Annexure 6.8: Design of Thrust Blocks

To design a thrust block for 900 mm diameter main conveying water at 11 kgs/cm^2 pressure (P).

The deviation angle α is 45° and density of concrete is 2,300 kgs/m^3. Soil density is assumed to be 1800 kgs/m^3 and angle of internal friction ϕ = 30^0.

Assume minimum cover of earth is 600 mm. Cohesion is 0 for sandy soils.

Horizontal Thrust: $\mathrm{F} = 2\ \mathrm{pA}\ \mathrm{Sin}\ \alpha/2$

Cross-sectional area $\mathrm{A} = \left(\frac{\pi}{4}\right)(90)^2 = 6364\ \mathrm{sq.\,cms.}$

$\mathrm{Sin}\ \alpha/2 = 0.382$

$\mathrm{F} = 2\ (11)\ (6364)\ (0.382)\ (10^3) = \ 53.48\ \mathrm{tonnes}$

(i) Lateral resistance to counteract the horizontal thrust:

Try a thrust block of size = 3.2M × 3.2M × 3.2M

Weight of thrust block = 3.2M × 3.2M × 3.2 M × 2.3 = 75.36 tonnes

Weight of water in the pipe = 0.785 × (0.9)^2 × 1 × 3.2 = 2.03 tonnes

Weight of earth = 0.9 × (3.2) (0.6) (1.8) = 3.11 tonnes

Total Weight 80.50 tonnes

Total force available considering frictional resistance of soil = 80.5 (0.3) = **24.15 tonnes**

(ii) Lateral resistance of soil against the block:

$$f_p = \gamma_s \frac{(\mathrm{H})^2}{2} \cdot L \cdot \frac{1 + Sin\theta}{1 - Sin\theta} + 2CHL\sqrt{\frac{1 + Sin\theta}{1 - Sin\theta}}$$

By assuming cohesion as 0, the above equation

$$\mathrm{Yields} = 1.8\frac{(3.2)^2}{2}\ (3.2)\ \frac{(1.5)}{0.5} = 88.47\ tonnes$$

(iii) Lateral resistance of soil when the thrust block is free to yield away from the soil mass i.e., the portion of projected pipes -

$$f_a = \gamma_s\ h\ \frac{1-Sin\theta}{1+Sin\theta} - 2C\sqrt{\frac{1-Sin\theta}{1+Sin\theta}}$$

$= (1.8)(0.9)\frac{(0.5)}{1.5} = 0.54\ \mathrm{tonnes}$

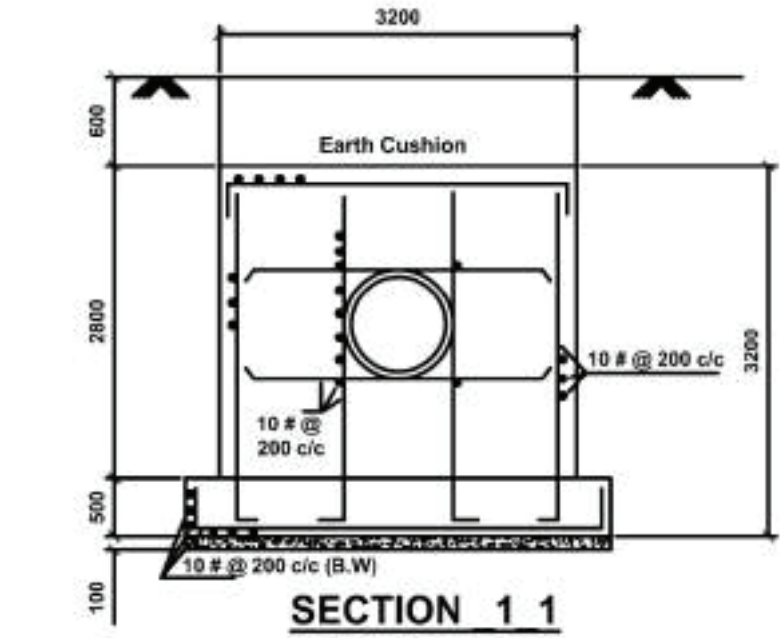
Total lateral resistance = 24.15 + 88.47 + 0.54 = **113.16 tonnes/m^2**

Total horizontal thrust = **53.48 tonnes**

Factor of safety = 113.16/53.48 = 2.19 which is O.K.

Reinforcement:

The minimum surface reinforcement in all thrust blocks shall be 5 kgs/sq. m (as per IRG 21-1972 Article 306.4). The spacing of these bars is not to exceed 500 mm. Hence provide 10 bars at 200 c/c which is more than 5 kgs/sqm.



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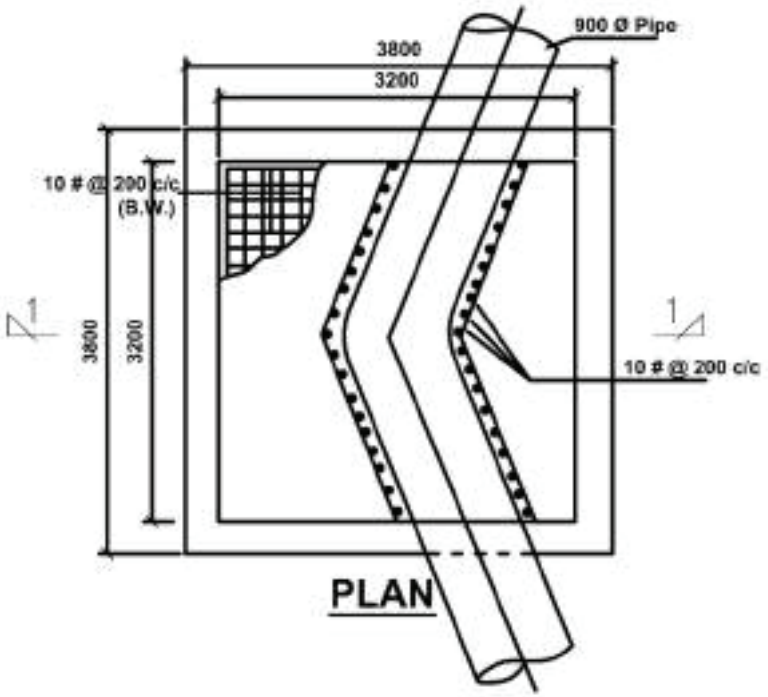

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Thrust Block for 45° Horizontal Bend