PILE LOAD TEST

Pile loading tests carried out for the following reasons:

- To determine the settlement under working load
- To determine the ultimate bearing capacity of pile
- As a proof of acceptability

TEST PROCEDURE ASTM D-1143

- Pile Load Test is performed on Test Pile which is meant only for testing purpose and does not make part of working piles; load test can also be performed on working piles to check the performance of working piles
- Test Pile is loaded to at least 2 times the design load or to failure
- Working piles are loaded to 1.5 times the design load
- Load is applied in increments, each of 25% of design load making total 8 load steps
- Each load increment is maintained till the settlement rate of pile comes below 0.25mm/hour
- The final load is kept for 24 hrs and dial gauges are monitored
- The unloading is also performed in decremented order

Reaction Load (Kentlage)

(Total Load=1.20xApplied Load on Pile)

By Stacking Sand Bags
(Girls College, Gawalmandi)

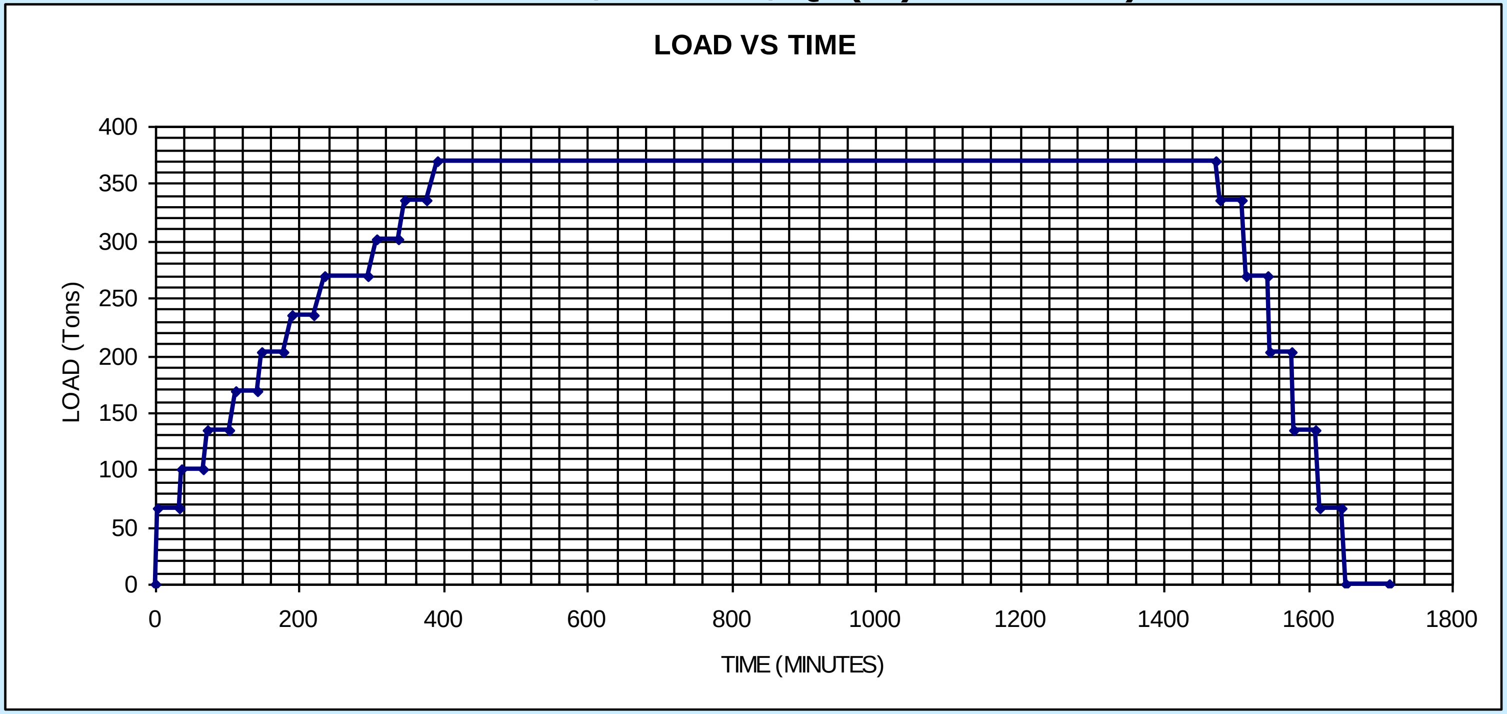
By Stacking Concrete Blocks
(Gujranwala Flyover)

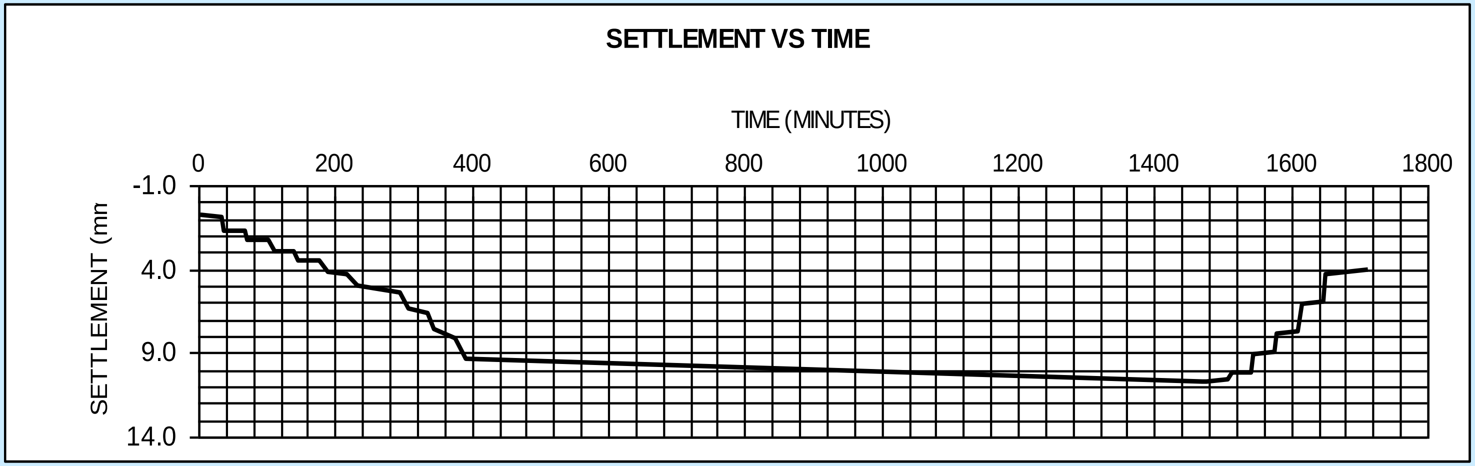
Hydraulic Jack, Settlement Gauges

Hydraulic Pump for Load Application

Load & Settlement ~Time Record

(GILRS DEGREE COLLEGE, GAWALMANDI, LAHORE
Dia=30 inch, L=100ft, Qa(th)=180 Tons)



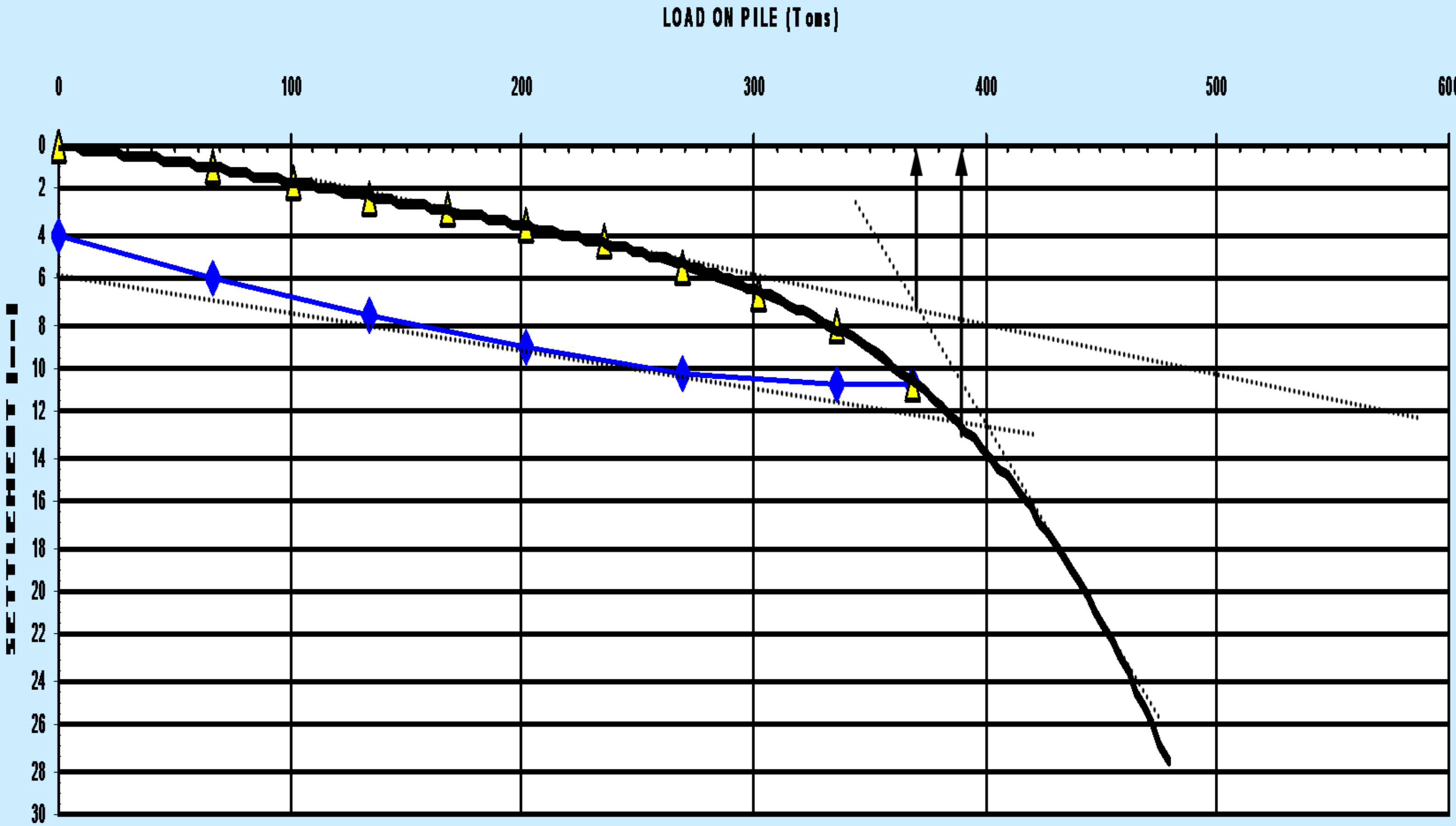


Criteria for Pile Failure Load

- The failure load is that which causes settlement equal to 10% of the pile diameter,
- The failure load is that load at which the rate of settlement continues undiminished without further increment of load, unless, of course, the rate is so slow as to indicate that it is due to consolidation of soil.
- **Drawing tangents to the initial and final portions of the load settlement curves and taking the point of intersection as the failure load.**
- **The failure load is the load where the net settlement is 6 mm.**

Evaluation of Pile Capacity

(DEGREE COLLEGE, GAWALMANDI, LAHORE)



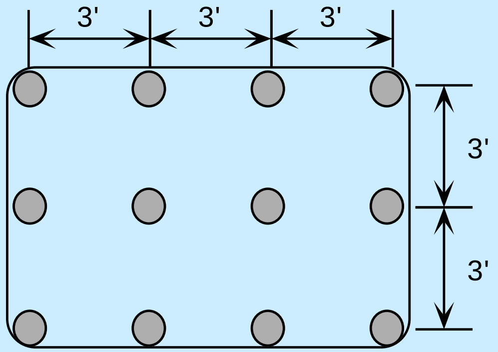
By Two tangent method: Q_u=370 tons

By 6 mm net settlement: Q_u=390 tons, **Q_a=380/2 =190 tons** ***∴F.O.S = 2***

$Q_{a(Th)}$=180 tons

Pile Group Efficiency

$$E_g = 1 - \phi \frac{(n-1)m + (m-1)n}{90mn}$$



Where,

E_g = pile group efficiency
ϕ = arctan (*d*/*s*), deg.
n = number of piles in a row
m = number of rows of piles
d = diameter of a pile
s = spacing of piles, centre to centre, in same unit as pile diameter.

For piles in cohesive soils, group efficiency may be assumed as 0.7 at pile spacing of 3D and I at pile spacing at 8D. Generally, in a pile group minimum pile spacing is 3D.

- The capacity of a group of piles may be less than the sum of the individual capacities of the piles making up the group. The efficiency of a pile group is the capacity of a group of piles divided by the sum of the individual capacities of the piles making up the group.

- In the case where a group of piles is comprised of end-bearing piles resting on bedrock (or on a layer of dense sand and gravel overlying bedrock), an efficiency of 1.0 may be assumed. In other words, a group of *n* piles will carry *n* times the capacity of a single pile. An efficiency of 1.0 is also often assumed by designers for friction piles driven in cohesionless soils.

- In the case where a group of piles is comprised of friction piles driven in cohesive soils, an efficiency of less than 1.0 is to be expected because stresses from individual piles build up and reduce the capacity of the pile group.

Group Effect of Piles

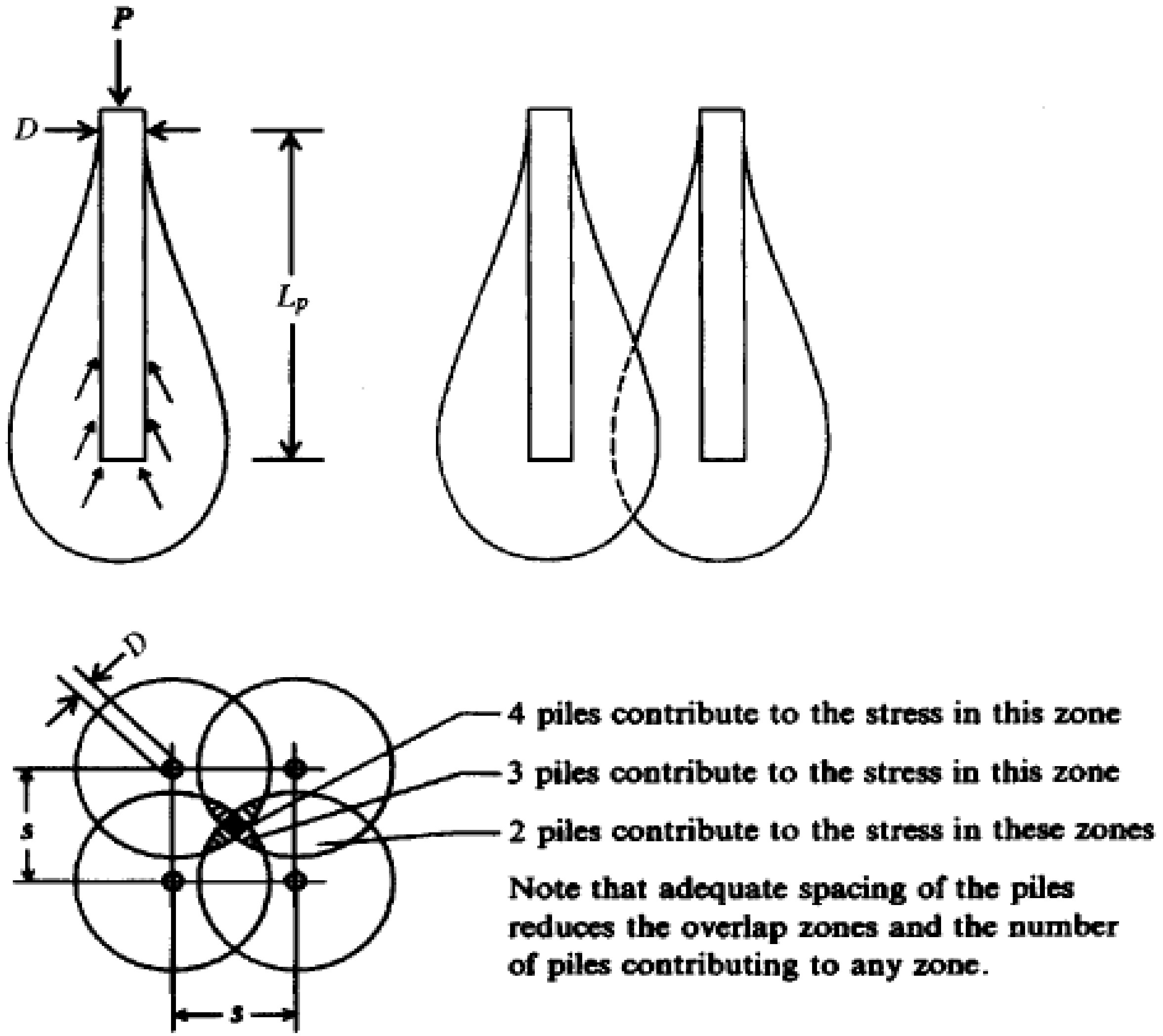
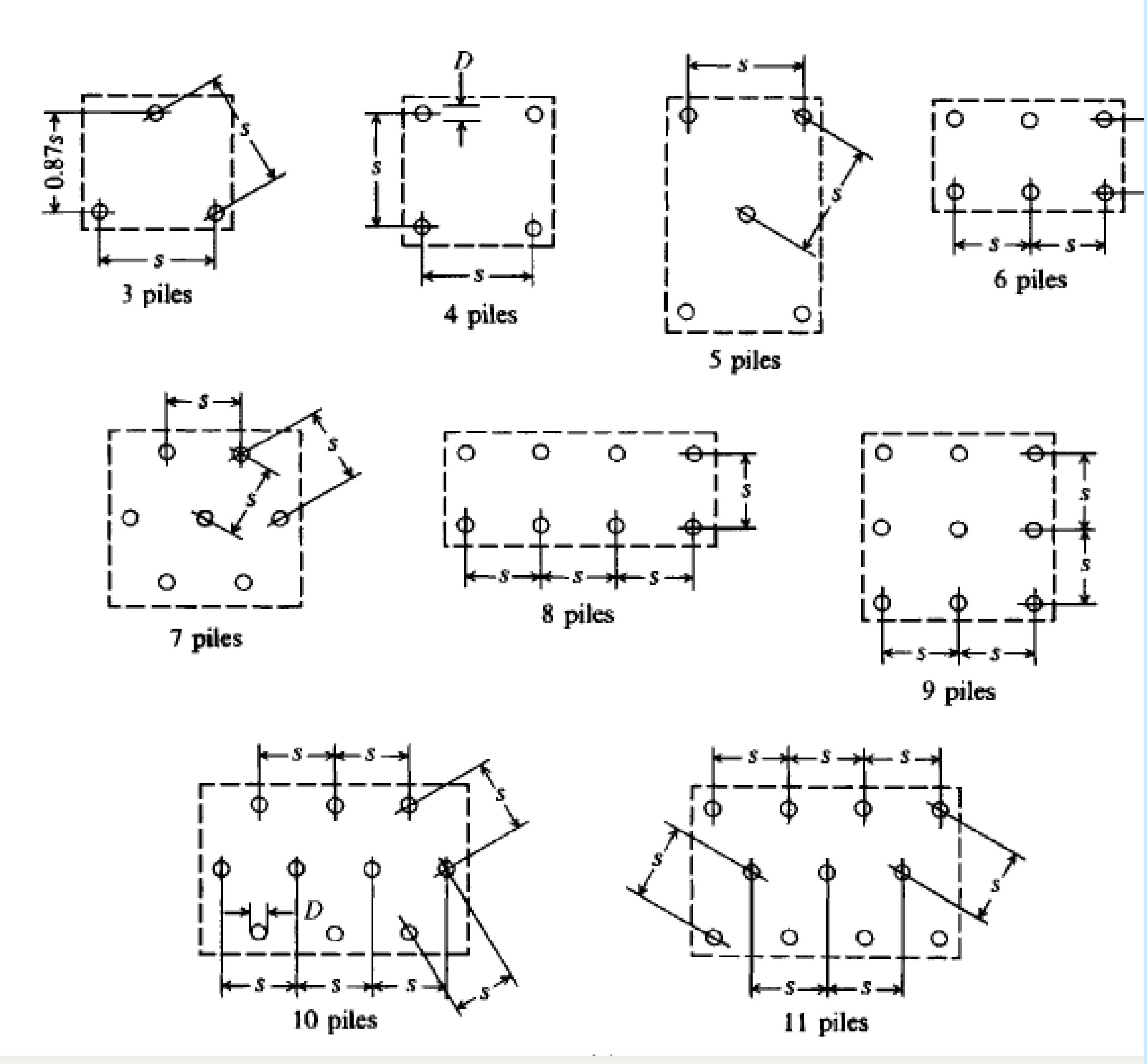


Figure 18-2 Stresses surrounding a friction pile and the summing effects of a pile group.

Typical Pile Group Patterns



Group Efficiency

- For driven piles in loose to medium dense sand, soil compaction will take place when pile spacing is less than 8D, the efficiency is more than 1, typically 1.2. For bored piles, the efficiency is much less which may be as low as 0.67 i.e., 2/3.
- For dense sand, pile driving may loosen the soil and efficiency is less than 1.
- ***For clayey soil***, the group efficiency is generally less than 1. Generally the efficiency at critical spacing (2B-3B) is 0.6~0.7 and is equal to 1 when pile spacing is 6D~8D.
- ***For Cohesionless soils:***

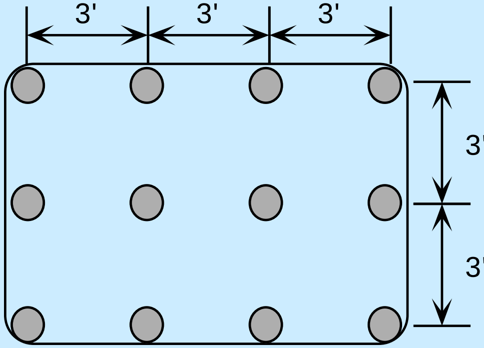
The current AASHTO provisions for group efficiencies for drilled shafts in cohesionless soils (AASHTO 10.8.3.6.3) states that regardless of cap contact with the ground:

E_g or η = 0.65 for a center-to-center spacing of 2.5 diameters,
E_g or η = 1.0 for a center-to-center spacing of 4.0 diameters or more, and

the value of η must be determined by linear interpolation for spacing between 2.5 and 4 diameters.

Example:

A pile group consists of 12 friction piles in cohesive soil. The diameter of each pile is 12 inch and c/c spacing is 3 ft. By means of a load test, the ultimate load of a single pile was found to be 100 kips. Determine the design capacity of the pile group, using the Converse-Labarre equation.



Solution:

$$E_g = 1 - \phi \frac{(n-1)m + (m-1)n}{90mn}$$

N = No. of Piles in a group = 12

ϕ = arctan (*d/s*) = arctan (1/3) = 18.4°

***m* = 3**

***n* = 4**

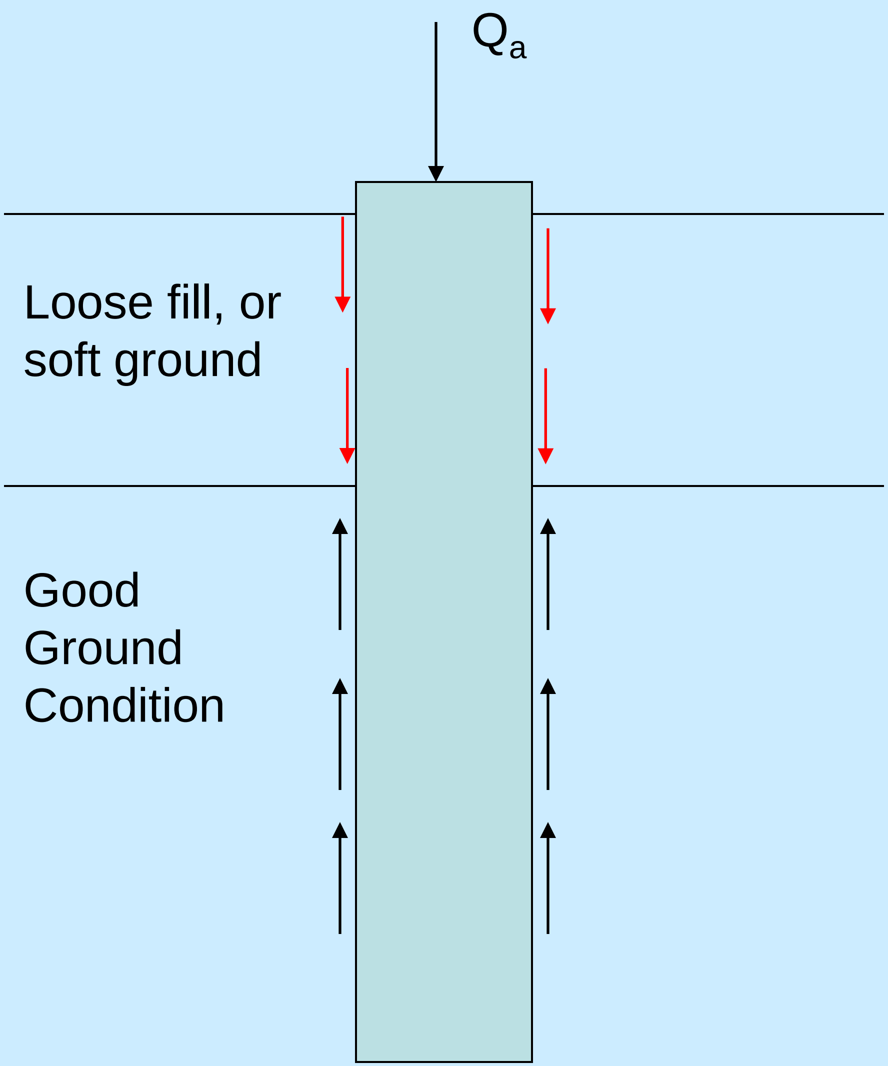
Allowable bearing capacity of a single pile = 100/2 = 50 kips

Design capacity of the pile group = E_g x N x Single Pile Capacity

= 0.71×12×50 = 426 kips.

Negative Skin Friction

- Loose/soft ground move more than pile settlement, therefore, the f_s is in downward direction
- This downward f_s loads the pile and is known as Negative Skin Friction or Down Drag
- The amount of Down Drag needs to be subtracted from pile capacity.
- Pile can be lubricated within such zone to reduce f_s



Negative Skin Friction

Negative skin friction is a downward drag force exerted on a pile by the soil surrounding it. Such a force can exist under the following conditions, among others:

1. If a fill of clay soil is placed over a granular soil layer into which a pile is driven, the fill will gradually consolidate. The consolidation process will exert a downward drag force on the pile (see Figure 11.35a) during the period of consolidation.
2. If a fill of granular soil is placed over a layer of soft clay, as shown in Figure 11.35b, it will induce the process of consolidation in the clay layer and thus exert a downward drag on the pile.
3. Lowering of the water table will increase the vertical effective stress on the soil at any depth, which will induce consolidation settlement in clay. If a pile is located in the clay layer, it will be subjected to a downward drag force.

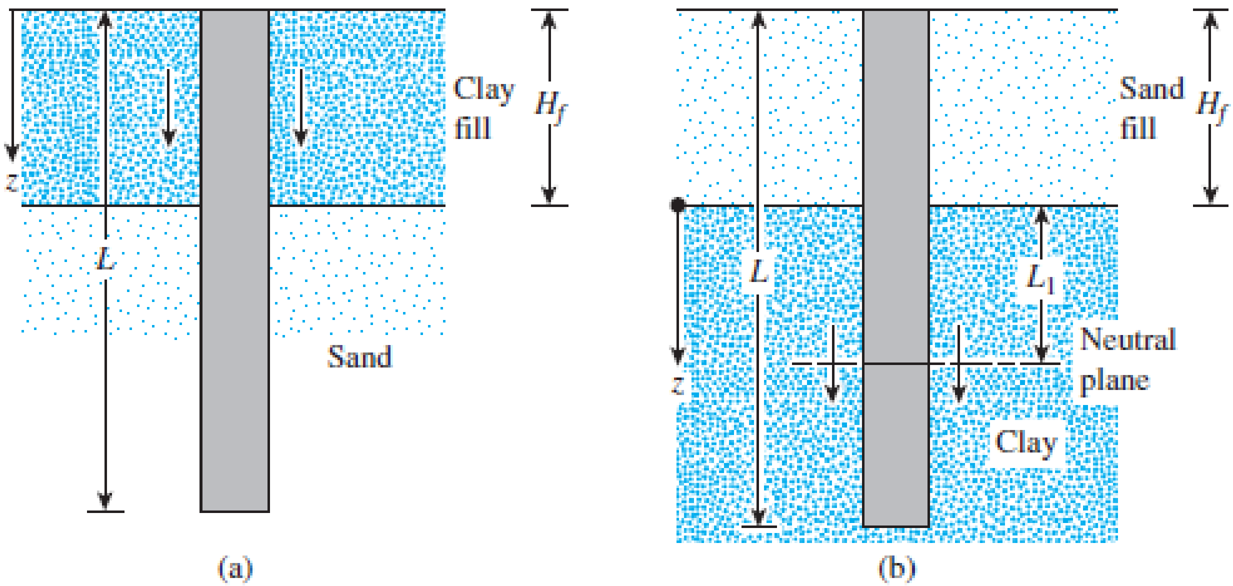


Figure 11.35 Negative skin friction