Wall Thickness

$$t = \frac{\varepsilon_{sh} E_s + f_s - n f_{ct}}{1000 f_s f_{ct}} T$$

- The value of ε_{sh} ,coefficient of shrinkage for reinforced concrete, is in the range of 0.0002 to 0.0004.
- The value of ε_{sh} for plain concrete ranges from 0.0003 to 0.0008.

However, this equation has traditionally used the value of 0.0003, the average value for reinforced concrete, with success.

Example

For f'_c= 30 MPa and f_y = 420 MPa, E_s=200×10³ MPa evaluate the wall thickness t necessary to prevent cracks resulting from shrinkage plus tensile forces.

f_{ct} = 0.1(30) = 3 MPa

fs= 420/3 = 140 MPa

$$E_c = 4700\sqrt{30} = 25740 \text{ MPa} \quad \Rightarrow \quad n = \frac{E_s}{E_c} \approx 8$$

$$t = \frac{\varepsilon_{sh} E_s + f_s - n f_{ct}}{1000 f_s f_{ct}} T = \frac{0.0003(200\times10^3) + 140 - 8(3)}{1000\times140\times3} T = 0.00042T$$

where T is in (N)

t in mm

Reinforcement

- The amount, size, and spacing of reinforcing bars has a great effect on the extent of cracking.
- The amount of reinforcement provided must be sufficient for strength and serviceability including temperature and shrinkage effects.
- The designer should provide proper details to ensure that cracking will occur at joints and that joints are properly leak proofed.
- The size of reinforcing bars should be chosen recognizing that cracking can be better controlled by using a larger number of small diameter bars rather than fewer larger diameter bars.
- Spacing of reinforcing bars should be limited to a maximum of 30 cm.

Reinforcement

- Minimum concrete cover for reinforcement in the tank wall should be at least 5cm.
- The wall thickness should be sufficient to keep the concrete from cracking. If the concrete does crack, the ring steel must be able to carry all the ring tension alone.
- In circular tanks, the location of horizontal splices should be staggered. Splices should be staggered horizontally by not less than one lap length or 90 cm and should not coincide in vertical arrays more frequently than every third bar.

Design of Circular Concrete Tanks

Reinforcement

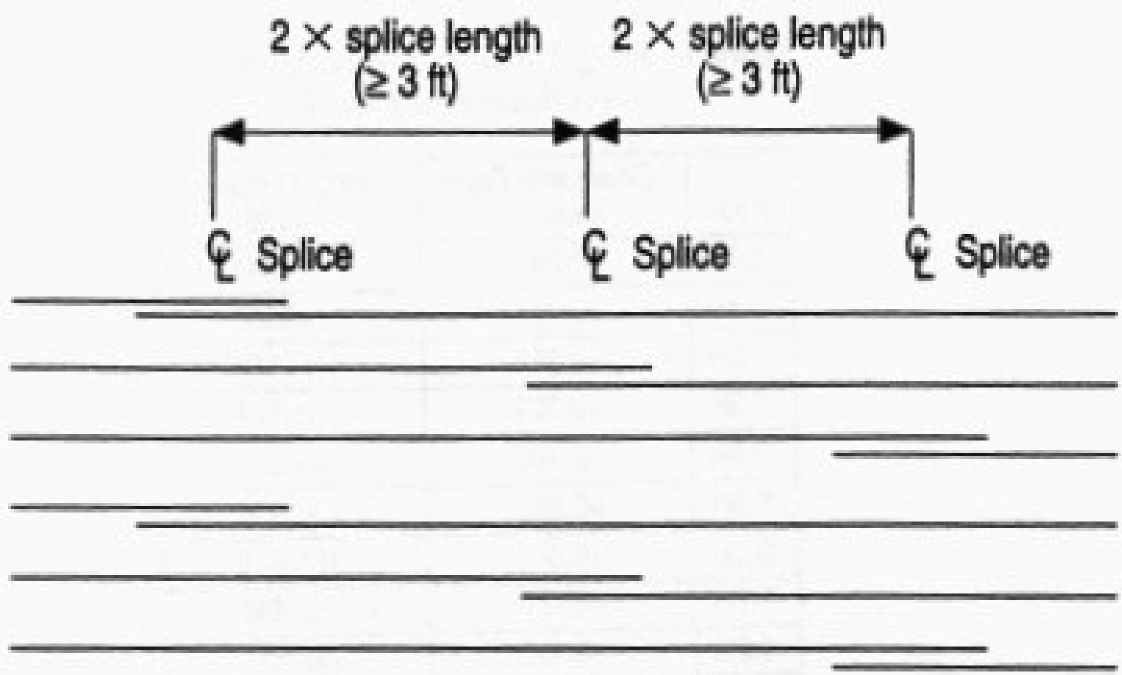


Figure 4—Staggering of ring bar splices

Crack Control

ACI 318-A more practical method which limit the maximum reinforcement spacing The Maximum Spacing S of reinforcement closest to the surface in tension (S in mm , fs in Mpa

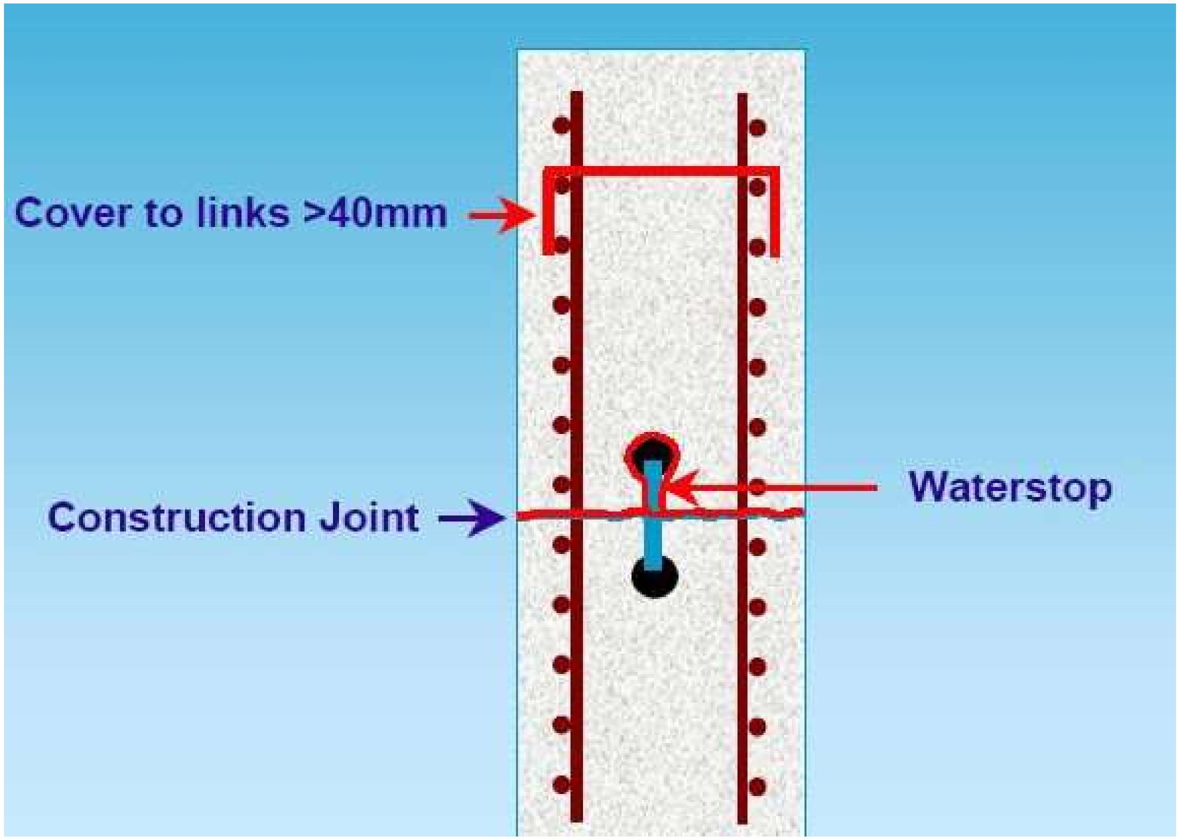
$$S \le \begin{cases} \dfrac{9500}{f_s} - 2.5C_c \\ \dfrac{7560}{f_s} \end{cases}$$

Where

C_c is the clear cover from the nearest surface of concrete in tension zone to surface of flexural reinforcement.

Design of Circular Concrete Tanks

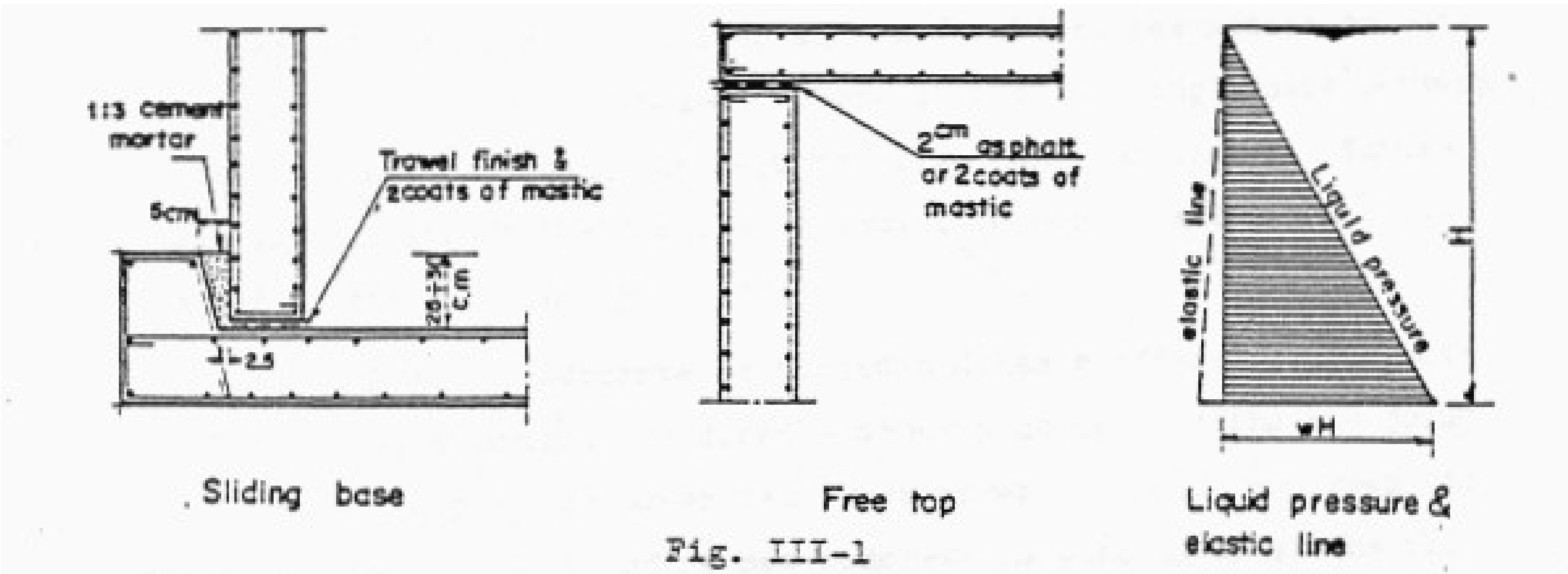
Water Stop Details



Design of Circular Concrete Tanks

Types of Wall Joints

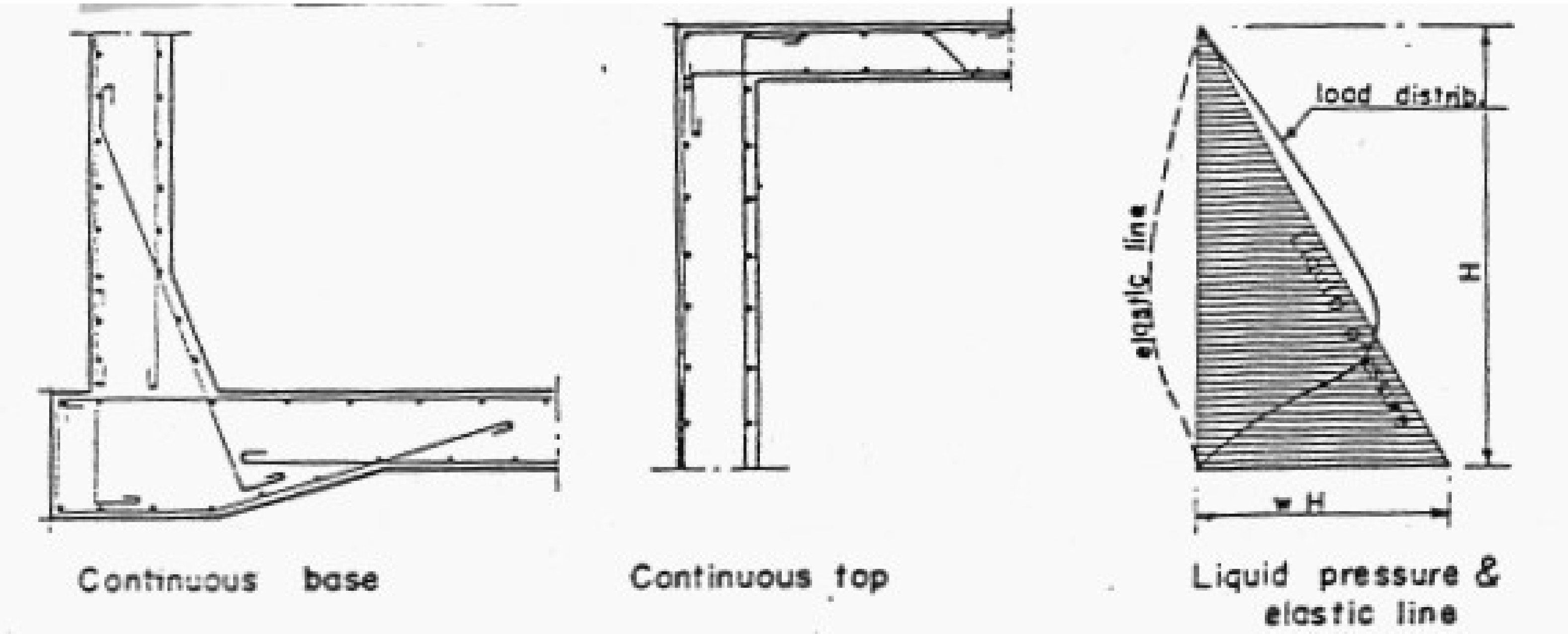
Free Joint (Sliding joint)



Design of Circular Concrete Tanks

Types of Wall Joints

Fixed Joint (Continuous joint)



Design of Circular Concrete Tanks

Types of Wall Joints

Hinged Joint

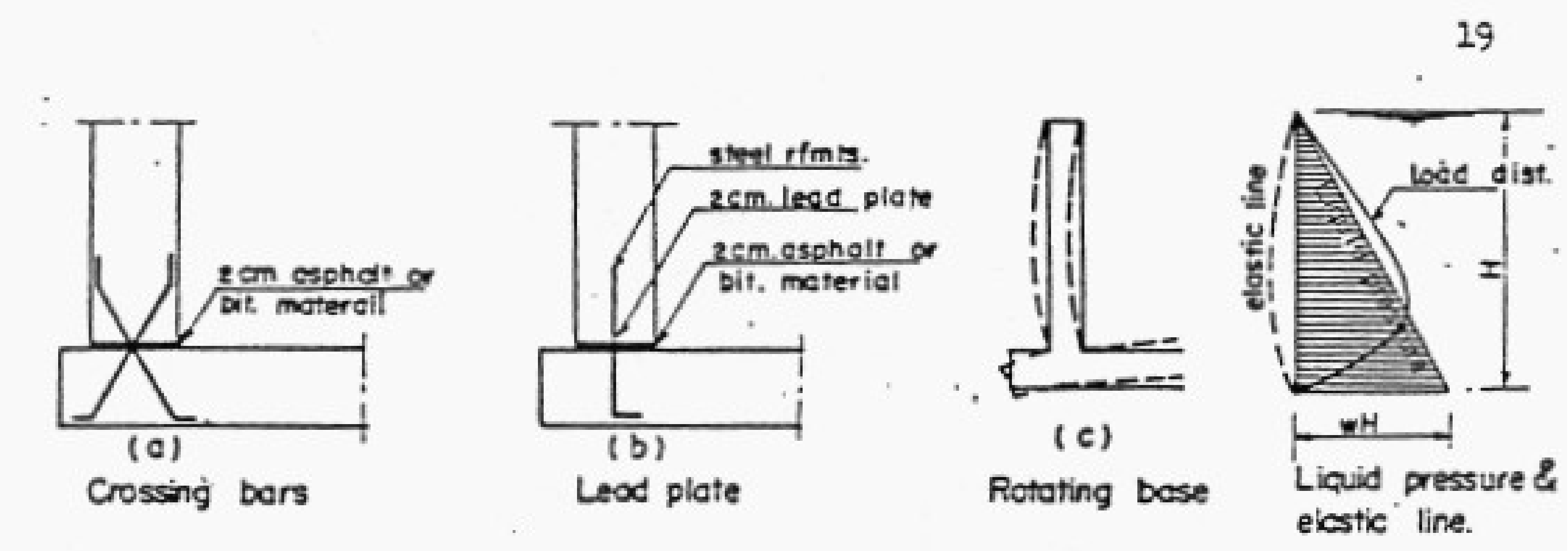


Fig. III-3

General Notes

- For the sliding bottom edge, water pressure is fully resisted by ring action without developing any bending moment or shear.

- For the hinged bottom edge, ring tension and maximum moment take place at the middle part of the wall.

General Notes

- For the fixed bottom edge, the water pressure will be resisted by ring action in the horizontal direction and cantilever action in the vertical direction. The maximum ring and maximum positive moment will be smaller than for the hinged bottom edge, while relatively large negative moment will be induced at the fixed bottom edge of the wall.

General Notes

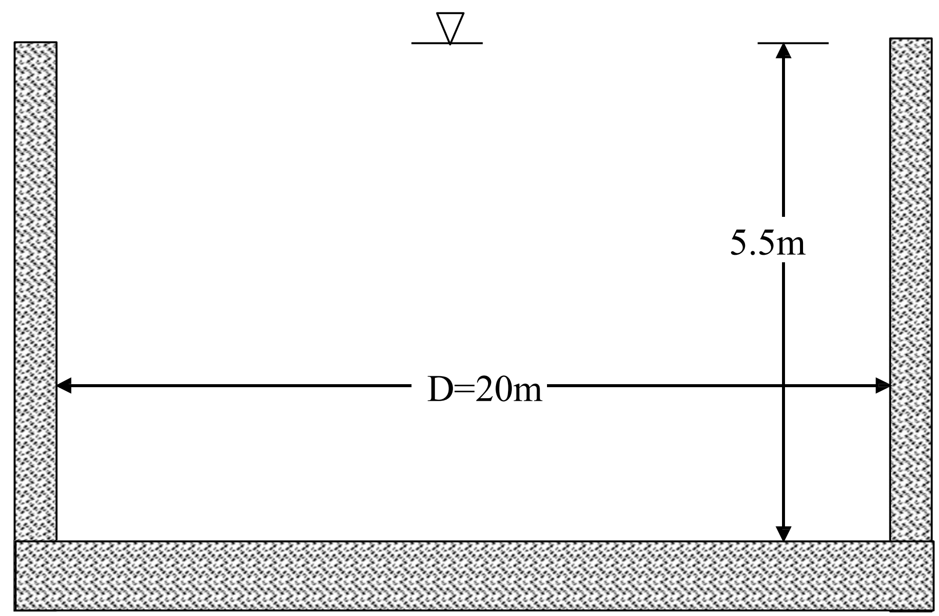
- In practice, it would be rare that the base would be fixed against rotation and such an assumption could lead to an improperly designed wall. It is more reasonable to assume that the base is hinged rather than fixed, which results in a more conservative design.
- For walls monolithically cast with the floor it is recommended to design the section at foot of the wall for max. negative moment from the total fixation assumption and max. positive moment and ring tension from the hinged base assumption.

Design of Circular Concrete Tanks

Example 1

The open cylindrical reinforced concrete tank is 5.5m deep and 20m in diameter. It is required to determine the internal forces and to design the wall for the following cases:

- **Bottom edge sliding**
- **Bottom edge hinged**
- **Bottom edge fixed**



Example 1 Bottom edge Sliding

Point	T(tension) force due to water pressure T= γxR
0.0 H	0
0.1 H	55
0.2 H	110
0.3 H	165
0.4 H	220
0.5 H	275
0.6 H	330
0.7 H	385
0.8 H	440
0.9 H	495
1.0H	550

$$T_{\max} = \gamma H R = 10 \times 5.5 \times 10 = 550\ KN\ /\ m$$

R : *radius of water tank*