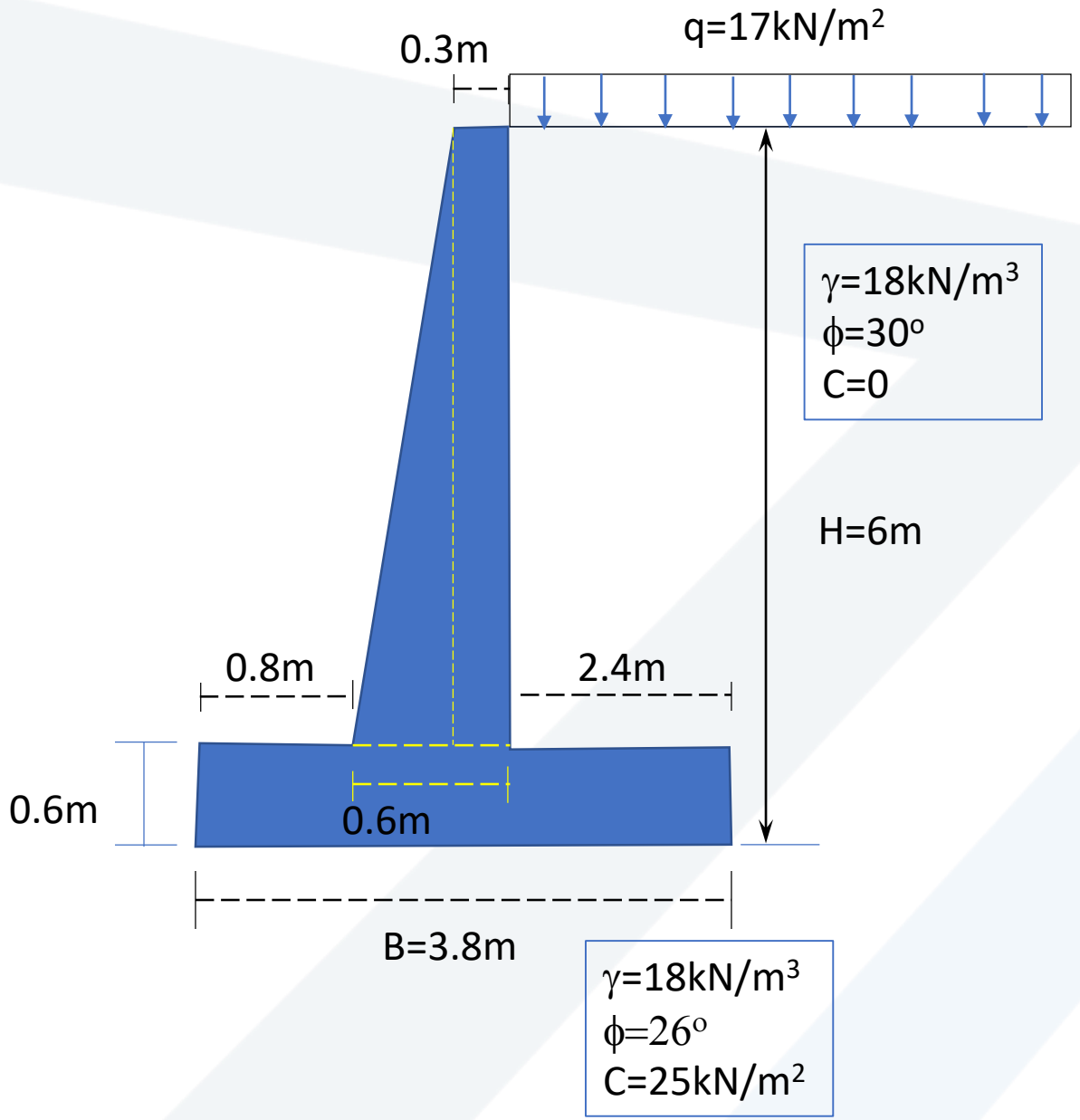
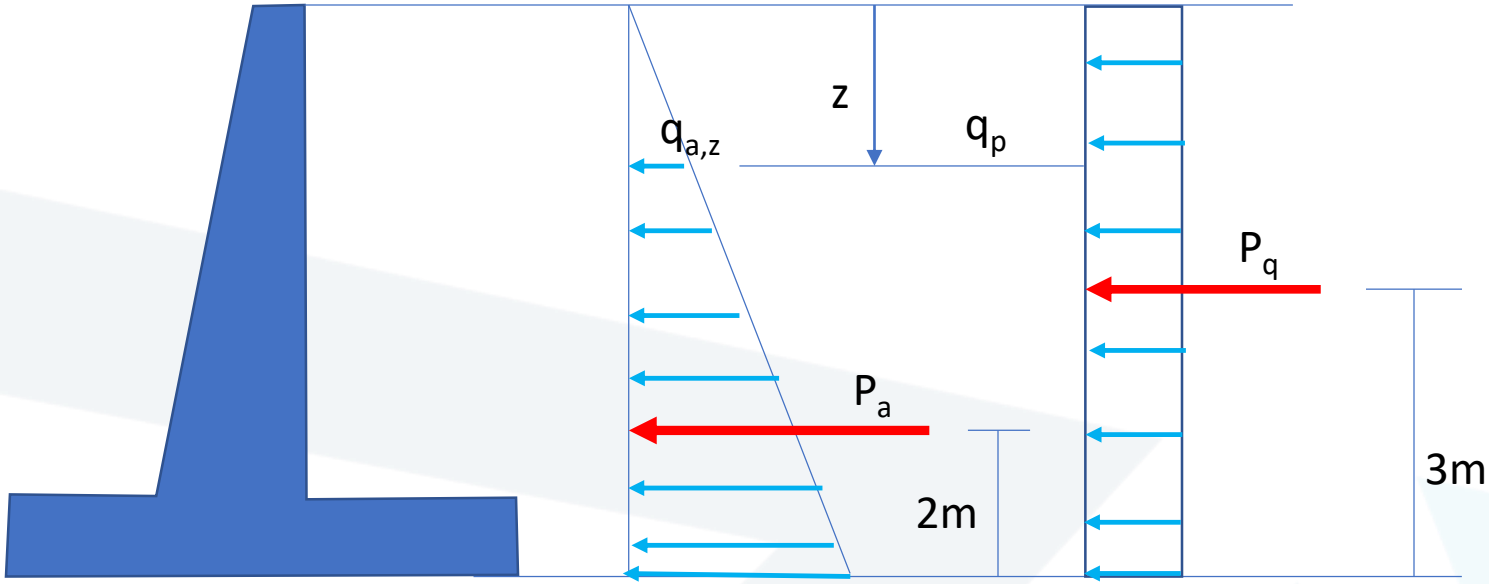
مثال



يطلب تصميم الجدار الاستنادي المبين بالشكل
علماً بأن قدرة تحمل التربة المسموحة
q_a=200kN/m²
fy=400 Mpa f'c=22.5MPa
q_{all}=200 kN/m²



$$q_{a,z} = \gamma . z . k_a$$

$$k_a = \tan^2(45 - \frac{\phi}{2}) = \tan^2(45 - \frac{30}{2}) = 0.33$$

$$q_{a,z} = 18 * 0.33 * z = 5.94z$$

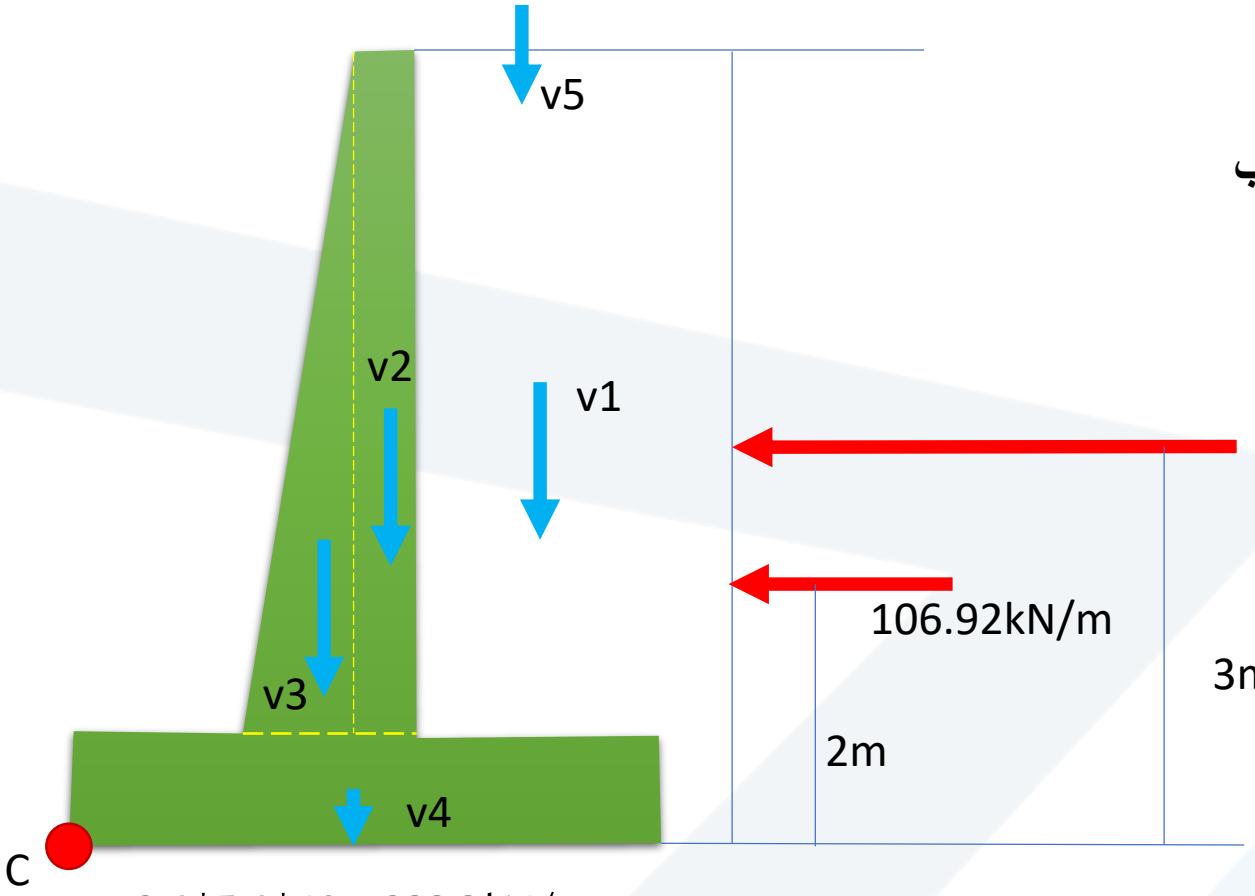
$$q_{a,2.7m} = 5.94 * 2.7 = 16.1 kN/m \qquad q_{a,5.4m} = 5.94 * 5.4 = 32.1 kN/m$$

$$q_{a,z=6m} = 5.94 * 6 = 35.64 kN/m^2$$

$$p_a = 35.64 * \frac{6}{2} = 106.92\, kN/m$$

$$q_q = q.k_a = 17 * 0.33 = 5.61 kN/m^2 \qquad p_q = 5.61 * 6 = 33.66\, kN/m$$

دراسة توازن الجدار على الانقلاب



$$\nu_1 = 2.4*5.4*18 = 233.3\,kN/m$$

$$\nu_2 = 0.3*5.4*25 = 40.5\,kN/m$$

$$\nu_3 = 0.3*\frac{5.4}{2}*25 = 20.25\,kN/m$$

$$\nu_4 = 0.6*3.8*25 = 57\,kN/m$$

$$\nu_5 = 17*2.4 = 40.8\,kN/m$$

$$V = \sum_{}^{4} \nu_i = 391.8 kN/m$$

$$M_R = \nu_1*2.6 + \nu_2*1.25 + \nu_3*1 + \nu_4*1.9 + \nu_{5*}2.6$$

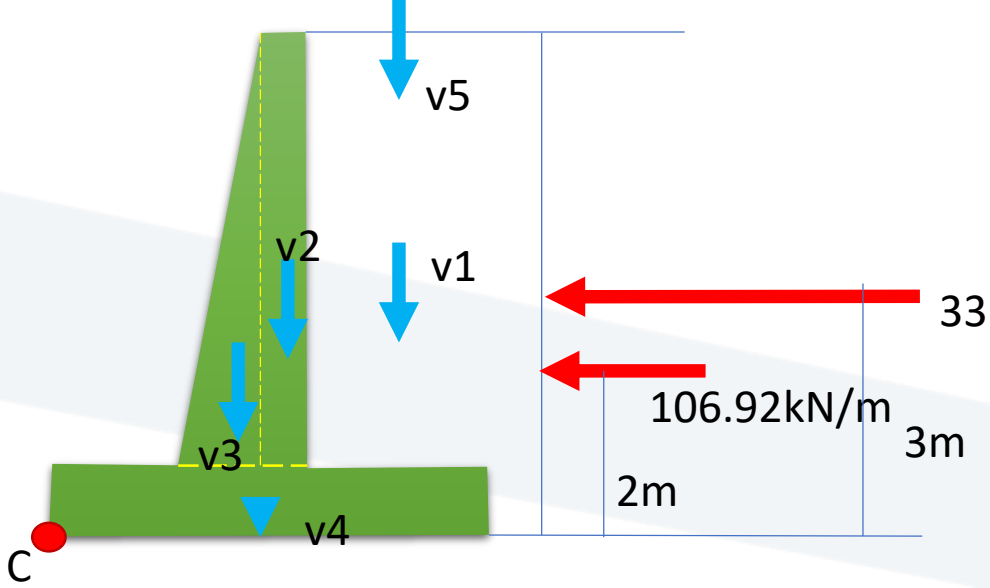
$$M_R = 233.3*2.6 + 40.5*1.25 + 20.25*1 + 57*1.9 + 40.8*2.6$$

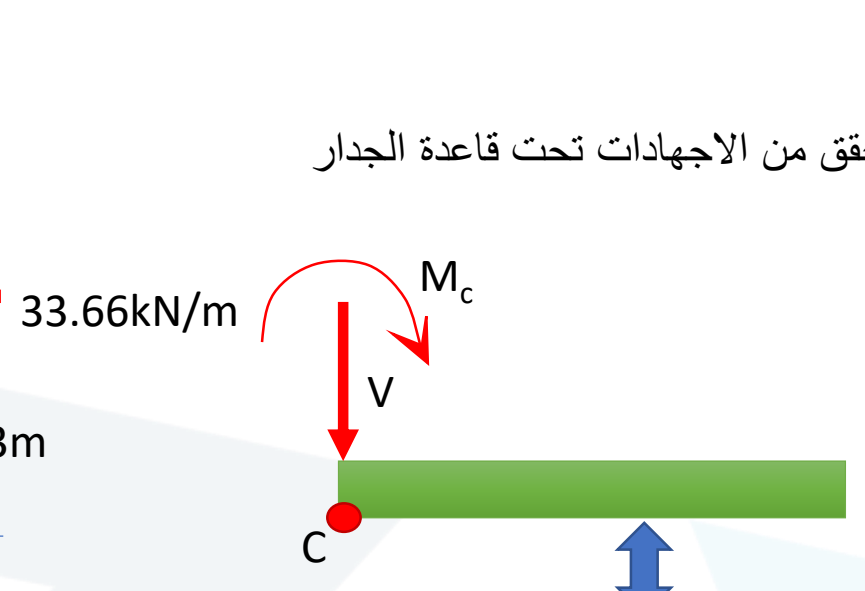
$$M_R = 891.9\,kN.m/m$$

$$M_O = 33.66*3 + 106.92*2 = 314.8\,kN.m/m$$

$$F_s = \frac{M_R}{M_O} = \frac{891.9}{314.8} = 2.8$$

التحقق من الاجهادات تحت قاعدة الجدار





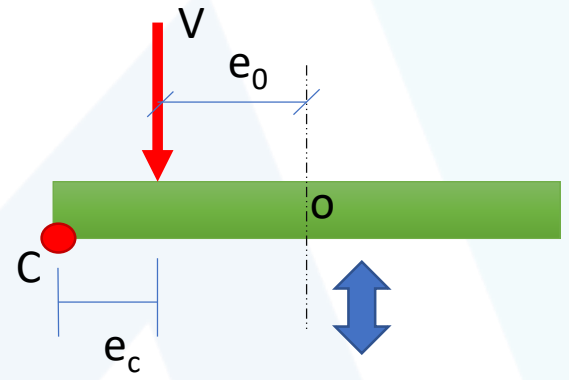
$$\sigma_{max,min}=\frac{V}{B}\left(1\pm\frac{6\,e_0}{B}\right)$$

$$e_0=\frac{B}{2}-e_c \qquad e_c=\frac{M_c}{V}$$

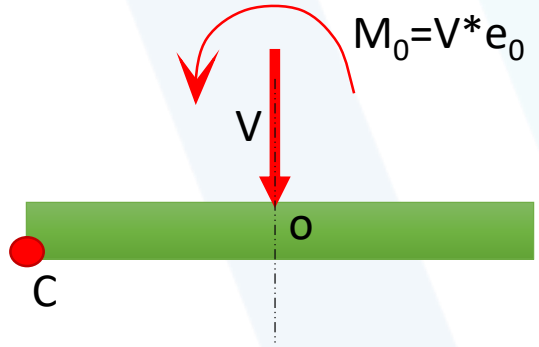
$$M_c=M_R-M_O=891.9-314.8=577.1\,kN.m/m$$

$$M_c=577.1\,kN.m/m$$

$$V=391.9\,kN/m$$

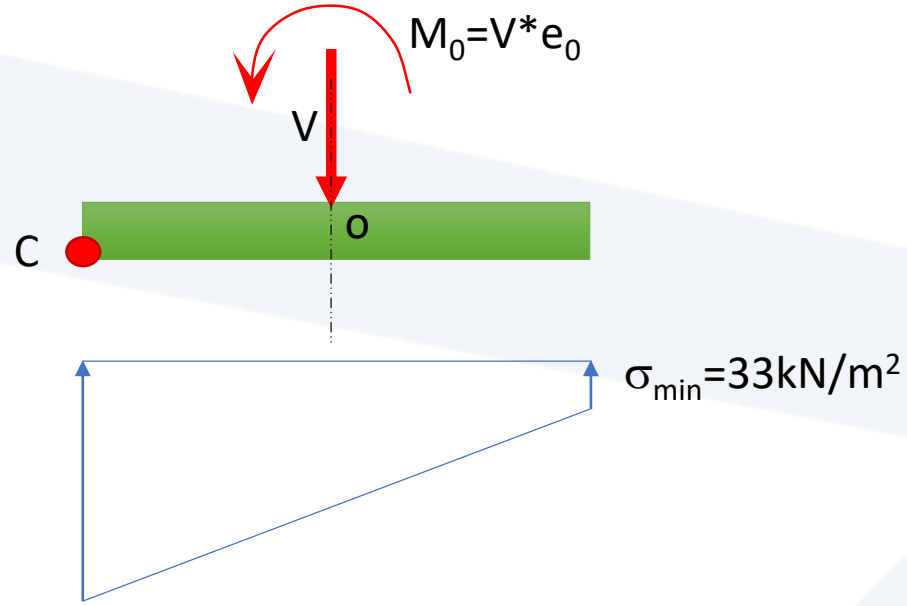


$$e_0=1.9-\frac{577.1}{391.9}=0.43m$$



$$\sigma_{max,min}=\frac{391.9}{3.8}\left(1\pm\frac{6*0.43}{3.8}\right)=103.1*(1\pm0.68)=\frac{173.2}{33}\ kN/m^2 \quad OK$$

دراسة توازن الجدار على الانزلاق



$$F_s=\frac{F_r}{F_d}$$

$$F_d=p_a+p_{a,q}=106.92+33.66=140.6\,kN/m$$

$$F_r=V*f+C^**B$$

$$f=\frac{2}{3}(\tan\phi_2)=\frac{2}{3}(\tan*26)=0.325$$

$$C^*=\frac{2}{3}C=\frac{2}{3}*25=16.7kN/m^2$$

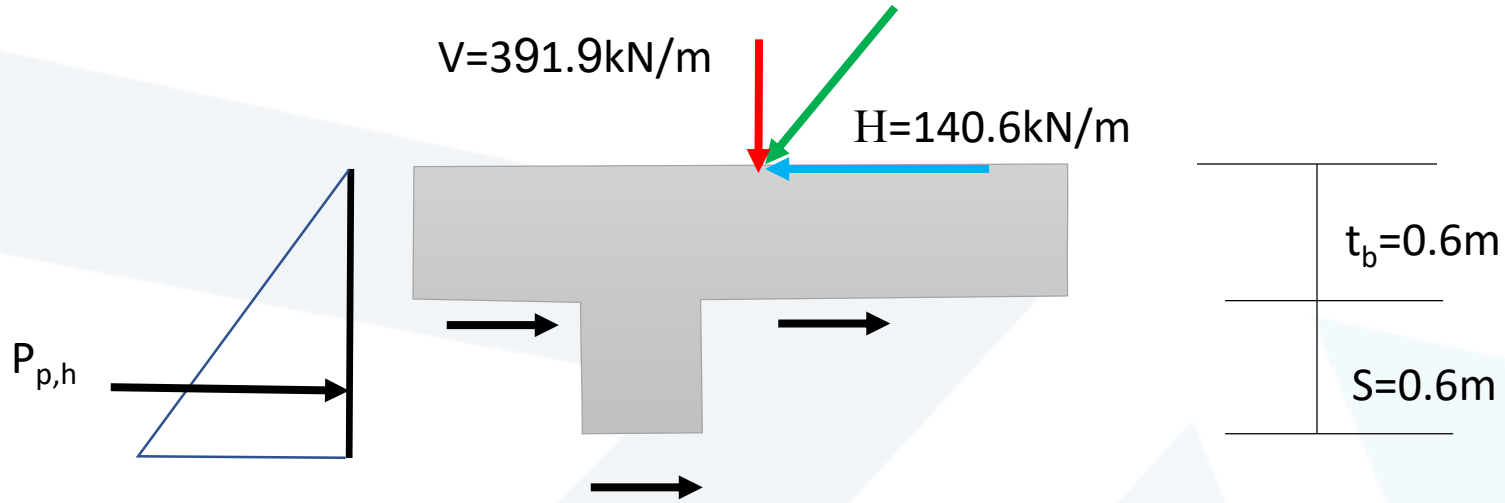
من أجل الدراسة الدقيقة، يجب دراسة حالة وجود القوة الحية وحالة عدم وجودها وأخذ عامل الأمان الأصغر. سنعتبر حالياً أن جميع القوى موجودة ونحسب عامل الأمان.

$$V=\sum_1^5 v_i=391.9\,kN/m$$

$$F_r=391.9*0.325+16.7*3.8=190.8\,k/m$$

$$F_s=\frac{F_r}{F_d}=\frac{190.8}{140.6}=1.36<1.5\ \text{Not OK}$$

نقترح اضافة سن

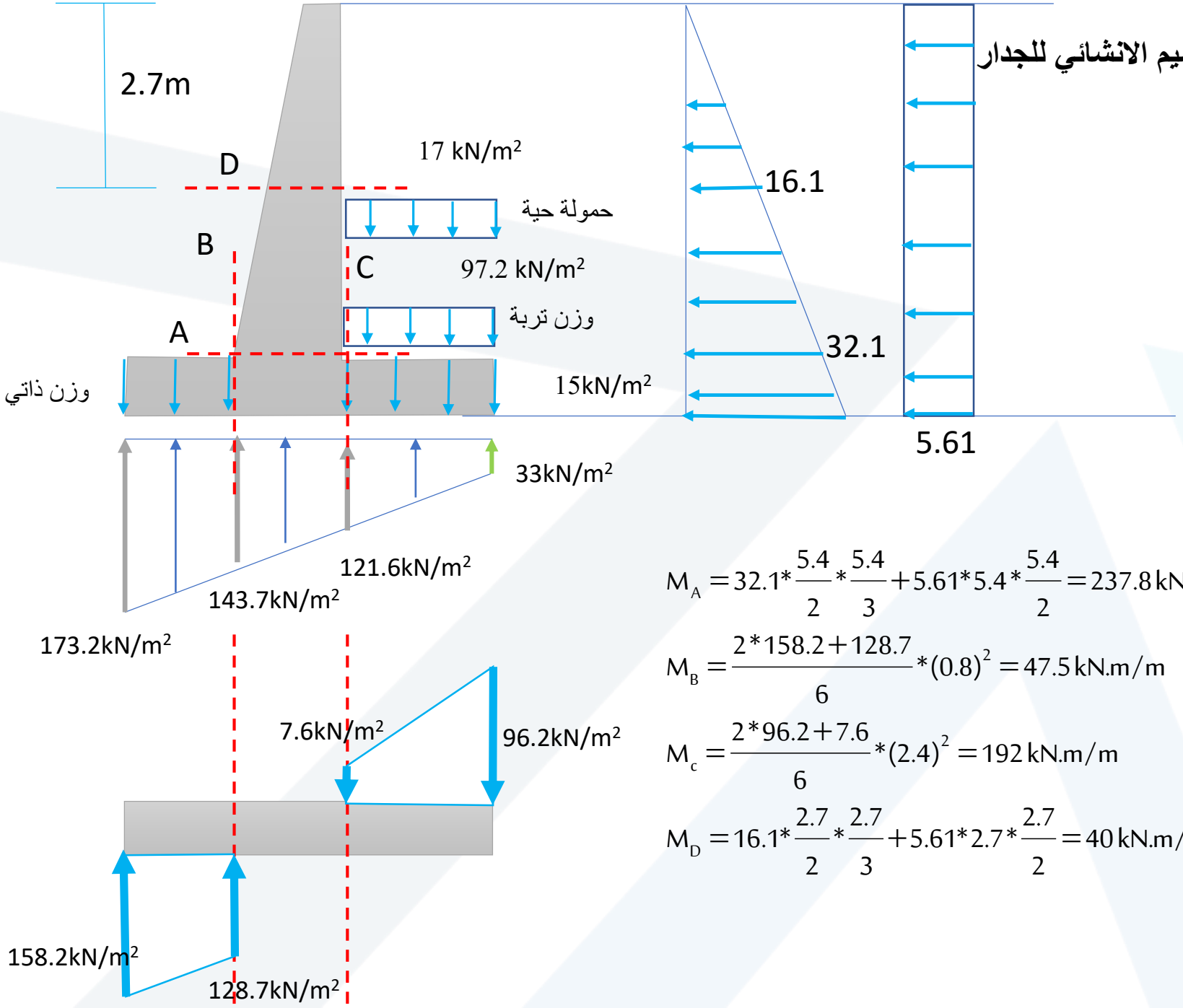


$$k_p = \tan^2(45+\frac{26}{2}) = \tan^2(45+\frac{30}{2}) = 2.56$$

$$P'_{p,h} = \frac{1}{2}\gamma(t_b+S)^2 k_p = 0.5*18*1.2^2*2.56 = 33.2\,kN/m$$

$$Fr = 190.8+33.2 = 224\,kN/m$$

$$FS = \frac{224}{140.6} = 1.59 > 1.5\ OK$$



$$M_A = 32.1 * \frac{5.4}{2} * \frac{5.4}{3} + 5.61 * 5.4 * \frac{5.4}{2} = 237.8\,\text{kN.m/m}$$

$$M_B = \frac{2*158.2+128.7}{6} * (0.8)^2 = 47.5\,\text{kN.m/m}$$

$$M_c = \frac{2*96.2+7.6}{6} * (2.4)^2 = 192\,\text{kN.m/m}$$

$$M_D = 16.1 * \frac{2.7}{2} * \frac{2.7}{3} + 5.61 * 2.7 * \frac{2.7}{2} = 40\,\text{kN.m/m}$$

حساب التسليح

1- باستخدام الطريقة المرنة، يحسب التسليح بالقانون :

$$A_s = \frac{M}{\gamma_z . d . \overline{\sigma}_s}$$

$$\overline{\sigma}_s = 0.55\, f_y = 0.55 * 400 = 220 \text{Mpa}$$

$$A_{s,A} = \frac{237.8}{0.87 * 0.54 * 220000} * 10000 = 23\, cm^2/m \Rightarrow 5T18 + 5T16 mm/m$$

$$A_{s,D} = \frac{40}{0.87 * 0.39 * 220000} * 10000 = 5.35\, cm^2/m$$

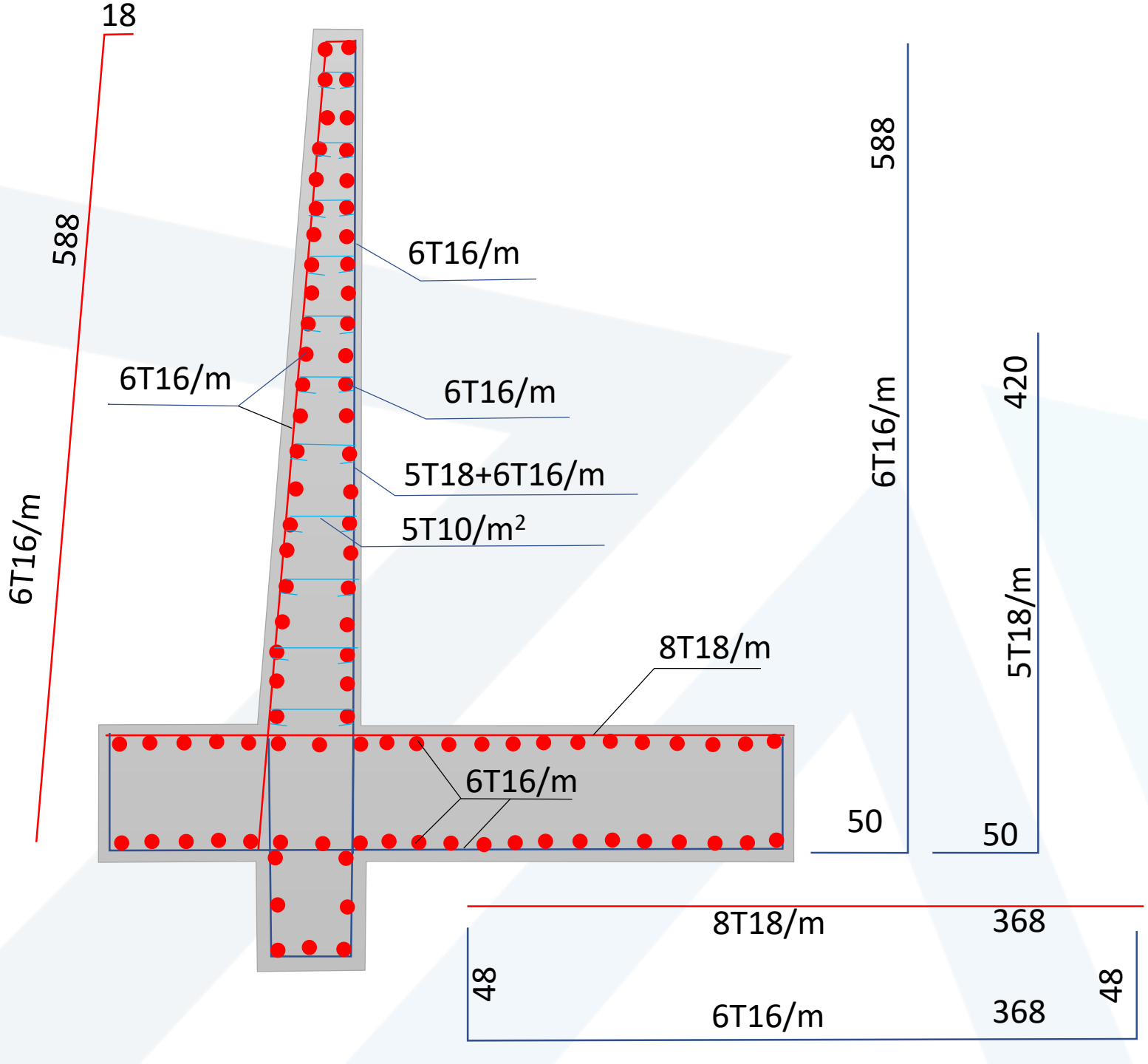
$$A_{s,B} = \frac{47.5}{0.87 * 0.54 * 220000} * 10000 = 4.6\, cm^2/m$$

$$A_{s,C} = \frac{192}{0.87 * 0.54 * 220000} * 10000 = 18.6 cm^2/m \Rightarrow 8T18 mm/m$$

$$A_{s,\min} = \frac{9}{f_y} * A'_c \qquad (unit \quad kg, cm)$$

$$A_{s,\min,A,B,C} = \frac{9}{4000} * 100 * 54 = 12.15\, cm^2 \Rightarrow 6T16 mm/m$$

$$A_{s,\min,D} = \frac{9}{4000} * 100 * 39 = 8.8\, cm^2 \Rightarrow 5T16/m$$


18
588
6T16/m
6T16/m
6T16/m
5T18+6T16/m
5T10/m²
8T18/m
6T16/m
588
6T16/m
420
5T18/m
50
50
8T18/m
368
48
6T16/m
368
48

تفصيلات التسليح