



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

EARTHQUAKE RESISTANT DESIGN OF FOUNDATIONS:

Lecture 2: Shallow Foundations – General Requirements

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ERD of Foundations - Modules

1. Introduction
2. Shallow Foundations
3. Pile Foundations
4. Well Foundations
5. SSI for Deep Foundations



Module - 2

Shallow Foundations



Module -2: Chapters

1. General Requirements
2. Bearing Capacity and Settlement
3. Combined Footings
4. Raft Foundations
5. Dynamic Bearing Capacity



Chapter 1: General Requirements

- **Types of Foundations**
- **Basic Criteria for Design**
- **Terminology**
- **Modes of Soil Failure**

Types of Foundations

Types of Structural Foundations

a) Shallow Foundations- $B > D_f$

b) Deep Foundations- $\frac{D_f}{B} > 1$

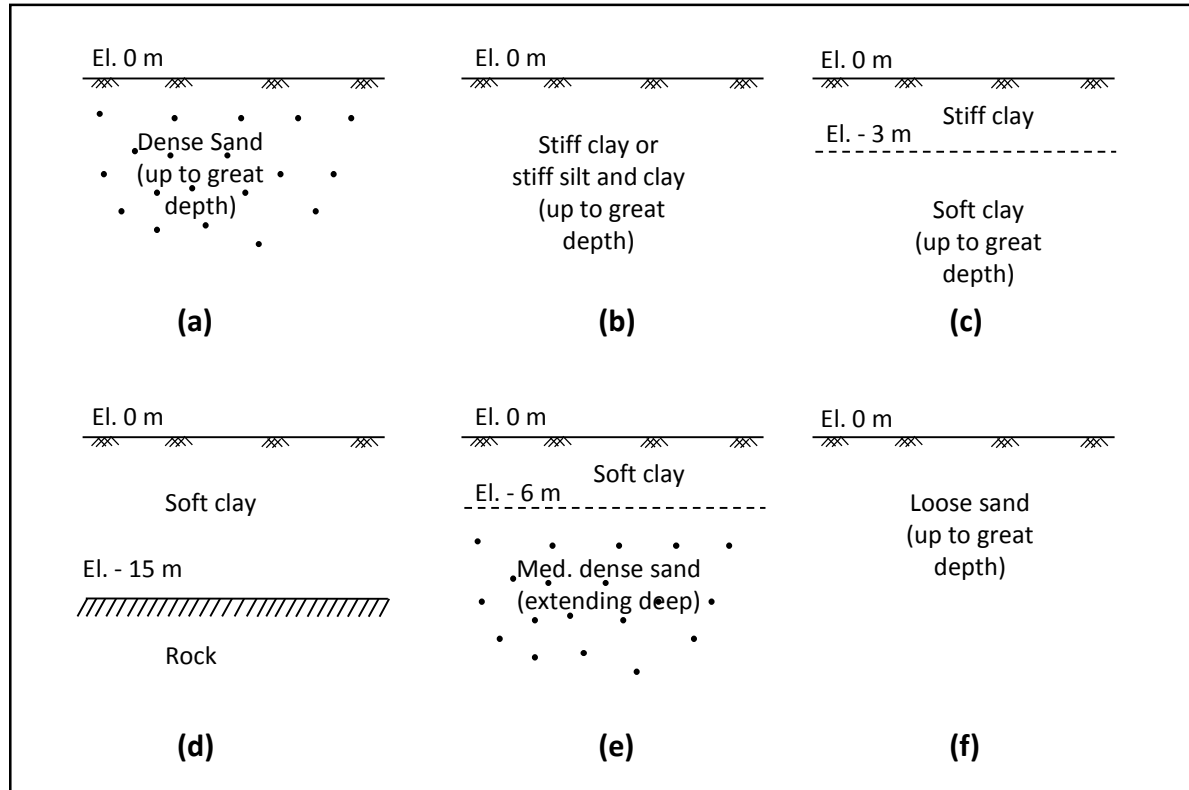
Moderately Deep Foundation $1 < \frac{D_f}{B} < 15$

Deep Foundation $\frac{D_f}{B} > 15$

Choice of a Foundation

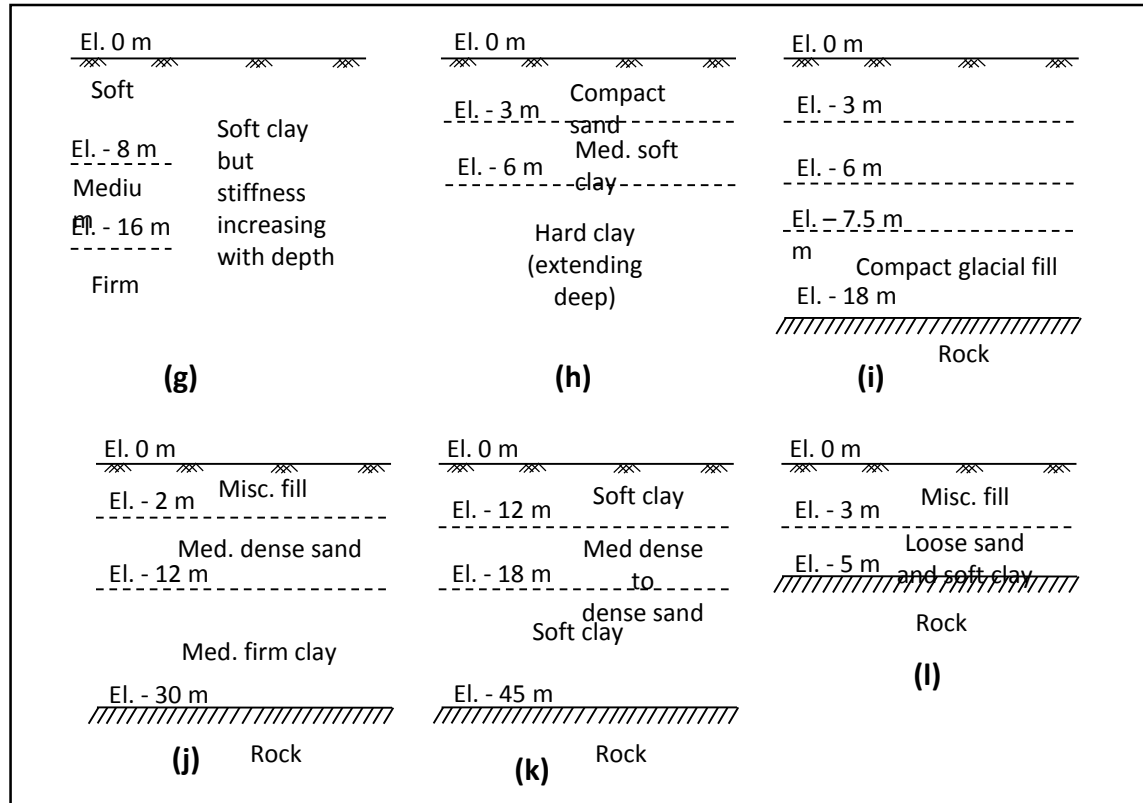
For reason of economy, shallow foundations are the first choice of an engineer for a structure unless they are considered inadequate.

Selection of Foundation Type



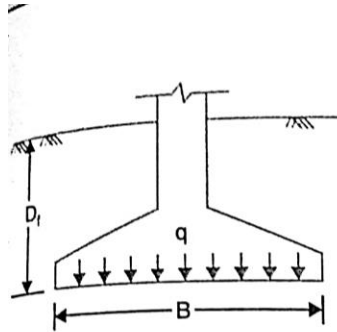
(a)-(c): Normal case – Shallow, Unusual case - Deep
(d) and (e) Deep Foundation
(f) Raft / densification/ piles

Selection of Foundation Type



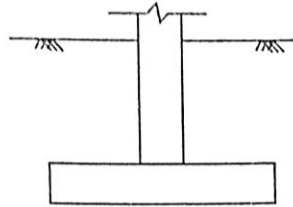
- (g) Raft / friction piles
- (h) Drilled piers / cast in-situ piles
- (i) Driven / cast in-situ piles
- (j) Piles
- (k) Piles / piers
- (l) End bearing piles / piers

Types of Shallow Foundations



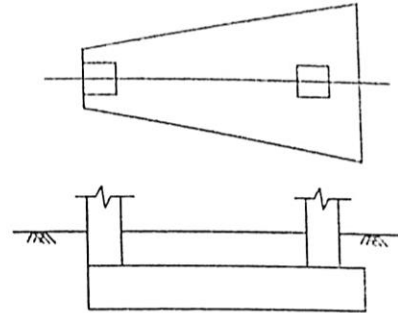
(a)

Strip Footing ($L \gg B$)



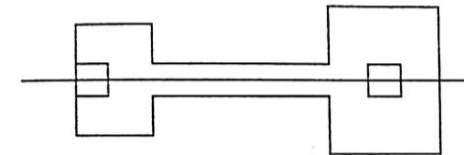
(b)

Isolated Footing



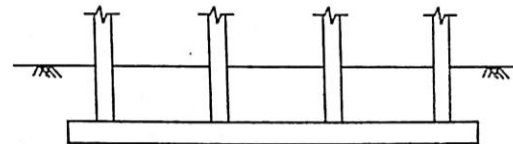
(c)

Trapezoidal Combined Footing



d)

Rectangular Combined Footing



(e)

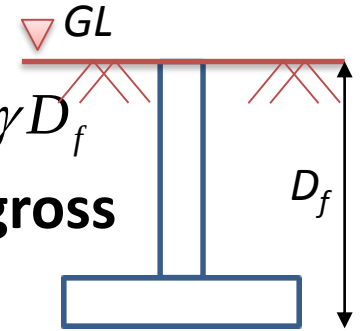
Raft or Mat Foundations

Relevant Codes

1. IS: 1904 (1986, Reaffirmed 1995, 2006): Code of Practice for Design and Construction of Foundation in soil: General Requirements, Bureau of Indian Standards, New Delhi.
2. IS: 6403 (1981, Reaffirmed 2002): Code of Practice for determination of Bearing Capacity of Shallow Foundations, Bureau of Indian Standards, New Delhi.
3. Eurocode 7: **Geotechnical Design Worked examples**

Terminology

1. Gross pressure (q_g) or gross loading intensity: Pressure due to weight of the superstructure, self weight of footing and weight of soil.
2. Net pressure or loading intensity (q_n): $q_n = q_g - \gamma D_f$
3. Ultimate bearing capacity (q_u): The minimum gross intensity of loading that the soil can support before it fails in shear is called the ultimate bearing capacity



Terminology

4. **Net ultimate bearing capacity (q_{nu}):** Maximum net intensity of load at base of the foundation that the soil can support before failing in shear. $q_{nu} = q_u - \gamma D_f$
5. **Net safe bearing capacity (q_{ns}):** The max net intensity of loading that the soil can safely support without the risk of shear failure. $q_{ns} = \frac{q_{nu}}{FS}$
6. **Safe bearing capacity (q_s):** The max gross intensity of loading the soil can carry safely without failing in shear.

$$q_s = q_{ns} + \gamma D_f = \left(\frac{q_{nu}}{FS} + \gamma D_f \right)$$

Modes of Soil Failure

Horizontal strip footing resting on the surface of homogeneous soil is subjected to gradually increasing load, characteristic load-settlement curves are obtained.

a) General Shear Failure

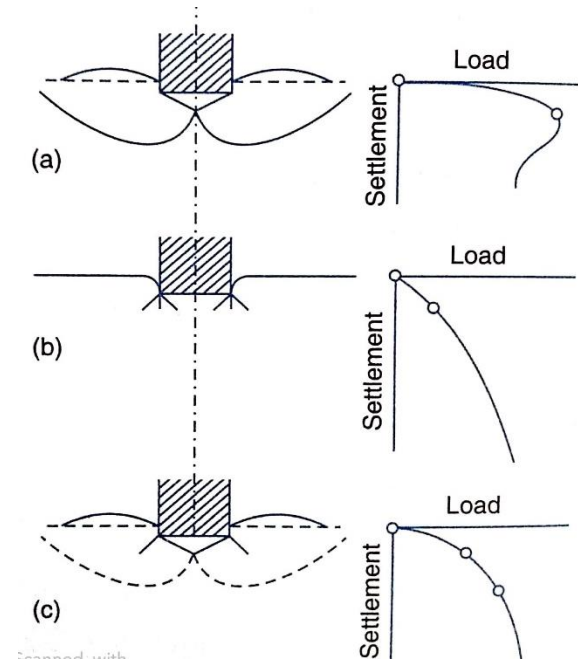
Brittle type, Dense sand: Well defined failure pattern

b) Punching Shear Failure

Highly Plastic Soil: Poorly defined failure pattern

c) Local Shear Failure

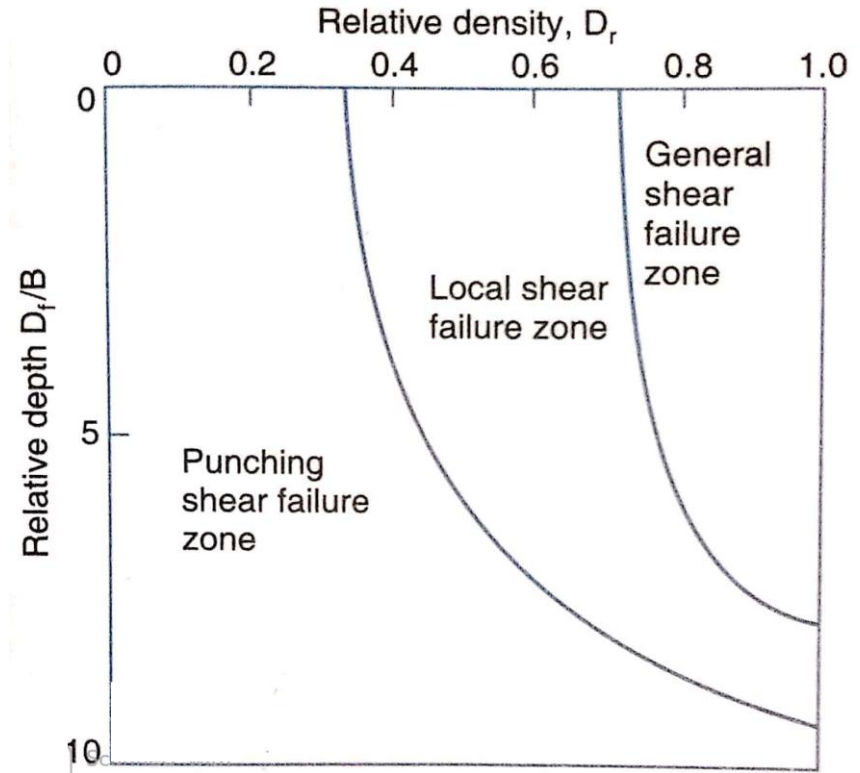
Medium dense or firm state: well defined wedge



Modes of Soil Failure

Different modes of failure at different relative densities

- General Shear $>70\%$
- Local Shear $30\% < D_r < 70\%$
- Punching Shear $<30\%$



Basic Criteria for Design

- **Location and Depth Criteria:** Performance is not adversely affected by factor such as lateral expulsion of soil, seasonal volume change by freezing etc.
- **Bearing Capacity Criteria:** Safe against shear failure with an adequate factor of safety
- **Settlement Criteria:** The settlement of foundation particularly differential settlement should be within permissible limit. Excessive settlement may affect the utility of the structure, spoil the appearance and even may cause damage to the structures.

Thank You

