10/07/14

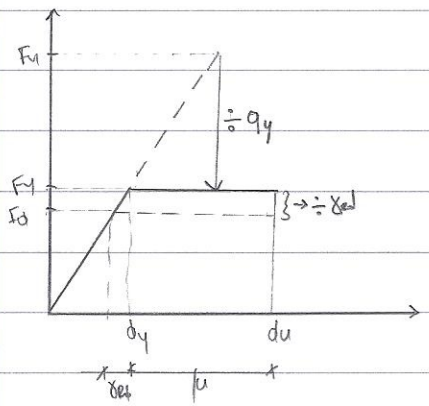
Αντισεισμική Τεχνολογία 1.

Άσκηση 20η

Για το κτήριο Β: $a_{gR} = 0,16 \cdot g$, $S = 1,20$, $T_B = 0,15\,sec$, $T_C = 0,50\,sec$, $\gamma_1 = 1,00$, $q = 3,0$

$k_A = 150.000\ kN/m$, $W_A = 3000\ kN$, $\gamma_{RdA} = 1,20$

$k_B = 350.000\ kN/m$, $W_B = 8000\ kN$, $\gamma_{RdB} = 1,40$



1) μ_A και d_{max_A} για ΕC8:

παραδοχή ίσων ενεργειών: $q_y = \sqrt{2 \cdot \mu - 1}$

$q_y = \frac{F_u^{el}}{F_y}$ =, όπου F_u^{el} από την ανάλυση ΕC8

F_y: $\gamma_{Rd_A} F_{dA} = 1,20 \cdot 0,10 \cdot 3000 \Rightarrow F_y = 360\,kN$

$F_u^{el} = m \cdot S_e(T_A)$

$T_A = 2 \cdot \pi \cdot \sqrt{\frac{m}{k_A}} = 0,281\,sec$ $\quad T_B \leq T_A \leq T_C$

Άρα $S_e(T_A) = a_g \cdot S \cdot \eta \cdot 2,5 = 1,6 \cdot 1,2 \cdot 1,0 \cdot 2,5 = 4,8\ m/s^2$

$F_u^{el} = m \cdot S_e(T_A) = 300 \cdot 4,8 = 1440\ kN$

άρα $q_y = \frac{1440}{360} = 4$. άρα $\mu_A = \frac{4^2+1}{2} = 8,5$.

$d_{max} = \mu_A \cdot d_y = \mu_A \cdot \frac{F_y}{k} = 8,5 \cdot \frac{360}{150.000} = 0,0204\,m$

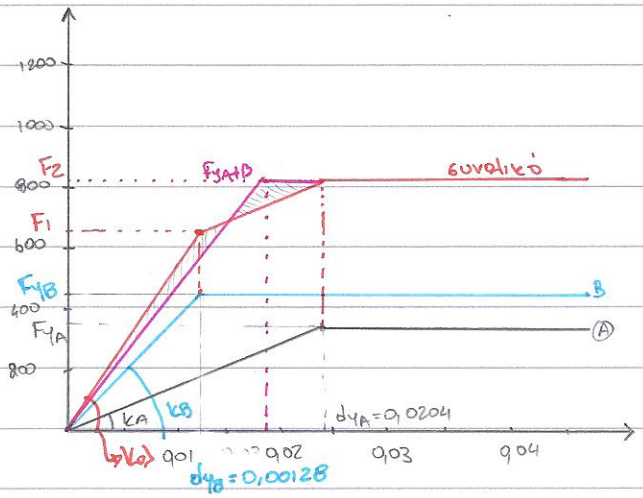
2) Για ανελαστικό σύνδεσμο πλαστώνεται και d_{max} για κάθε κτήριο.

$T_{kB} = 2 \cdot \pi \cdot \sqrt{\frac{200}{350.000}} = 0,15\,sec = T_B$,

$S_d(T_{kB}) = \frac{0,48 g}{3} = 1,6\ m/s^2$ άρα $F_d = 1,6\ m/s^2 \cdot 200 = 320\,kN$.

$F_{y_B} = \gamma_{Rd_B} \cdot F_d = 448\,kN$

$$dy,B = \frac{F_y}{k} = \frac{448}{350000} = 0,00128\,m.$$



- Για $dy_B = 0,00128m$

  $F_1 = k_{o1} \cdot dy_B = 640\,kN$

- Για $dy_A = 0,0204\,m$

  $F_2 = F_{yA} + F_{yB} = 808kN$

⊛ Θέλουτε τα 2 γραμμοσκιασμένα εμβαδά να είναι ίσα $F_{yA+B} = 808\,kN$

Από το σχήμα: $dy_{AB} = 0,00178m$

$$K_{A+B} = \frac{F_{y,AB}}{dy,_{AB}} = \frac{808}{0,00178} = 453932,58\ kN/m$$

$$T_{AB} = 2\cdot\pi\cdot\sqrt{\frac{m}{k}} = 0,208sec > 0,15sec \rightarrow Se(T_{AB}) = 4,8\ m/s^2$$

$$Fu^{el} = m\cdot Se(T_{AB}) = 9400kN.$$

$$\text{άρα } q_y = \frac{Fu^{el}}{Fy} = \frac{2400}{808} = 2,97 \quad \text{άρα } \mu = \frac{2,97^2+1}{2} = 4,91$$

$$dmax = \mu\cdot dy = 4,91\cdot 0,00178 = 0,0087\,m\ ,\ \mu'_A = \frac{du_{AB}}{dy_A}\ ,\ \mu'_B = \frac{du_{AB}}{dy_B}$$

3) Για δύσκαμπτο ανώδεφο → μ_A'', μ_B'', du_A'', du_B''

$K_x = 200.000\,kN/m.$

$$\{u_i\} = \Gamma_i\cdot\{\varphi_i\}\cdot\frac{Se(T)}{\omega_1^2}$$

$$[k] = \begin{bmatrix} 350 & -200 \\ -200 & 550 \end{bmatrix} \times 10^3\ kN/m. \qquad [M] = \begin{bmatrix} 0,3 & 0 \\ 0 & 0,2 \end{bmatrix} \times 10^3\ Mgr$$

Χαρακτηριστική εξίσωση:

$$|[k]-\omega^2[M]| = 0 \Rightarrow \begin{bmatrix} 350-0,3\omega^2 & -200 \\ -200 & 550-0,2\omega^2 \end{bmatrix} = 0 \rightarrow 0,06\omega^4 - 235\omega^2 + 152500 = 0 \Rightarrow$$

$$\Rightarrow \omega_{1,2}^2 \begin{cases} \omega_1^2 = 821,055 \rightarrow T_1 = 0,22sec \\ \omega_2^2 = 3095,61 \rightarrow T_2 = 0,113\ sec \end{cases}$$

Ιδιοτροφές:

$$[K] - \omega_n^2 [M] = \begin{Bmatrix} \varphi_A^i \\ \varphi_B^i \end{Bmatrix} \longrightarrow \{\varphi_1\} = \begin{Bmatrix} 1,000 \\ 0,518 \end{Bmatrix}, \quad \{\varphi_2\} = \begin{Bmatrix} 1,000 \\ -2,893 \end{Bmatrix}$$

$$\Gamma_1 = \frac{\Sigma m_j \varphi_j^{(i)}}{\Sigma m_j (\varphi_j^i)^2} = 1,14 \quad , \quad \Gamma_2 = -0,141.$$

$$M_1 = \Gamma_1 \times \Sigma m_j \varphi_j^1 = 460,59 > 90\% \text{ mas.}$$

Για $T_1 = 0,22 \text{ sec} \rightarrow Se(T_1) = 4,8 \text{ m/s}^2$

Για $T_2 = 0,113 \text{ sec} \rightarrow Se(T_2) = 4,09 \text{ m/s}^2$

Για την 1η ιδιοτροφή: $\begin{Bmatrix} u_A^1 \\ u_B^1 \end{Bmatrix} = 1,14 \times \begin{Bmatrix} 1,000 \\ 0,518 \end{Bmatrix} \times \frac{4,8}{(2\pi/0,22)^2} = \begin{Bmatrix} 0,00672 \\ 0,00348 \end{Bmatrix}$

Για την 2η ιδιοτροφή: $\begin{Bmatrix} u_A^2 \\ u_B^2 \end{Bmatrix} = -0,141 \times \begin{Bmatrix} 1,000 \\ -2,893 \end{Bmatrix} \times \frac{4,09}{(2\pi/0,113)^2} = \begin{Bmatrix} -0,00018 \\ 0,000539 \end{Bmatrix}$

$$u_A = \sqrt{(u_A^1)^2 + (u_A^2)^2} = 0,00672 \text{ m.}$$

$$u_B = \sqrt{(u_B^1)^2 + (u_B^2)^2} = 0,00352 \text{ m.}$$

Επόμενως:

$$\mu_A'' = \frac{0,00672}{0,0024} = 2,80$$

$$\mu_B'' = \frac{0,00352}{0,00128} = 2,75$$