Análisis Dinámico Modal Espectral

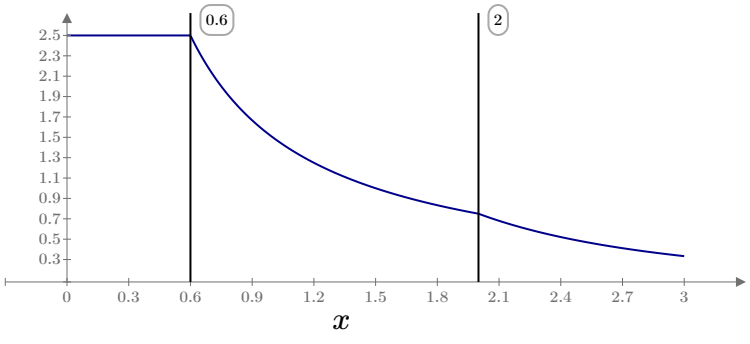
Ingeniería Sismorresistente y Prevención de Desastres ES831 H R.C.

PARÁMETROS SÍSMICOS E030

Ubicación: Zona 4	$Z := 0.45$
Uso: Centro de Salud	$U := 1.5$
Tipo de suelo: S2	$S := 1.05$
Periodo corto	$T_P := 0.6$
Periodo largo	$T_L := 2.0$
Sistema Estructural: C.A. Pórticos	$R_0 := 8$
Regular en planta	$I_p := 1$
Regular en altura	$I_a := 1$
Coeficiente de reducción	$R := R_0 \cdot I_p \cdot I_a = 8$

COEFICIENTE DE AMPLIFICACIÓN SÍSMICA E030

$$C(x) := \text{if}\left(x < T_P, 2.5, \text{if}\left(T_P < x \wedge x < T_L, 2.5 \cdot \frac{T_P}{x}, 2.5 \cdot \left(\frac{T_P \cdot T_L}{x^2}\right)\right)\right)$$



$C(x)$

DEFINICIÓN DE MASAS Y RIGIDECES

Nota: Dirección Larga (más desfavorable)

Peso sísmico

$w6 := 890.599$ *tonnef*	$m6 := \frac{w6}{g} = 0.908$ *tonnef* $\cdot \frac{s^2}{cm}$	$k6 := 906.449 \frac{tonnef}{cm}$
$w5 := 1011.459$ *tonnef*	$m5 := \frac{w5}{g} = 1.031$ *tonnef* $\cdot \frac{s^2}{cm}$	$k5 := 906.449 \frac{tonnef}{cm}$
$w4 := 1011.459$ *tonnef*	$m4 := \frac{w4}{g} = 1.031$ *tonnef* $\cdot \frac{s^2}{cm}$	$k4 := 906.449 \frac{tonnef}{cm}$
$w3 := 1011.459$ *tonnef*	$m3 := \frac{w3}{g} = 1.031$ *tonnef* $\cdot \frac{s^2}{cm}$	$k3 := 906.449 \frac{tonnef}{cm}$
$w2 := 1013.072$ *tonnef*	$m2 := \frac{w2}{g} = 1.033$ *tonnef* $\cdot \frac{s^2}{cm}$	$k2 := 922.508 \frac{tonnef}{cm}$
$w1 := 993.843$ *tonnef*	$m1 := \frac{w1}{g} = 1.013$ *tonnef* $\cdot \frac{s^2}{cm}$	$k1 := 1797.101 \frac{tonnef}{cm}$

$$mM := \begin{bmatrix} m6 & 0 & 0 & 0 & 0 & 0 \\ 0 & m5 & 0 & 0 & 0 & 0 \\ 0 & 0 & m4 & 0 & 0 & 0 \\ 0 & 0 & 0 & m3 & 0 & 0 \\ 0 & 0 & 0 & 0 & m2 & 0 \\ 0 & 0 & 0 & 0 & 0 & m1 \end{bmatrix}$$

$$mK := \begin{bmatrix} k6 & -k6 & 0 & 0 & 0 & 0 \\ -k6 & k5+k6 & -k5 & 0 & 0 & 0 \\ 0 & -k5 & k4+k5 & -k4 & 0 & 0 \\ 0 & 0 & -k4 & k3+k4 & -k3 & 0 \\ 0 & 0 & 0 & -k3 & k2+k3 & -k2 \\ 0 & 0 & 0 & 0 & -k2 & k1+k2 \end{bmatrix}$$

OBTENCIÓN DE FRECUENCIAS Y PERIODOS

$$\det(mK - a \cdot mM) = 0 \qquad A = \frac{mI}{a} = mK^{-1} \cdot mM$$

$$matrizA := mK^{-1} \cdot mM = \begin{bmatrix} 0.005 & 0.005 & 0.004 & 0.003 & 0.002 & 0.001 \\ 0.004 & 0.005 & 0.004 & 0.003 & 0.002 & 0.001 \\ 0.003 & 0.004 & 0.004 & 0.003 & 0.002 & 0.001 \\ 0.002 & 0.003 & 0.003 & 0.003 & 0.002 & 0.001 \\ 0.001 & 0.002 & 0.002 & 0.002 & 0.002 & 0.001 \\ 0.001 & 0.001 & 0.001 & 0.001 & 0.001 & 0.001 \end{bmatrix} s^2$$

Las frecuencias se denominan de menor a mayor

$$\omega_i := \text{csort}\left(\frac{1}{\text{eigenvals}(matrizA)}, 0\right) = \begin{bmatrix} 62.56878 \\ 534.30568 \\ 1339.69031 \\ 2256.4016 \\ 3040.339 \\ 3491.92354 \end{bmatrix} \frac{1}{s^2}$$

Periodos

$$\omega_1 := \left\| \sqrt{\omega_i^{\widehat{0}}} \right\| = 7.91 \ \frac{1}{s} \qquad \omega_2 := \left\| \sqrt{\omega_i^{\widehat{1}}} \right\| = 23.1151 \ \frac{1}{s} \qquad \omega_3 := \left\| \sqrt{\omega_i^{\widehat{2}}} \right\| = 36.6018 \ \frac{1}{s}$$

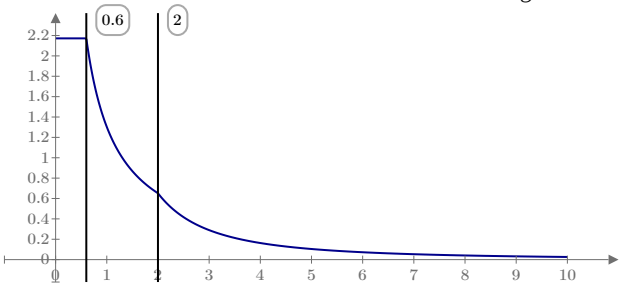
$$T_1 := \frac{2 \cdot \pi}{\omega_1} = 0.794 \ s \qquad T_2 := \frac{2 \cdot \pi}{\omega_2} = 0.272 \ s \qquad T_3 := \frac{2 \cdot \pi}{\omega_3} = 0.172 \ s$$

$$\omega_4 := \left\| \sqrt{\omega_i^{\widehat{3}}} \right\| = 47.5016 \ \frac{1}{s} \qquad \omega_5 := \left\| \sqrt{\omega_i^{\widehat{4}}} \right\| = 55.1393 \ \frac{1}{s} \qquad \omega_6 := \left\| \sqrt{\omega_i^{\widehat{5}}} \right\| = 59.0925 \ \frac{1}{s}$$

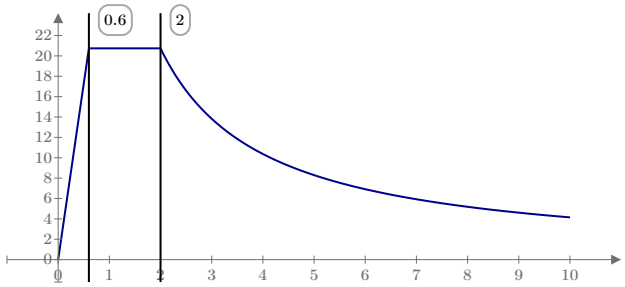
$$T_4 := \frac{2 \cdot \pi}{\omega_4} = 0.132 \ s \qquad T_5 := \frac{2 \cdot \pi}{\omega_5} = 0.114 \ s \qquad T_6 := \frac{2 \cdot \pi}{\omega_6} = 0.106 \ s$$

ESPECTROS DE DISEÑO E030

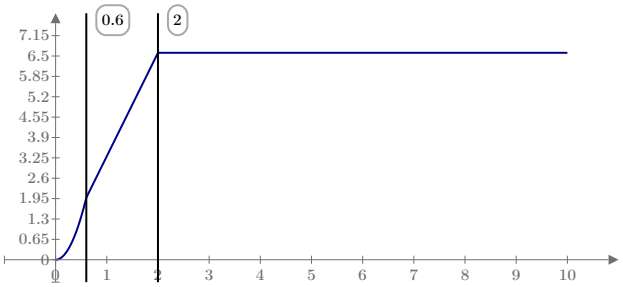
ESPECTRO DE ACELERACIONES $\frac{m}{s^2}$



ESPECTRO DE VELOCIDADES $\frac{cm}{s}$



ESPECTRO DE DESPLAZAMIENTOS cm



$$S_a = \begin{bmatrix} 1.641 \\ 2.172 \\ 2.172 \\ 2.172 \\ 2.172 \\ 2.172 \end{bmatrix} \frac{m}{s^2} \qquad S_v = \begin{bmatrix} 20.741 \\ 9.397 \\ 5.934 \\ 4.573 \\ 3.939 \\ 3.676 \end{bmatrix} \frac{cm}{s} \qquad S_d = \begin{bmatrix} 2.622 \\ 0.407 \\ 0.162 \\ 0.096 \\ 0.071 \\ 0.062 \end{bmatrix} cm$$

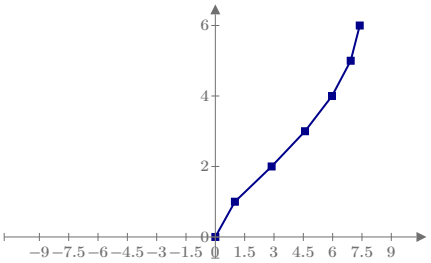
OBTENCIÓN DE MODOS DE VIBRACIÓN

$$i := \begin{bmatrix} 6 & 5 & 4 & 3 & 2 & 1 \end{bmatrix}^T$$

PRIMER MODO

$$Mod1 := mK - \omega_1{}^2 \cdot mM = \begin{bmatrix} 849.63 & -906.45 & 0 & 0 & 0 & 0 \\ -906.45 & 1748.36 & -906.45 & 0 & 0 & 0 \\ 0 & -906.45 & 1748.36 & -906.45 & 0 & 0 \\ 0 & 0 & -906.45 & 1748.36 & -906.45 & 0 \\ 0 & 0 & 0 & -906.45 & 1764.32 & -922.51 \\ 0 & 0 & 0 & 0 & -922.51 & 2656.2 \end{bmatrix} \frac{tonnef}{cm}$$

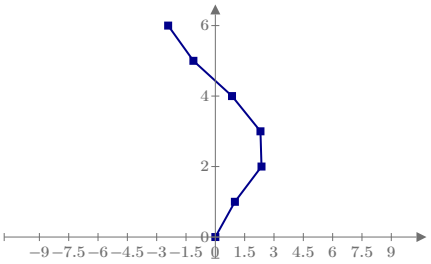
$$\phi_{mod1} = \begin{bmatrix} 7.386 \\ 6.923 \\ 5.967 \\ 4.587 \\ 2.879 \\ 1 \end{bmatrix}$$



SEGUNDO MODO

$$Mod2 := mK - \omega_2{}^2 \cdot mM = \begin{bmatrix} 421.21 & -906.45 & 0 & 0 & 0 & 0 \\ -906.45 & 1261.81 & -906.45 & 0 & 0 & 0 \\ 0 & -906.45 & 1261.81 & -906.45 & 0 & 0 \\ 0 & 0 & -906.45 & 1261.81 & -906.45 & 0 \\ 0 & 0 & 0 & -906.45 & 1276.99 & -922.51 \\ 0 & 0 & 0 & 0 & -922.51 & 2178.12 \end{bmatrix} \frac{tonnef}{cm}$$

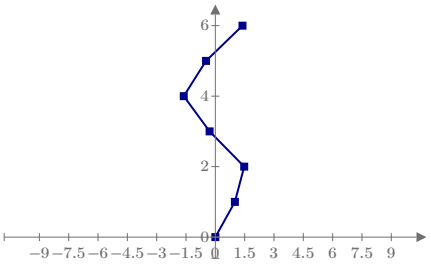
$$\phi_{mod2} = \begin{bmatrix} -2.414 \\ -1.122 \\ 0.853 \\ 2.309 \\ 2.361 \\ 1 \end{bmatrix}$$



TERCER MODO

$$Mod3 := mK - \omega_3{}^2 \cdot mM = \begin{bmatrix} -310.2 & -906.45 & 0 & 0 & 0 & 0 \\ -906.45 & 431.14 & -906.45 & 0 & 0 & 0 \\ 0 & -906.45 & 431.14 & -906.45 & 0 & 0 \\ 0 & 0 & -906.45 & 431.14 & -906.45 & 0 \\ 0 & 0 & 0 & -906.45 & 445 & -922.51 \\ 0 & 0 & 0 & 0 & -922.51 & 1361.92 \end{bmatrix} \frac{tonnef}{cm}$$

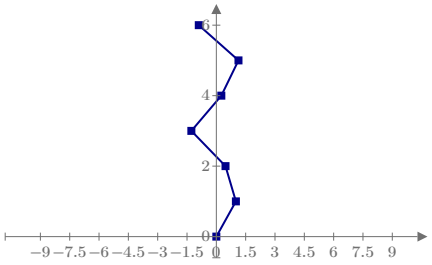
$$\phi_{mod3} = \begin{bmatrix} 1.389 \\ -0.476 \\ -1.616 \\ -0.293 \\ 1.476 \\ 1 \end{bmatrix}$$



CUARTO MODO

$$Mod4 := mK - \omega_4{}^2 \cdot mM = \begin{bmatrix} -1142.72 & -906.45 & 0 & 0 & 0 & 0 \\ -906.45 & -514.36 & -906.45 & 0 & 0 & 0 \\ 0 & -906.45 & -514.36 & -906.45 & 0 & 0 \\ 0 & 0 & -906.45 & -514.36 & -906.45 & 0 \\ 0 & 0 & 0 & -906.45 & -502.01 & -922.51 \\ 0 & 0 & 0 & 0 & -922.51 & 432.89 \end{bmatrix} \frac{tonnef}{cm}$$

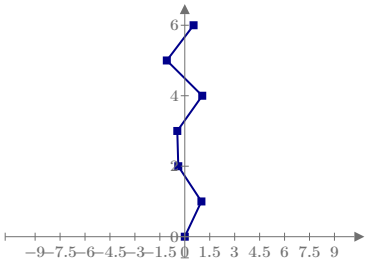
$$\phi_{mod4} = \begin{bmatrix} -0.898 \\ 1.132 \\ 0.256 \\ -1.278 \\ 0.469 \\ 1 \end{bmatrix}$$



QUINTO MODO

$$Mod5 := mK - \omega_5{}^2 \cdot mM = \begin{bmatrix} -1854.66 & -906.45 & 0 & 0 & 0 & 0 \\ -906.45 & -1322.91 & -906.45 & 0 & 0 & 0 \\ 0 & -906.45 & -1322.91 & -906.45 & 0 & 0 \\ 0 & 0 & -906.45 & -1322.91 & -906.45 & 0 \\ 0 & 0 & 0 & -906.45 & -1311.85 & -922.51 \\ 0 & 0 & 0 & 0 & -922.51 & -361.59 \end{bmatrix} \frac{tonnef}{cm}$$

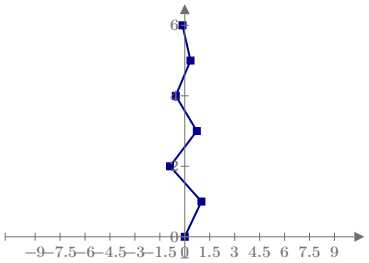
$$\phi_{mod5} = \begin{bmatrix} 0.528 \\ -1.081 \\ 1.049 \\ -0.45 \\ -0.392 \\ 1 \end{bmatrix}$$



SEXTO MODO

$$Mod6 := mK - \omega_6{}^2 \cdot mM = \begin{bmatrix} -2264.77 & -906.45 & 0 & 0 & 0 & 0 \\ -906.45 & -1788.68 & -906.45 & 0 & 0 & 0 \\ 0 & -906.45 & -1788.68 & -906.45 & 0 & 0 \\ 0 & 0 & -906.45 & -1788.68 & -906.45 & 0 \\ 0 & 0 & 0 & -906.45 & -1778.36 & -922.51 \\ 0 & 0 & 0 & 0 & -922.51 & -819.24 \end{bmatrix} \frac{tonnef}{cm}$$

$$\phi_{mod6} = \begin{bmatrix} -0.138 \\ 0.344 \\ -0.542 \\ 0.725 \\ -0.888 \\ 1 \end{bmatrix}$$



MATRIZ MODAL

$$\phi_{mod} := \text{augment}\left(\phi_{mod1}, \phi_{mod2}, \phi_{mod3}, \phi_{mod4}, \phi_{mod5}, \phi_{mod6}\right)$$

$$\phi_{mod} = \begin{bmatrix} 7.386 & -2.414 & 1.389 & -0.898 & 0.528 & -0.138 \\ 6.923 & -1.122 & -0.476 & 1.132 & -1.081 & 0.344 \\ 5.967 & 0.853 & -1.616 & 0.256 & 1.049 & -0.542 \\ 4.587 & 2.309 & -0.293 & -1.278 & -0.45 & 0.725 \\ 2.879 & 2.361 & 1.476 & 0.469 & -0.392 & -0.888 \\ 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

FACTORES DE PARTICIPACIÓN

PRECÁLCULOS

$$B := \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}^{T}$$

$$\phi_{mod}{}^{T} \cdot mM \cdot B = \begin{bmatrix} 2872.201 \\ 336.343 \\ 134.143 \\ 79.645 \\ 59.109 \\ 51.465 \end{bmatrix} \frac{s^2}{m} \cdot tonnef \qquad \phi_{mod}{}^{T} \cdot mM \cdot \phi_{mod} \cdot B = \begin{bmatrix} 16698.819 \\ 1960.957 \\ 803.241 \\ 504.757 \\ 397.607 \\ 281.183 \end{bmatrix} \frac{s^2}{m} \cdot tonnef$$

FACTOR DE PARTICIPACIÓN DE MASA (FPM)

$$FPM := \frac{\phi_{mod}{}^{T} \cdot mM \cdot B}{\phi_{mod}{}^{T} \cdot mM \cdot \phi_{mod} \cdot B} = \begin{bmatrix} 0.172 \\ 0.172 \\ 0.167 \\ 0.158 \\ 0.149 \\ 0.183 \end{bmatrix} \begin{array}{l} \text{Modo 1} \\ \text{Modo 2} \\ \text{Modo 3} \\ \text{Modo 4} \\ \text{Modo 5} \\ \text{Modo 6} \end{array}$$

MASA EFECTIVA MODAL - PORCENTAJE DE PARTICIPACIÓN DE MASA

$$\varphi := \frac{\left(\phi_{mod}{}^{T} \cdot mM \cdot B\right)^2}{\phi_{mod}{}^{T} \cdot mM \cdot \phi_{mod} \cdot B} = \begin{bmatrix} 494.019 \\ 57.69 \\ 22.402 \\ 12.567 \\ 8.787 \\ 9.419 \end{bmatrix} \frac{s^2}{m} \cdot tonnef$$

$$\sum \varphi = 604.885 \ \frac{s^2}{m} \cdot tonnef \qquad ppm := \frac{\varphi}{\sum \varphi} = \begin{bmatrix} 0.817 \\ 0.095 \\ 0.037 \\ 0.021 \\ 0.015 \\ 0.016 \end{bmatrix}$$

Mayor al 90% (E.030)

$$ppm_0 + ppm_1 = 0.912$$

El 90% de participación de masa se alcanza con el segundo modo; de acuerdo con la norma E.030, se debe trabajar al menos con los tres primeros modos o hasta que se alcance el 90% de participación con modos superiores. Con fines académicos, se seguirá analizando considerando los 6 modos obtenidos de los cálculos matriciales.

DESPLAZAMIENTOS

DESPLAZAMIENTOS n MÁXIMOS

$$n_{max} := \overrightarrow{FPM \cdot S_d} = \begin{bmatrix} 0.451 \\ 0.07 \\ 0.027 \\ 0.015 \\ 0.011 \\ 0.011 \end{bmatrix} \ cm$$

MATRIZ R MODAL

$$R_{mod} := \mathrm{diag}\left(n_{max}\right) = \begin{bmatrix} 0.451 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.07 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.027 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.015 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.011 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.011 \end{bmatrix} \ cm$$

DESPLAZAMIENTOS MODALES

$$U_{mod} := \phi_{mod} \cdot R_{mod} = \begin{bmatrix} 3.331 & -0.168 & 0.038 & -0.014 & 0.006 & -0.002 \\ 3.122 & -0.078 & -0.013 & 0.017 & -0.011 & 0.004 \\ 2.691 & 0.059 & -0.044 & 0.004 & 0.011 & -0.006 \\ 2.069 & 0.161 & -0.008 & -0.019 & -0.005 & 0.008 \\ 1.299 & 0.165 & 0.04 & 0.007 & -0.004 & -0.01 \\ 0.451 & 0.07 & 0.027 & 0.015 & 0.011 & 0.011 \end{bmatrix} \ cm$$

Piso 6
Piso 5
Piso 4
Piso 3
Piso 2
Piso 1

COMBINACIÓN DE RESPUESTAS

De acuerdo con Art. 29.3.4. (E.030)

DESPLAZAMIENTOS

$$U_{E030\_1} := \left\| \begin{array}{l} \text{for } i \in 0..5 \\ \quad \left\| \begin{array}{l} U^{\widehat{i}} \leftarrow 0 \ cm \\ \text{for } j \in 0..5 \\ \quad \left\| U^{\widehat{i}} \leftarrow U^{\widehat{i}} + \left\| \left(0.75 \cdot R \cdot U_{mod}{}^{\langle j \rangle}\right)^{\widehat{i}} \right\| \right. \end{array} \right. \\ U \end{array} \right\|$$

$$U_{E030\_1} = \begin{bmatrix} 21.3485 \\ 19.477 \\ 16.8944 \\ 13.6197 \\ 9.1476 \\ 3.51 \end{bmatrix} \ cm$$

$$U_{E030\_2} := \left\| \begin{array}{l} \text{for } i \in 0..5 \\ \quad \left\| \begin{array}{l} U^{\widehat{i}} \leftarrow 0 \ cm^2 \\ \text{for } j \in 0..5 \\ \quad \left\| U^{\widehat{i}} \leftarrow U^{\widehat{i}} + \left\| \left(0.75 \cdot R \cdot U_{mod}{}^{\langle j \rangle}\right)^2{}^{\widehat{i}} \right\| \right. \end{array} \right. \\ \sqrt{U} \end{array} \right\|$$

$$U_{E030\_2} = \begin{bmatrix} 20.0148 \\ 18.7413 \\ 16.1544 \\ 12.4499 \\ 7.858 \\ 2.7461 \end{bmatrix} \ cm$$

$$U_{E030} := 0.25 \cdot U_{E030\_1} + 0.75 \cdot U_{E030\_2} = \begin{bmatrix} 20.34822 \\ 18.92525 \\ 16.33936 \\ 12.74238 \\ 8.18042 \\ 2.9371 \end{bmatrix} \ cm$$

DERIVAS

$$\Delta_{mod} := \left\| \begin{array}{l} \text{for } i \in 0..5 \\ \quad \left\| \begin{array}{l} \text{for } j \in 0..5 \\ \quad \left\| \begin{array}{l} \text{if } i < 5 \\ \quad \left\| \Delta_{i,j} \leftarrow U_{mod_{i,j}} - U_{mod_{i+1,j}} \right. \\ \text{else} \\ \quad \left\| \Delta_{i,j} \leftarrow U_{mod_{i,j}} \right. \end{array} \right. \end{array} \right. \\ \Delta \end{array} \right.$$

$$H := \begin{bmatrix} 310 \\ 310 \\ 310 \\ 310 \\ 310 \\ 310 \end{bmatrix} \ cm$$

$$\Delta_{mod} = \begin{bmatrix} 0.209 & -0.09 & 0.05 & -0.031 & 0.017 & -0.005 \\ 0.431 & -0.138 & 0.031 & 0.013 & -0.023 & 0.01 \\ 0.623 & -0.102 & -0.036 & 0.023 & 0.016 & -0.014 \\ 0.77 & -0.004 & -0.048 & -0.027 & -0.001 & 0.018 \\ 0.848 & 0.095 & 0.013 & -0.008 & -0.015 & -0.021 \\ 0.451 & 0.07 & 0.027 & 0.015 & 0.011 & 0.011 \end{bmatrix} \ cm$$

$$\delta_{mod} := \left\| \begin{array}{l} \text{for } i \in 0..5 \\ \quad \left\| \delta^{\langle i \rangle} \leftarrow \overrightarrow{\Delta_{mod}^{\langle i \rangle} \cdot \overrightarrow{H^{-1}}} \right. \\ \delta \end{array} \right.$$

$$\delta_{mod} = \begin{bmatrix} 0.000674 & -0.000291 & 0.000163 & -0.0001 & 0.000055 & -0.000018 \\ 0.001391 & -0.000444 & 0.0001 & 0.000043 & -0.000073 & 0.000033 \\ 0.002009 & -0.000327 & -0.000116 & 0.000075 & 0.000051 & -0.000047 \\ 0.002484 & -0.000012 & -0.000155 & -0.000086 & -0.000002 & 0.000059 \\ 0.002734 & 0.000306 & 0.000042 & -0.000026 & -0.000048 & -0.000069 \\ 0.001455 & 0.000225 & 0.000087 & 0.000049 & 0.000034 & 0.000037 \end{bmatrix}$$

$$\delta_{E030\_1} := \left\| \begin{array}{l} \text{for } i \in 0..5 \\ \quad \left\| \begin{array}{l} \delta^{\widehat{\langle i \rangle}} \leftarrow 0 \\ \text{for } j \in 0..5 \\ \quad \left\| \delta^{\widehat{\langle i \rangle}} \leftarrow \delta^{\widehat{\langle i \rangle}} + \left\| \left(0.75 \cdot R \cdot \delta_{mod}^{\langle j \rangle} \right)^{\widehat{\langle i \rangle}} \right\| \right. \end{array} \right. \\ \delta \end{array} \right.$$

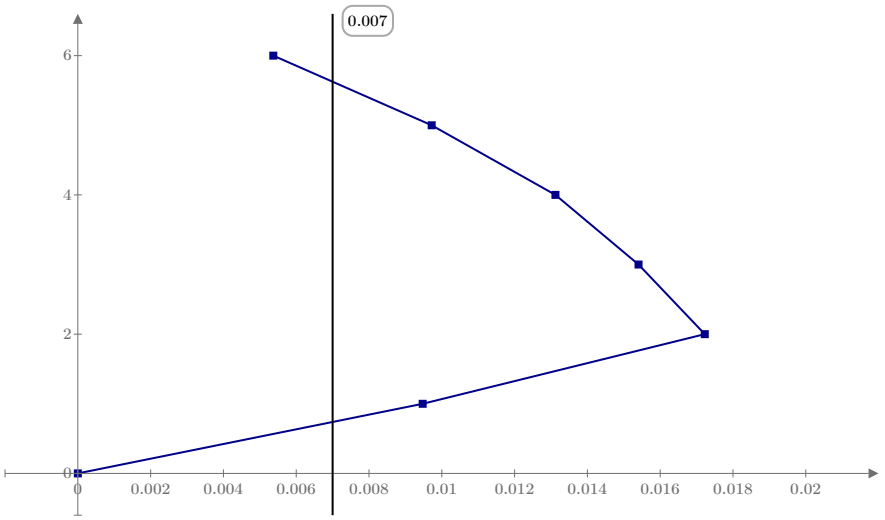
$$\delta_{E030\_1} = \begin{bmatrix} 0.0078 \\ 0.0125 \\ 0.0157 \\ 0.0168 \\ 0.0193 \\ 0.0113 \end{bmatrix}$$

$$\delta_{E030\_2} := \left\| \begin{array}{l} \text{for } i \in 0..5 \\ \quad \left\| \begin{array}{l} \delta^{\widehat{\langle i \rangle}} \leftarrow 0 \\ \text{for } j \in 0..5 \\ \quad \left\| \delta^{\widehat{\langle i \rangle}} \leftarrow \delta^{\widehat{\langle i \rangle}} + \left\| \left(0.75 \cdot R \cdot \delta_{mod}^{\langle j \rangle} \right)^{2\,\widehat{\langle i \rangle}} \right\| \right. \end{array} \right. \\ \sqrt{\delta} \end{array} \right.$$

$$\delta_{E030\_2} = \begin{bmatrix} 0.0046 \\ 0.0088 \\ 0.0122 \\ 0.0149 \\ 0.0165 \\ 0.0089 \end{bmatrix}$$

$$\delta_{E030} := 0.25 \cdot \delta_{E030\_1} + 0.75 \cdot \delta_{E030\_2} = \begin{bmatrix} 0.00537 \\ 0.00972 \\ 0.01312 \\ 0.0154 \\ 0.01723 \\ 0.00947 \end{bmatrix}$$

GRÁFICA Y COMPARACIÓN CON LÍMITE No debe exceder 0.007 (E.030)



$$\delta_{E030} = \begin{bmatrix} 0.0054 \\ 0.0097 \\ 0.0131 \\ 0.0154 \\ 0.0172 \\ 0.0095 \end{bmatrix}$$

Piso 6 $\text{if}\left(\delta_{E030_0} \le 0.007, \text{“Cumple”}, \text{“No cumple”}\right) = \text{“Cumple”}$

Piso 5 $\text{if}\left(\delta_{E030_1} \le 0.007, \text{“Cumple”}, \text{“No cumple”}\right) = \text{“No cumple”}$

Piso 4 $\text{if}\left(\delta_{E030_2} \le 0.007, \text{“Cumple”}, \text{“No cumple”}\right) = \text{“No cumple”}$

Piso 3 $\text{if}\left(\delta_{E030_3} \le 0.007, \text{“Cumple”}, \text{“No cumple”}\right) = \text{“No cumple”}$

Piso 2 $\text{if}\left(\delta_{E030_4} \le 0.007, \text{“Cumple”}, \text{“No cumple”}\right) = \text{“No cumple”}$

Piso 1 $\text{if}\left(\delta_{E030_5} \le 0.007, \text{“Cumple”}, \text{“No cumple”}\right) = \text{“No cumple”}$

Como se observa en la comparación, las derivas superan los límites de la norma E.030 en todos los pisos excepto el último. **Es necesario el reforzamiento y/o rediseño.**