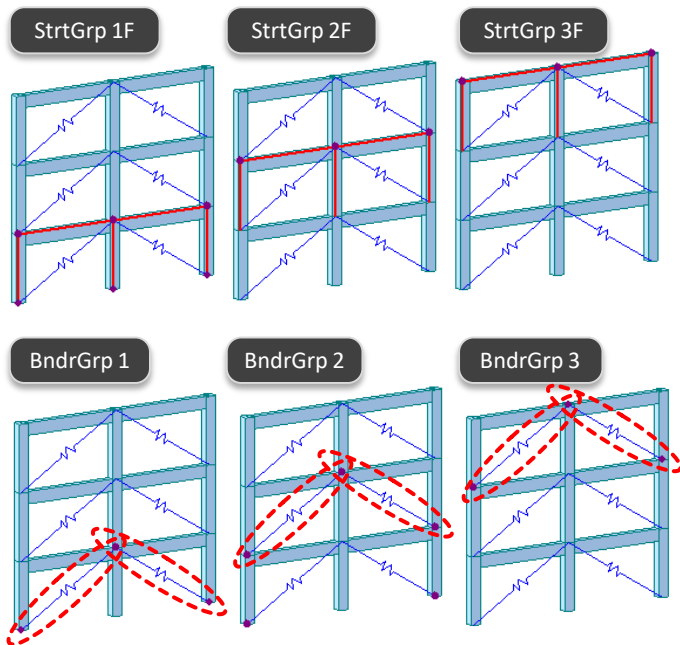
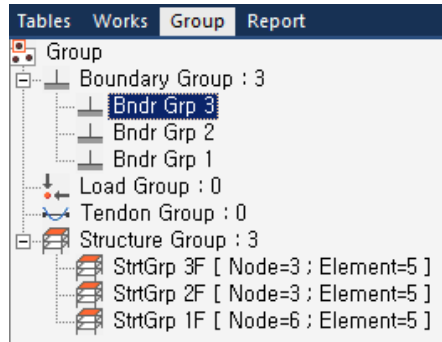
File Edit View Window Help

TIME HISTORY ANALYSIS | ENERGY RESULT PERCENTATE ; TIME HISTORY LOADCASE NO. = 1

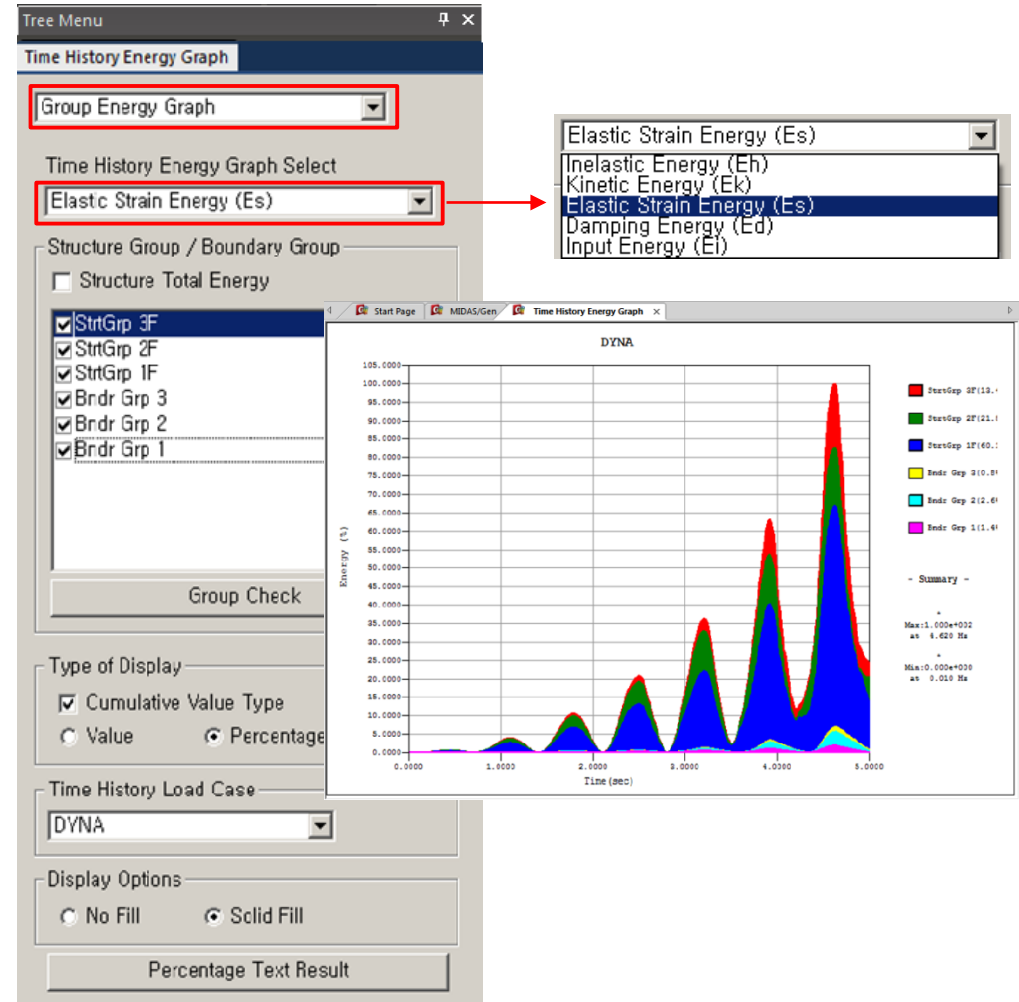
| Energy Graph   |    | Percentage (%) |
|--|----|----------------|
| (1) Dissipated Inelastic Energy [Inelastic Hinge]    | Eh | 9.196          |
| (2) Kinetic Energy                                   | Ek | 6.503          |
| (3) Elastic Strain Energy                            | Es | 0.237          |
| (4) Damping Energy                                   | Ed | 37.396         |
| (5) Maxwell Damper Energy [Oil Damper]               | Em | 9.149          |
| (6) Velocity Dependent Device Energy                 | Ev | 0.000          |
| (7) Strain Dependent Device [Steel   Hyst. Isolator] | Et | 6.959          |
| (8) Isolator Device Energy                           | Eo | 30.559         |
| (9) Plastic Strain Energy [Plastic Material (Plate)] | Ep | 0.000          |
| (10) Input Energy                                    | Ei | 100.000        |
| Error (Input Energy[Ei] - Energy Sum{(1)~(9)})       |    | 0.000          |

## 1. Gráfico de resultados de energía para el análisis tiempo historia

### Result > T.H. Graph/Text > Time History Energy Graph



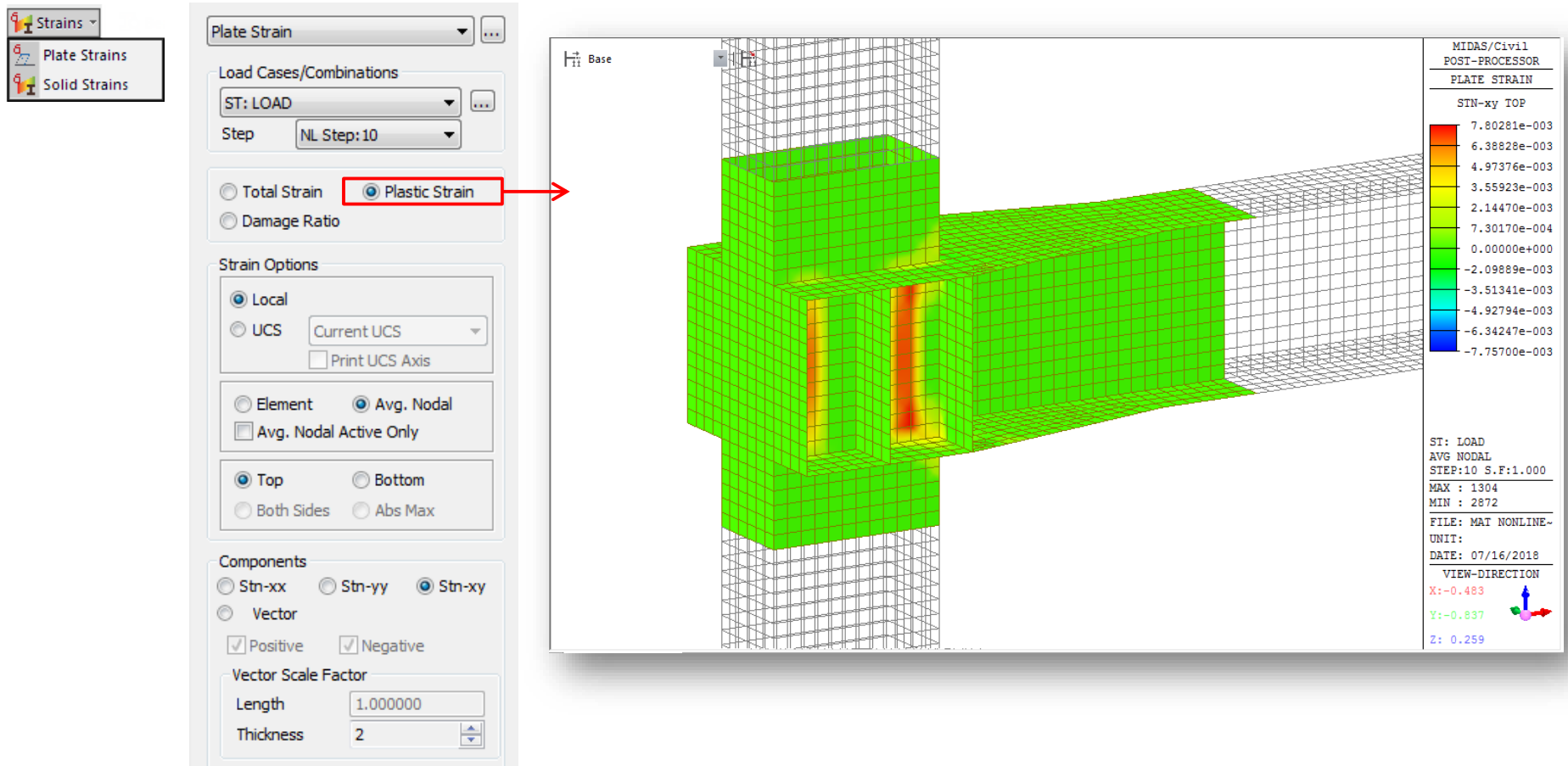
< Resultado de salida para la distribución en grupo para cada ítem >



## 2. Resultados de deformación para el análisis no lineal de materiales

- Se proporcionan resultados de deformación para materiales plásticos, es decir, Tresca, Von Mises, Mohr-Coulomb, Drucker-Prager y Daño de Concreto.
- Se proporcionan índices de daños para la compresión y la tensión para el modelo de "Concrete Damage" "Daño en concreto".

### Results > Results > Strains > Plate Strains/ Solid Strains



## 2. Resultados de deformación para el análisis no lineal de materiales

- Results > Tables > Results Tables > Plate/ Solid > Strain(local)/ Strain(Global)

The screenshot shows the MIDAS Gen Results Tables menu. The 'Plate' menu is highlighted on the left, and the 'Solid' menu is highlighted on the right. The 'Strain (Local)' option is selected in both menus. A table of results is shown on the right side of the image.

| Elem | Load | Step   | Node | Part | Strain-xx   | Strain-yy  | Strain-xy  | Strain-Max | Strain-Min  | Angle (deg) | Max-Shear  | Comp. Damage | Tens. Damage | Damage     |
|------|------|--------|------|------|-------------|------------|------------|------------|-------------|-------------|------------|--------------|--------------|------------|
| 1    | LDC1 | nl_001 | Cent | Top  | -9.802e-005 | 5.819e-005 | 0.000e+000 | 5.819e-005 | -9.802e-005 | 90.0000     | 7.811e-005 | 6.720e-002   | 0.000e+000   | 6.720e-002 |
|      |      |        |      | Bot  | -9.802e-005 | 5.819e-005 | 0.000e+000 | 5.819e-005 | -9.802e-005 | -90.0000    | 7.811e-005 | 6.720e-002   | 0.000e+000   | 6.720e-002 |
| 1    | LDC1 | nl_002 | Cent | Top  | -2.612e-004 | 1.551e-004 | 0.000e+000 | 1.551e-004 | -2.612e-004 | 90.0000     | 2.082e-004 | 1.791e-001   | 1.197e-007   | 1.791e-001 |
|      |      |        |      | Bot  | -2.612e-004 | 1.551e-004 | 0.000e+000 | 1.551e-004 | -2.612e-004 | 90.0000     | 2.082e-004 | 1.791e-001   | 1.197e-007   | 1.791e-001 |
| 1    | LDC1 | nl_003 | Cent | Top  | -4.181e-004 | 2.482e-004 | 0.000e+000 | 2.482e-004 | -4.181e-004 | 90.0000     | 3.332e-004 | 2.768e-001   | 1.197e-007   | 2.768e-001 |
|      |      |        |      | Bot  | -4.181e-004 | 2.482e-004 | 0.000e+000 | 2.482e-004 | -4.181e-004 | 90.0000     | 3.332e-004 | 2.768e-001   | 1.197e-007   | 2.768e-001 |
| 1    | LDC1 | nl_004 | Cent | Top  | -7.988e-004 | 4.742e-004 | 0.000e+000 | 4.742e-004 | -7.988e-004 | 90.0000     | 6.365e-004 | 3.963e-001   | 1.197e-007   | 3.963e-001 |
|      |      |        |      | Bot  | -7.988e-004 | 4.742e-004 | 0.000e+000 | 4.742e-004 | -7.988e-004 | 90.0000     | 6.365e-004 | 3.963e-001   | 1.197e-007   | 3.963e-001 |
| 1    | LDC1 | nl_005 | Cent | Top  | -1.237e-003 | 7.343e-004 | 0.000e+000 | 7.343e-004 | -1.237e-003 | 90.0000     | 9.856e-004 | 4.946e-001   | 1.197e-007   | 4.946e-001 |
|      |      |        |      | Bot  | -1.237e-003 | 7.343e-004 | 0.000e+000 | 7.343e-004 | -1.237e-003 | 90.0000     | 9.856e-004 | 4.946e-001   | 1.197e-007   | 4.946e-001 |
| 1    | LDC1 | nl_006 | Cent | Top  | -1.708e-003 | 1.014e-003 | 0.000e+000 | 1.014e-003 | -1.708e-003 | 90.0000     | 1.361e-003 | 5.690e-001   | 1.197e-007   | 5.690e-001 |
|      |      |        |      | Bot  | -1.708e-003 | 1.014e-003 | 0.000e+000 | 1.014e-003 | -1.708e-003 | -90.0000    | 1.361e-003 | 5.690e-001   | 1.197e-007   | 5.690e-001 |
| 1    | LDC1 | nl_007 | Cent | Top  | -2.197e-003 | 1.305e-003 | 0.000e+000 | 1.305e-003 | -2.197e-003 | 90.0000     | 1.751e-003 | 6.247e-001   | 1.197e-007   | 6.247e-001 |
|      |      |        |      | Bot  | -2.197e-003 | 1.305e-003 | 0.000e+000 | 1.305e-003 | -2.197e-003 | -90.0000    | 1.751e-003 | 6.247e-001   | 1.197e-007   | 6.247e-001 |
| 1    | LDC1 | nl_008 | Cent | Top  | -2.693e-003 | 1.599e-003 | 0.000e+000 | 1.599e-003 | -2.693e-003 | 90.0000     | 2.146e-003 | 6.692e-001   | 1.197e-007   | 6.692e-001 |
|      |      |        |      | Bot  | -2.693e-003 | 1.599e-003 | 0.000e+000 | 1.599e-003 | -2.693e-003 | -90.0000    | 2.146e-003 | 6.692e-001   | 1.197e-007   | 6.692e-001 |
| 1    | LDC1 | nl_009 | Cent | Top  | -3.193e-003 | 1.896e-003 | 0.000e+000 | 1.896e-003 | -3.193e-003 | 90.0000     | 2.545e-003 | 7.069e-001   | 1.197e-007   | 7.069e-001 |
|      |      |        |      | Bot  | -3.193e-003 | 1.896e-003 | 0.000e+000 | 1.896e-003 | -3.193e-003 | -90.0000    | 2.545e-003 | 7.069e-001   | 1.197e-007   | 7.069e-001 |
| 1    | LDC1 | nl_010 | Cent | Top  | -3.695e-003 | 2.193e-003 | 0.000e+000 | 2.193e-003 | -3.695e-003 | 90.0000     | 2.944e-003 | 7.352e-001   | 1.197e-007   | 7.352e-001 |
|      |      |        |      | Bot  | -3.695e-003 | 2.193e-003 | 0.000e+000 | 2.193e-003 | -3.695e-003 | -90.0000    | 2.944e-003 | 7.352e-001   | 1.197e-007   | 7.352e-001 |
| 1    | LDC1 | nl_011 | Cent | Top  | -4.197e-003 | 2.492e-003 | 0.000e+000 | 2.492e-003 | -4.197e-003 | 90.0000     | 3.344e-003 | 7.573e-001   | 1.197e-007   | 7.573e-001 |
|      |      |        |      | Bot  | -4.197e-003 | 2.492e-003 | 0.000e+000 | 2.492e-003 | -4.197e-003 | -90.0000    | 3.344e-003 | 7.573e-001   | 1.197e-007   | 7.573e-001 |
| 1    | LDC1 | nl_012 | Cent | Top  | -4.700e-003 | 2.790e-003 | 0.000e+000 | 2.790e-003 | -4.700e-003 | 90.0000     | 3.745e-003 | 7.793e-001   | 1.197e-007   | 7.793e-001 |
|      |      |        |      | Bot  | -4.700e-003 | 2.790e-003 | 0.000e+000 | 2.790e-003 | -4.700e-003 | -90.0000    | 3.745e-003 | 7.793e-001   | 1.197e-007   | 7.793e-001 |
| 1    | LDC1 | nl_013 | Cent | Top  | -5.203e-003 | 3.089e-003 | 0.000e+000 | 3.089e-003 | -5.203e-003 | 90.0000     | 4.146e-003 | 7.990e-001   | 1.197e-007   | 7.990e-001 |
|      |      |        |      | Bot  | -5.203e-003 | 3.089e-003 | 0.000e+000 | 3.089e-003 | -5.203e-003 | -90.0000    | 4.146e-003 | 7.990e-001   | 1.197e-007   | 7.990e-001 |
| 1    | LDC1 | nl_014 | Cent | Top  | -5.706e-003 | 3.388e-003 | 0.000e+000 | 3.388e-003 | -5.706e-003 | 90.0000     | 4.547e-003 | 8.101e-001   | 1.197e-007   | 8.101e-001 |
|      |      |        |      | Bot  | -5.706e-003 | 3.388e-003 | 0.000e+000 | 3.388e-003 | -5.706e-003 | -90.0000    | 4.547e-003 | 8.101e-001   | 1.197e-007   | 8.101e-001 |
| 1    | LDC1 | nl_015 | Cent | Top  | -6.209e-003 | 3.686e-003 | 0.000e+000 | 3.686e-003 | -6.209e-003 | 90.0000     | 4.948e-003 | 8.206e-001   | 1.197e-007   | 8.206e-001 |
|      |      |        |      | Bot  | -6.209e-003 | 3.686e-003 | 0.000e+000 | 3.686e-003 | -6.209e-003 | -90.0000    | 4.948e-003 | 8.206e-001   | 1.197e-007   | 8.206e-001 |
| 1    | LDC1 | nl_016 | Cent | Top  | -6.713e-003 | 3.985e-003 | 0.000e+000 | 3.985e-003 | -6.713e-003 | 90.0000     | 5.349e-003 | 8.311e-001   | 1.197e-007   | 8.311e-001 |
|      |      |        |      | Bot  | -6.713e-003 | 3.985e-003 | 0.000e+000 | 3.985e-003 | -6.713e-003 | -90.0000    | 5.349e-003 | 8.311e-001   | 1.197e-007   | 8.311e-001 |
| 1    | LDC1 | nl_017 | Cent | Top  | -7.217e-003 | 4.285e-003 | 0.000e+000 | 4.285e-003 | -7.217e-003 | 90.0000     | 5.751e-003 | 8.416e-001   | 1.197e-007   | 8.416e-001 |
|      |      |        |      | Bot  | -7.217e-003 | 4.285e-003 | 0.000e+000 | 4.285e-003 | -7.217e-003 | -90.0000    | 5.751e-003 | 8.416e-001   | 1.197e-007   | 8.416e-001 |
| 1    | LDC1 | nl_018 | Cent | Top  | -7.722e-003 | 4.584e-003 | 0.000e+000 | 4.584e-003 | -7.722e-003 | 90.0000     | 6.153e-003 | 8.521e-001   | 1.197e-007   | 8.521e-001 |
|      |      |        |      | Bot  | -7.722e-003 | 4.584e-003 | 0.000e+000 | 4.584e-003 | -7.722e-003 | -90.0000    | 6.153e-003 | 8.521e-001   | 1.197e-007   | 8.521e-001 |

&lt;Plate Strain (local) menu&gt;

&lt;Solid Strain (local) menu&gt;

Tabla de Deformaciones en Plate

### 3. Función multi-lineal de fuerza-deformación para Point Spring Support y Elastic Link

- La curva multi-lineal para Point Spring Support y Elastic Link se puede definir como una función sin limitación en términos de cantidad de datos.

< Versión Anterior >

Point Spring

Boundary Group Name: Default

Options: ☒ Add ☐ Replace ☐ Delete

Point Spring (Local Direction):

Type: Multi-Linear

Multi-Linear Type: Unsymmetric

|   | x: m | y: kN |
|---|------|-------|
| a | 0    | 0     |
| b | 0    | 0     |
| c | 0    | 0     |
| d | 0    | 0     |
| e | 0    | 0     |
| f | 0    | 0     |

Direction: Dx(+)

Multi-lineal es definida en 6 puntos en la versión anterior.

< Civil 2019 (v1.1) >

Point Spring

Deformation-Forces Function: 02

Direction: Dz(-)

Elastic Link

Deformation-Forces Function: 01

Options: ☒ Add ☐ Delete

Elastic Link Data:

Type: Multi-Linear

Direction: Dx

Shear Spring Location: ☐

Dist. Ratio From End I: 0.5

Beta Angle: 0 [deg]

2 Nodes:

☐ Copy Elastic Link

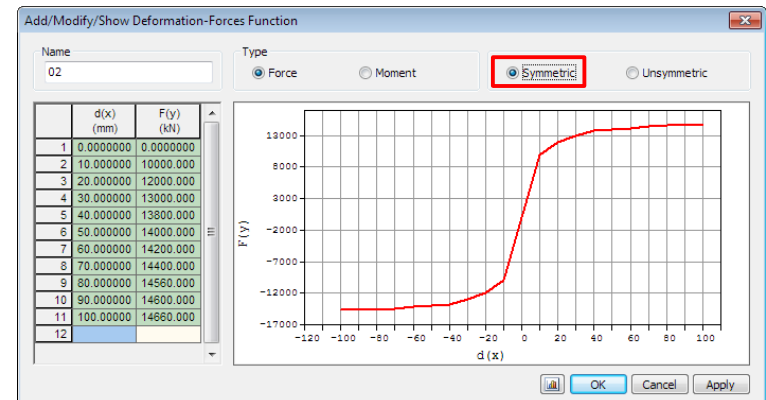
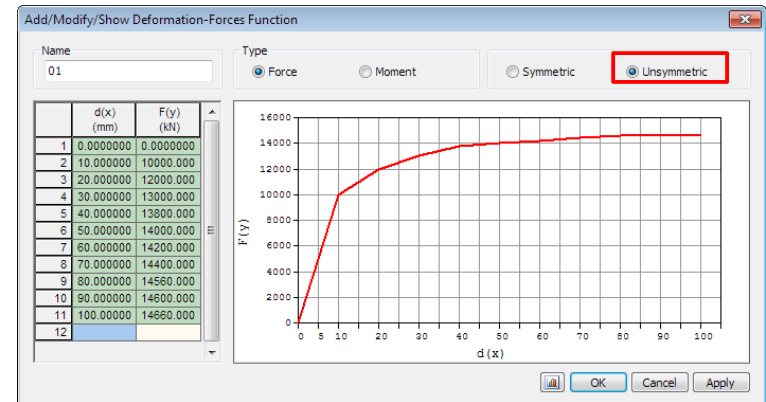
☐ Node Inc. ☒ Distance

Axis: ☒ x ☐ y ☐ z

Distances: [ ] mm

(Example: 5, 3, 4.5, 3@5.0)

Apply Close



#### 4. Informe de análisis de la vía férrea con la configuración de unidades estadounidense

- El informe de Análisis de Vías Férreas es compatible con el sistema de unidades de EE. UU. Y con el sistema de unidades SI.

- Structure > Wizard > Rail Track Analysis Model > Rail Track Analysis Report**

**Rail Track Analysis Report**

Working Directory: E:\W0622\Sample\Sample Model File\W

Sample Model File\_Add1\_RelativeDisp.mcb  
 Sample Model File\_Add1\_RelativeDisp\_Mov1.mcb  
 Sample Model File\_Add1\_RelativeDisp\_Mov2.mcb  
 Sample Model File\_Add1\_RelativeDisp\_Mov3.mcb  
 Sample Model File\_Add1\_RelativeDisp\_Mov4.mcb  
 Sample Model File\_Add1\_RelativeDisp\_Mov5.mcb  
 Sample Model File\_Add1\_RelativeDisp\_Mov6.mcb  
 Sample Model File\_Add1\_RelativeDisp\_Mov7.mcb  
 Sample Model File\_Add1\_RelativeDisp\_Mov8.mcb  
 Sample Model File\_Add1\_RelativeDisp\_Mov9.mcb  
 Sample Model File\_Add2\_RotationAngle.mcb

Unit Setting  
☐ N-mm  
☒ kips-in

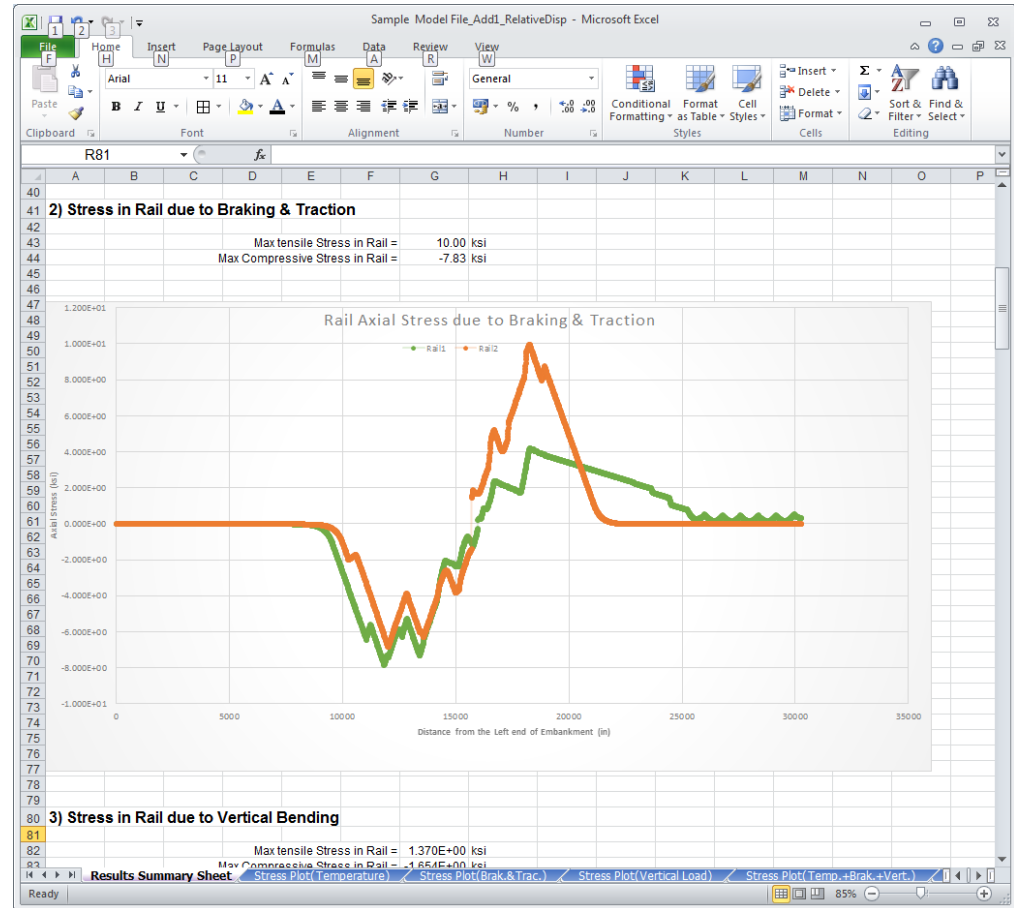
Checking Criteria  
 Maximum permissible additional rail stresses  
 Compressive stress: 12 ksi  
 Tensile stress: 14 ksi

Permissible horizontal displacements due to Braking/Traction  
 Relative displacement between Deck and Rail: 0.5 in  
 Absolute displacement of the Deck: 0.5 in

Permissible displacement between Top of Deck end and Embankment or between Top of two consecutive Deck ends: 0.5 in

OK Cancel

Configuración de Unidades en Reporte



Reporte de Análisis de Vías Férreas

## 5. Interfaz de datos con midas GTS NX

- Las reacciones de Point Spring Support se pueden exportar a GTS NX.
- Los resultados de fuerza-desplazamiento del suelo pueden ser importados desde GTS NX a midas Civil, y los datos de entrada de los point spring supports multi-lineales son actualizados.

- File > Export > Nodal Results for GTS**
- File > Import > Nodal Results for GTS**



**Export Nodal Results**

Target Nodes

☒ All (By Supports, Point Spring, Spec. Disp.)

☐ Selected Nodes

Select Load Case & Direction

Stage: Base

Load Cases/Combination: ST: SW

Step:

Result Type: Reactions

Result Components: All

OK Cancel



**Export Nodal Results**

Target Nodes

☐ All (By Supports, Spec. Disp.)

☐ Selected Nodes

☒ Load Sets (By Force): User Defined

Output Data

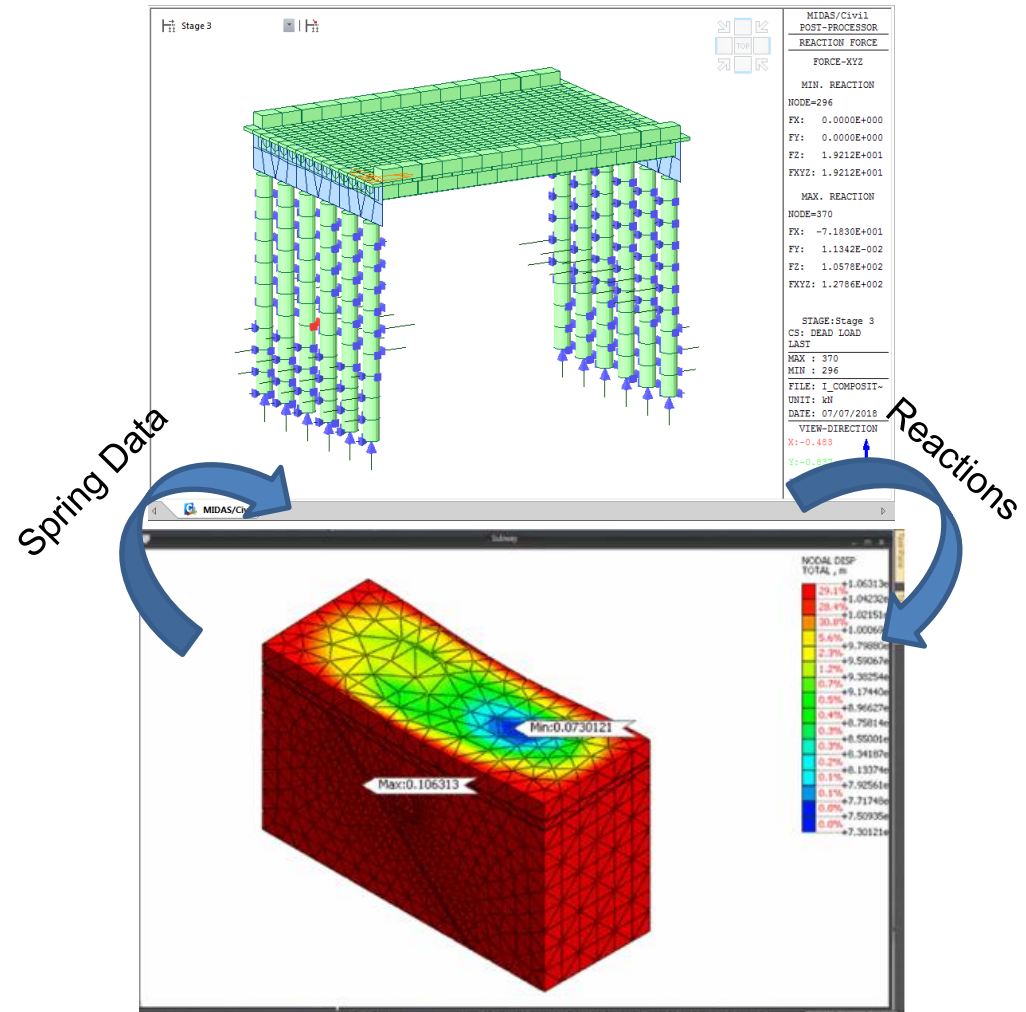
Analysis Set: NS\_every step3

Step: Nonlinear Static(In-situ)

Result Type: Reactions

Result Components: All

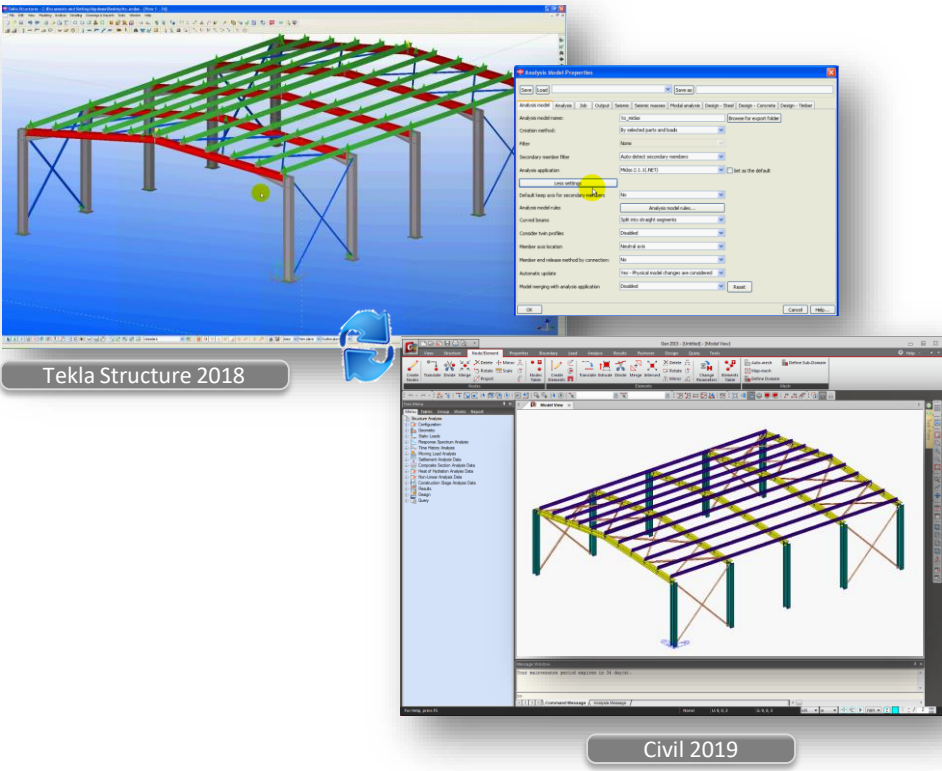
OK Cancel Apply



6. Interfaz Tekla Structure 2018

- La interfaz de Tekla Structures es una herramienta proporcionada para agilizar todo el proceso de modelado, análisis y diseño de una estructura mediante transferencia de datos directa con midas Civil.
- La transferencia de datos está limitada a elementos estructurales.
- a interfaz de Tekla Structure nos permite transferir directamente los datos de un modelo de Tekla a midas Civil y devolverlo al modelo de Tekla. El archivo de texto de midas Civils (\* .mct) se usa para la transferencia en ambas direcciones.

- File > Import > midas Civil MCT File
- File > Export > midas Civil MCT File



| Category                   | Features                                  | Tekla <> Gen |
|----------------------------|---|--------------|
| MATERIAL                   | concrete                                  | <>           |
|                            | steel                                     | <>           |
|                            | pre cast - wood and other types           | <>           |
|                            | Material user defined                     | <>           |
| ELEMENT TYPE/<br>ROTATIONS | vertical column                           | <>           |
|                            | inclined column                           | <>           |
|                            | straight beam                             | <>           |
|                            | curved beam                               | >            |
|                            | Slab                                      | <>           |
|                            | vertical panel                            | >            |
| 2D ELEMENTS                | Concrete panels and slab                  | <>           |
| BOUNDARY CONDITIONS        | support                                   | >            |
|                            | beam end release                          | <>           |
|                            | section offset                            | >            |
| STATIC LOAD                | self weighth                              | >            |
|                            | linear load<br>(uniform or trapezoidal)   | <>           |
| MERGE OPTION               | new element                               | <>           |
|                            | new element that<br>divide other elements | <>           |
|                            | topology changes                          | <>           |