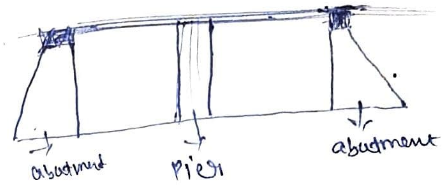
Part-(1)

UNIT-4

Material For Pier and abutment :-

Mass Concrete :

M20 = with maximum size aggregate to fill the pier



Rubble Massonary = 1:4

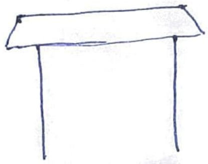
For Brick Massonary :- 1:4

Prestress Concrete = M30 , M40.

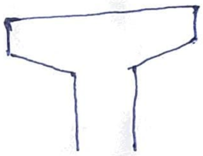
Types of Pier :-

(1) Solid pier.

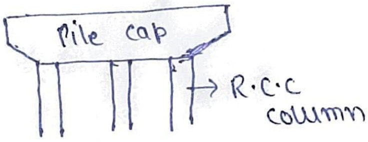
2) Trestle pier



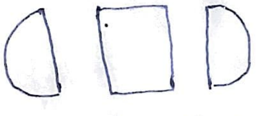
Solid pier



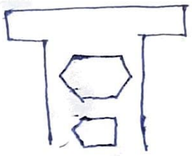
Hammer Head Pier.



Testle type



Cellular R.C pier.



Framed pier

Forces Acting on pier :-

?

Design of Pier :

Step- 1. Height :- 1 - 1.5m above from High flood level (H.F.L)

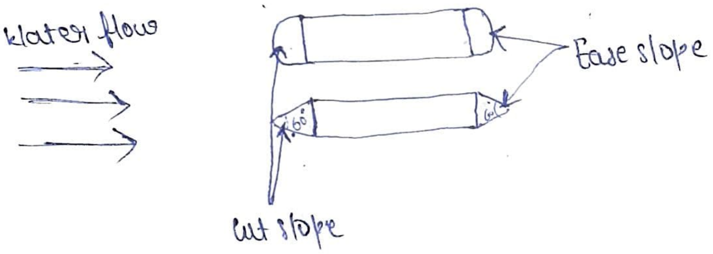
Step - 2 Pier Width :

Width depend upon bearing minimum 600mm

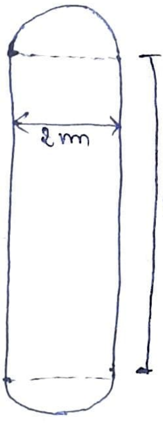
Step-3 Pier Batter :-

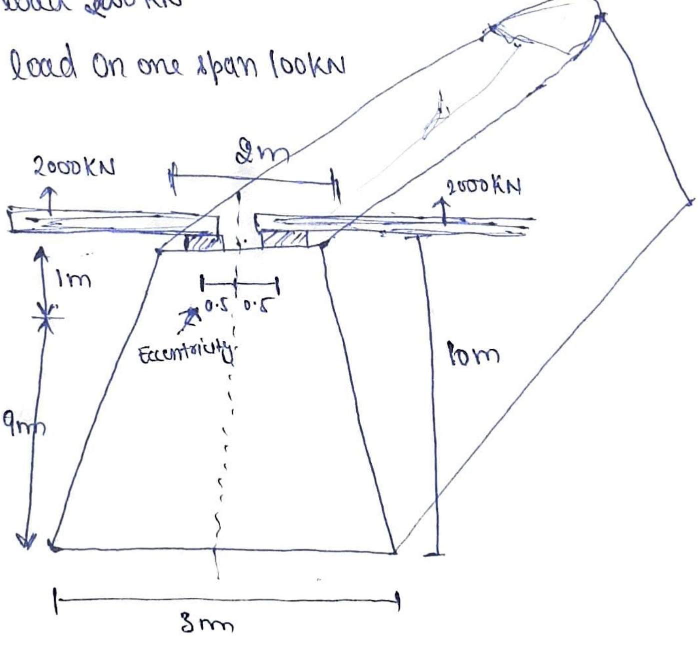
Slope = 1:12 to 1:24

Step-4 Cut and Ease Water :-



Ques:- Check the stability of pier
Given Dead load 2000 KN
Reaction due to live load on one span 100KN





Breaking forces. 140KN

Wind pressure = $= 2.4 \text{ KN/m}^2$

density of Concrete = $= 24 \text{ KN/m}^3$

Calculate i) dead load and self wt. of pier

2) Effect of buoyancy

3) Effect due to eccentricity of live load.

4) Effect due to longitudnal force.

5) Effect due to wind pressure.

Solution :-

Step-I DL from both span $= 2 \times 2000 = 4000$ KN

self wt. of pier $= \underset{\substack{\downarrow \\ \text{ht.}}}{10} \times \frac{1}{2}(\underset{\substack{\downarrow \\ \text{top}}}{2}+\underset{\substack{\downarrow \\ \text{bottom}}}{3}) \times 8.5 \times 24$ (ht. × mean × length × density)

$= 5100$

Total D.L $= 4000 + 5100 = 9100$ KN

Compressive stress at base of Pier =

$$\sigma = \frac{\text{Load}}{\text{Area}} = \frac{9100}{8.5 \times 3} = 356.8 < 2 \text{ N/mm}^2 = 2000 \text{ KN/m}^2$$

$= 356.8 < 2000 \text{ KN/m}^2$ safe.

Effect of Buoyancy :-

Vol. of water $= 9 \times \left(\frac{1}{2}(3+2.1)\right) \times 8.5$

$= 195 \text{ m}^3$

Buoyant force $= 195 \times \underset{\substack{\downarrow \\ \text{density of water}}}{10} = 1950$

Tensile force $= \frac{\text{Load}}{\text{Area}} = \frac{P}{A} =$ (put -ve sign because of tensile force)

$$= -\left(\frac{1950}{8.5 \times 3}\right)$$

$$= -76.47 \text{ KN/m}^2 < 2000 \text{ KN/m}^2$$

safe

3. Effect due to Eccentricity :-

$e = 0.5$ given

Moment = load × eccentricity

$= 1000 \times 0.5$

$M = 500$ KN. m

$$Z = \frac{I}{Y} = \frac{bd^3/12}{d/2} = \frac{bd^2}{6}$$

$$= \frac{8.5 \times 3^2}{6} = 12.75 \text{ m}^2$$

$$\sigma \text{ (stress)} = \frac{P}{A} \pm \frac{M}{Z}$$

$$= \frac{1000}{8.5 \times 3} \pm \frac{500}{12.75}$$

$\sigma_{max} = 39.2 + 39.2 = 78.4 \text{ KN/m}^2 < 2000 \text{ KN/m}^2$

$\sigma_{min} = 39.2 - 39.2 = 0$

safe

step-4 Longitudnal breaking force :-

$F = 140$ given

Moment at base $=$ ~~1400~~ $F \times h$

$= 140 \times 10 = 1400$

$$\sigma_{max} = \pm \frac{M}{Z} = \frac{1400}{12.75} = +109.8 \text{ KN/m}^2 < 2000 \text{ KN/m}^2$$

safe

$$\sigma_{min} = -\frac{1400}{12.75} = -109.8 \text{ KN/m}^2 < 2000 \text{ KN/m}^2$$

safe

Step-5 Total wind pressure :-

$= 2.4 \times$ [illegible]

$= 2.4 \times \frac{1}{2}(2+3) \times 10$

$F = 60$ KN

Moment at base $= F \cdot \frac{h}{2} = \frac{60 \times 10}{2} = \underline{\underline{300 \text{ KN.m}}}$

Section modulus

$Z = \frac{I}{y} = \frac{bd^2}{6}$

$= \frac{3 \times 8.5^2}{6} = \underline{\underline{36.125 \text{ m}^2}}$

Stress $= \sigma = \pm \frac{M}{Z} = \frac{300}{36.125} = \underline{\underline{8.30}} < 2000$ KN/m^2

safe.

UNIT - 4

(Part- B)

NUMERICAL → Design of well foundation
→ Design of pier

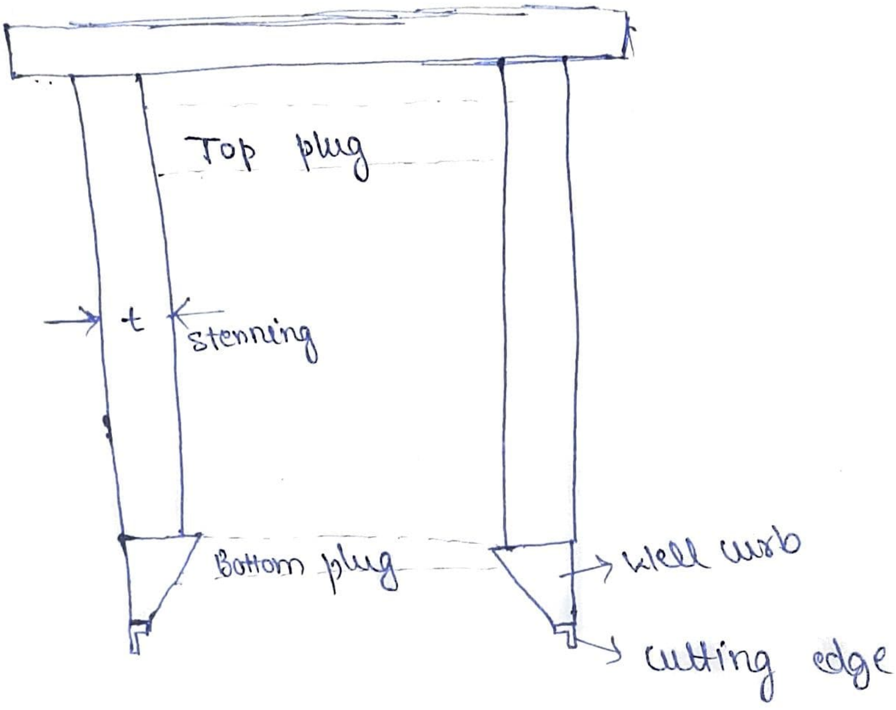
Theory → Bearing, Joint
Wing wall, Pier, abutment.

Well Foundation :-

It is also reffered for major bridge crossing river where the soil strata comprises of sand and stiffy clay. The foundation comprises of single, large diameter of well or a group of smaller well singular circular shape, double D ~~dia~~. shape, square or rectangular shape.

Component of Well foundation :-

1. Stenning
2. Well curb
3. Bottom and top plug.



4. Well Cap

5. Sand filling

6. cutting Edge

Well Stenning :-

Minimum t = 500mm (upto 5m)

More than 8m (thickness is taken 1000m)

$t = K de \sqrt{L}$

Ques: Design of well foundation for a pier of a major highway to suit the following data. Pg. 500

Internal dia. = 2.5 m

Type of soil strata, clay, K = 0.033

Depth of Well = 25m

Use M20 & Fe 415.

Sol:

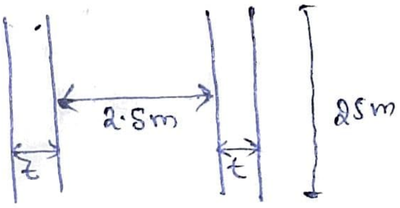
Step-I Thickness of stenning :-

K = 0.033 L = length

de (external dia.) =

$t = K \cdot de \sqrt{L}$

$t = 0.033\,(2.5 + 2t)\sqrt{25}$



~~t = 0.5 (because of assuming)~~

~~0.5 = 0.033 (2.5 + 2t) √25~~

$t = 0.033\,(2.5 + 2t)\,5$

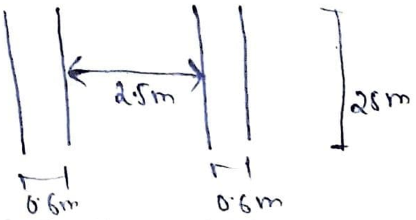
$= 0.033 \times 2.5 \times 5 + 0.033 \times 2t \times 5$

$= 0.4125 + 0.33t$

$t - 0.33t = 0.4125$

$0.67t = 0.4125$

$t = 0.60$



For R.C.C well minimum longitudnal Reinforcement

A_{sc} = 0.2% of gross cross-sectional area.
or

= 0.2% of total area.

Hoop Reinforcemend :-

It should not be less than 0.04% of volume per unit length.

External dia = $d_e = 2.5 + 2 \times 0.6$

$= 2.5 + 1.2 =$ ~~26.2 m~~

$= 3.7\ m$

Intornal dia = $d_i = 2.5\ m$

Step :- Longitudnal reinforcement :-

$$A_{sc} = \frac{0.2}{100}\left[\frac{\pi}{4} \times (3.7^2 - 2.5^2)\right]$$

$$= 0.001168\ m^2$$

$$= 0.001168 \times (10^3\ mm)^2$$

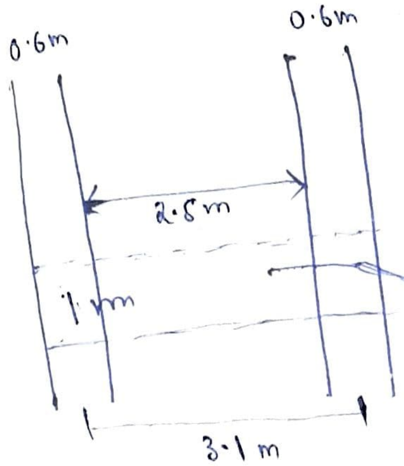
$$A_{sc} = 0.001168 \times 10^6\ mm^2$$

$$= \underline{11680\ mm^2}$$

→ for both faces = $11680\ mm^2$

→ for single face = $\frac{11680}{2} = 5840\ mm^2$

3 Hoop Reinforcement :-



= 0.4% of volume per unit length

$$= \frac{0.4}{100}\left[\frac{\pi}{4} \times (3.7^2 - 2.5^2) \times 1 \times 7200\right]$$

= 16.8 kg/m

Using 10mm bar for Hoop reinforcement

$$\underbrace{\pi \cdot D}_{\text{circumference length}} = \pi \times \left(\frac{3.7 + 2.5}{2}\right)$$

$= \pi \times 3.1$

$= 9.738$ m

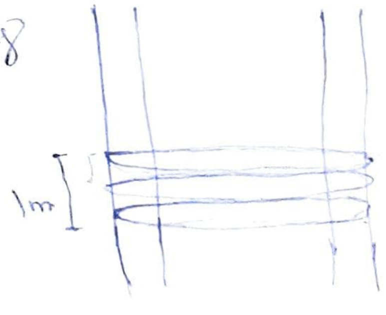
Weight of one bar of 10mm = 0.62 kg/m (∴ always taken 0.62 for 10mm)

One bar of 16 mm =	1.58 kg/m
one bar of 20 mm =	2.47 kg/m

Weight of One hoop = 0.62 × 9.738

= 6.03 kg

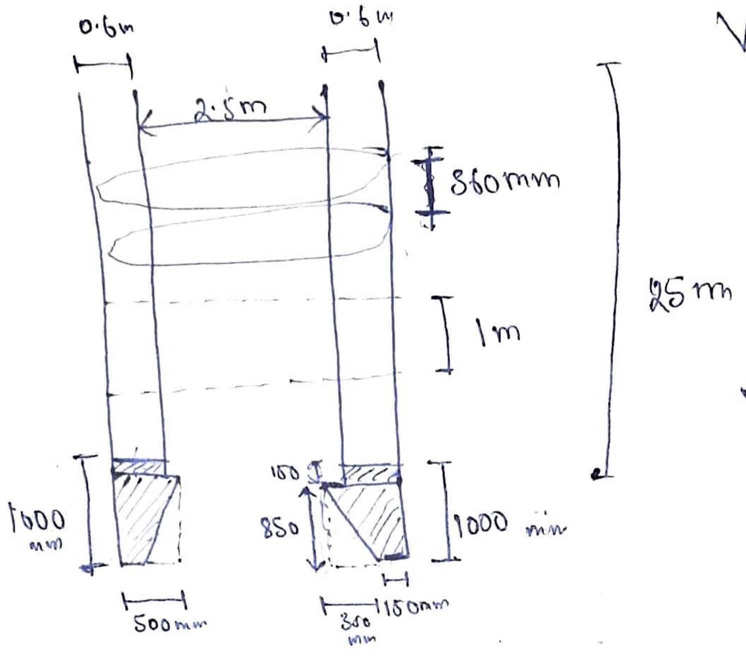
Number of hoop $= \frac{16.8}{6.03} \simeq 2.78$



Spacing of hoop in 1m $= \frac{1000}{2.78} = 359.6$

= 360 mm

Step - 4 Well Curb :- (Volume of curb)

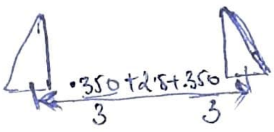


$$V = \frac{\pi}{4}(3.7^2 - 2.5^2) - \frac{1}{2}(0.35 \times 0.85 \times \pi \times 2.73)$$

$$V = \underline{\underline{4.56}}$$

$\left(\frac{1}{2} \times 0.35 \times 0.85\right)$ = Triangle area

$\pi \times 2.73$ = circumfrence



= 2.73

Total quantity of steel in curb :-

V = 4.56

weight = 4.56 × 72 kg

= 328 kg

Provide ~~[illegible]~~ ties at 300mm, 8 hoopes of 20mm diameter

Weight of 8 hoops of 20mm dia = 8 × 2.47 × π × 3.1 = 192.44 kg

no. of bars

wt./kg given (at perevious page)

avg. diameter

Weight of 6 hoops of 16mm dia = 6 × 1.58 × π × 3.1 = 92.32 kg

Taken value from perevious page

circumference of hoop = π × D = π × 3.1 =

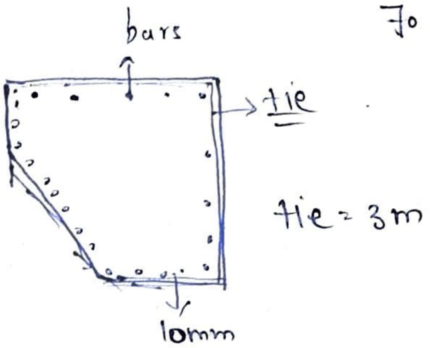
No. of ties = πD/300mm = $\frac{\pi D}{.3\,m}$ = $\frac{\pi \times 3.1}{.3}$ = 32.46

≃ 33 ties

1 tie wt. = 0.62×3

33 ——— = $0.62 \times 3 \times 33$

tie = 61.4



wt.

8 ϕ 20 mm = 192

6 ϕ 16 mm = 92.4

Tie = 61.4

345

$345 > \boxed{324}$ → Provide

Theory :-

Bridge Foundation :- The cost of the foundation depend upon the type of soil at site, span of check, type of foundation, maximum scour depth ; soil pressure at base.

Types of Foundation :-

1. Shallow
2. Deep

1. Shallow Foundation :-

It Transfer the load from super and sub-structure to ground by the bearing of the bottom of foundation.

2. Deep Foundation :-

Types:

(a) Pile foundation

(b) Well foundation

(c) Open cassion foundation.

(d) Pneumatic cassion foundation.

Bridge Bearing :-

Bearing provided in the bridges at the Junction of the girder ~~of the~~ or slab and the top of the pier or abutment. Bearing transfer the load from super-structure to sub-structure in such a way that bearing stresses develop are within safe permissible limit.

Bearing provide for small movement of super structure. The moment are due to the various reason :-

(i) Movement of girder in longitudnal

(ii) Deflection of girder cause rotation at the support.

(iii) Due to sinking of support.

iv) Shrinkage and creep

v) Prestressing face.