

# Built Environment Portfolio

Substructure:  
Foundations



# Foundation Design



⇒ Purpose of a foundation

- To safely transmit structural loadings to the soil

# Foundation Design

## ⇒ Building Regulations

- Building shall be constructed so that the combined dead, imposed and wind loads are sustained and transmitted by it to the ground -

- Safely
- Little deflection
- Maintain stability



# Foundation Design

⇒ Performance requirements

- Strength and stability

- Durability

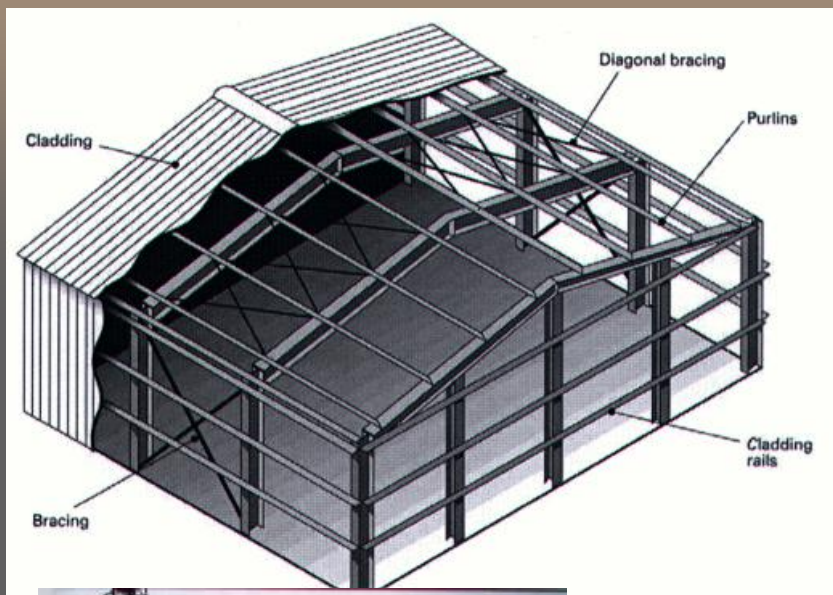


# Foundation Design



⇒ Key factors dictating foundation type

- Form of construction
- Soil make up
- Loadings



# Foundation Design

## ⇒ Soil classification

- Firm
- Medium firm
- Loose

## ⇒ Rock

- Hard
- Rigid
- Strong



# Soils

⇒ Key properties:



- Particle size
- Density
- Moisture content
- Plasticity
- porosity

# Rock classification



- ➔ Igneous
  - Granite
  - Basalt
- ➔ Sedimentary
  - Sandstones
  - Limestones
  - Chalk
- ➔ Metamorphic
  - Slate
  - Marble

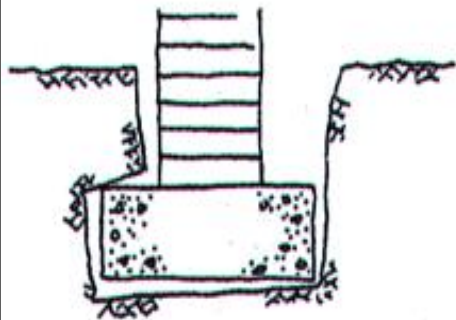
# Foundation construction

## Some terminology

- ⇒ Ultimate bearing capacity
- ⇒ Allowable bearing pressure
- ⇒ Subsidence
- ⇒ Settlement
- ⇒ Compaction
- ⇒ Consolidation



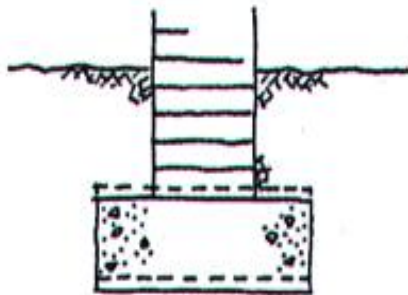
# Modes of failure



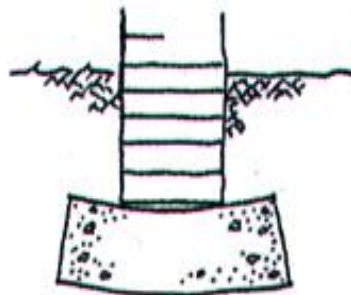
(a) Soil movement



(c) Shear failure



(b) Soil failure due to overloading



(d) Bending failure

⇒ Soil movement

⇒ Soil failure

⇒ Shear failure

⇒ Bending

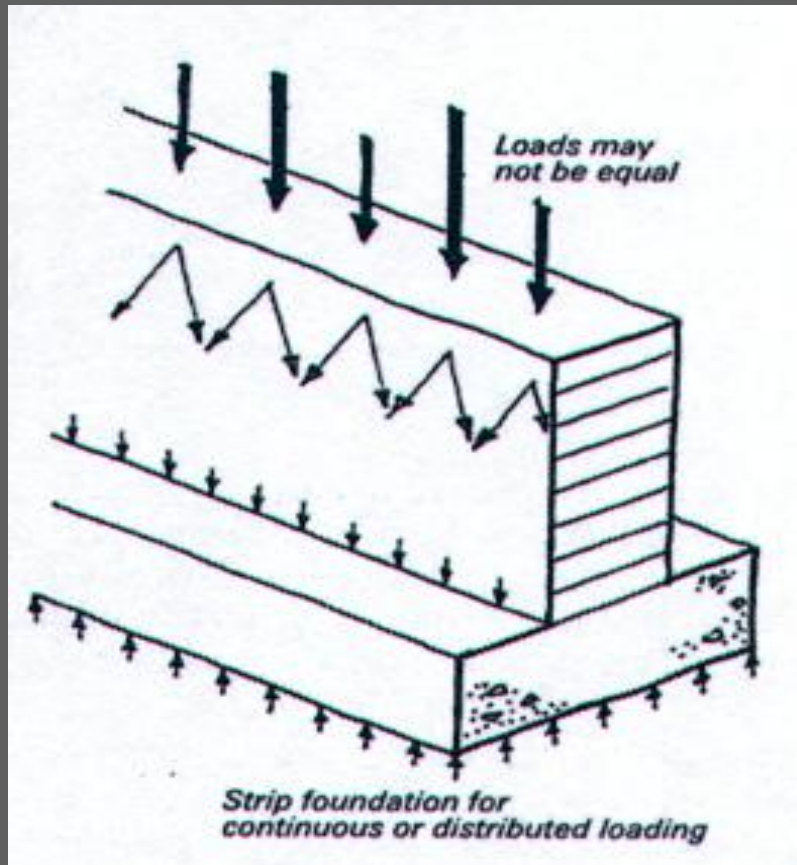
# Types of foundation

## Shallow foundations

Those which transfer the loads of the structure to the soil at a level close to the lowest floor of the building



# Types of foundation



## Strip foundations

Designed for a continuous load which is presumed to be equal along the whole length of the foundation.

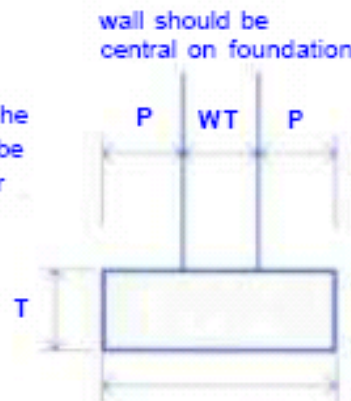
For larger buildings involving column construction, such foundations are sometimes referred to as combined foundations

# Building Regulations A1/2 Part E

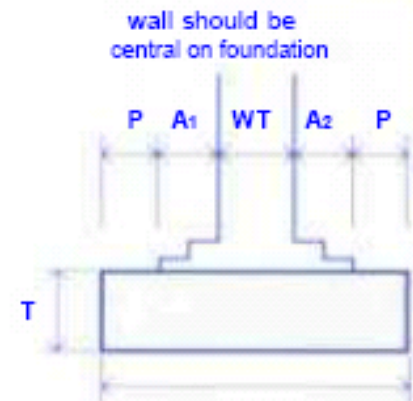
## Strip foundations of plain concrete

**Diagram 24 Foundation dimensions**

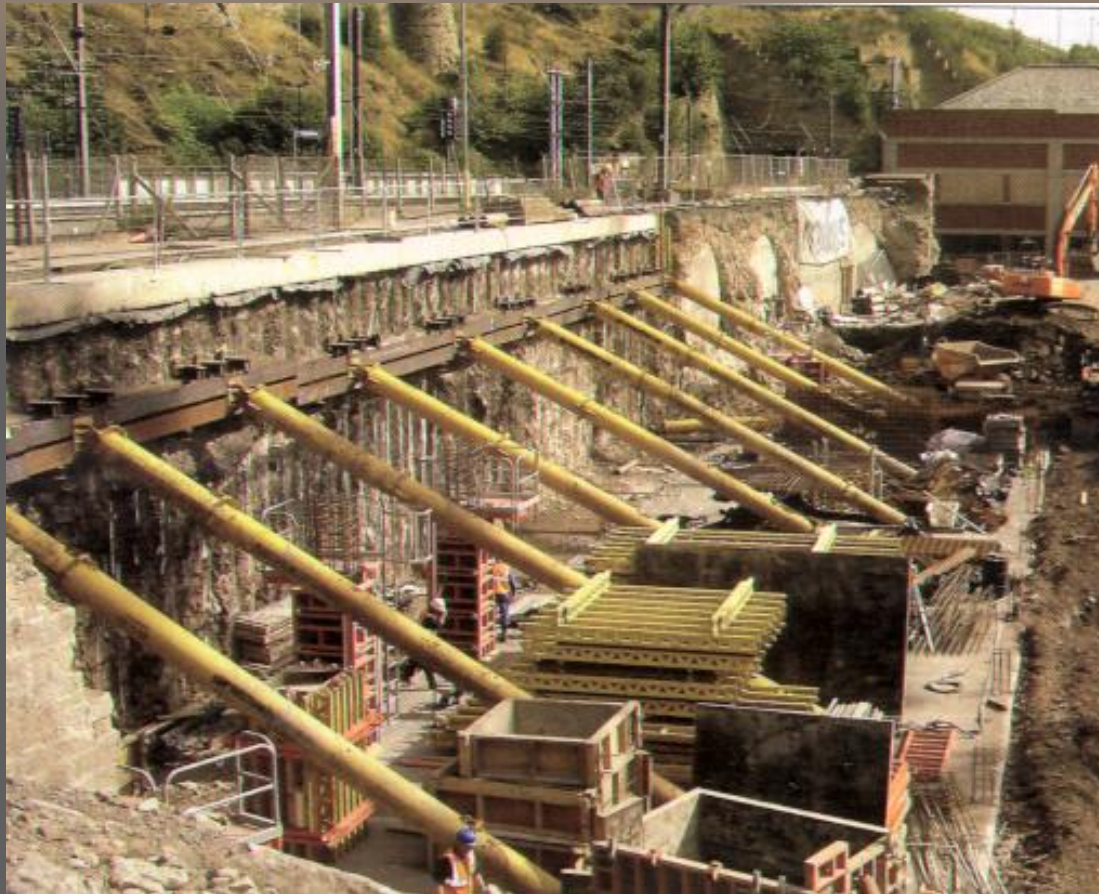
in both the cases shown in this Diagram, the thickness of the foundation should either be equal to P or 150mm, whichever is greater



(a) Strip foundation foundation width should be not less than the appropriate dimension in Table 12



(b) Strip foundation with footing foundation width should be not less than the appropriate dimension in Table 12 plus offset dimensions A<sub>1</sub> and A<sub>2</sub>.



Piled (Deep) Foundations

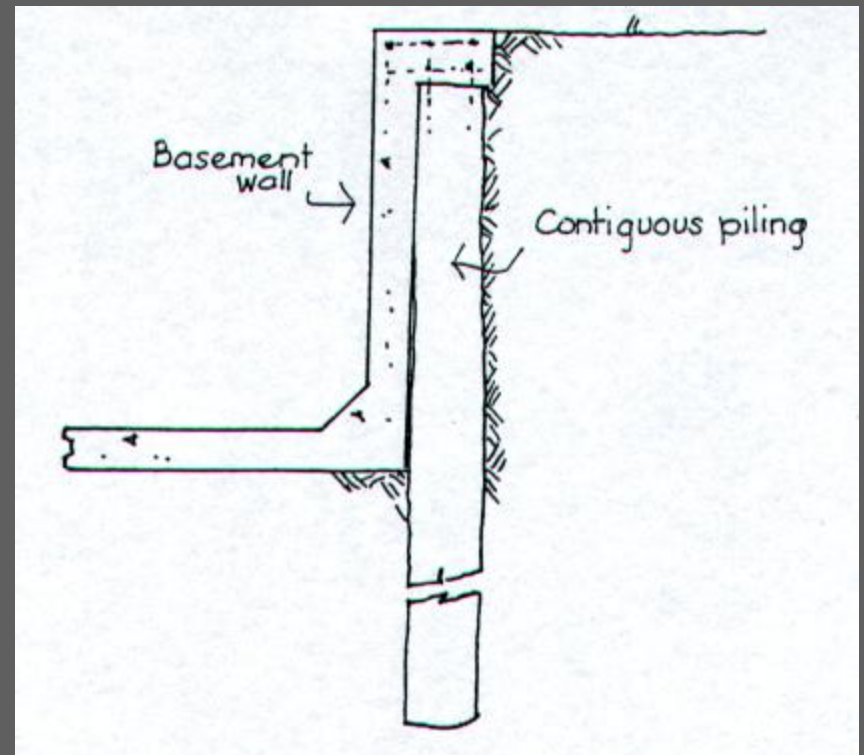


# Minimum widths of strip foundations (Building Regulations A1/2 Part E

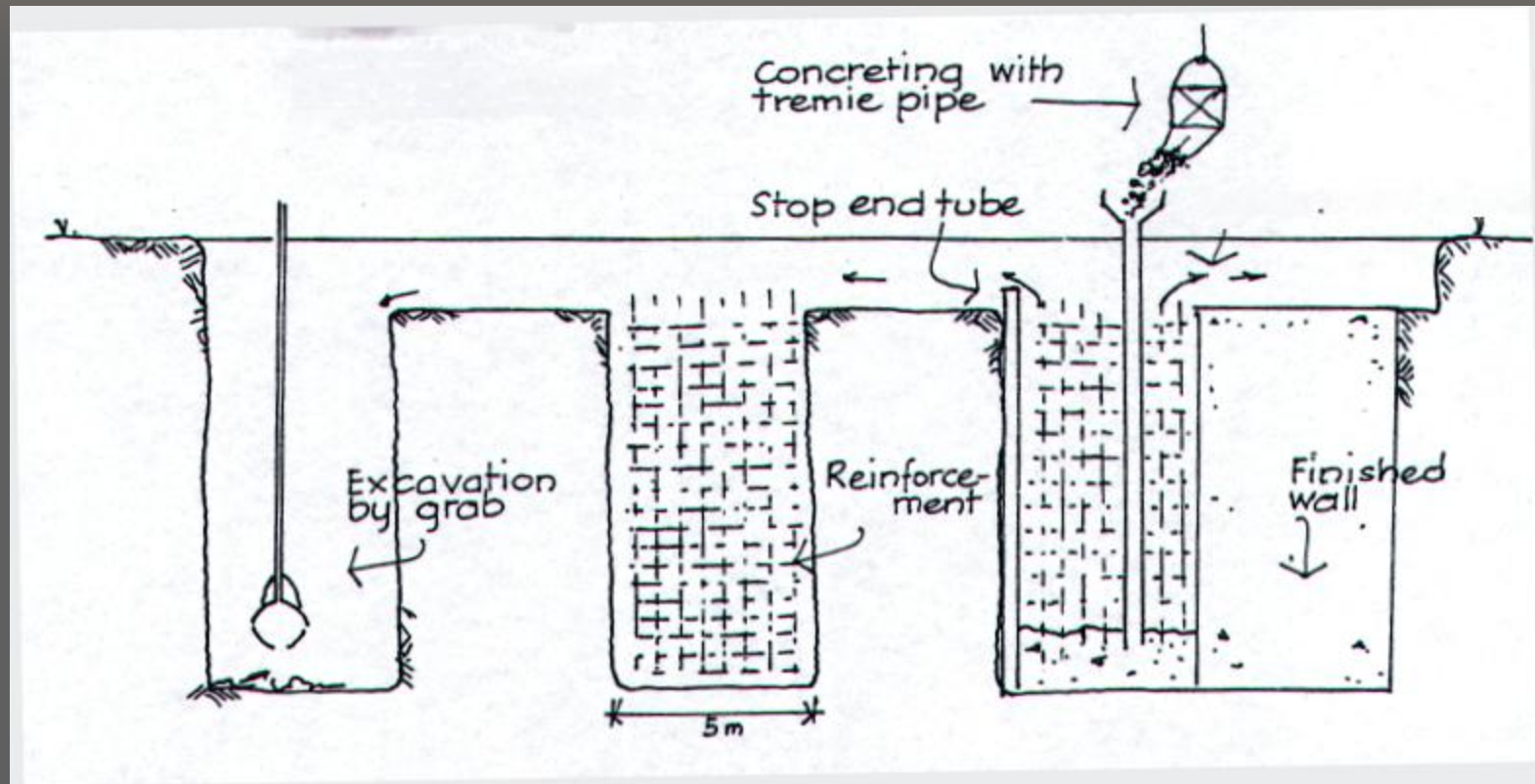
**Table 12 Minimum width of strip foundations**

| Type of subsoil                        | Condition of subsoil                               | Field test applicable                                                                                                    | Total load of load-bearing walling not more than (kN/linear metre) |     |                                                                                                                                   |     |     |     |
|----------------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|-----|-----------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|
|                                        |                                                    |                                                                                                                          | 20                                                                 | 30  | 40                                                                                                                                | 50  | 60  | 70  |
|                                        |                                                    |                                                                                                                          | Minimum width of strip foundation (mm)                             |     |                                                                                                                                   |     |     |     |
| I<br>rock                              | not inferior to sandstone, limestone or firm chalk | requires at least a pneumatic or other mechanically operated pick for excavation                                         | in each case equal to the width of wall                            |     |                                                                                                                                   |     |     |     |
| II<br>gravel sand                      | compact compact                                    | requires pick for excavation. Wooden peg 50mm square in cross section hard to drive beyond 150mm                         | 250                                                                | 300 | 400                                                                                                                               | 500 | 600 | 650 |
| III<br>clay sandy clay                 | stiff stiff                                        | cannot be moulded with the fingers and requires a pick or pneumatic or other mechanically operated spade for its removal | 250                                                                | 300 | 400                                                                                                                               | 500 | 600 | 650 |
| IV<br>clay sandy clay                  | firm firm                                          | can be moulded by substantial pressure with the fingers and can be excavated with graft or spade                         | 300                                                                | 350 | 450                                                                                                                               | 600 | 750 | 850 |
| V<br>sand silty sand clayey sand       | loose loose loose                                  | can be excavated with a spade. Wooden peg 50mm square in cross section can be easily driven                              | 400                                                                | 600 | In relation to types V, VI and VII foundations do not fall within the provisions of this section if the total load exceeds 30kN/m |     |     |     |
| VI<br>silt clay sandy clay silty clay  | soft soft soft soft                                | fairly easily moulded in the fingers and readily excavated                                                               | 450                                                                | 650 |                                                                                                                                   |     |     |     |
| VII<br>silt clay sandy clay silty clay | very soft very soft very soft                      | natural sample in winter conditions exudes between fingers when squeezed in fist                                         | 600                                                                | 850 |                                                                                                                                   |     |     |     |

# Basement Construction



# Diaphragm Wall



# Types of foundations

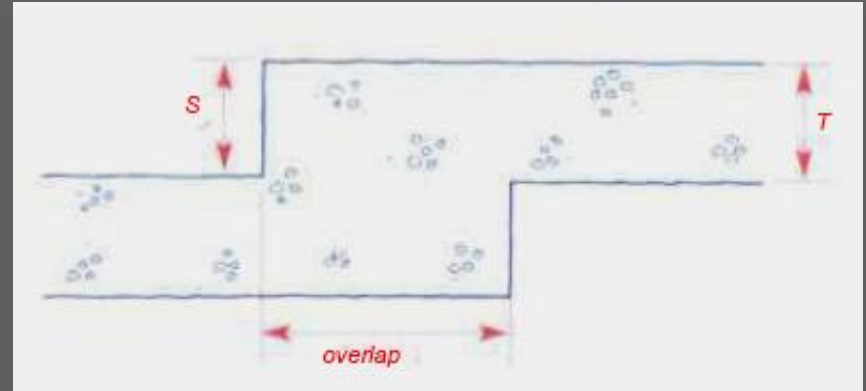
## Stepped foundations

### Strip foundations

Min thickness - 150mm

Overlap –  $2 \times S$ , or

$T$  (max 500mm), or  
300mm, whichever is greater

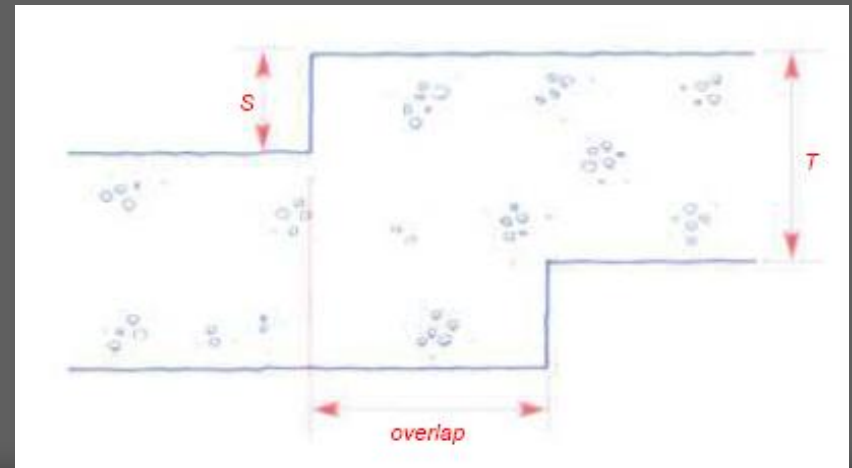


### Trench fill foundations

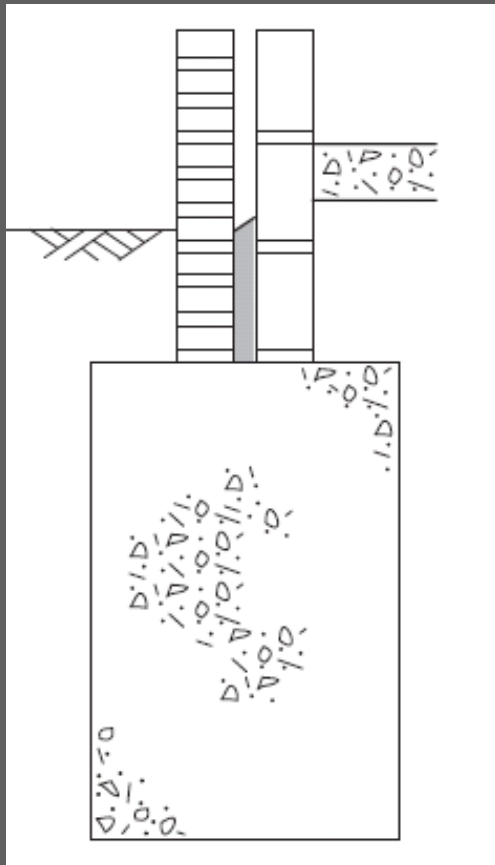
Overlap not less than:

$2 \times S$ , or

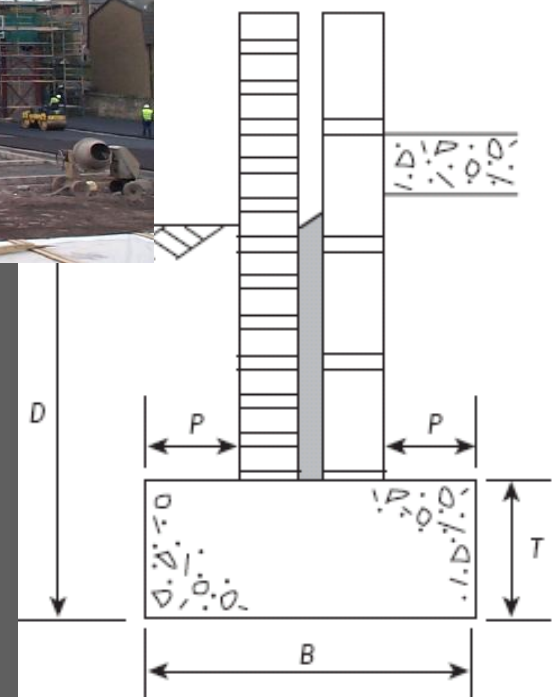
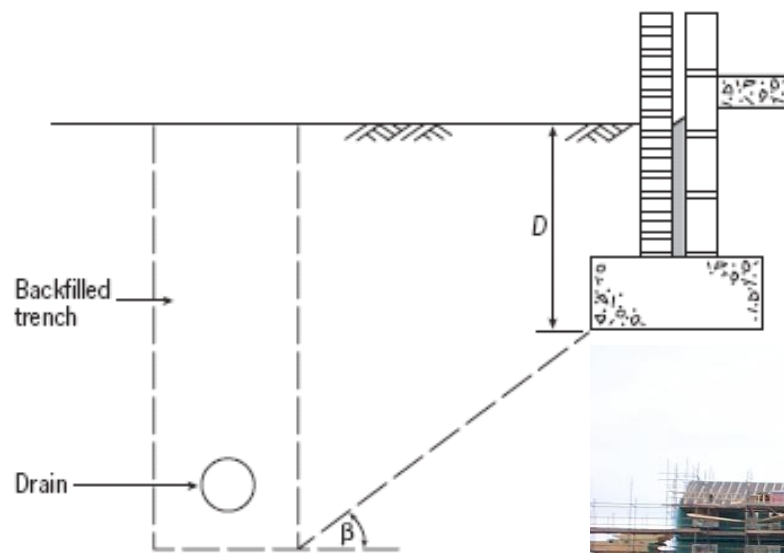
1m, whichever is greater



# Types of foundations

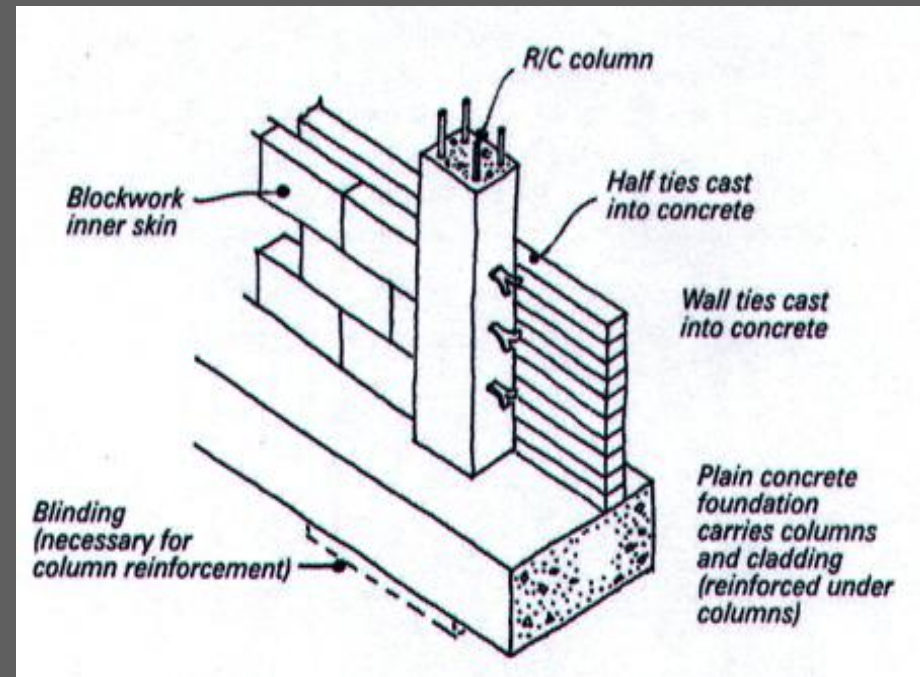


Deep strip foundation



# Types of foundation

Combining point loads and continuous loads on to a strip foundation.

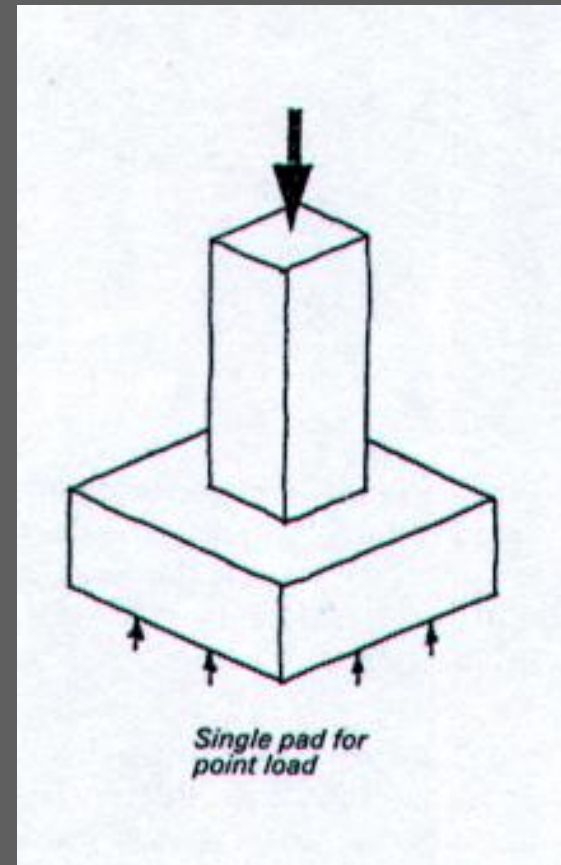


# Types of foundations

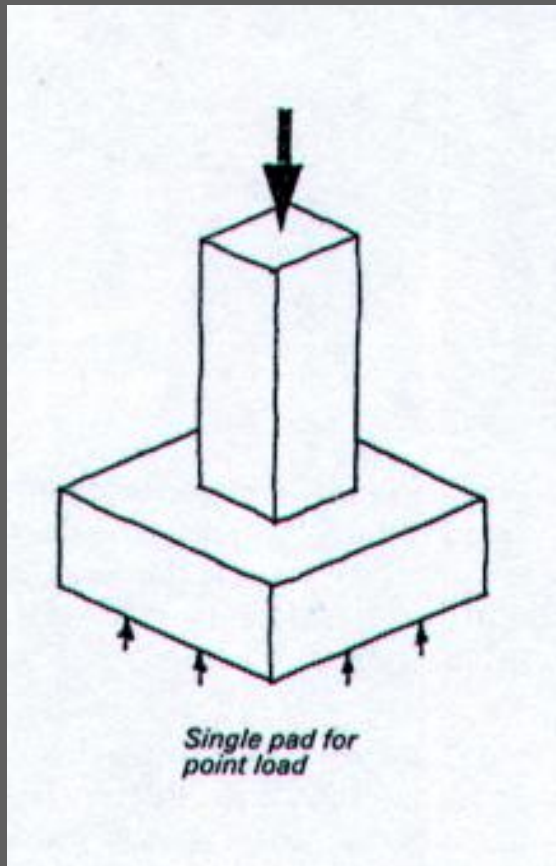
## Pad foundations

Designed to carry individual loads:

- Steel stanchions
- Concrete columns
- Brick pillars
- Timber posts



# Types of foundations

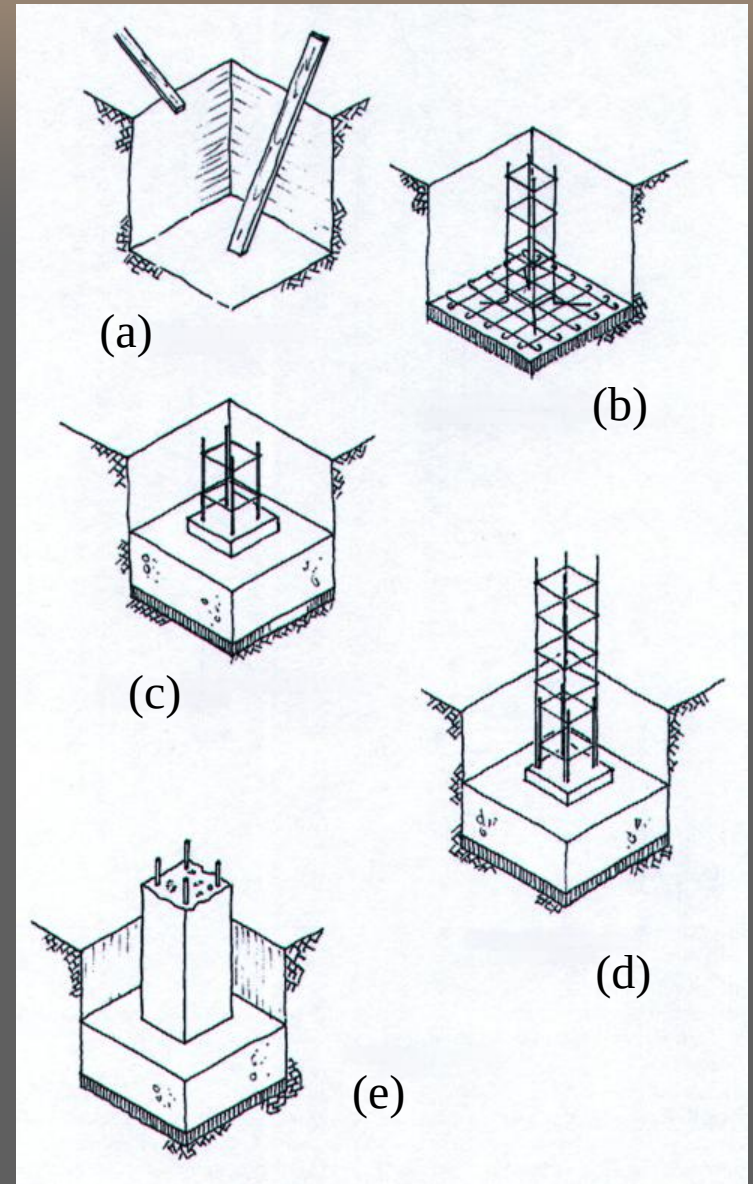


Workshop

Prepare an activity sequence for the construction of an insitu concrete column to a pad foundation

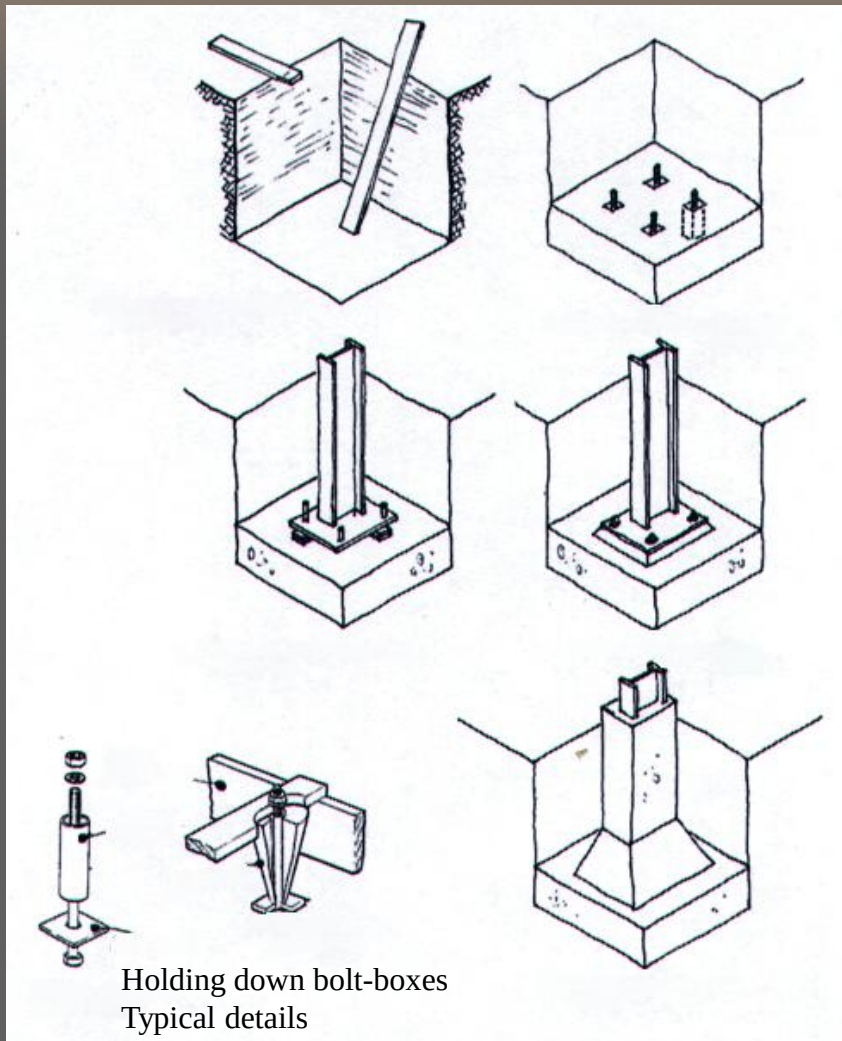
## Construction sequence

- (a) Excavate and support as necessary
- (b) Place blinding concrete, pad reinforcement and starter bars
- (c) Cast concrete pad, set out column and cast kicker
- (d) Place column cage reinforcement
- (e) Cast column and backfill



## Alternative sequence for steel stanchion

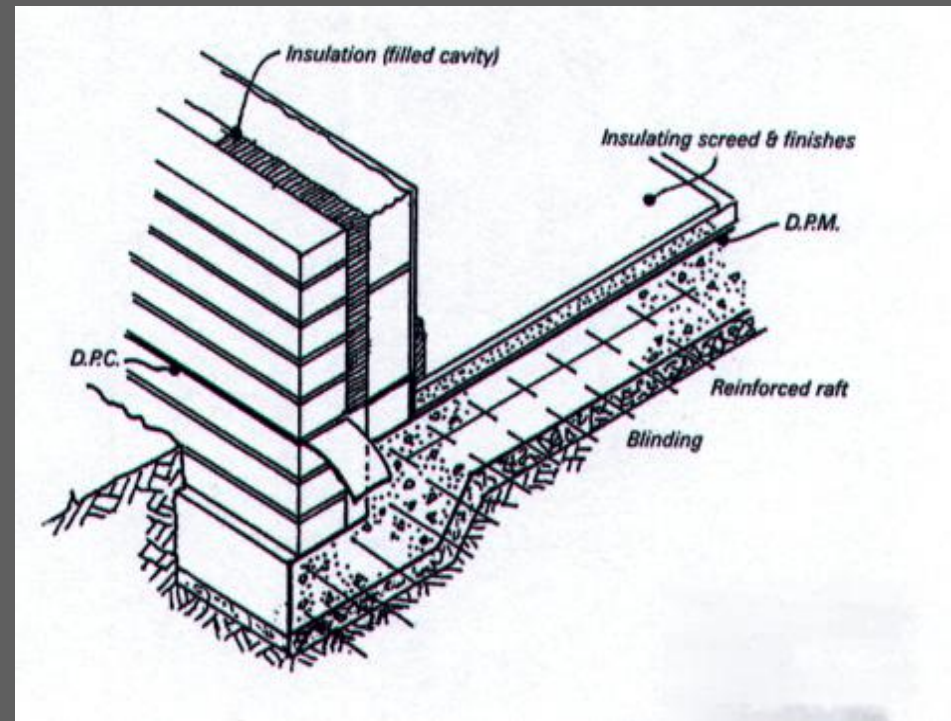
- (a) Excavate for foundation (if necessary)
- (b) Cast foundation with holding down bolts
- (c) Place and level shims, erect stanchion
- (d) Grout up and tighten bolts
- (e) Encase in concrete and backfill



# Types of foundations

## Raft foundations

A concrete structure continuous in two directions covering an area equal to or greater than the building's base.

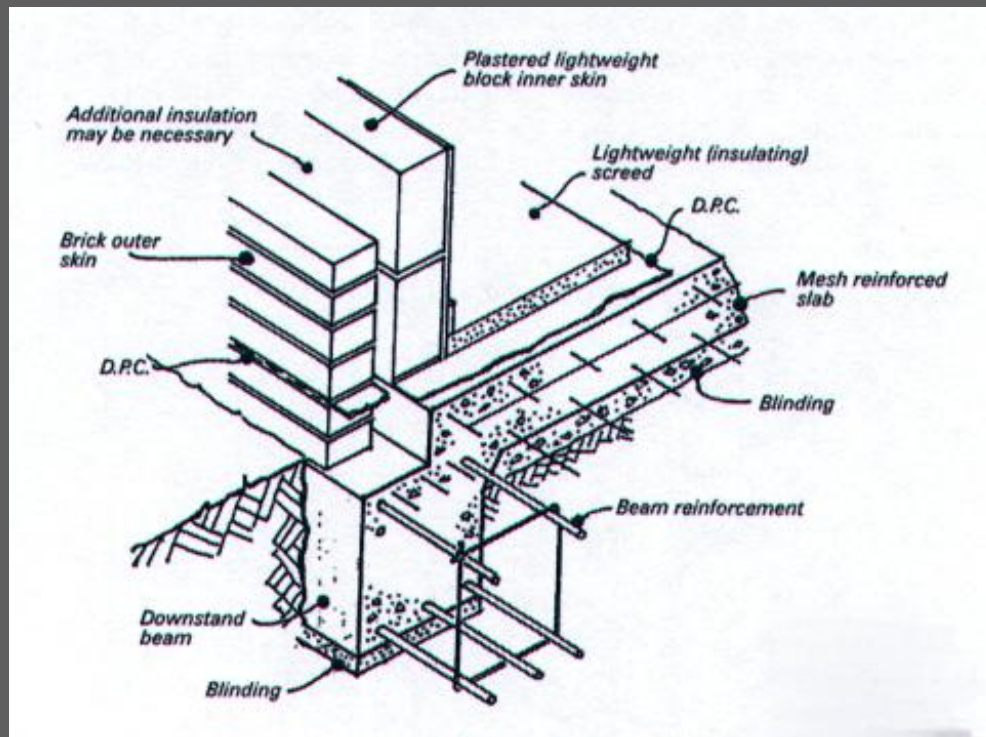


Simple raft construction

# Types of foundations

Rafts are considered :

- Where lightly loaded structures are used on poor subsoils
- Where variations in soil conditions necessitate a considerable spread of the loads
- For heavier loads in place of isolated foundations
- Where mining subsidence is likely



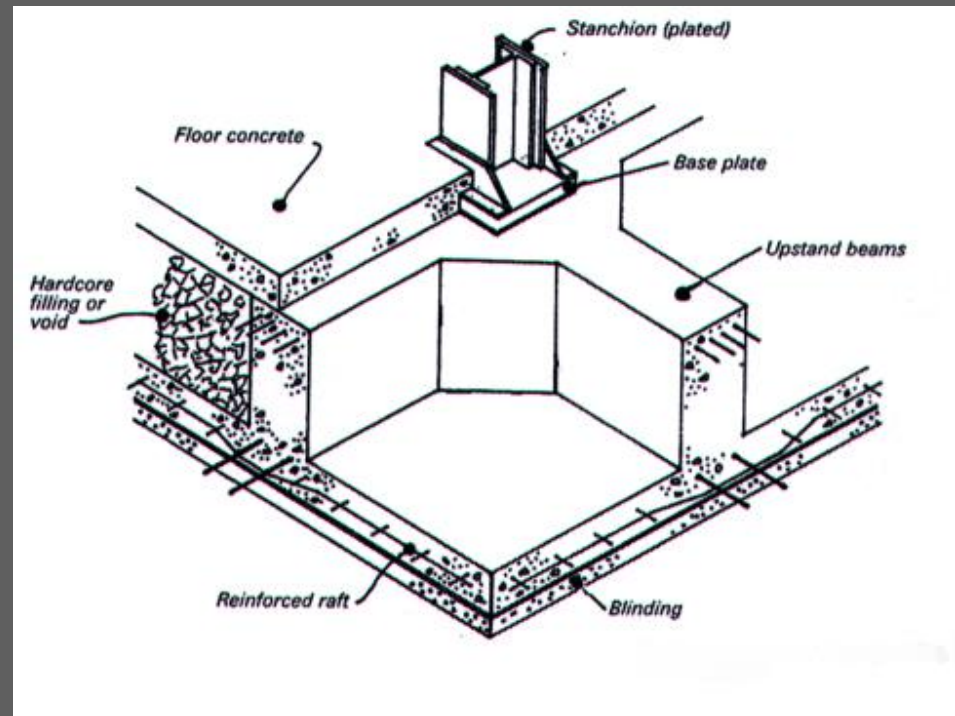
Beam and slab raft

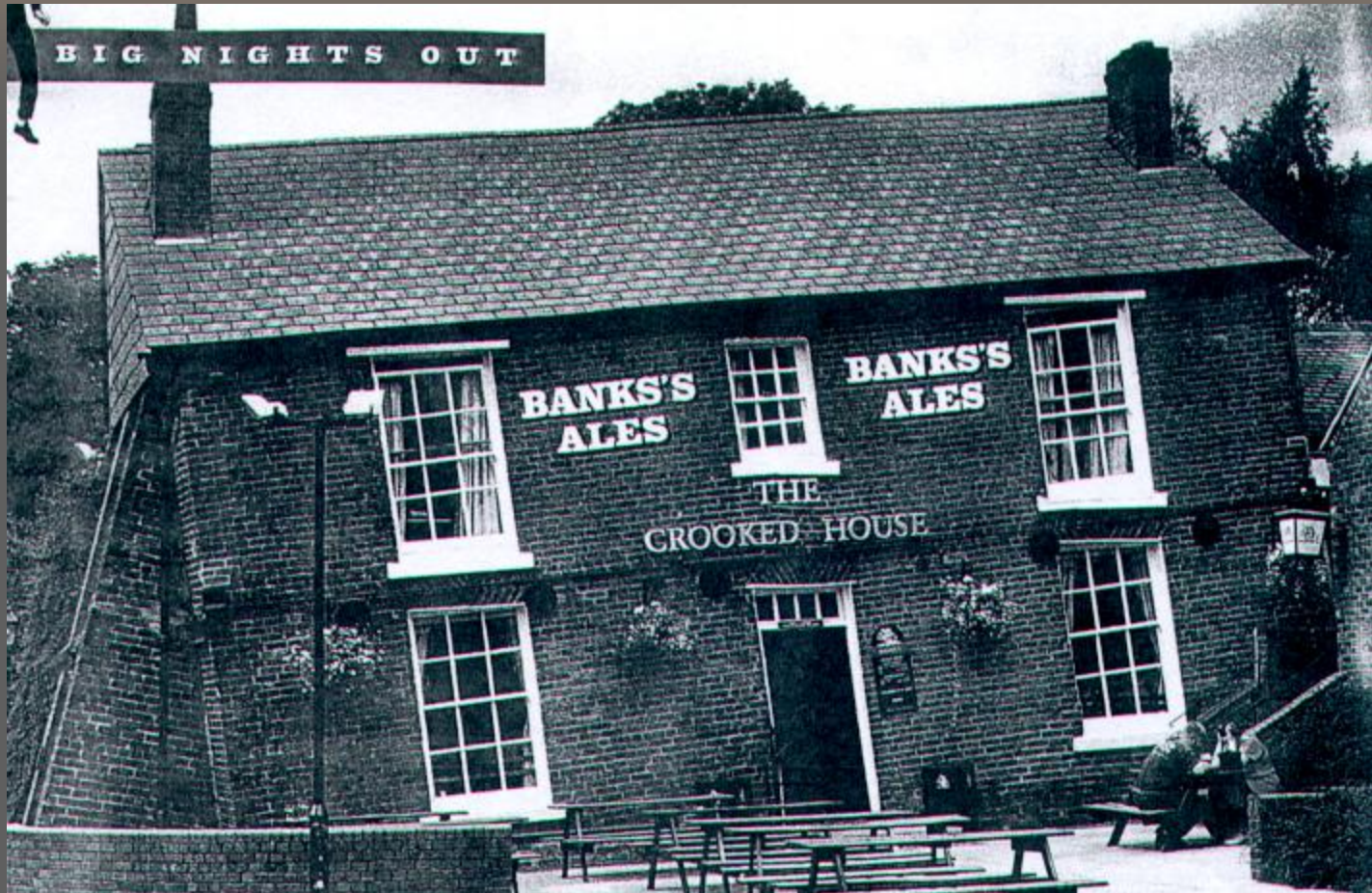
# Types of foundations

Beam and raft (upstand beams)

Workshop

Consider the detail shown for the upstand beam and raft and comment on the construction process





What happens if we get it wrong!

# Discussion

Using the knowledge gained on foundations consider the development of:

Cellular form of raft foundation.  
Cantilever foundations  
Combined column foundation

Write notes to explain:

what  
why  
where etc.

