Module 5 : Design of Deep Foundations

Lecture 20 : Introduction [Section 20.1 : Introduction]

Objectives

In this section you will learn the following

- Introduction

Module 5 : Design of Deep Foundations

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INTRODUCTION

The shallow foundations are used in case of small buildings or structures, which carry lesser loads, and hence the loads are dissipated into the soil mass at much lower depth. However when we are considering large structures, which carry heavy loads, the loads are dissipated at greater depths where usually the soil bearing capacity is quite high. One guideline of differentiating between the shallow and deep foundations is that in case of the deep foundations the depth of foundations is more than the dimension of the structure (usually the width is considered as the dimension).

DIFFERENT TYPES OF DEEP FOUNDATION

Deep foundations are of the following types:

- Deep footings.
- Piles.
- Piers.
- Caissons /Well foundations.

Recap

In this section you have learnt the following.

- Introduction

Objectives

In this section you will learn the following

- Requirement For Deep Foundations
- Classification Of Piles
- Points To Be Considered For Choosing Piles
- Pile Classification
- Piles In Clay
- Piles In Sand
- Settlement Of Pile Groups
- Codal Provision

Module 5 : Design of Deep Foundations

Lecture 20 : Introduction [Section 20.2 : Design Methodology For Piles]

DESIGN METHODOLOGY FOR PILES

The detailed design methodology of piles is described in the following sections.

REQUIREMENT FOR DEEP FOUNDATIONS

Generally for structures with load >10 t/m^2 , we go for deep foundations. Deep foundations are used in the following cases:

- Huge vertical load with respect to soil capacity.
- Very weak soil or problematic soil.
- Huge lateral loads eg. Tower, chimneys.
- Scour depth criteria.
- For fills having very large depth.
- Uplift situations (expansive zones)
- Urban areas for future large and huge construction near the existing building.

CLASSIFICATION OF PILES

1. **Based on material**

- Timber piles
- Steel piles
- Concrete piles
- Composite piles (steel + concrete)

2. **Based on method of installation**

- Driven piles ----(i) precast (ii) cast-in-situ.
- Bored piles.

3. **Based on the degree of disturbance**

- Large displacement piles (occurs for driven piles)
- Small displacement piles (occurs for bored piles)

POINTS TO BE CONSIDERED FOR CHOOSING PILES

- Loose cohesion less soil develops much greater shaft bearing capacities if driven large displacement piles are used.
- Displacement effect enhanced by tapered shafts.
- Potential increased of shaft capacities is undesirable if negative friction is to be feared. (Negative friction is also called drag down force)
- High displacement piles are undesirable in stiff cohesive soils, otherwise excessive heaving takes place.
- Encountered with high artesian pressures on cased piles should be excluded. (Mainly for bridges and underwater construction)
- Driven piles are undesirable due to noise, damage caused by vibration, ground heaving.
- Heavy structures with large reactions require high capacity piles and small diameter cast-in-situ piles are inadequate.

PILE CLASSIFICATION

- Friction piles.
- End bearing piles.
- Compaction piles.(Used for ground movement, not for load bearing)
- Tension piles/Anchored piles.(To resist upliftment)
- Butter piles (Inclined) --- +ve and –ve.

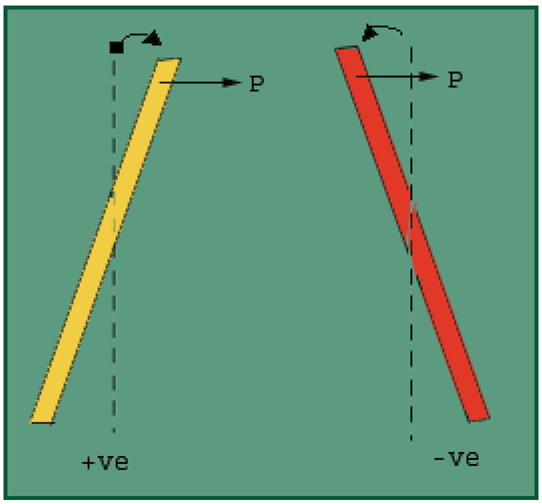


Fig. 5.1 Direction of load is same as the direction of batter. (Rotation of pile)

- Raymond piles. (Driven cast-in-situ piles, first tapered shell is driven and then cast)
- Franki Piles (Driven cast-in-situ piles, first casing is driven upto 2m depth, then cast a block within that casing and then drive the block. When it reaches the particular depth, take out the casing and cast the piles.)
- Underreamed piles (bored cast-in-situ piles, bulbs used, hence not possible to install in loose sand and very soft clays.)

PILES IN CLAY

Zone of influence

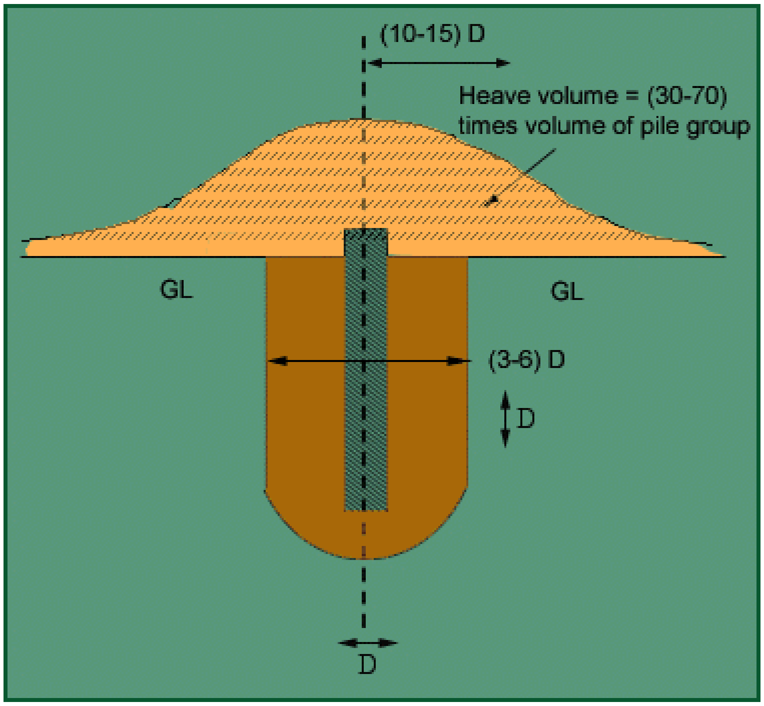
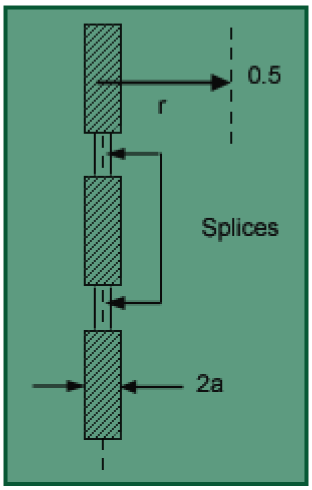


Fig.5.2 Driven piles in clay

The heaving effect can be felt upto (10 –15) D from the centerline of the pile. Due to driving load, pressure is generated and as a result heaving occurs. Afterwards with time, the heaved part gets consolidated and strength gradually increases as the material regains shear strength within 3 – 6 months time after the installation of the pile. This regain of strength is called thixotrophy.

On the first day some part of the pile will be driven and on the second day some part of the pile may move up due to the gain of shear strength. This is known as the *wakening of the pile.* By the driving force, the extra pore pressure generated is (5 – 7) times the C_u of the soil. Bearing capacity of the pile is 9 C_u . Hence due to this property, maximum single length of the pile theoretically can be upto 25m but 10-12m is cast at a time. Then by splicing technique the required hired length of the pile is obtained. Special types of collars are used so that the splices become weak points. Concrete below the grade M20 is never used.

Pile Diameter	Maximum length (m)
250	12
300	15
350	18
400	21
450	25



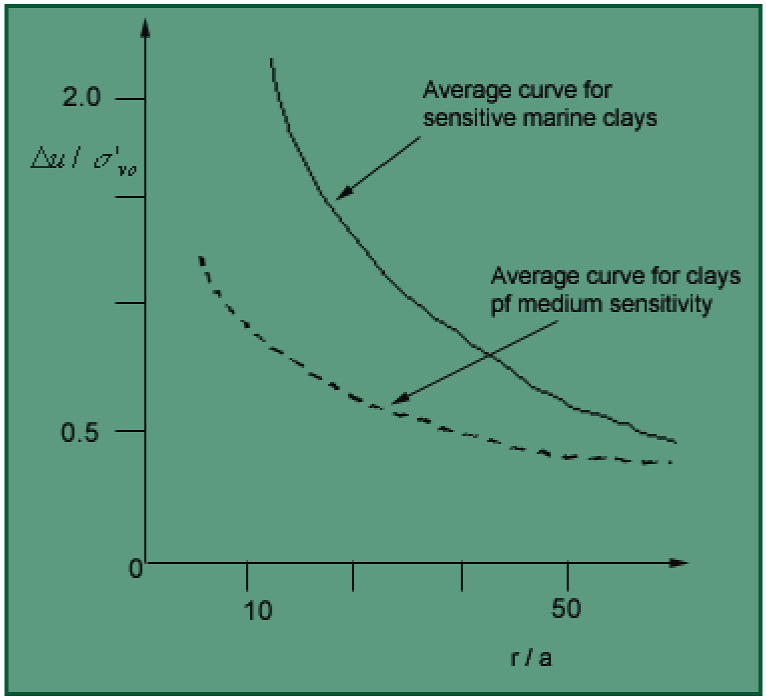


Fig.5.3 Generation of

PILES IN SAND

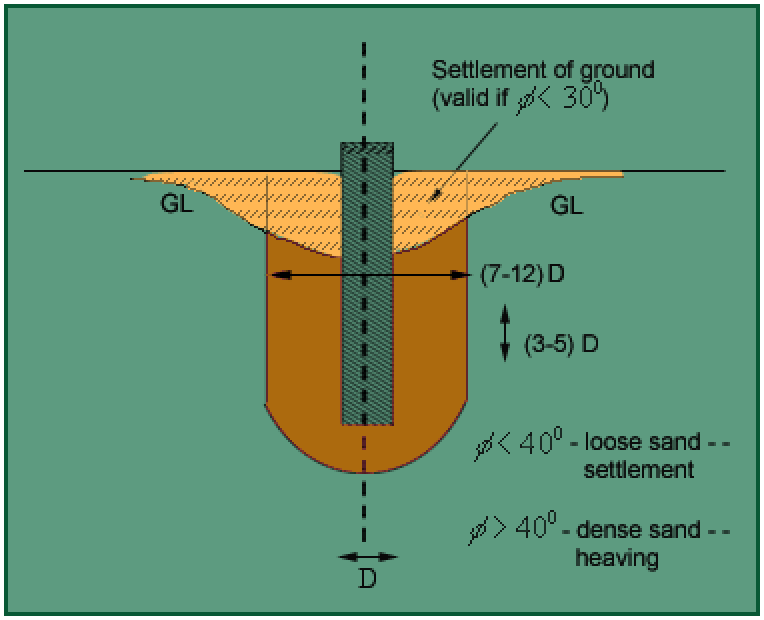


Fig.5.4a Driven piles in loose sand

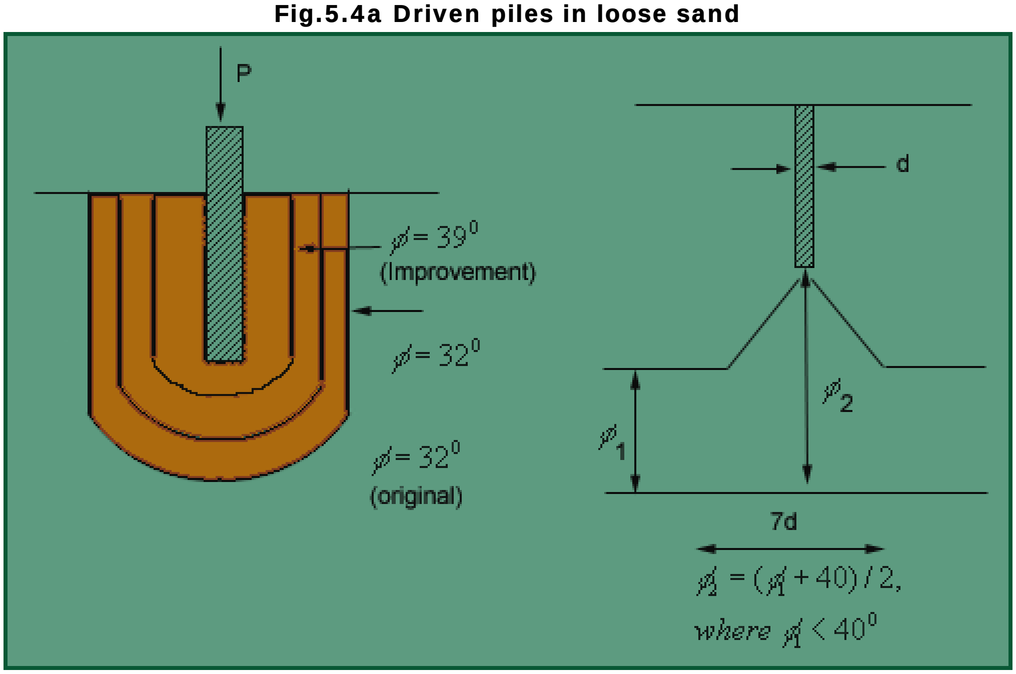


Fig.5.4b Improvement in f due to pile driving

SETTLEMENT OF PILE GROUPS

Assume 2V:1H dispersion for settlement of pile groups.

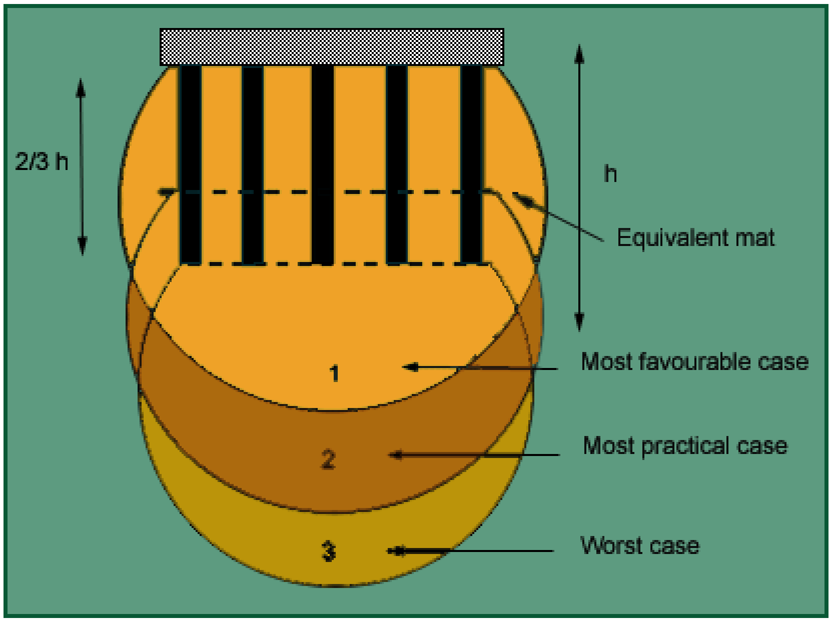


Fig.5.5 Settlement of pile groups

CODAL PROVISION

SAFE LOAD ON PILES/PILE GROUPS (Ref. IS: 2911 Part IV 1979)

Single pile:

1. Safe load = Least of the following loads obtained from routine tests on piles :

- 2/3 of the final load at which total settlement is 12mm.
- 50% of the final load at which settlement is 10% of the pile dia.(for uniform dia. piles) and 7.5% of bulb dia. (for Underreamed piles)
- 2/3 of the final load at which net settlement is 6mm.
- Consider pile as column and find the total compressive load depending on the grade of concrete and dimensions. Eg. Consider a 300mm dia pile made of M20 concrete. $\sigma_{cc} = 5N/mm^2$.

Therefore, ultimate load = $\frac{\pi}{4} \times 300^2 \times 5 = 353.4KN$.

Group of piles:

2. Safe load = Least of the following loads obtained from

- Final load at which total settlement of pile group attains a value of 25mm.
- 2/3 of the final load at which the total settlement attains a value of 40mm.

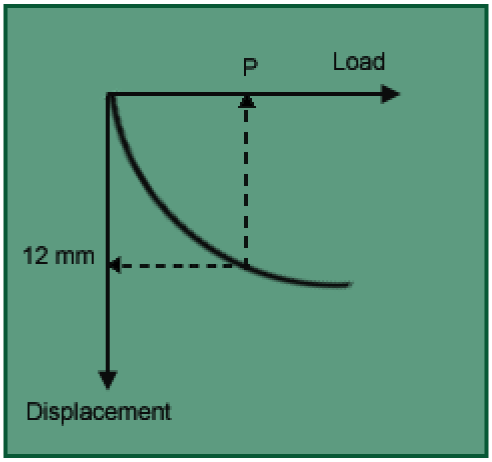


Fig.6 Load vs Displacement Curve for piles

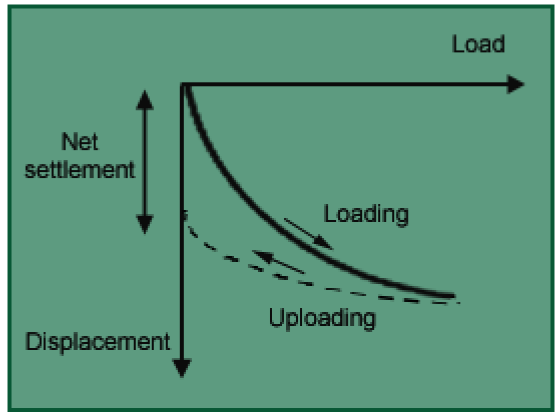


Fig.5.7 Loading and unloading curve for piles

Recap

In this section you have learnt the following.

- Requirement For Deep Foundations
- Classification Of Piles
- Points To Be Considered For Choosing Piles
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Congratulations, you have finished Lecture 20. To view the next lecture select it from the left hand side menu of the page