4.2 Load carrying capacity of pile:

- The ultimate Load carrying capacity of pile or ultimate Load bearing resistance of pile is the maximum load which it can be carry without failure.
- The pile transfer the load in two ways
    1) Through the tip in compression is called end bearing or point bearing
    2) By shear along the surface is called as skin friction
- All type of pile behave both end bearing and skin friction

The Load carrying capacity of pile can be determined by following method

1. Dynamic Analysis
2. Static Analysis
3. Pile load test
4. Penetration test

1. Dynamic Analysis:

The load carrying capacity of a driven pile can be estimated from the resistance against penetration developed during driving operation with a hammer.

i)Engineering news formula

$$Q_a = \frac{WH}{F(S+C)}$$

$$Q_a = allowable\ load$$

H= height of fall

W=weight of hammer in kg

F=Factor of safety=6

S=settlement or penetration

C=empirical constant=2.5cm

ii)Drop hammer

$$Q_a = \frac{WH}{b(S+2.5)}$$

a)single acting hammer

$$Qa = \frac{WH}{6(s+0.25)}$$

b)double acting hammer

$$Qa = \frac{(W + ap)H}{6(s + 0.25)}$$

iii)Hileys formula

$$Q_f = \frac{WH\eta_h\eta_b}{s + \frac{C}{2}}$$

$$Q_f = ultimate\ load\ on\ pile$$

C=elastic compression

$$C = c_1 + C_2 + C_3$$

$$c_1, C_2, C_3 = temporary\ elastic\ constant$$

C_1 value :

Precast=0.12-0.5

Steel=0.04-0.16

Timber=0.05-0.2

$$C_2 = \frac{Q_a L}{AE}$$

C_3 value:

C_3 =0.1=average value

C_3 =0=hard soil

C_3 =0.3=residual soil

$$\eta_b = \frac{W + e^2P}{W + p}, W > ep$$

$$\eta_b = \frac{W + e^2P}{W + p} - \left(\frac{W - ep}{w + p}\right)^2, W < ep$$

P=weight of pile helmet/cap

e= coefficient of restitution value

For timber pile e=0

For steel pile e=0.5

$$\eta_h = 100\% = \text{drop hammer}$$

$$\eta_h = 75 - 85\% = \text{single acting hammer}$$

$$\eta_h = 100\% = \text{Diesel hammer}$$

1. For single acting hammer

e=0 to 0.25

2. Double acting hammer

$$C_1 = 1.77.\frac{Q_u}{A}$$

$$C_2 = 0.0657\frac{Q_u L}{A}$$

$$C_3 = 3.55\frac{Q_u}{A}$$

A=Area of pile in cm^2

L=length of pile in m

R= resistance

Safe load on pile:

$$Q_s = \frac{Q}{F}$$

Problems:

Dynamic Analysis:

1. A wooden pile is being driven with a drop hammer weight 20KN and having a free fall of1m.the penetration in the last blow is 5mm.Determine the load carrying capacity of pile according to engineering news formula.

Given data:

W=20KN

H=1m=100cm

S=5mm=5/10cm=0.5cm

To find:

Qa=?

Soln:

i)Engineering news formula

$$Q_a = \frac{WH}{F(S+C)}$$

W.K.T F=6,C=2.5

$$Q_a = \frac{20x100}{6(0.5+2.5)} = 111.11KN$$

2.A reinforced concrete pile weighing 30KN inclusive of pile cap and a dolly driven by drop hammer of weight 40KN and having a effective fall of 0.8m .The average set per blow is 1.4cm .The temporary elastic compression is 1.8cm.assume the coefficient of restitution as 0.25and FOS of 2.Determine the allowable load.

Given data:

concrete pile weighing (p)=30KN

drop hammer of weight (W)=40KN

H=0.8m=80cm

S=1.4cm

C=1.8cm

e=0.25

FOS=2

To find:

Allowable load(Q)=?

Soln:

Hileys formula

$$Q_f = \frac{WH\eta_h\eta_b}{s + \frac{C}{2}}$$

$$\eta_b = \frac{W+e^2P}{W+p}, W>ep$$

$$\eta_b = \frac{W+e^2P}{W+p} - \left(\frac{W-ep}{w+p}\right)^2, W<ep$$

ep=0.25x30=7.5KN

W=40KN

W>ep, therefore

$$\eta_b = \frac{W + e^2P}{W + p}$$

$$\eta_b = \frac{(40 + (0.25^2)x30)}{30 + 40} = \frac{41.87}{70} = 0.598$$

$$\eta_h = 100\% = 1 = \text{drop hammer}$$

$$Q_f = \frac{40x80x1x0.598}{1.4 + \frac{1.8}{2}} = \frac{1913.6}{2.3} = 832KN$$

$$Q_a = \frac{Q_f}{F} = \frac{832}{2} = 416KN$$

3. A reinforced concrete pie weighing 30 kN is driven by a drop hammer weighing 40 kN and having an effective fall of 0.80m. The average set per bow is 1.40 cm. The total temporary elastic compression is 1.80 cm, assuming the coefficient of restitution as 0.25 and factor of safety of 2. Determine the ultimate bearing capacity and the allowable load for the pile.

Given:

P = 30 k W

W = 40 K W

η_n H = 0.8 m = 80 cmS = 1.4 cm

C = 1.8 cm

η_n = 1 for drop hammer.

P x e = 30 x 0.25

= 7.5 k w

∴ w> p e

Efficiency hammer blow

∴ η_b = w + e 2 p / (w + p)

= 40 + 0.252 x 30 / (40 + 30)

η_b = 0.598

Ultimate load on pile

Q_f = η_n w H η_b / (s + c/2)

= 1 x 40 x 80 x0.598/ (1.4 + 1.8/2)

= 1914.286 / (1.4 + 0.9)

Q_f = 832.3 k W

Allowable load = Q_f/ FOS

= 832.3 /2.0

Q_a=416.2 k W