Example 1 (Design of Rectangular Tank)

- **Steel in short direction**
  - ✓ **Positive moment at center**

$$M_{tx} = \frac{M_{txu}\ coef.\times q \times a^2}{1000}, \qquad Maximun\ M_{tx}\ coef. = 78$$

$$q_u = S_d \times (1.2 \times DL + 1.6 \times LL)$$

$$q_u = 1.6 \times (1.2 \times 0.3 \times 1 \times 25 + 1.6 \times 1) = 17 kn/m$$

$$M = 1.6 \times 78 \times 17 \times (6)^2 / 1000 = 76\ kn.m/m$$

DL factors of 1.2 for slab own weight
LL assumed to be 1 kn/m2

$$\rho = \frac{0.85(30)}{420}\left[1 - \sqrt{1 - \frac{2.61(10)^6(76)}{1000(243)^2(30)}}\right] = 0.0034 > \rho_{min}$$

$$A_s = 0.0034 \times 1000 \times 243 = 826\ mm^2/m$$

Use 8ϕ12 mm/m for bottom Reinforcement

Example 1 (Design of Rectangular Tank)

- **Steel in long direction**
  - ✓ **Positive moment at center**

$$M_{tx} = \frac{M_{txu}\,coef.\times q \times a^2}{1000}, \qquad Maximun\ M_{tx}\,coef. = 51$$

$$M = 1.6\times 51\times 17\times (6)^2 / 1000 = 50kn.m/m$$

$$d = 300-50-12-6 = 232$$

$$\rho = \frac{0.85(30)}{420}\left[1-\sqrt{1-\frac{2.61(10)^6(50)}{1000(232)^2(30)}}\right] = 0.0025 < \rho_{min}$$

$$A_s = 0.0033\times 1000\times 232 = 770\ mm^2/m$$

Use 8ϕ12 mm/m for bottom Reinforcement

Example 1 (Design of Rectangular Tank)

- **Moment near corners**
  - ✓ **Maximum Mtx and Mty Coef. =49**

$$M_{tx} = \frac{M_{txu}\ coef. \times q \times a^2}{1000}, \qquad Maximun\ M_{tx}\ coef. = 49$$

$$M = 1.6 \times 49 \times 17 \times (6)^2 / 1000 = 48 kn.m / m$$

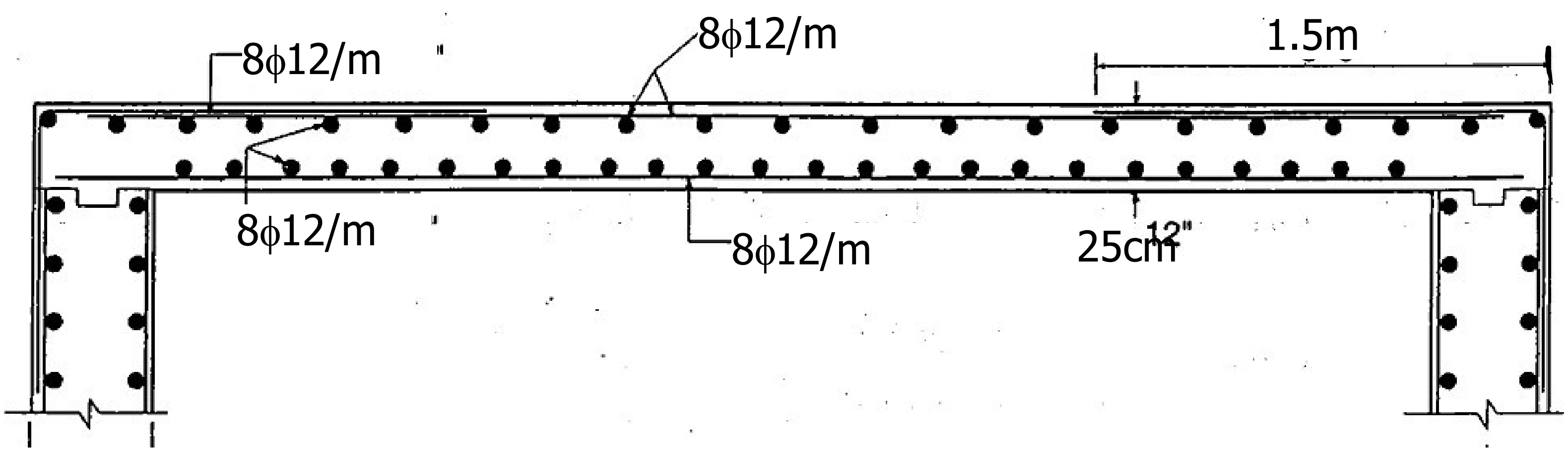
$$d = 300 - 50 - 12 - 6 = 232$$

$$\rho = \frac{0.85(30)}{420}\left[1 - \sqrt{1 - \frac{2.61(10)^6(48)}{1000(232)^2(30)}}\right] = 0.0024 < \rho_{min}$$

$$A_s = 0.0033 \times 1000 \times 232 = 770\ mm^2 / m$$

Use 8ϕ12 mm/m for bottom Reinforcement

Example 1 (Design of Rectangular Tank)



Slab Reinforcement Details

Details at Bottom Edge

All tables except one are based on the assumption that the bottom edge is hinged. It is believed that this assumption in general is closer to the actual condition than that of a fixed edge.

- Consider first the detail in Fig. 9, which shows the wall supported on a relatively narrow continuous wall footing,

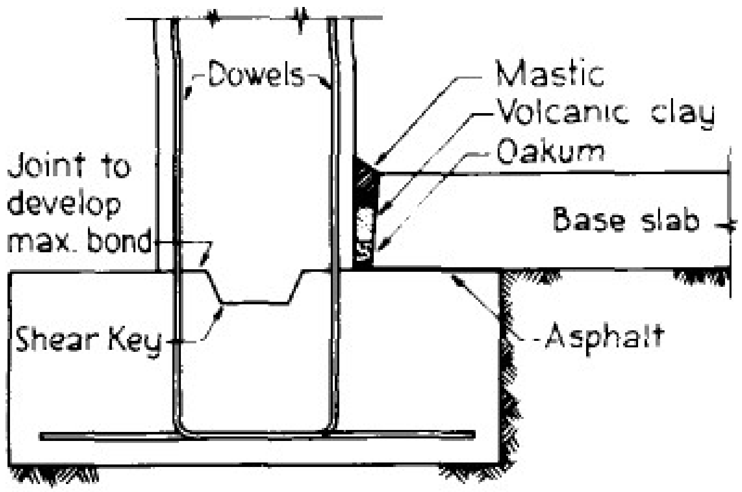


Fig. 9.

Details at Bottom Edge

- In Fig. 9 the condition of restraint at the bottom of the footing is somewhere between hinged and fixed but much closer to hinged than to fixed.
- The base slab in Fig. 9 is placed on top of the wall footing and the bearing surface is brushed with a heavy coat of asphalt to break the adhesion and reduce friction between slab and footing.
- The vertical joint between slab and wall should be made watertight. A joint width of 2.5 cm at the bottom is considered adequate.
- A waterstop may not be needed in the construction joints when the vertical joint is made watertight

Details at Bottom Edge

- In Fig. 10 a continuous concrete base slab is provided either for transmitting the load coming down through the wall or for upward hydrostatic pressure.
- In either case, the slab deflects upward in the middle and tends to rotate the wall base in Fig. 10 in a counterclockwrse direction.

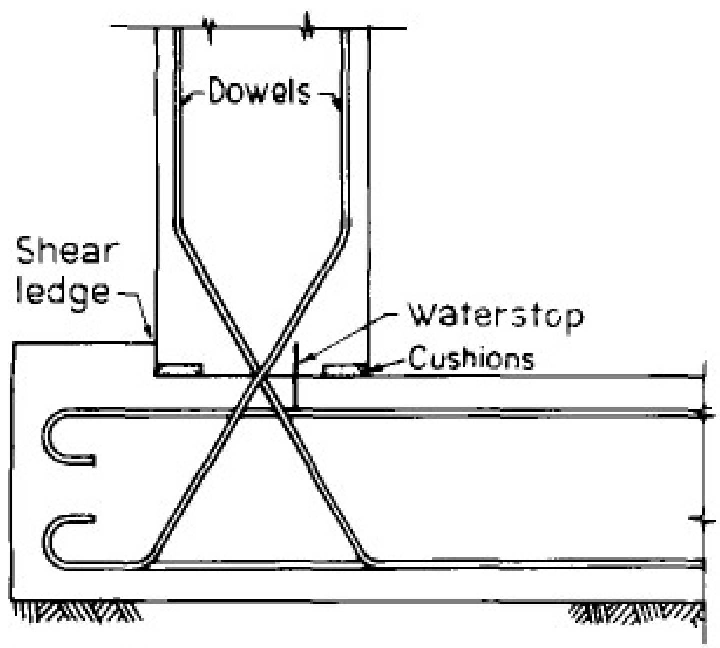


Fig. 10.

Details at Bottom Edge

- The wall therefore is not fixed at the bottom edge and it is difficult to predict the degree of restraint
- The waterstop must then be placed off center as indicated.
- Provision for transmitting shear through direct bearing can be made by inserting a key as in Fig. 9 or by a shear ledge as in Fig. 10.
- At top of wall the detail in Fig. 10 may be applied except that the waterstop and the shear key are not essential. The main thing is to prevent moments from being transmitted from the top of the slab into the wall because the wall is not designed for such moments.

Tanks Directly Built on Ground

Tanks on Fill or Soft Weak Soil

- The stress on the soil due to weight of the tank and water is generally low (~0.6 kg/cm^2 for a depth of water of 5m)
- But it is not recommended to construct a tank directly on unconsolidated soil of fill due to serious differential settlement.
- Soft weak clayey layers and similar soils may consolidate to big values even under small stresses.
- It is recommended to support the tank on columns and isolated or strip footings if the stiff soil layers are at a reasonable depth from the ground surface (see Figure 1).

Tanks Directly Built on Ground

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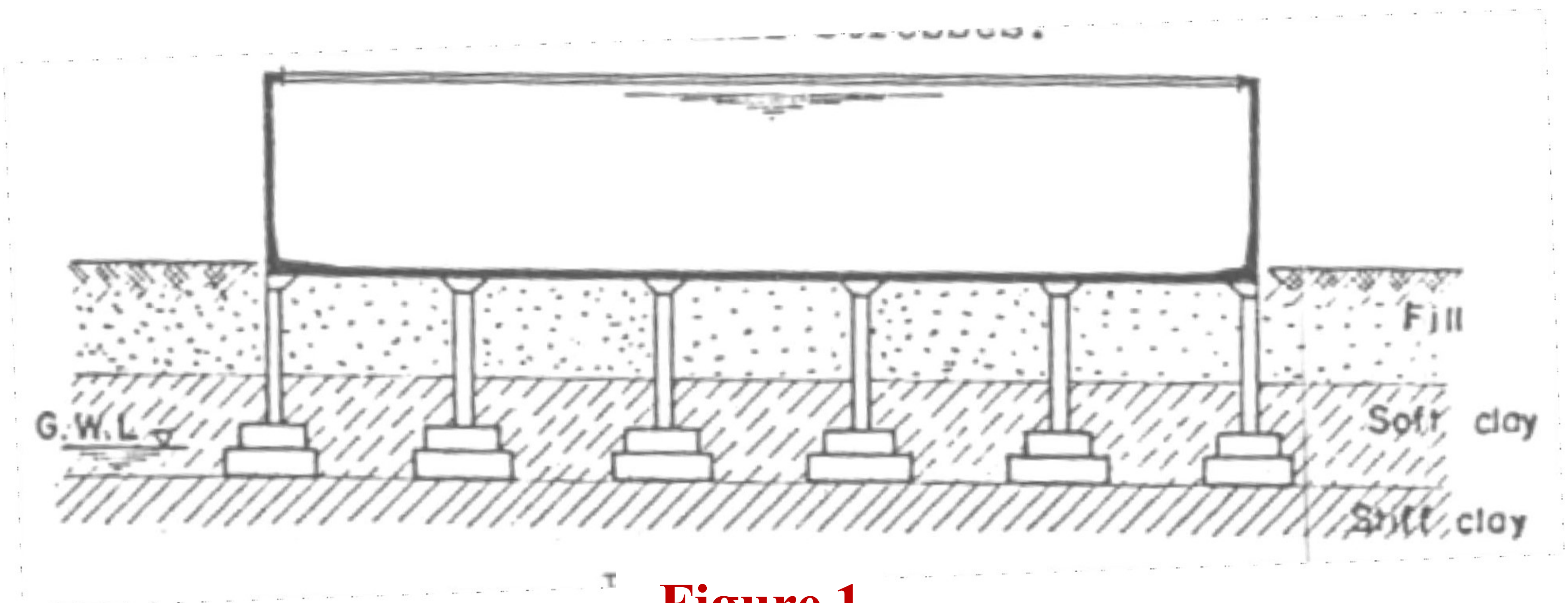

Figure 1

Tanks Directly Built on Ground

Tanks on Fill or Soft Weak Soil

- In case of medium soils at foundation level, raft foundation may be used (see Figure 2).

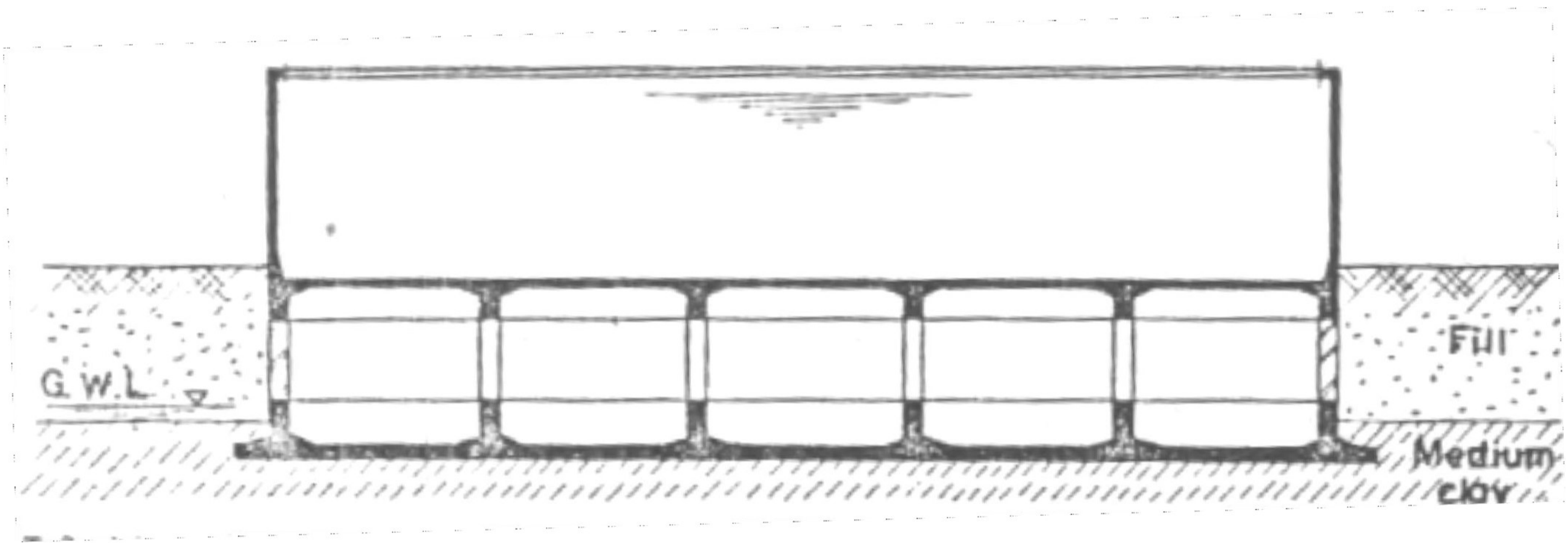

Figure 2

Tanks Directly Built on Ground

Tanks on Fill or Soft Weak Soil

- If the incompressible layers are deep or the ground water level is high one may support the tank on piles. The piles cap may acts as column capitals (see Figure 3).

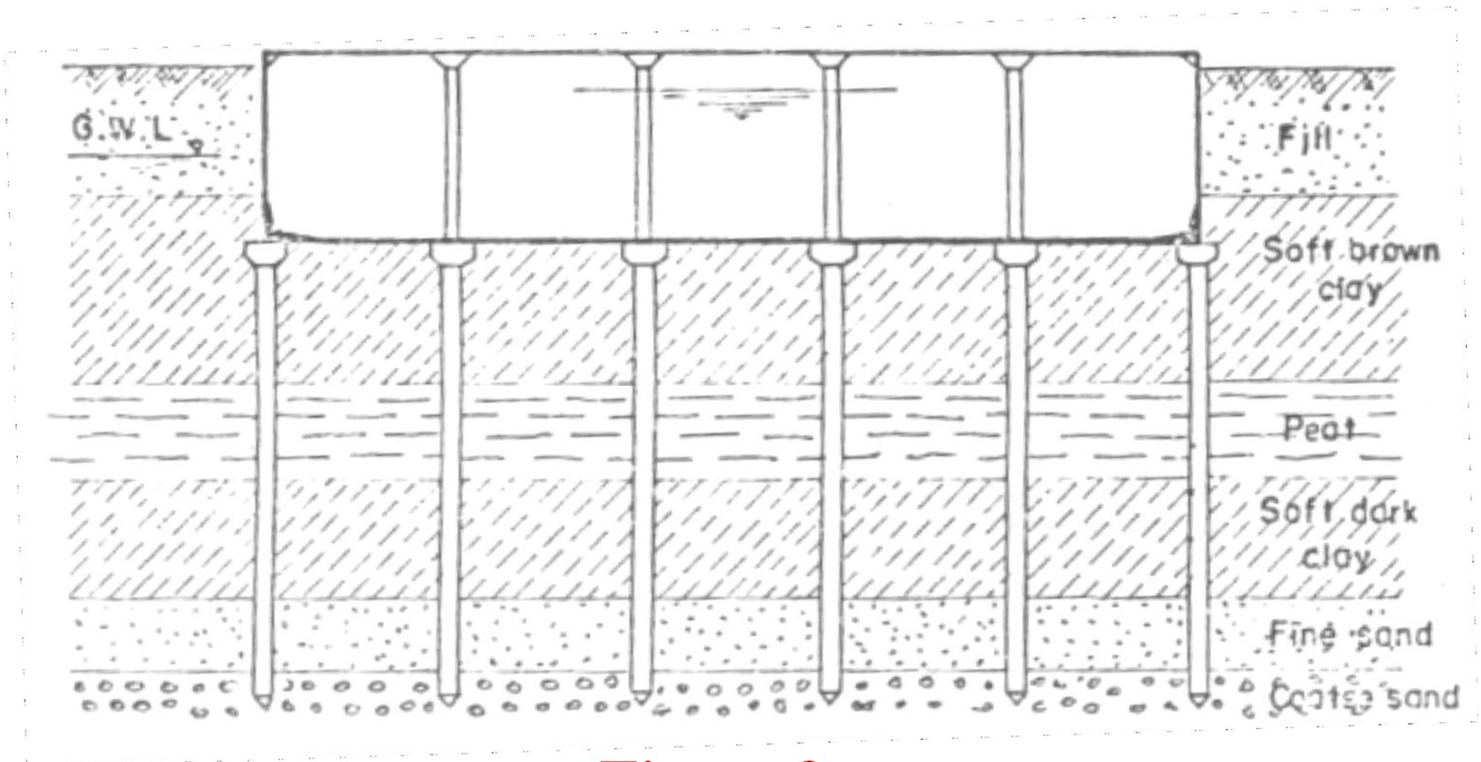

Figure 3

Tanks Directly Built on Ground

Tanks on Rigid Foundation.

- If the tank supported by a rigid foundation then it the vertical reaction of the wall will be resisted by area beneath it.
- The distance L beyond which no deformation or bending moment can be calculated approximately as follow:

$$\frac{wL^3}{24EI} - \frac{ML}{6EI} = 0 \qquad \Rightarrow L = 2\sqrt{\frac{M}{w}}$$

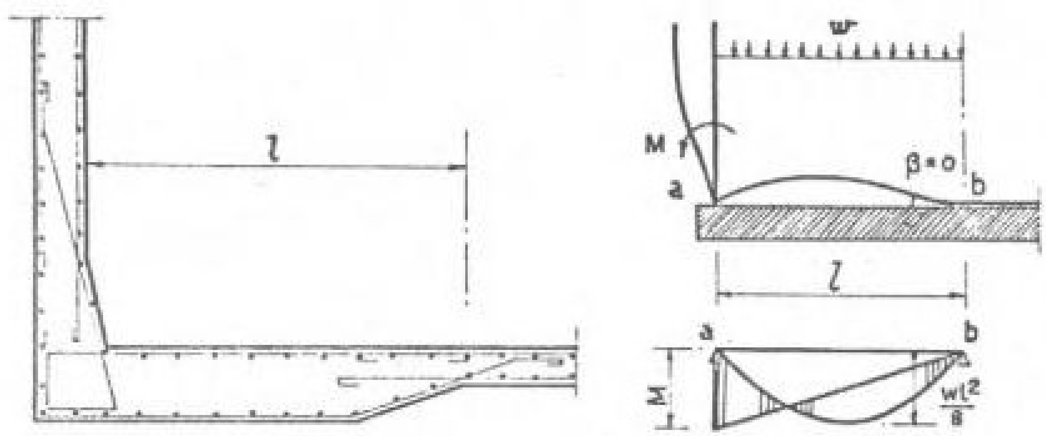

Figure 4

Tanks Directly Built on Ground

Tanks on Compressible Soils

- Floors of tanks resisting on medium clayey or sandy soils may be calculated in the following manner:
- The internal forces transmitted from the wall to the floor may be assumed to be distributed on the soil by the distance L=0.4 to 0.6H.
- The length L is chosen such that the maximum stress σ_1 is smaller than the allowed soil bearing pressure, $\sigma_2 > \sigma_1/2$ on clayey soils and $\sigma_2 > 0$ on sandy soils.
- This limitations are recommended in order to prevent relatively big rotations of the floor at b.

Tanks Directly Built on Ground

Tanks on Compressible Soils

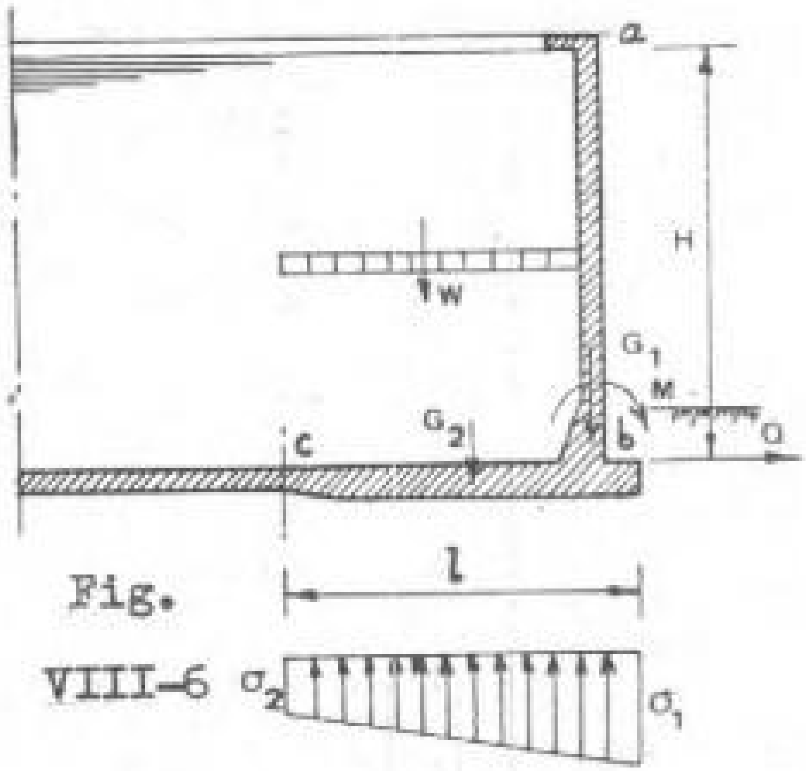

Figure 5

G1 = weight of the wall and roof
G2 = weight of the floor cb
W= weight of water on cb