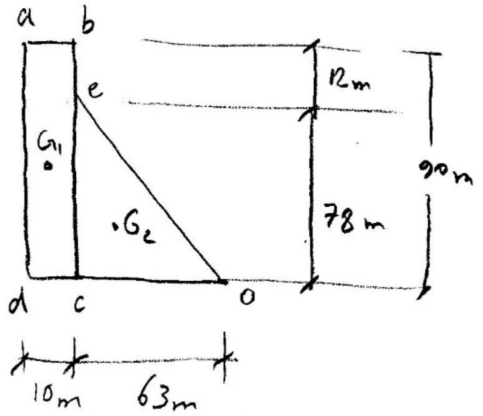
۱۴ العرول م. س

مثال ۳-۴

با فرض $\gamma_c = 2.4 \frac{t_f}{m^3}$ و $\alpha = 0.15$

نیرو و لنگرهای ناشی از زلزله را حول O حساب کنید



الف) روش معمولی $\quad \alpha_h = \alpha = 0.15$

abcd: $F_{eh_1} = 0.15 \times 2.4 [78+12] \times 10 \times 1 = 324^t = 3178.44 \text{ kN}$

eco: $F_{eh_2} = 0.15 \times 2.4 [\frac{1}{2} \times 78 \times 63] \times 1 = 884.52^t = 8677.14 \text{ kN}$

نیروی افقی $\quad F_{eh} = F_{eh_1} + F_{eh_2} = 1208.52^t = 11855.58 \text{ kN}$

لنگر ناشی از F_{eh} $\quad M_o = 324 (\frac{90}{2}) + 884.52 (\frac{78}{3}) = 37577.52^{t.m} = 368635.47 \text{ kN.m}$

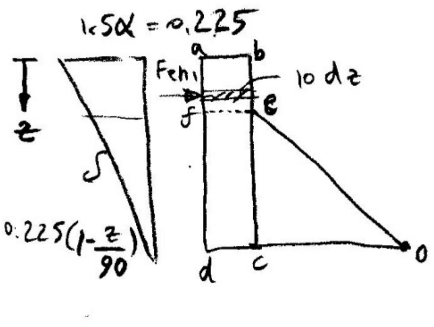
نیروی قائم $\quad \alpha_v = 0.5\alpha = 0.075$

$F_{ev_1} = \frac{1}{2} F_{eh_1} = 162^t = 1589.22 \text{ kN}$, $F_{ev_2} = \frac{1}{2} F_{eh_2} = 442.26^t = 4338.57 \text{ kN}$

$F_{ev} = F_{ev_1} + F_{ev_2} = 604.26^t = 5927.79 \text{ kN}$

لنگر ناشی از F_{ev}: $\quad 162 (63 + \frac{10}{2}) + 442.26 (\frac{2}{3} \times 63) = 29590.92^{t.m} = 290286.93 \text{ kN}$

جهت F_h و F_v می‌تواند تغییر کند. در بدترین حالت هر دو لنگر با هم جمع می‌شوند.



ب) روش مثلثی لرزه‌ای

$$F_{eh_1} = \int_0^{12} \overbrace{2.4 (1 \times 10 dz)}^{dm} \overbrace{(0.225 \times (1 - \frac{z}{90}))}^{a}$$

abef

$$= 2.4 (10)(0.225) \left[(12-0) - \frac{1}{2(90)} (12^2 - 0) \right] = 60.48^t = 593.31 \text{ kN}$$

$$F_{eh} = F_{eh_1} + \int_{12}^{90} (2.4) \left[10 + \frac{63}{78} (z-12) \right] dz \, (0.225)(1 - \frac{z}{90})$$

کل

$$F_{eh} = 60.48 + 565.83 = 626.31^t = 6144.06 \text{ kN}$$

گشتاور حول نقطه O

$M_{O_1} = F_{ev_1}(90-6) = 60.48^{t}(84)^{m} = 5080.32^{t.m}$

تقسیم

دقیق $M_{O_1} = \int_0^{12}(90-z)\,dF = \int_0^{12}(90-z)(2.4)(1\times10\,dz)(0.225)(1-\frac{z}{90})$

$M_{O_1} = 2.4(10)(0.225)\int_0^{12}(90-z)(1-\frac{z}{90})\,dz = 5.4\int_0^{12}(90-\underbrace{z-z}_{-2z}+\frac{1}{90}z^2)\,dz$

$M_{O_1} = 5.4\left[90(12)-[12^2-0]+\frac{1}{90\times3}(12^3-0)\right] = 5088.96^{t.m} = 49922.70\ kN.m$

$M_{O_2} = \int_{12}^{90}(90-z)\,dF = \int_{12}^{90}(90-z)(2.4)(10+\frac{63}{78}(z-12))dz\,(0.225)(1-\frac{z}{90})$

$M_{O_2} = 0.54\int_{12}^{90}(90-z)(\frac{63}{78}z+\frac{24}{78})(1-\frac{z}{90})\,dz$

$M_{O_2} = \frac{0.54}{78}\int_{12}^{90}\left[90-2z+\frac{1}{90}z^2\right]\left[\frac{63}{1}z+\frac{24}{1}\right]$

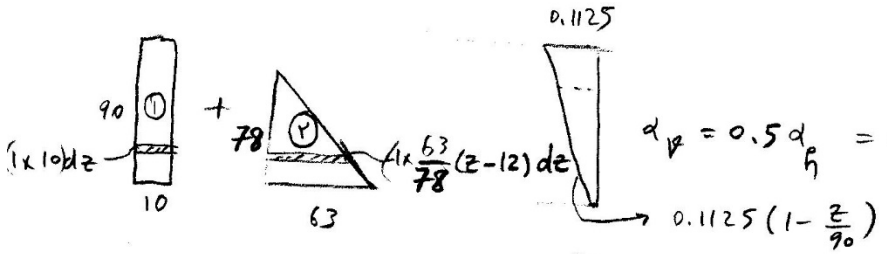
$M_{O_2} = \frac{0.54}{78}\int_{12}^{90}\left(2160+\underbrace{5670z-48z}_{+5622z}-126z^2+\underbrace{\frac{24}{90}}_{15}z^2+\underbrace{\frac{63}{90}}_{10}z^3\right)dz$

$\frac{-1886}{15}z^2$

$M_{O_2} = \frac{0.54}{78}\left[2160z+\frac{5622}{2}z^2-\frac{1886}{15(3)}z^3+\frac{7}{10\times4}z^4\right]_{12}^{90} = 23544.32^{t.m}$

$168480+2236431.6-304807.77+114781.21$

$M_O = M_{O_1}+M_{O_2} = 5088.96^{t.m}+23544.32^{t.m} = 28633.28^{t.m} = 280892.52^{kN.m}$



$a_p = 0.5\,a_h = 0.5(0.225) = 0.1125$

$F_{ev1} = \rho\int a\,dV = 2.4\int_0^{90}0.1125(1-\frac{z}{90})(10)dz = 2.70\left[z-\frac{z^2}{180}\right]_0^{90} = 121.5^{t} = 1191.92^{kN}$

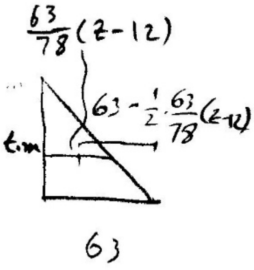
$F_{ev2} = 2.4\int_{12}^{90}0.1125(1-\frac{z}{90})(1)(\frac{63}{78})(z-12)\,dz$

$F_{ev2} =$

$F_{ev2} = 191.65$

$F_{ev} = F_{ev1}+F_{ev2} = 313.15^{t} = 3071.96\ kN$

تنش برشی قائم



$$M'_{01} = 2.4 \int_0^{90} (10\,dz)\left(1-\frac{z}{90}\right)(0.1125)\left(63+\frac{10}{2}\right) = 8262^{\,t.m}$$

$$M'_{02} = 2.4 \int_0^{90} 0.1125\left(1-\frac{z}{90}\right)\left(\frac{63}{78}\right)(z-12)\left[63-0.5\left(\frac{63}{78}\right)(z-12)\right] = 9055.27^{\,t.m}$$

$$M'_0 = M'_{01} + M'_{02} = 17317.27^{\,t.m}$$

روش طیف پاسخ

وزن واحد طول سد $\qquad W = 2.4\left[10\times 90 + \frac{78\times 63}{2}\right] = 8056.8^{\,t} = 79037.21^{\,kN}$

فاصله مرکز سطح تا کف سد $\qquad \bar{H} = \dfrac{10\times 90\times 45 + \frac{78\times 63}{2}\times\frac{78}{3}}{10\times 90 + \frac{78\times 63}{2}} = 31.09\,m$

$$\alpha_h = 0.15$$

$$F_{eh} = 0.6\,\alpha_h W = 0.6\times(0.15)(8056.8^{\,t}) = 725.11^{\,t} = 7113.35^{\,kN}$$

$$M_0 = 0.9\,\alpha_h \bar{H}.W = 0.9\,(0.15)(31.09^{\,m})(8056.8^{\,t}) = 33815.6^{\,tm}$$

$$= 331731.02^{\,kN.m}$$

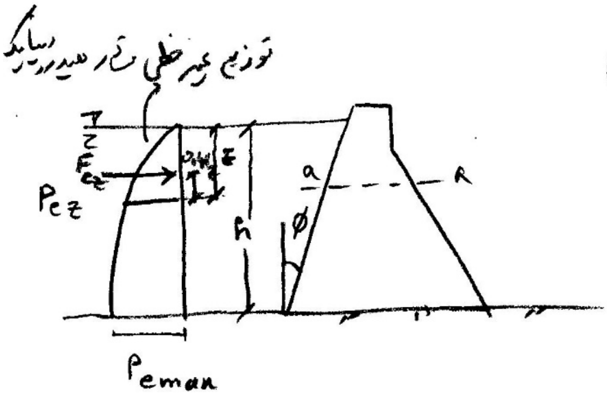
$$\alpha_v = 0.5\,\alpha_h = 0.5\times 0.15 = 0.075$$

$$F_{ev} = 0.6\,(0.075)(8056.8) = 362.56^{\,t}$$

$$M'_0 = 0.9\,(0.075)\left(10\times 90\times \underset{?}{68} + \frac{78\times 63}{2}\times\frac{2}{3}\times 63\right)\times 2.4$$

$$M'_0 = 26631.83\ t.m = 261258.23\ kN.m$$

نیروی زلزله ناشی از آب پشت سد (نیروی هیدرودینامیکی)



$$P_{ez} = C_e\,\alpha_h\,\gamma_w\,h$$

α_h : ضریب شتاب افقی زلزله

h : ارتفاع آب

C_e : ضریب بدون بعد