Design of Water Tanks

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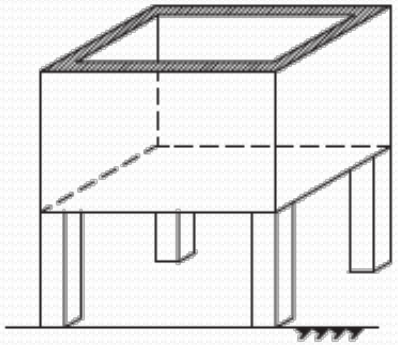
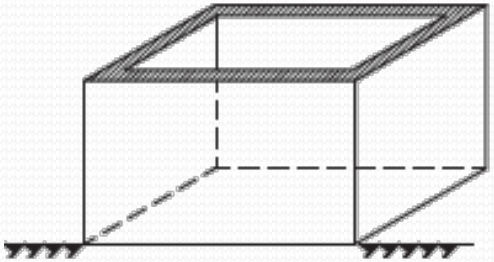
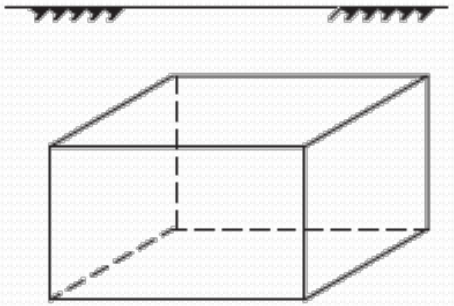
2011

Classification of Water Tanks According to Position Relative to Ground Level

- Elevated Tank
- Earth rested Tank
- Underground Tank



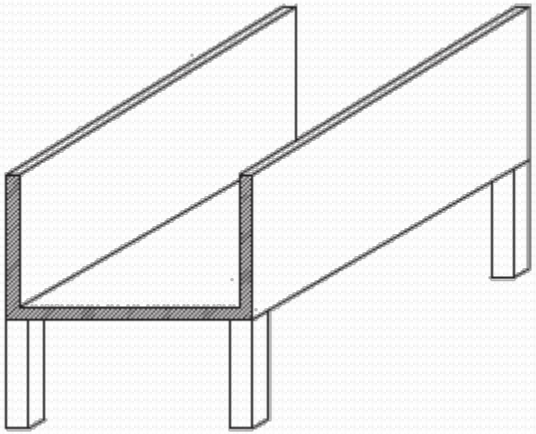




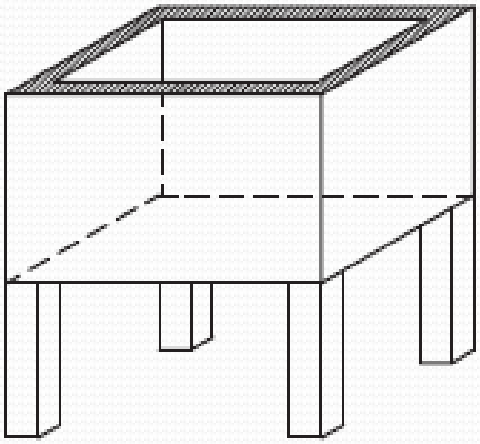
Elevated Tanks

Classification of Elevated Tanks According to Shape

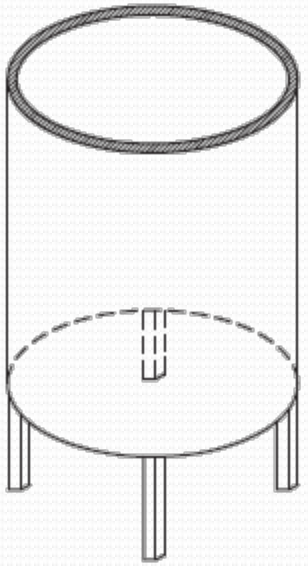
Open Channel



Rectangular Tank

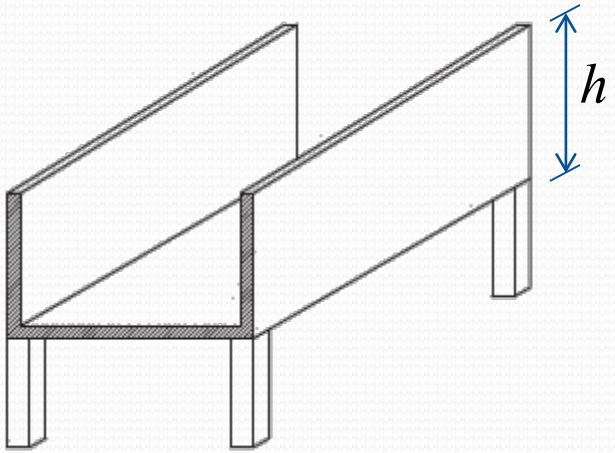


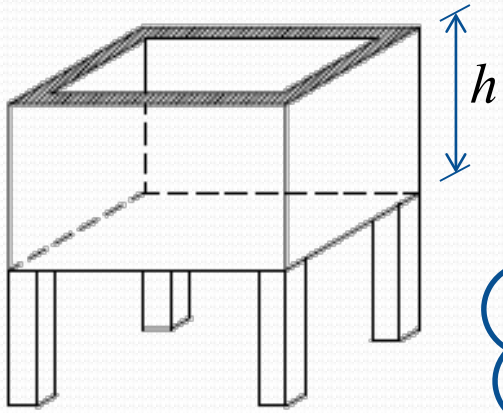
Circular Tank



Statical Systems of Elevated Tanks

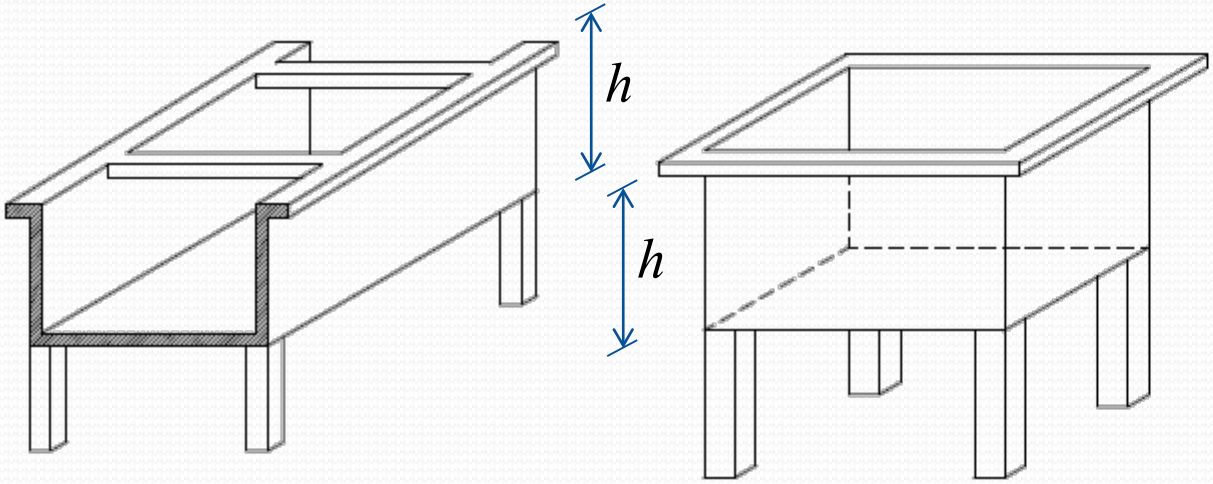
1. Tanks With free top end

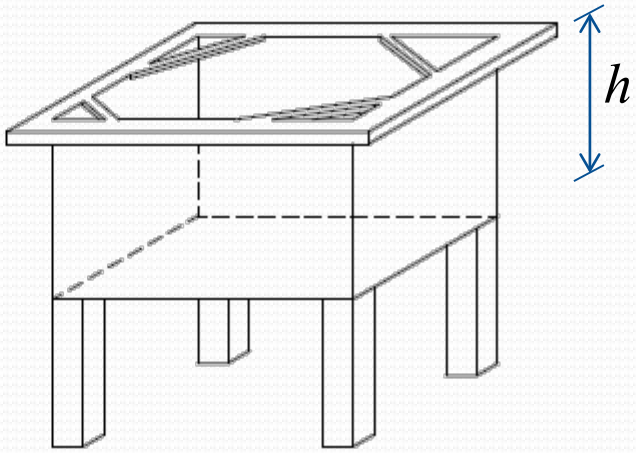




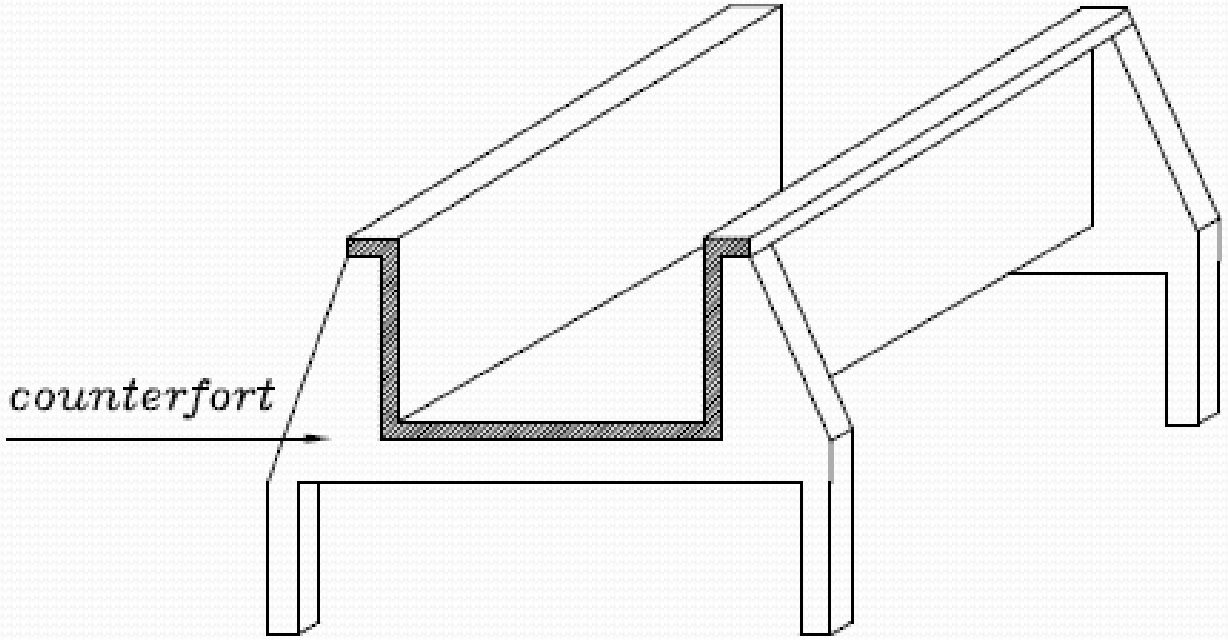
$h \leq 3.0$ m

2. Tanks with top beams and ties (3.0 < h ≤ 5.0 m)



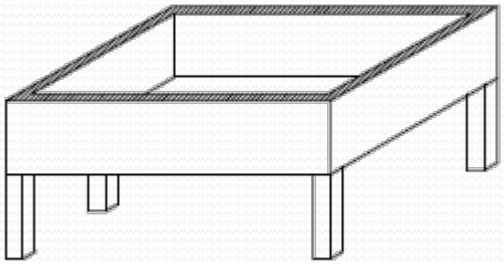


3. Tanks with Counterforts (h ≥ 7.0 m)

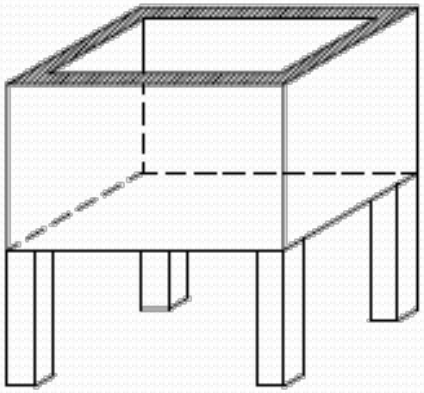


Classification of Elevated Tanks According to Depth

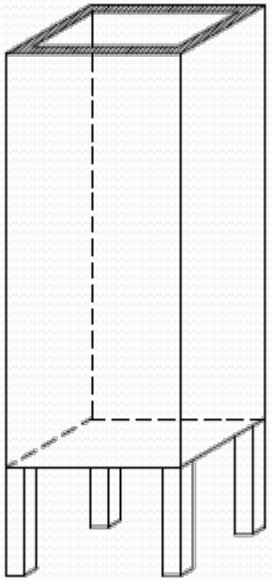
Shallow Tank



Medium Tank



Deep Tank



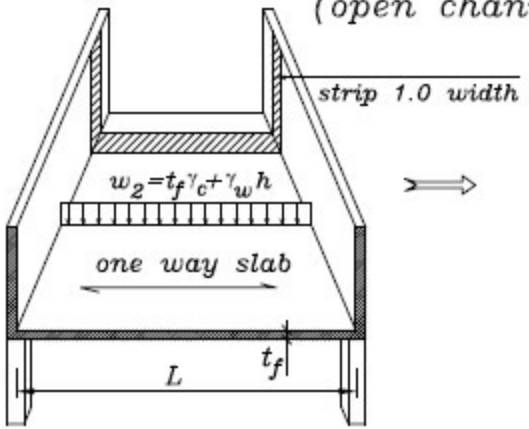
Analysis of Elevated Tanks

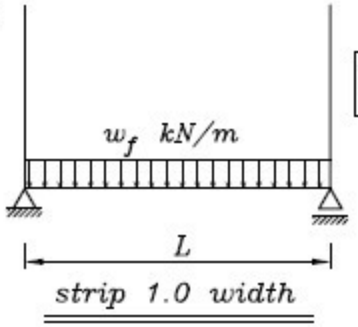
1– Floor slabs ارضية الخزان

– Types of floor slabs

a– One way slabs $(t_f = \frac{L_s}{16} \not< 250mm)$

حيث تكون ارضية الخزان عبارة عن بلاطات (one way) مرتكزة على حوائط الخزان التى تعمل ككمرات مثل (open channel tank)

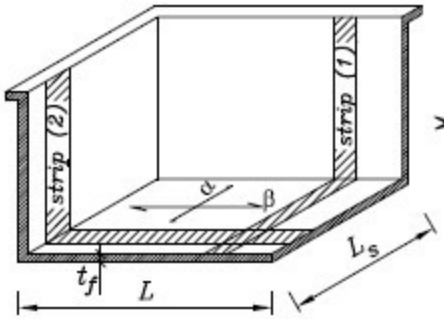


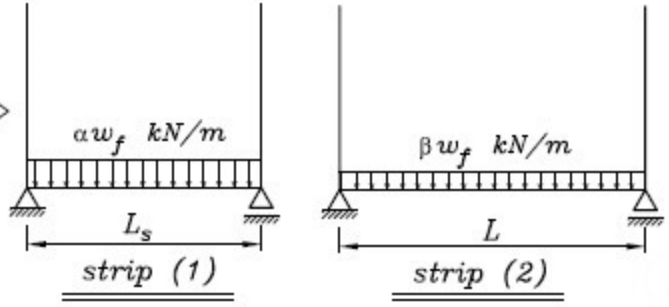


$$w_f = t_f \gamma_c + \gamma_w h \quad kN/m^2$$

a– Two way slabs $(t_f = \frac{L_s}{16} \not< 250mm)$ $\frac{L}{L_s} < 2$

حيث تكون ارضية الخزان عبارة عن بلاطات (two way) مرتكزة على حوائط الخزان التى تعمل ككمرات مثل (rectangular tank)





How to get α & β

Calculate $r = \frac{m\ L}{m`\ L_s} \geqslant 1.00$

حيث $(m, m`)$ معاملات تتوقف على حالة اتصال اطوال البلاطة (L, L_s)

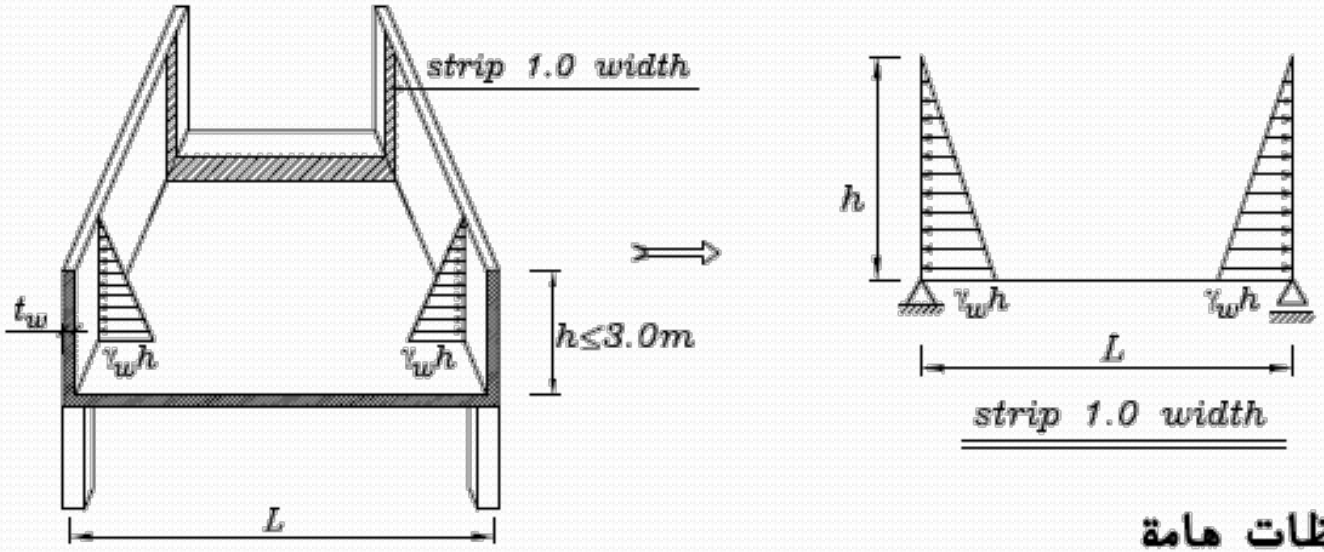
Strip			
m or $m`$	1.00	0.87	0.76

$$\alpha = \frac{r^4}{1+r^4} \quad , \quad \beta = \frac{1}{1+r^4}$$

(Grashoff equations)

2– Side walls حوائط الخزان

a– Cantilever walls $(t_w = \frac{H}{10} \not< 250mm)$



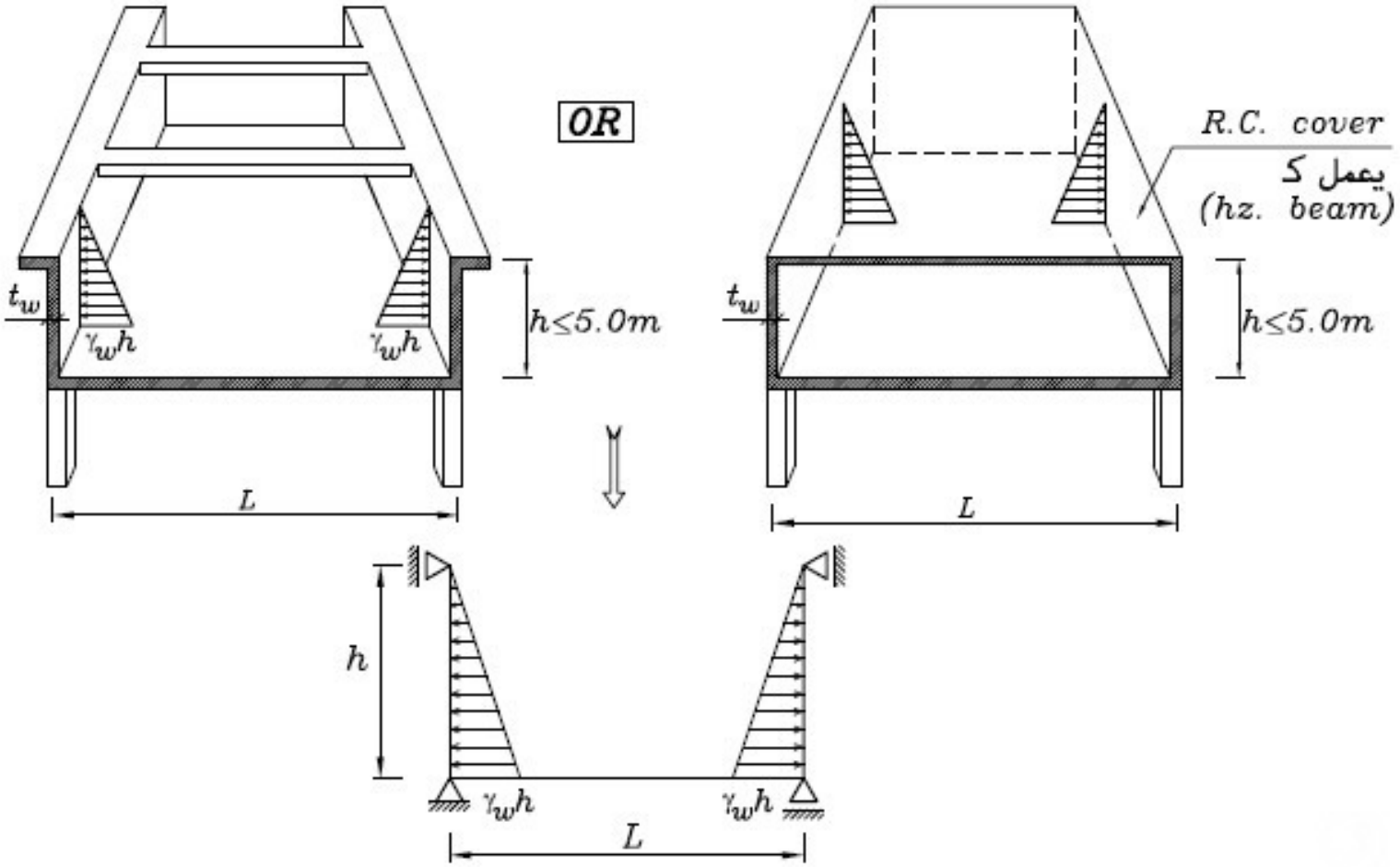
ـ ملحوظات هامة

١-لا يتم وضع كمرة افقية طالما ان ارتفاع الحائط $(h \leq 3.0m)$

٢-لا يفضل زيادة ارتفاع الحائط الكابولى $(cantilever\ wall)$ عن $(3.0m)$ حتى لا تكون العزوم كبيرة و بالتالى نحتاج قطاع خرسانى كبير عند اتصال الحائط بالارضية .

b–One way in vertical direction

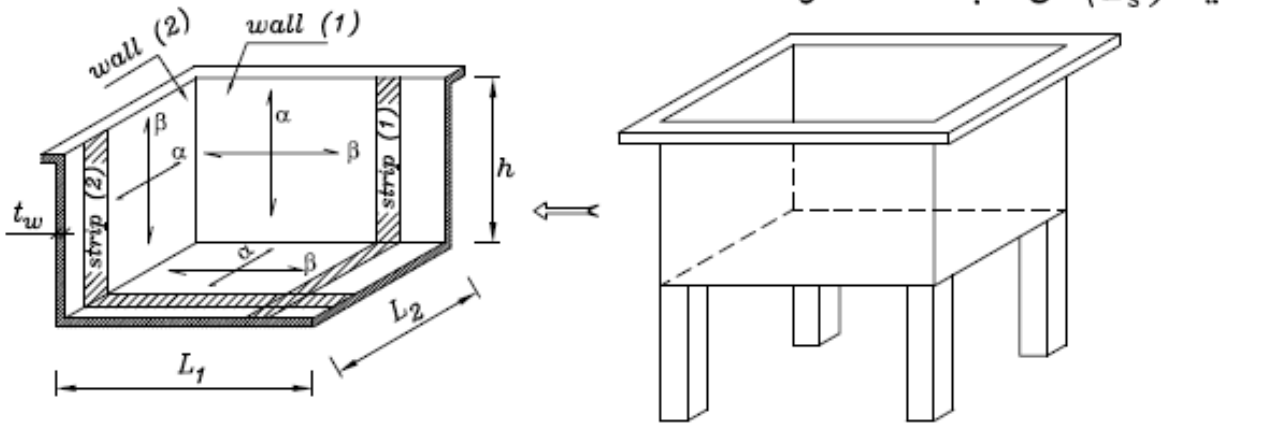
$(t_w = \frac{H}{16} \not< 250mm)$



c–Two way slabs

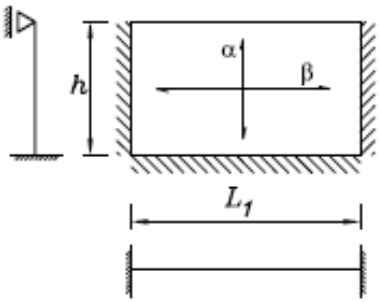
$(t_w = \frac{L_s}{16} \nless 250mm)$ $\boxed{\frac{L}{L_s} < 2}$

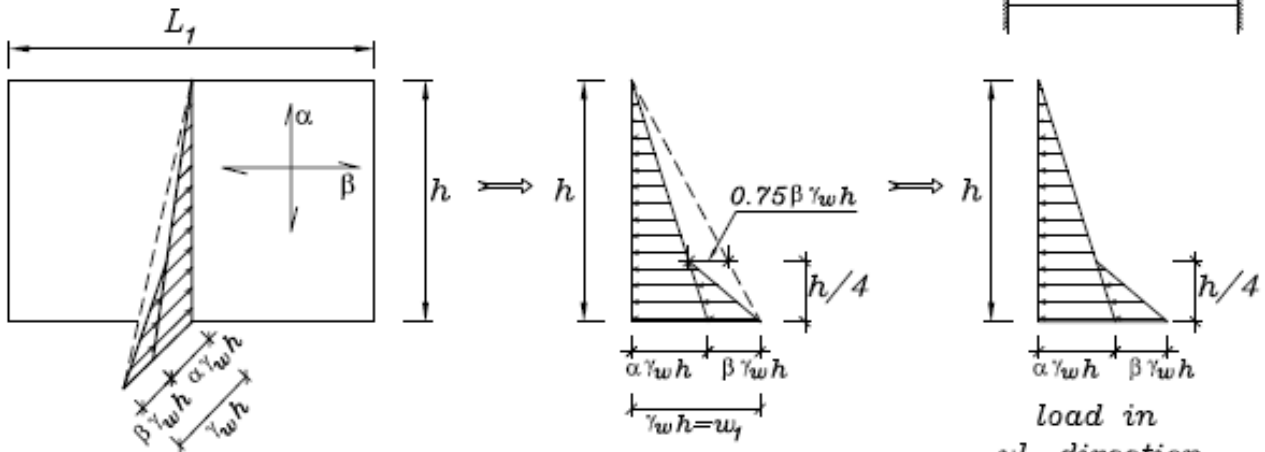
حيث (L_s) هى البعد الاصغر للحائط



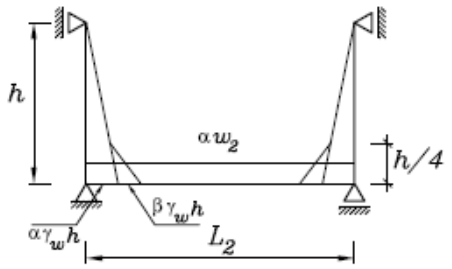
For wall (w_1) :

$$r = \frac{m\ L_1}{m\ h} = \frac{0.76L_1}{0.87h} \qquad (assuming\ L_1 > h)$$





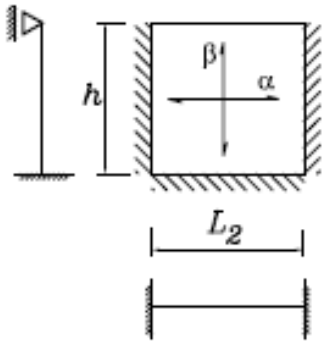
– VL. strip (1)

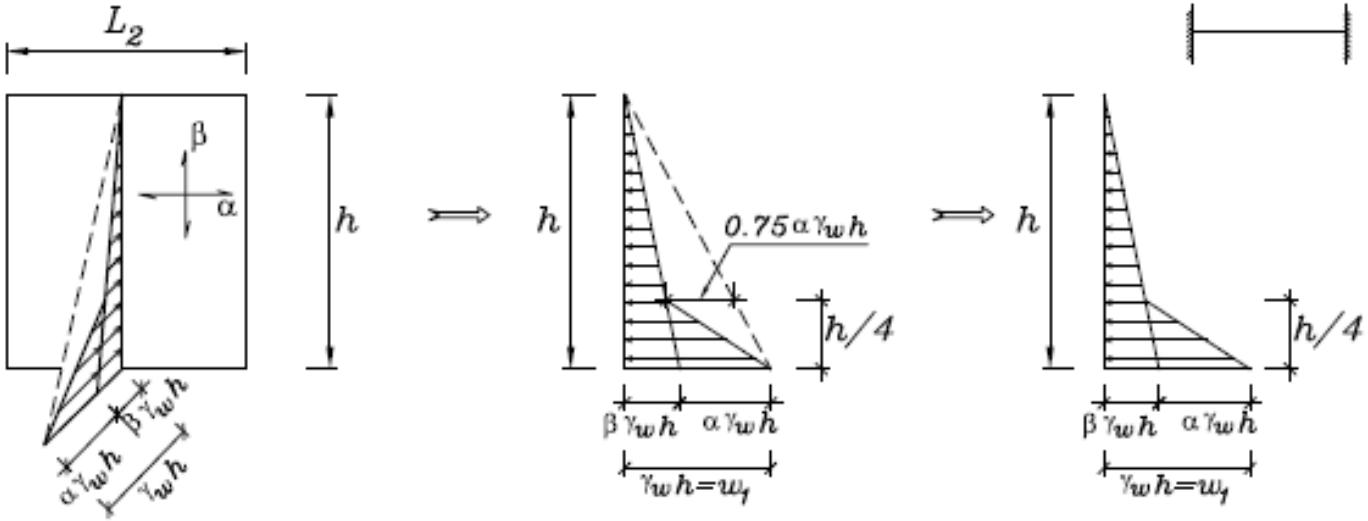


For wall (w_2) :

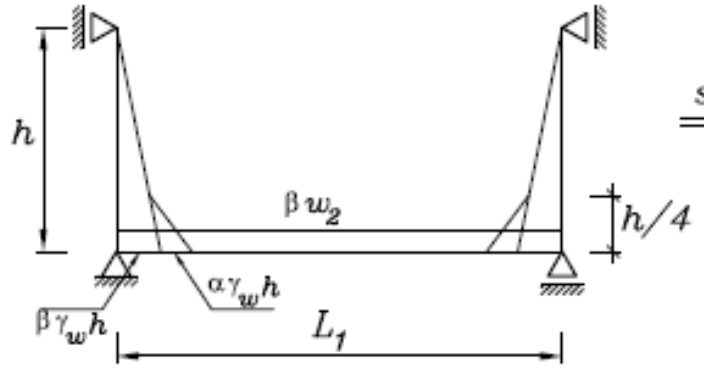
$$r = \frac{m\ h}{m`\ L_2} = \frac{0.87h}{0.76L_2}$$

(assuming $h > L_2$)



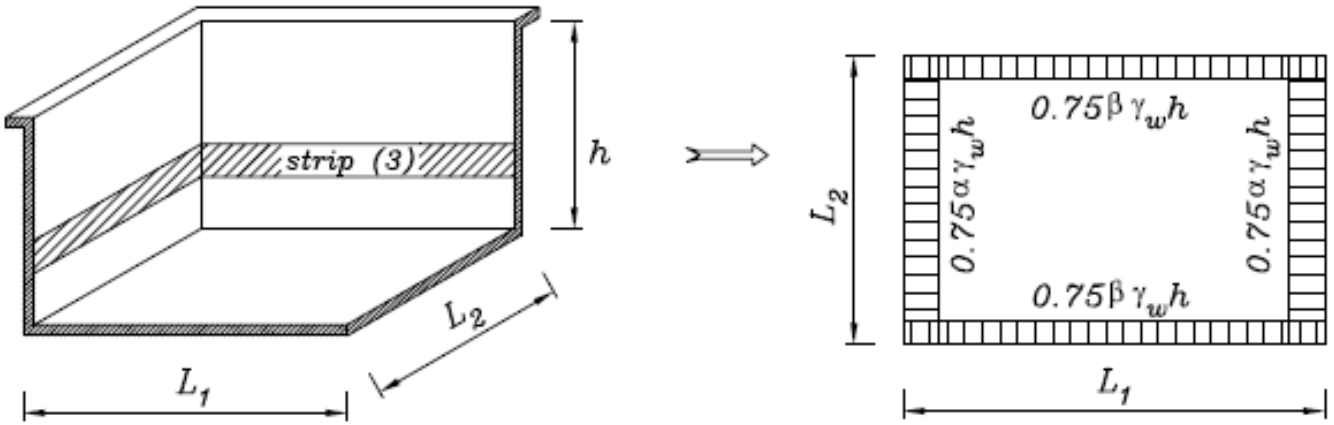


– VL. strip (2)



strip 1.0 width

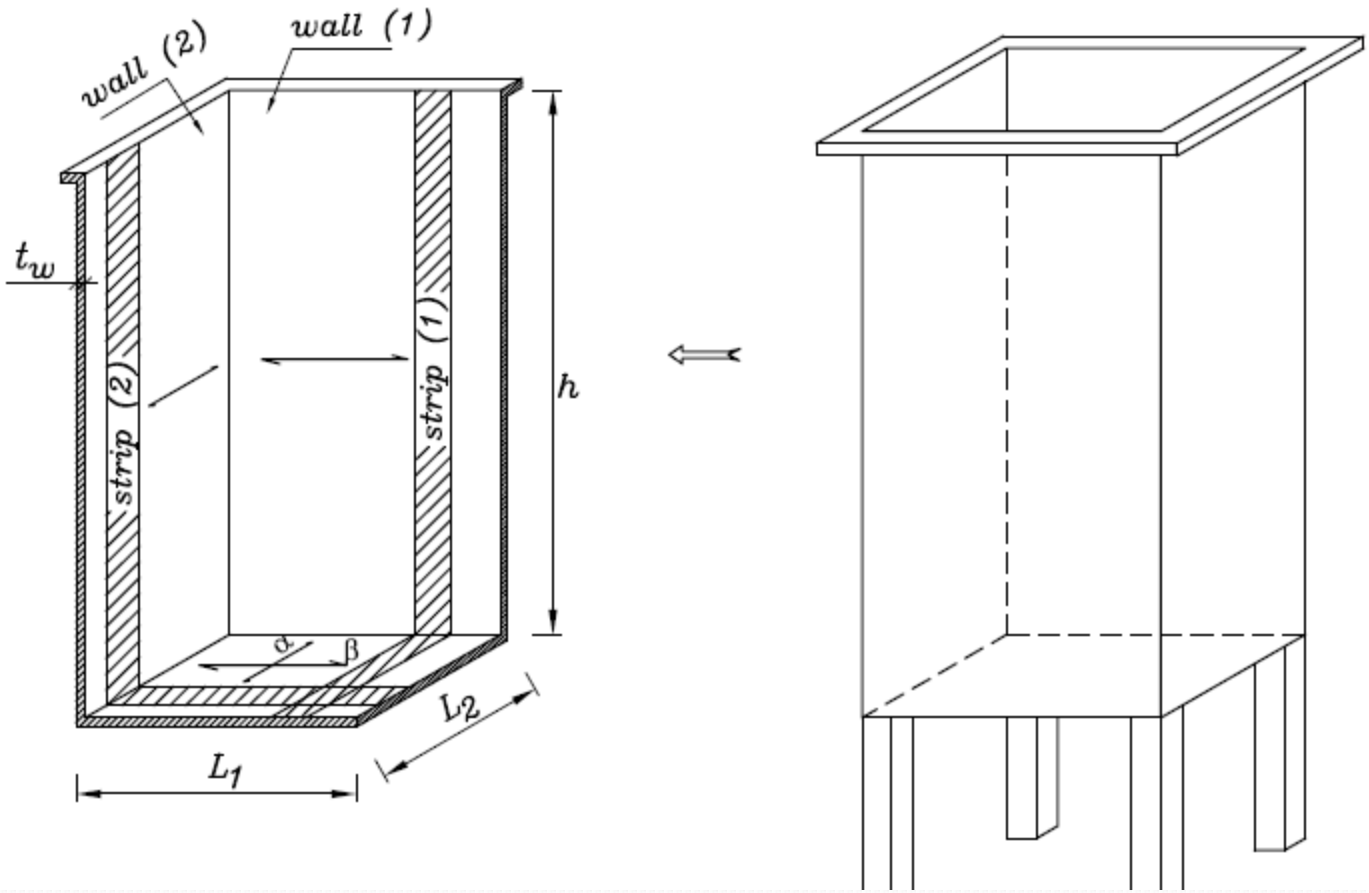
– HZ. strip (3) at (h/4) from floor



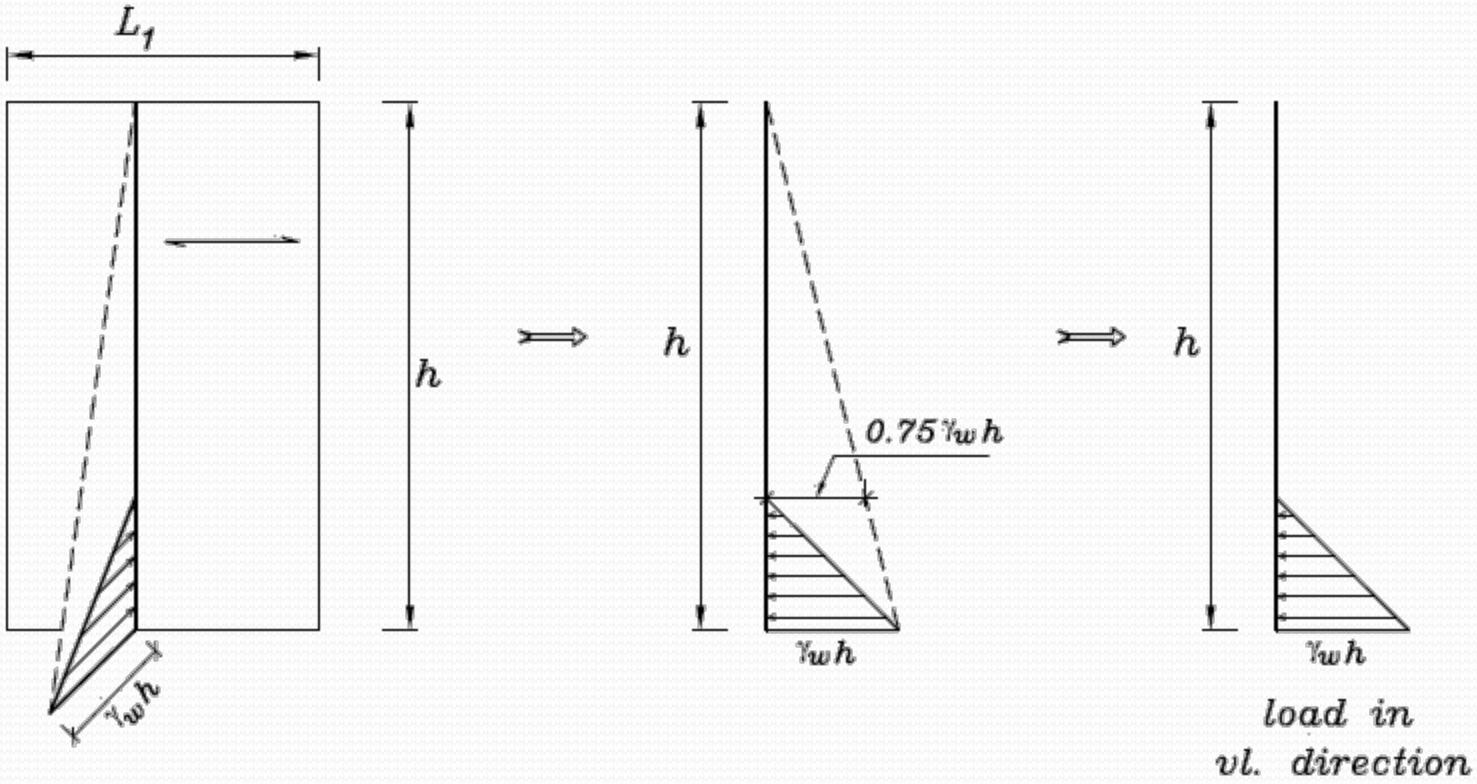
d–One way in horizontal direction (deep tank)

$\frac{h}{L} \geq 2$

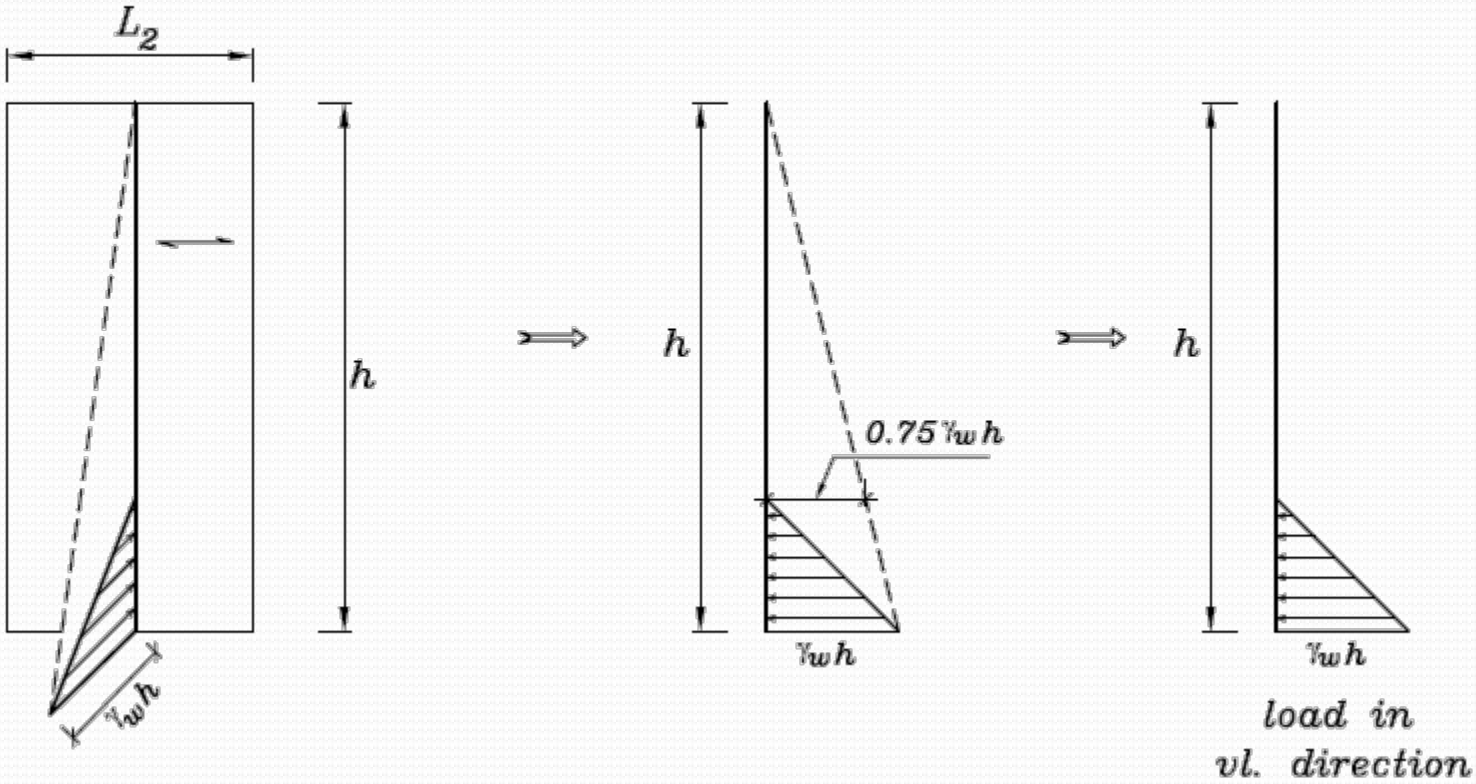
$(t_w = \frac{L_s}{16} \nless 250mm)$

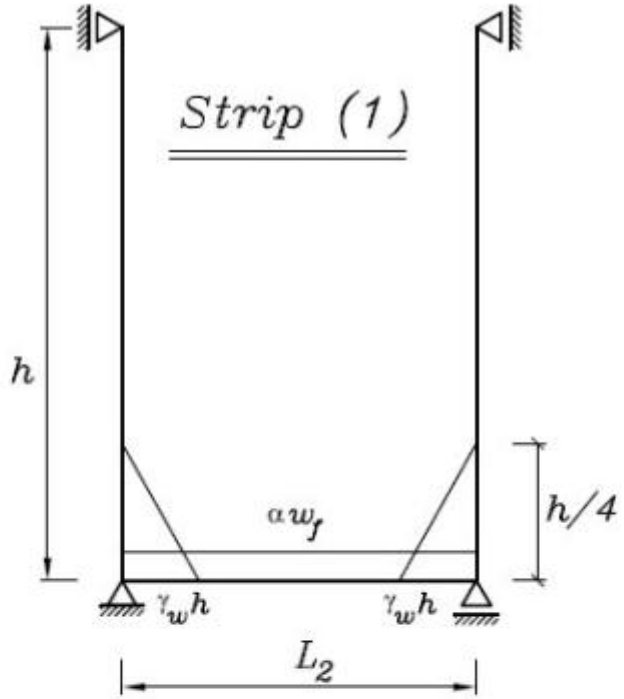


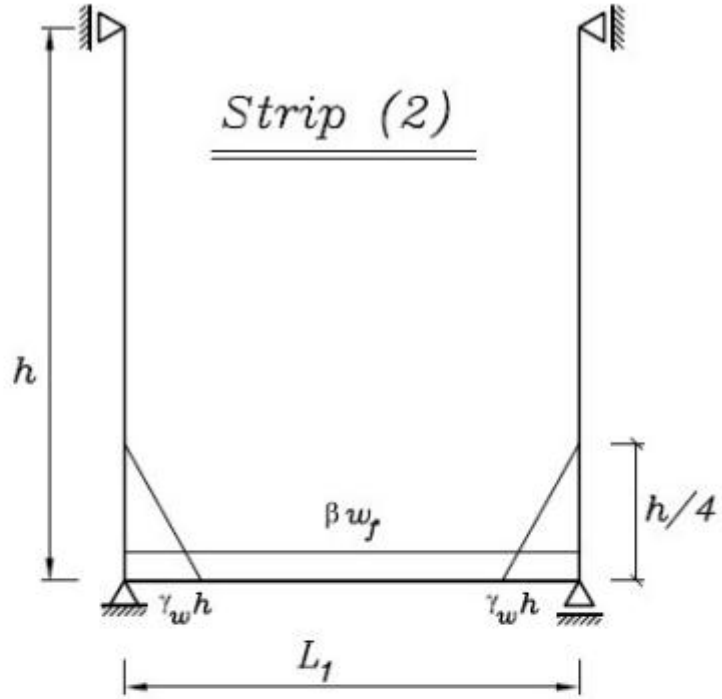
For wall (w_1) :


L_1
h
$\gamma_w h$
h
h
$0.75\gamma_w h$
$\gamma_w h$
h
$\gamma_w h$
load in
vl. direction

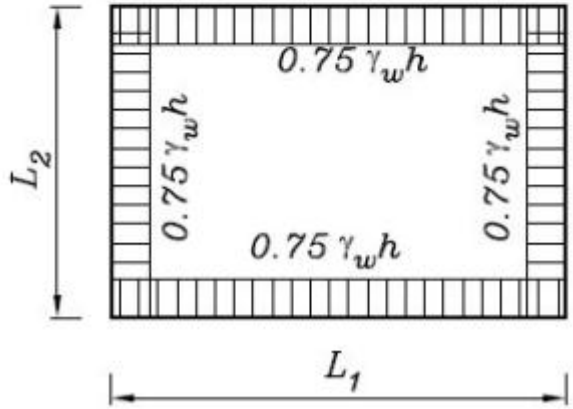
For wall (w_2) :


L_2
h
$\gamma_w h$
h
$0.75\gamma_w h$
$\gamma_w h$
h
$\gamma_w h$
load in
vl. direction





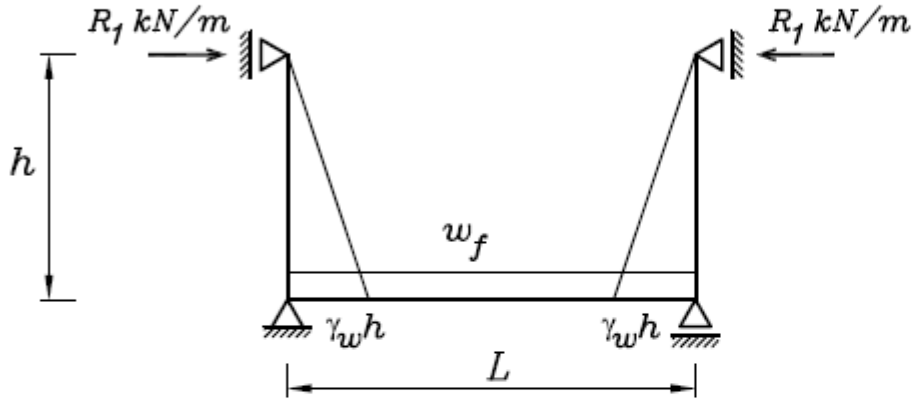
Strip (3) : horizontal strip at $(\frac{h}{4})$

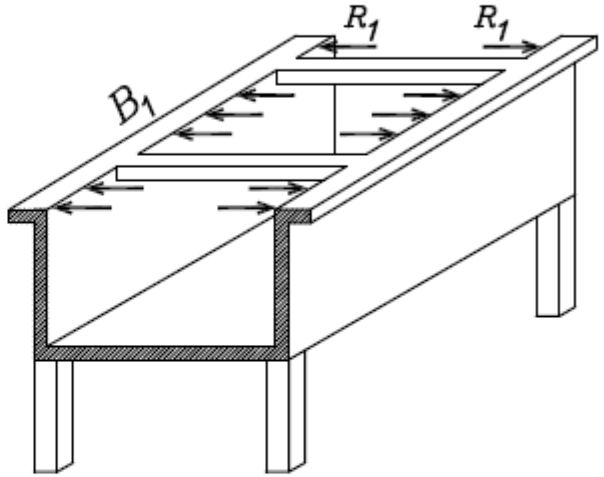


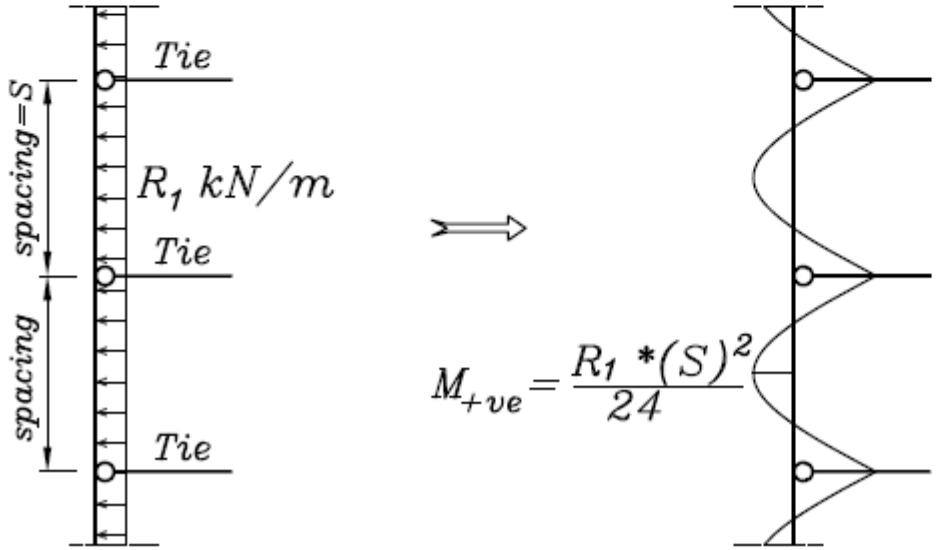
3–Supporting elements

1– Top horizontal beams

a– Horizontal beam of open channel tank





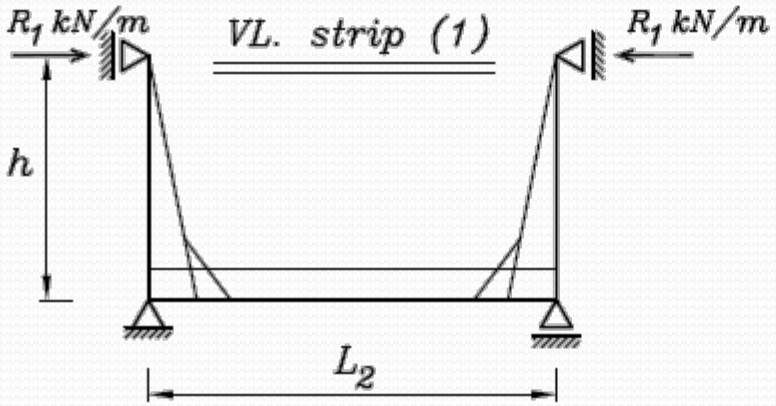


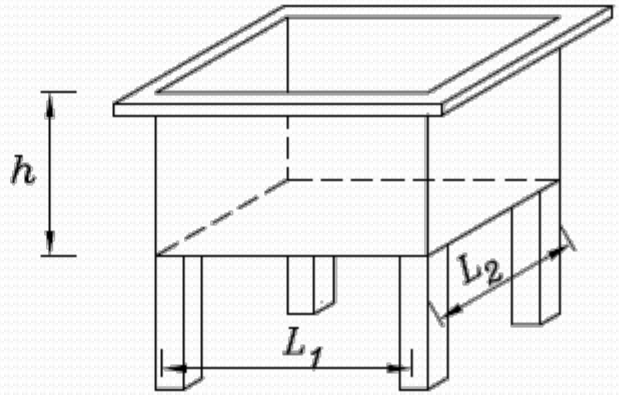
$$M_{-ve} = \frac{R_1 * (S)^2}{12}$$

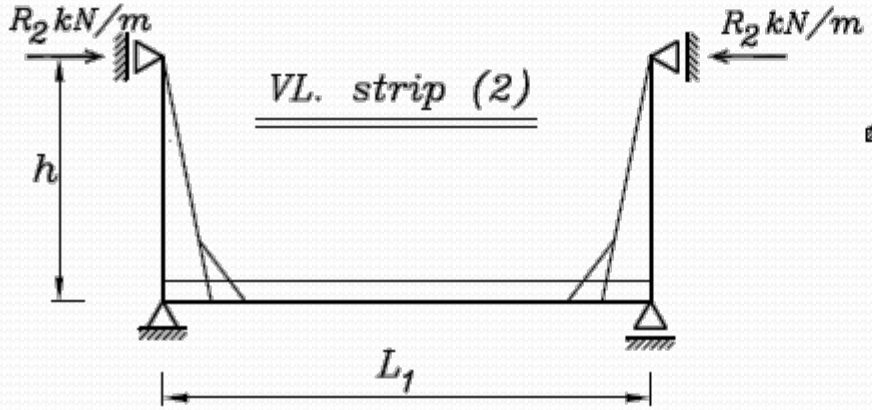
$$M_{+ve} = \frac{R_1 * (S)^2}{24}$$

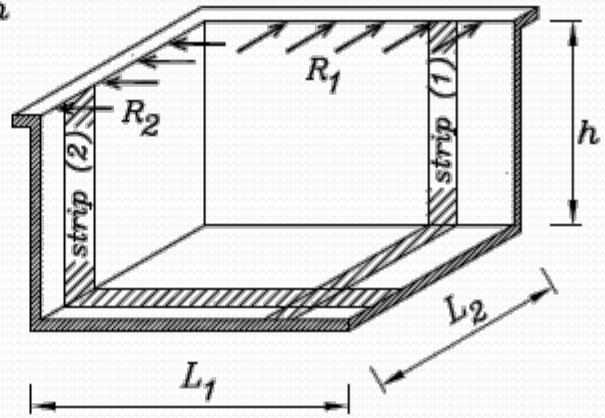
$\rightarrow$ Tension in tie $= R_1 * S$

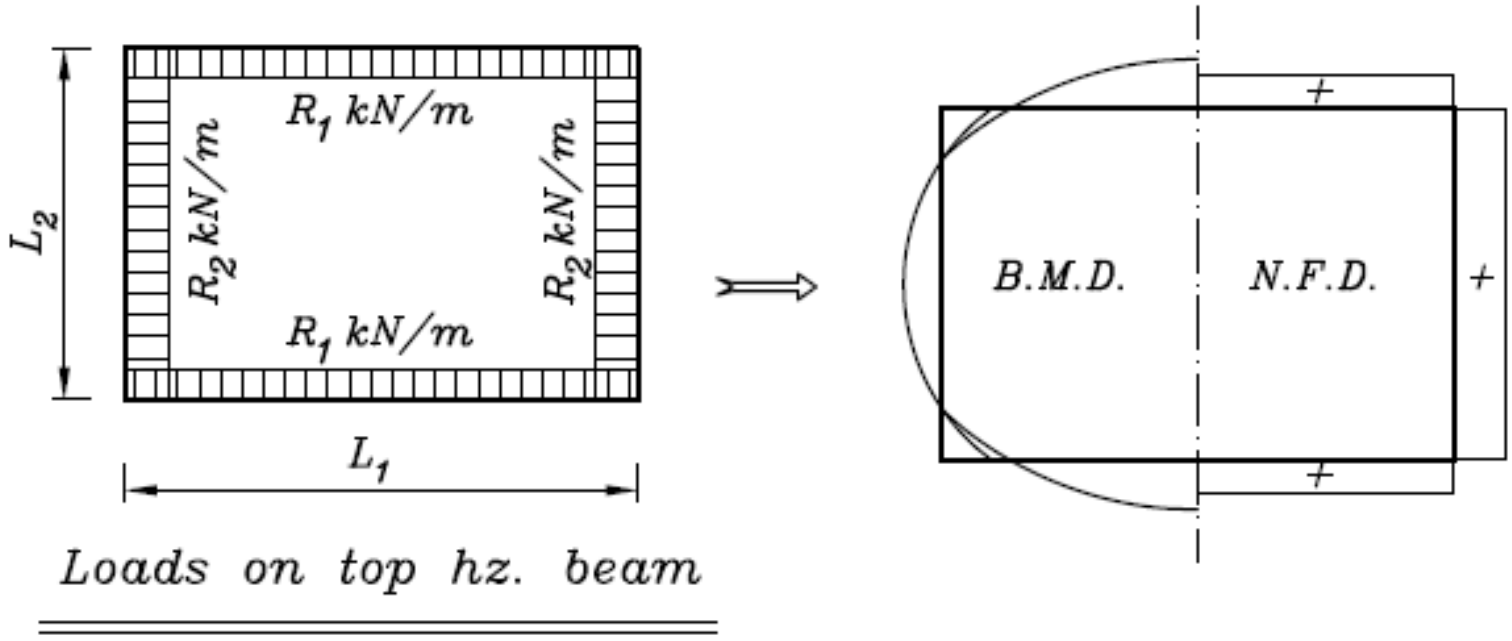
b– Closed frame without ties (L≤7.0m)





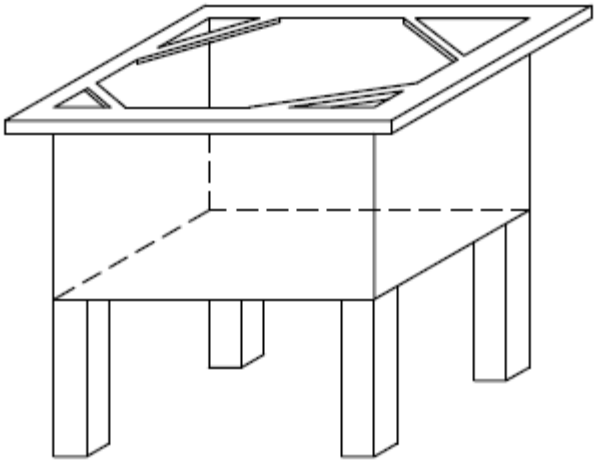


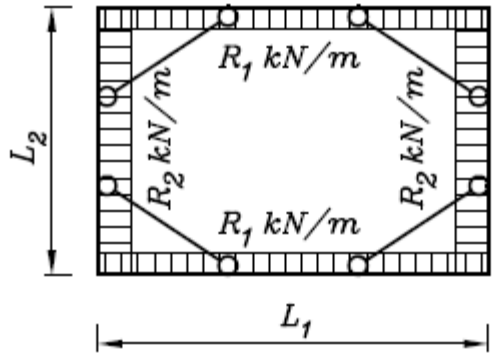




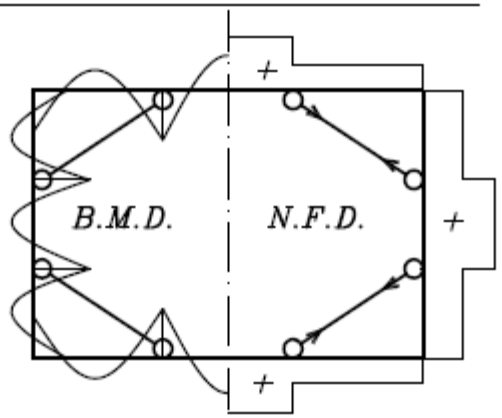
Loads on top hz. beam

d– Closed frame with ties (L>7.0m)





Loads on top hz. beam



ـ ملحوظة

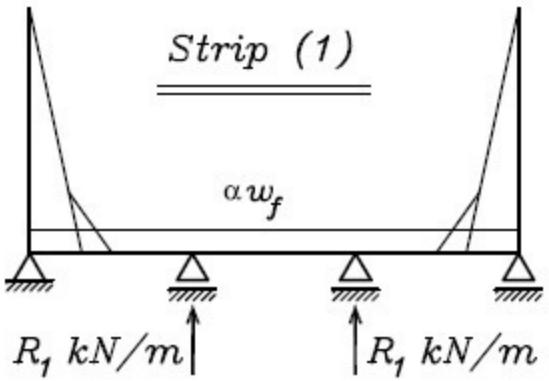
فى حالة ان طول الكمرة اكبر من(7.0m)يفضل وضع(tie)ليقلل (lateral displacement)للكمرة و بالتالى تكون(rigid)بحيث تعمل كركيزة بالنسبة الى (vertical wall)

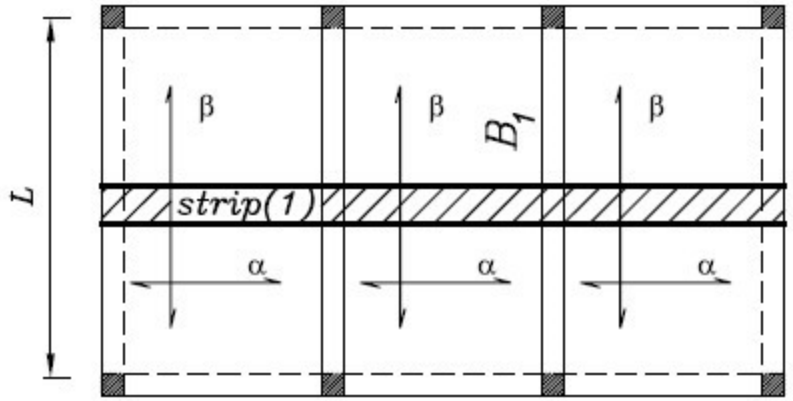
2- Floor beams

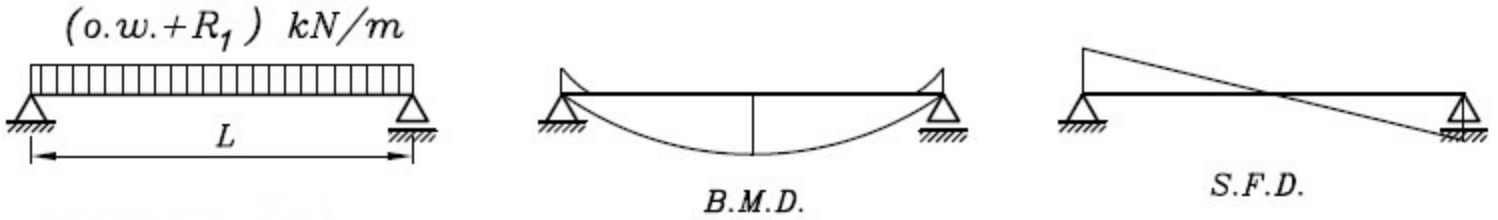
يوجد طريقتان لحساب الاحمال على الكمرة

- Method (1)

حيث نعكس ردود افعال الشرائح العمودية على الكمرة $(R_1 \quad kN/m)$

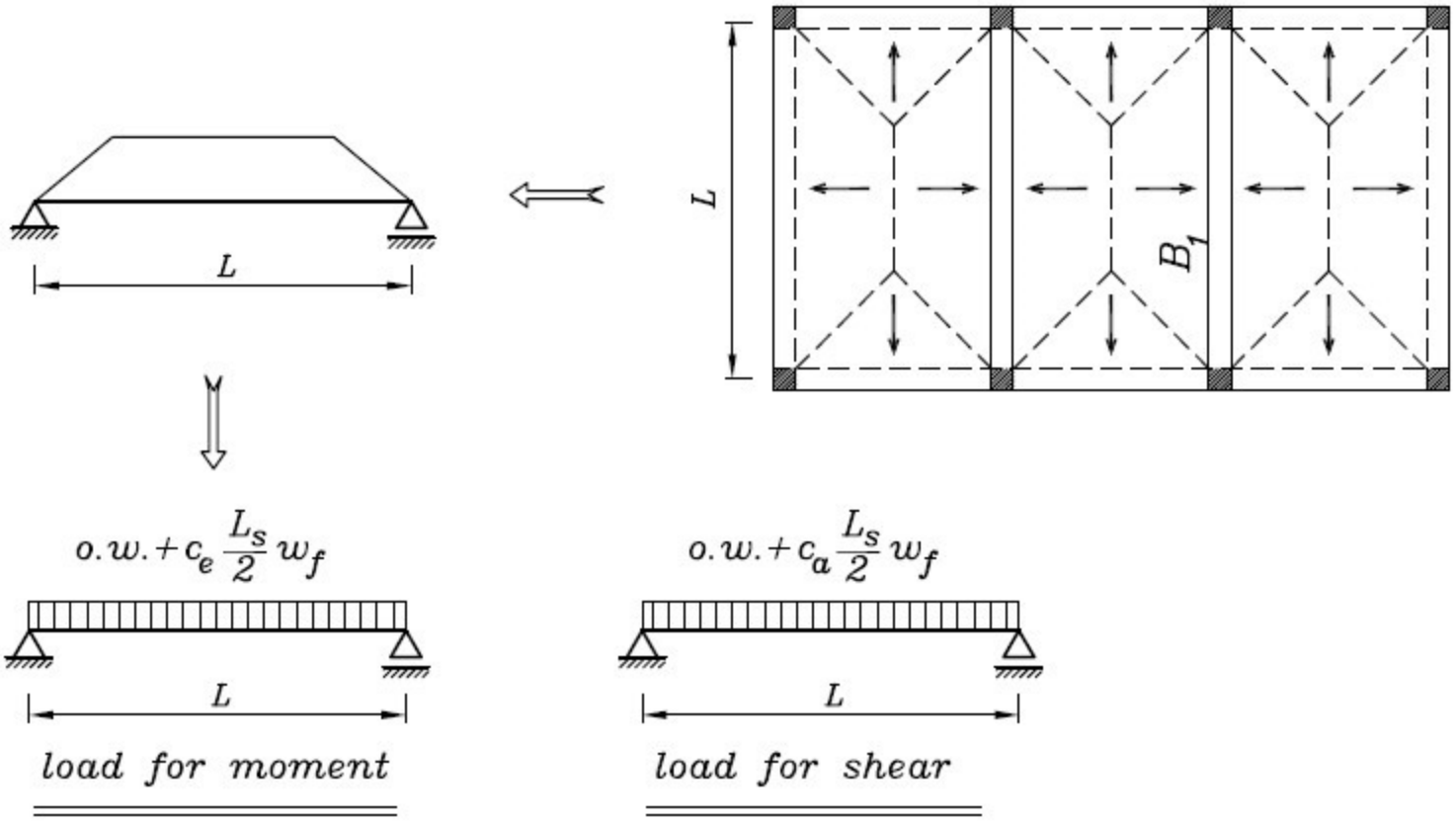




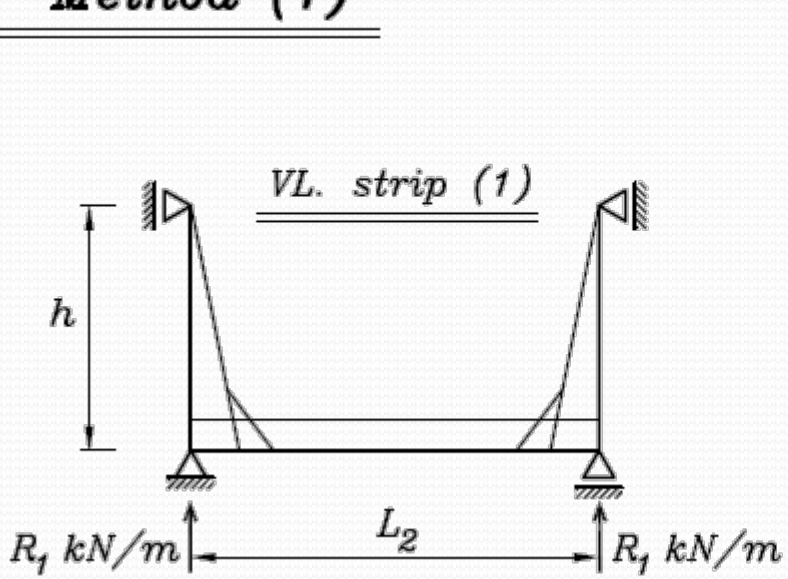


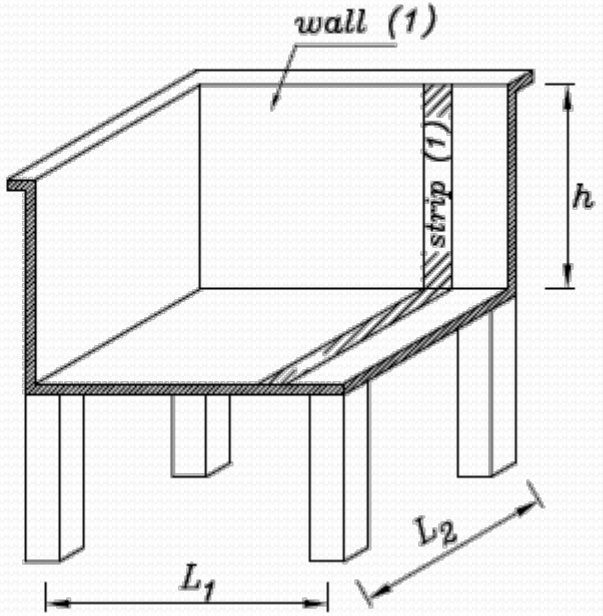
– Method (2)

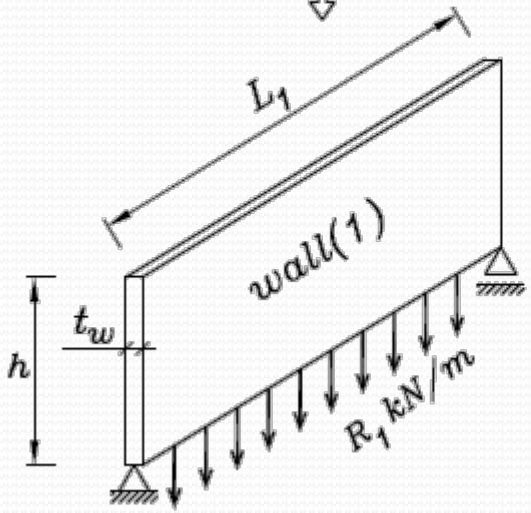
و هو عمل (load distribution) و حساب الاحمال الواقعة على الكمرة

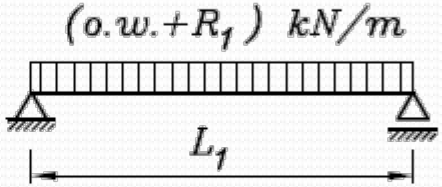


– Method (1)





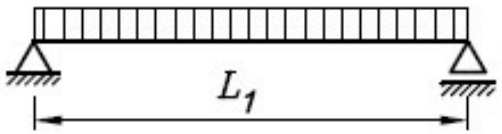




o.w. of wall=$t_w . h \gamma_c$

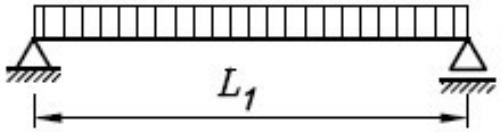
– Method (2)

$o.w. + c_e \frac{L_s}{2} w_f$

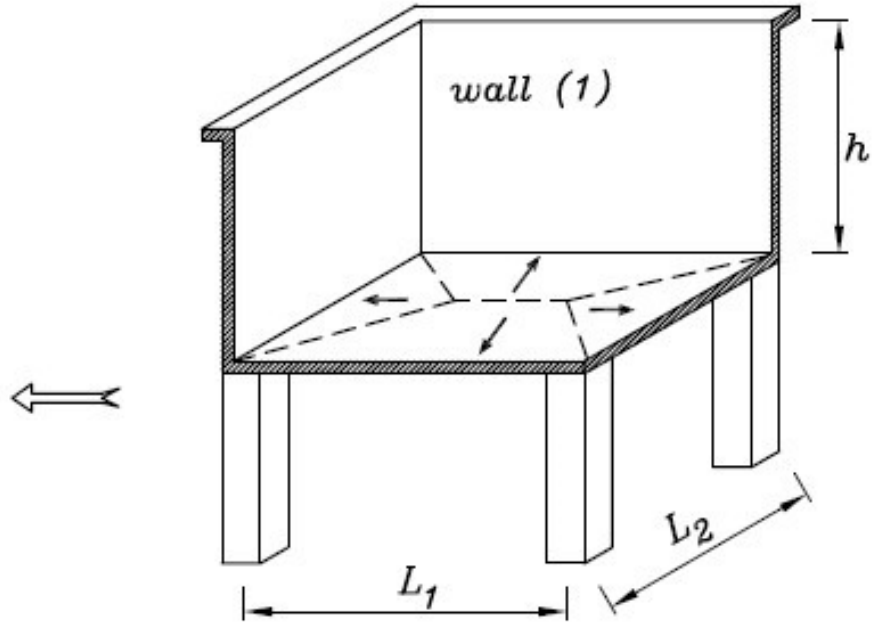


load for moment

$o.w. + c_a \frac{L_s}{2} w_f$



load for shear



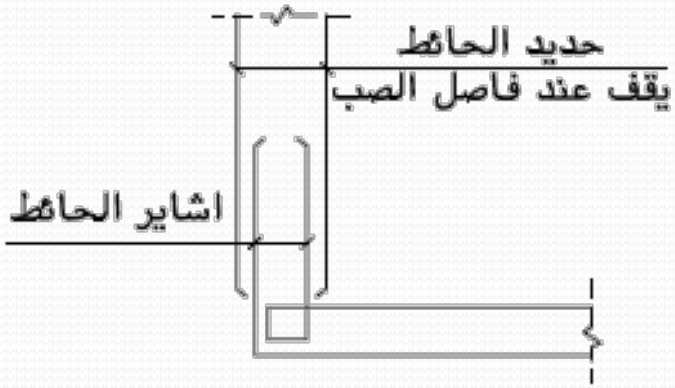
Reinforcement Details For Elevated Rectangular Tanks

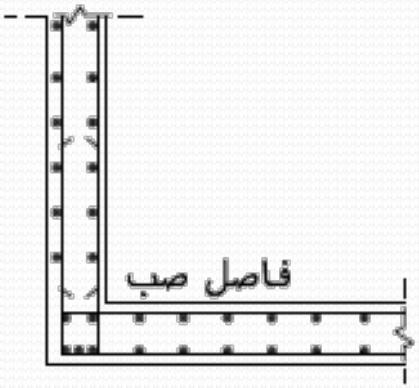
١-عدد الاسياخ يتراوح من (٥-١٠) اسياخ فى المتر .

٢-اقل كمية من الحديد توضع فى بلاطات الخزانات هى

$$A_{s_{min}} = \begin{cases} 5\phi 12/m \text{ for main steel (at tension side)} \\ 5\phi 10/m \text{ for secondary steel (at compression side)} \end{cases}$$

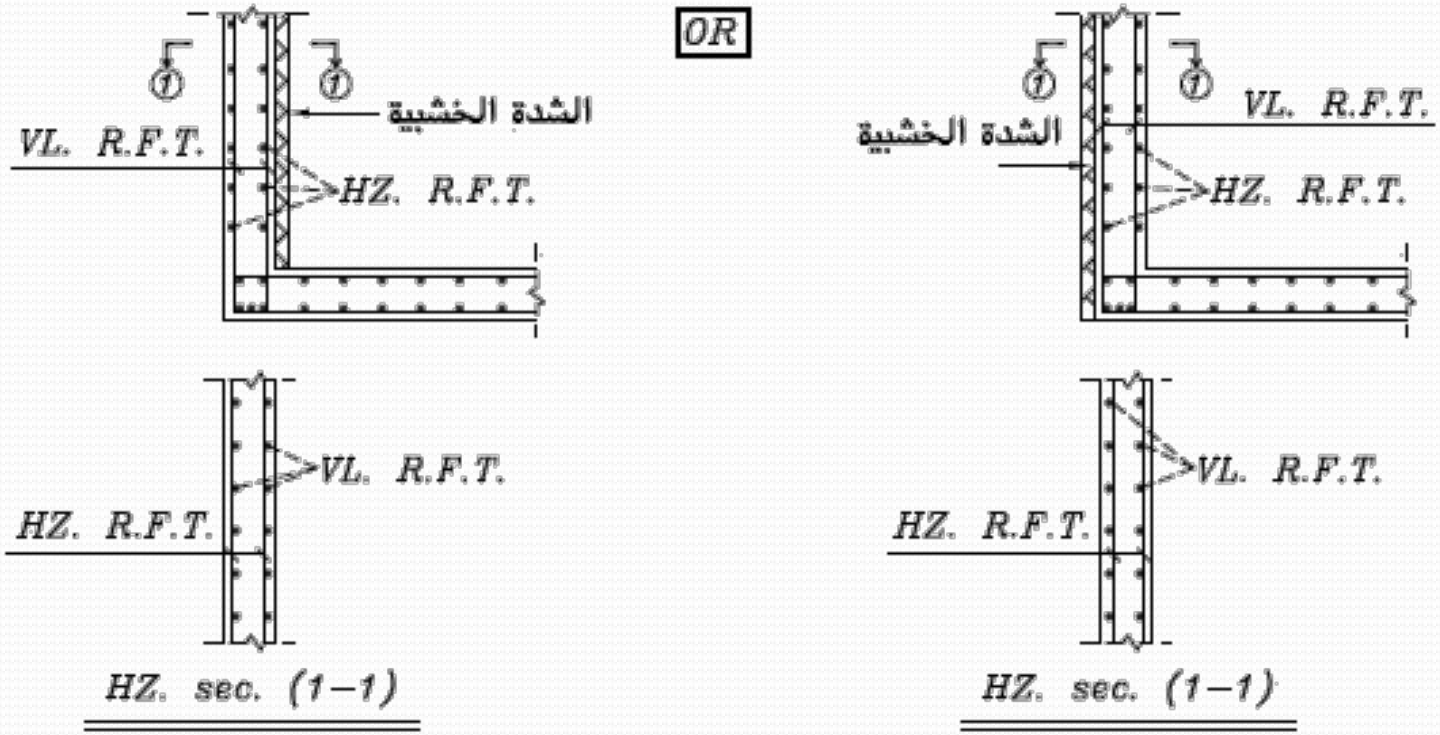
٣-يجب مراعاة مراحل صب الخزان بمعنى انه نتيجة صب ارضية الخزان اولا ثم صب الحائط بعد ذلك فان اشاير الحائط تخرج من ارضية الخزان و لا يدخل تسليح الحائط فى ارضية الخزان



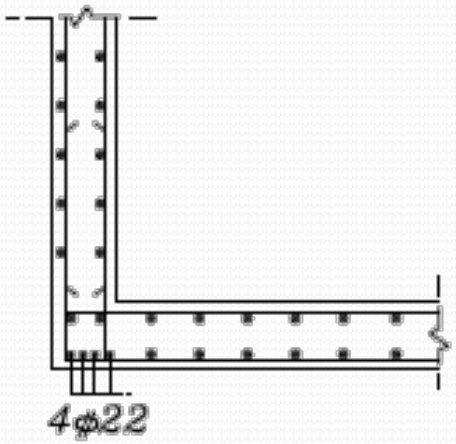


٤-يتم رص الحديد الافقى للحائط كما يلى لسهولة التنفيذ

يتم وضع الشدة ثم وضع الحديد الراسى للحائط يليه الحديد الافقى ثم يوضع الحديد الراسى فى الجهة المقابلة يليه الحديد الافقى كما يتضح من الرسم



-يتم تركيز حديد اسفل و اعلى الحائط لان الحائط يعمل ككمرة بالنسبة للارضية .



كيفية رسم (concrete dimensions) للخزان

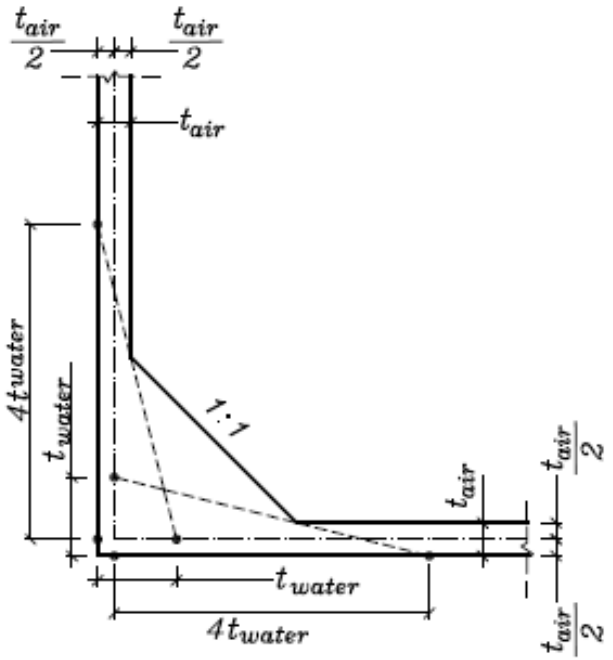
١ - نرسم (C.L.) للخزان و نوقع عليه تخانة (air sections) بحيث تكون التخانة فى منتصف الـ (C.L.)

ـ ملحوظة

يقصد بتخانة (air sections) هى ($\frac{L_s}{16}$ or $\frac{H}{10}$ $\nleq 250mm$)

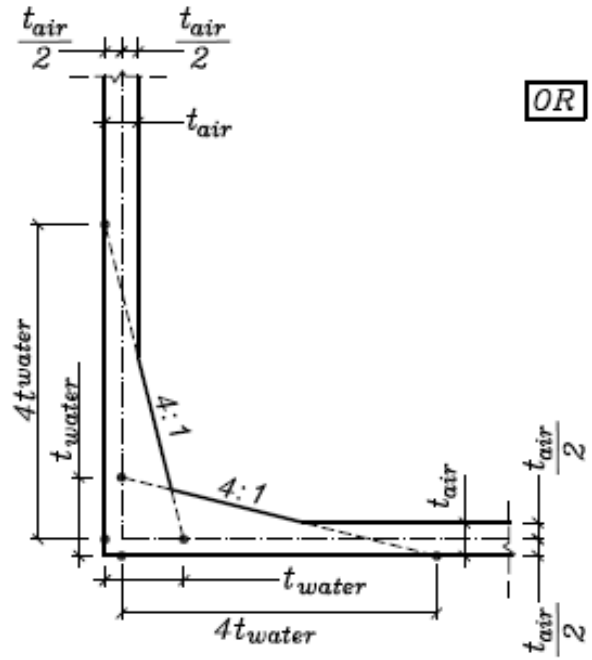
٢ - نوقع تخانة (water sections) كما بالرسم و منها نرسم الخزان .

How to draw the haunch

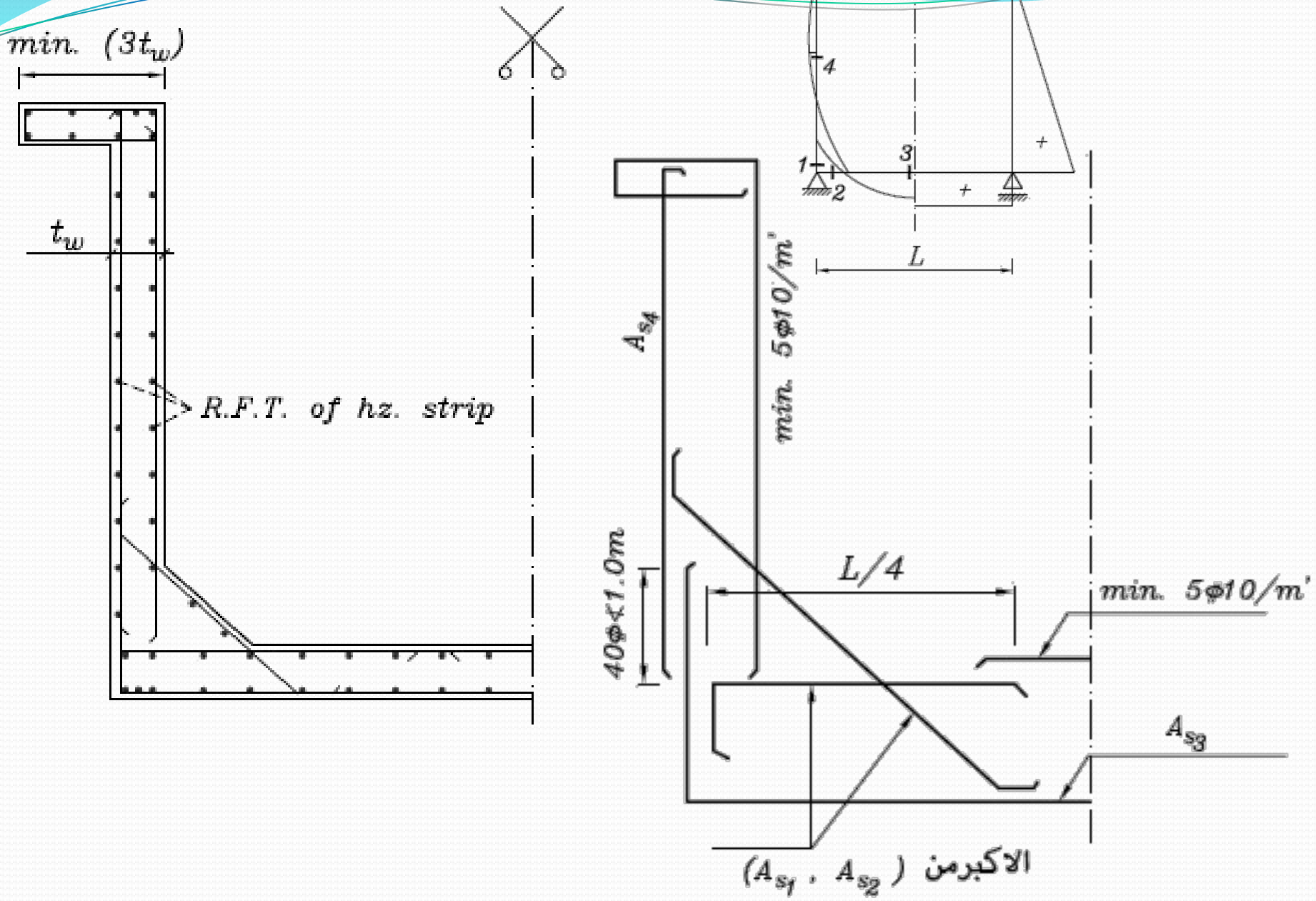


اسهل فى التنفيذ و لكن تاخذ حجم اكبر من الخزان

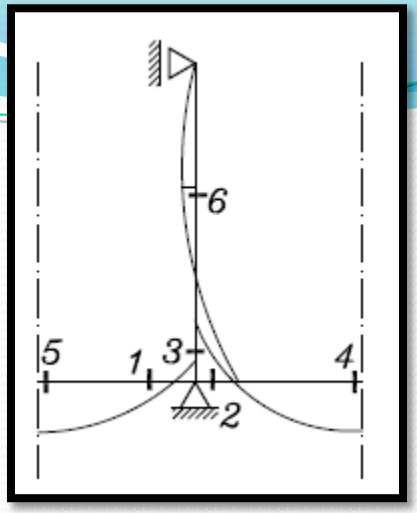
OR

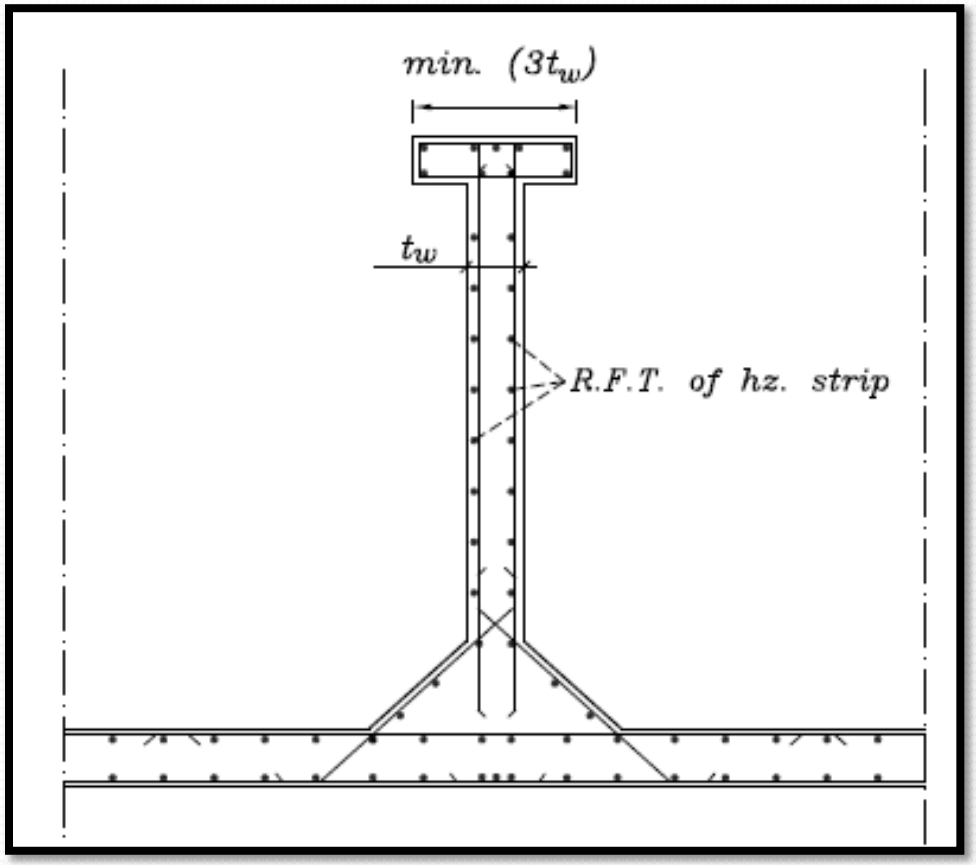


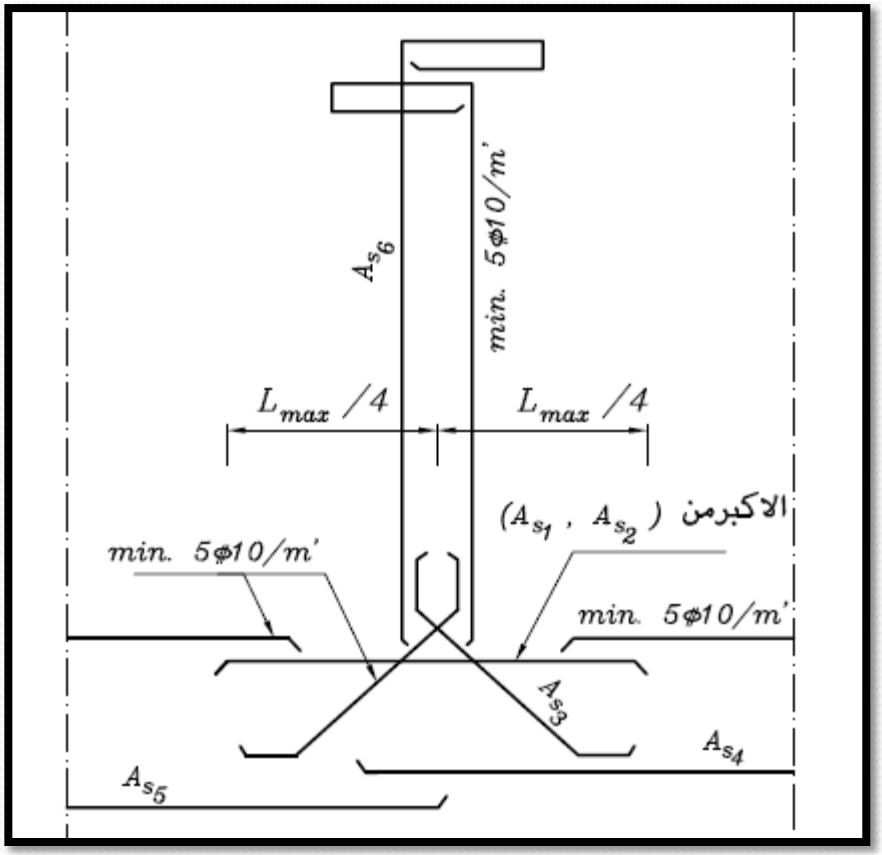
اصعب فى التنفيذ و لكن تاخذ حجم اقل من الخزان


min. $(3t_w)$
t_w
R.F.T. of hz. strip
4
1
3
2
+
+
+
L
A_{s4}
min. 5φ10/m'
40φ<1.0m
L/4
min. 5φ10/m'
A_{s3}
$(A_{s1}$, $A_{s2})$ الاكبرمن

b- internal walls

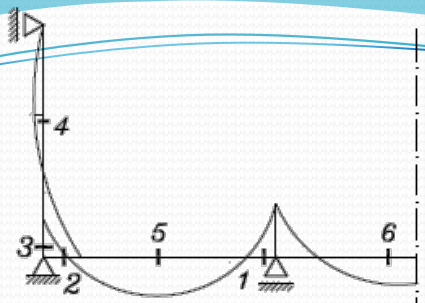


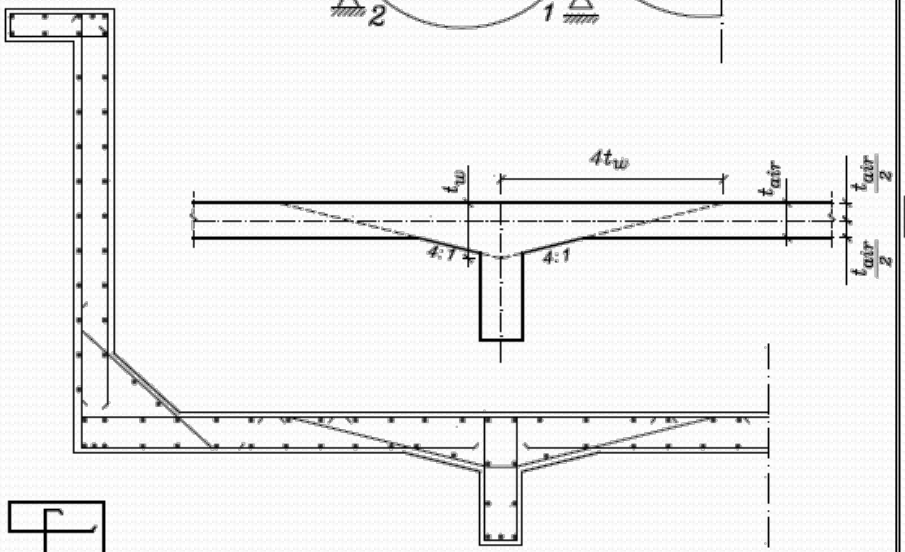


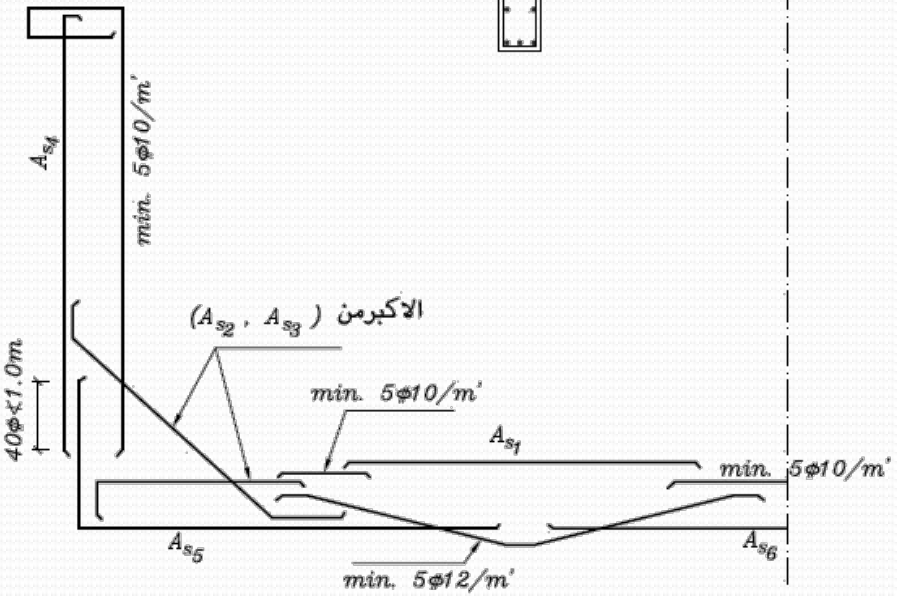


2- Floors

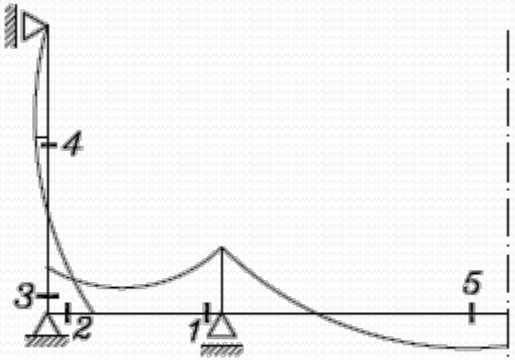
- Case (a)

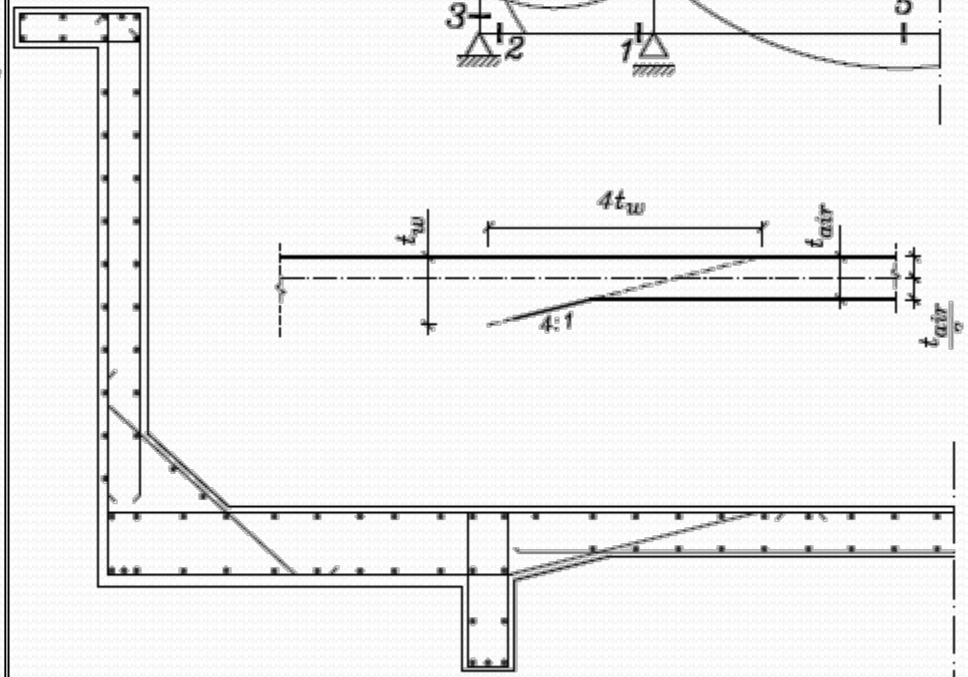






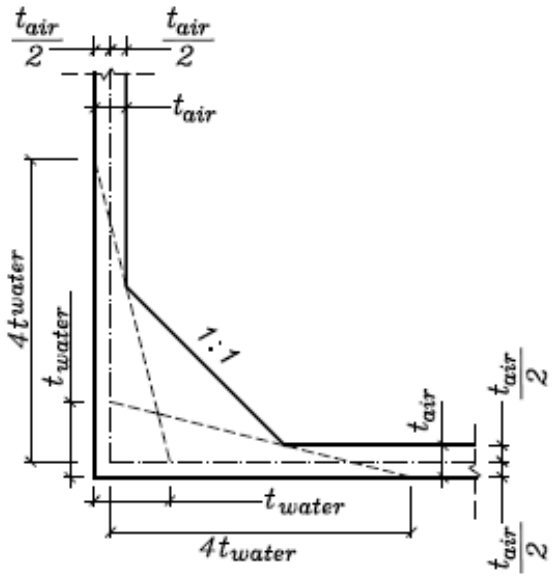
Case (b)

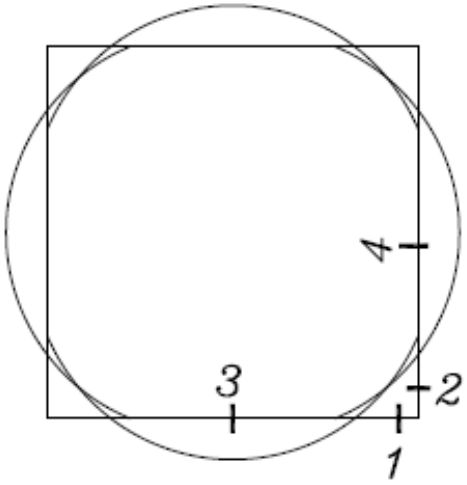


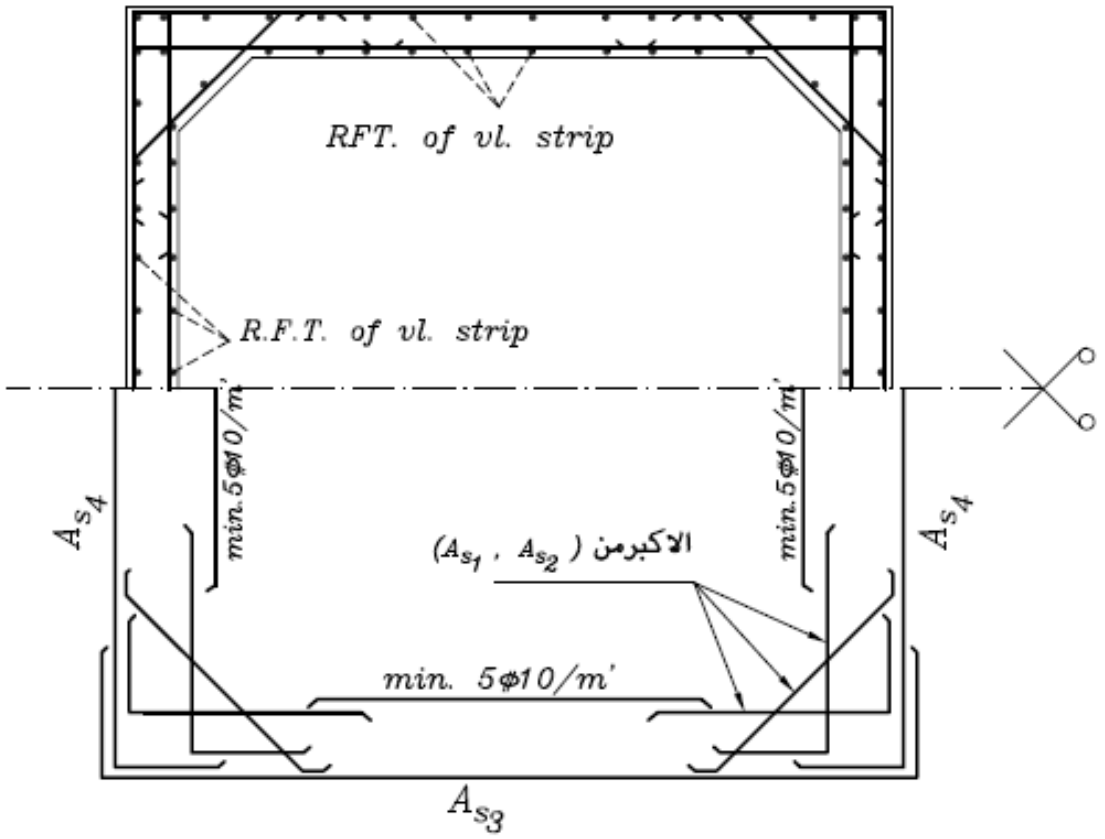


3- Hz. strip

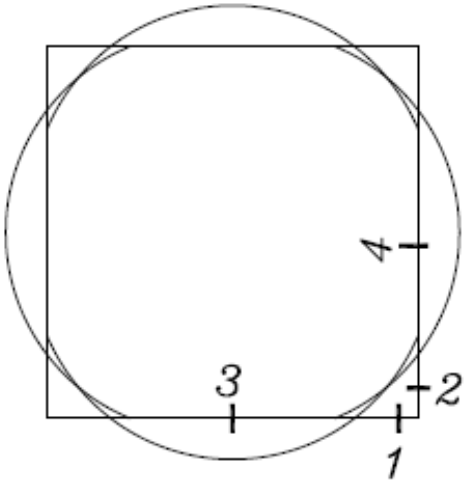
Case (a): haunch at hz. strip

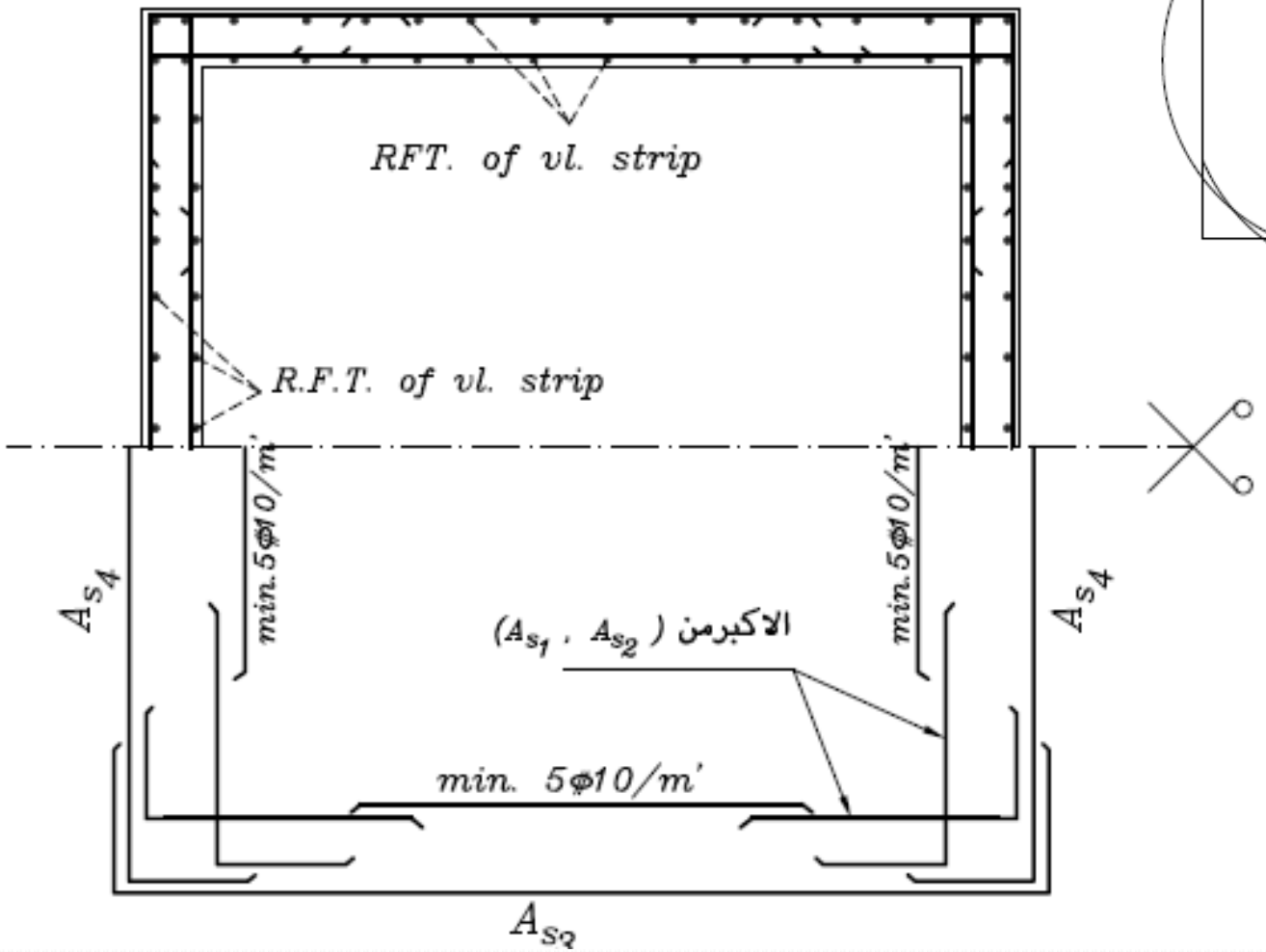


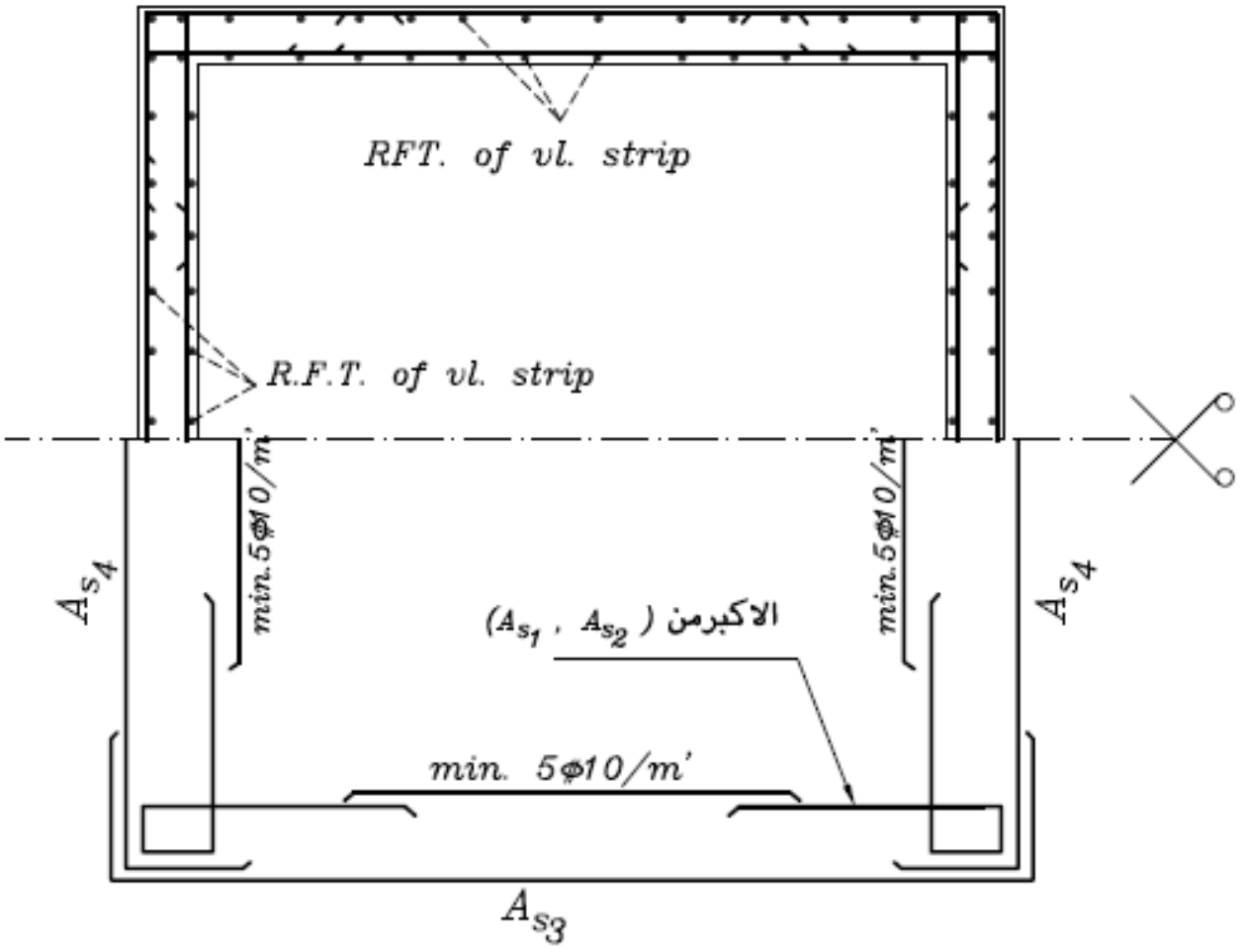


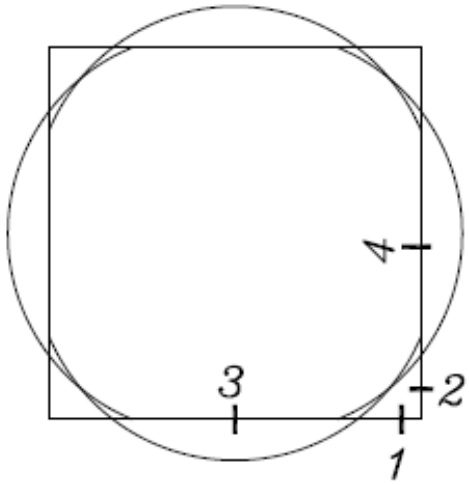


Case (b): no haunch at hz. strip






RFT. of vl. strip
R.F.T. of vl. strip
min.5φ10/m'
min.5φ10/m'
A_{s4}
A_{s4}
$(A_{s_1}$ ، $A_{s_2})$ الاكبرمن
min. 5φ10/m'
A_{s3}


4
3
2
1