Notes and Exam Paper Questions on the topic of:

Foundations and External walls

- Foundations form the major part of a buildings substructure (along with the rising walls, hardcore and ground floors)
- Once the substructure is complete the building is out of the ground and the superstructure (above damp-proof course level) can be built.
- As a major function of foundations is to support the buildings structure, it is vital that it be built on firm footings.
- Firm footings are not found near the grounds surface, therefore excavations need to be carried out to find a firm footing.

CLEARING THE SITE

- TREES AND VEGETATION:
    - Trees planted near buildings can cause unequal settlement because the roots extract moisture from the soil. This causes soil around the tree roots to shrink.
    - Retain trees if possible. As well as adding character, the presence of trees maintains the water table at a lower level than if they were not present

Top Soil

•Top layer of soil about 350mm deep

•Easy to compress therefore unsuitable for building on

•Remove and stockpile for garden,etc.

Subsoil Types

•There are four major subsoil (soil remaining once topsoil is removed) types

•Each is different with its own characteristics, the most important characteristic being its BEARING CAPACITY

•Bearing capacity (capability) refers to the weight that the subsoil can support without movement occurring.

•Some initial movement called settlement is allowed during and immediately after construction.

- There are four types:
    - Rock
    - Coarse-grained non-cohesive soils
    - Fine-grained cohesive soils
    - Peat and made-up ground

PRINCIPLES OF FOUNDATION DESIGN

Based on soil type and the purpose of the building, a suitable foundation can be designed and constructed.

- All foundations must be:
    - Able to safely sustain and transmit to the ground the combined dead and live loads so as not to cause any settlement in any part of the building
    - Constructed to avoid damage by swelling, shrinkage or freezing of the subsoil
    - Strong enough to prevent downward vertical loads shearing through the foundation at the point of application
    - Able to withstand attack from corrosive elements in the soil, e.g. sulphates

LOADS TO BE CARRIED BY FOUNDATIONS

- The loads supported by a foundation are made up of:
    - The Dead Load – combined weight of substructure, superstructure, all constructional elements and finishes
    - The Superimposed Load – weight of occupants, furniture, moveable goods and even snow resting on the roof
    - The Wind Load – force that wind blowing from any direction at a likely maximum velocity, will exert on the building

Concrete

- Concrete is the material which is vital for a foundations structure.
- Concrete as we know it now consists of:
    - Cement
    - Aggregate (coarse and fine) (about 80% of mix)
        - Coarse – gravels, crushed stone – must be clean
        - Fine – must pass through 5mm sieve, e.g. sand
    - Water

Why we use concrete?

•Very strong in compression

•When cement is mixed with water a chemical reaction known as hydration takes place.

•The resulting paste coats the surface of the aggregates and binds them together.

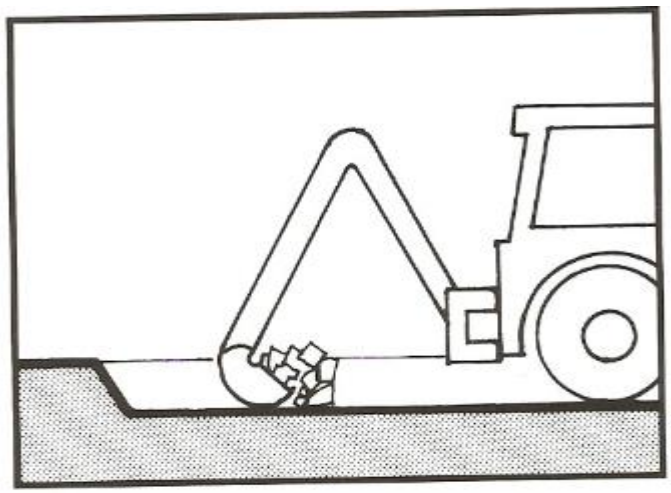
•The binding is achieved by the progressive setting and hardening of the mix

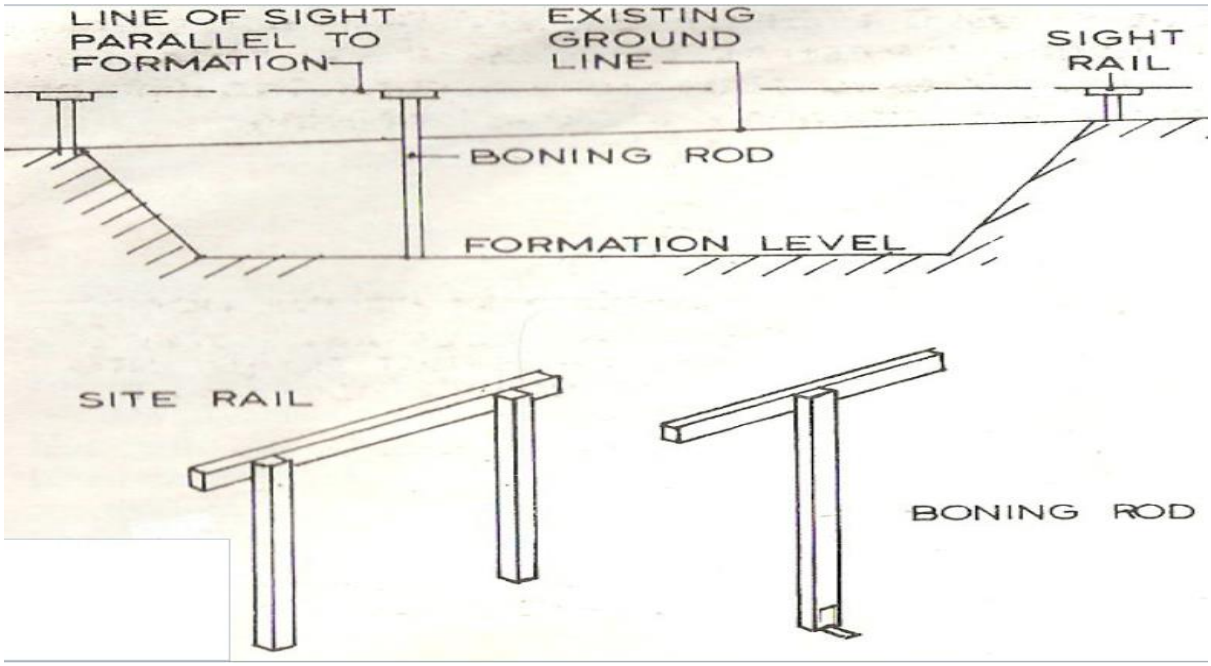
Settlement

- Settlement results from:
    - Consolidation of soil
    - Cohesive soils bulging
    - Removal of water from soil
    - Plastic flow of soil from under the building
    - Soil erosion by wind or water
    - Foundation design must allow settlement to occur evenly to avoid straining or cracking

TOPSOIL – EASILY COMPRESSED SOIL 150MM-300MM DEEP AT TOP OF SOIL LAYERS.

ONCE THE TOPSOIL HAS BEEN EXCAVATED A FIRM LEVEL FOOTING IS FOUND FOR THE ENTIRE AREA. FROM HERE THE EXCAVATIONS FOR PLACING THE FOUNDATIONS CAN BE CARRIED OUT.





- This is done by using site rails and boning rods
- Sight Rails allow sighting to be done, and consist of LEVEL PEGS DRIVEN INTO THE GROUND. They are placed OUTSIDE THE PROPOSED AREA OF EXCAVATION SO AS NOT TO OBSTRUCT THE WORK.
- Should be high enough above ground to allow for sighting
- Helps to keep excavations IN LINE.

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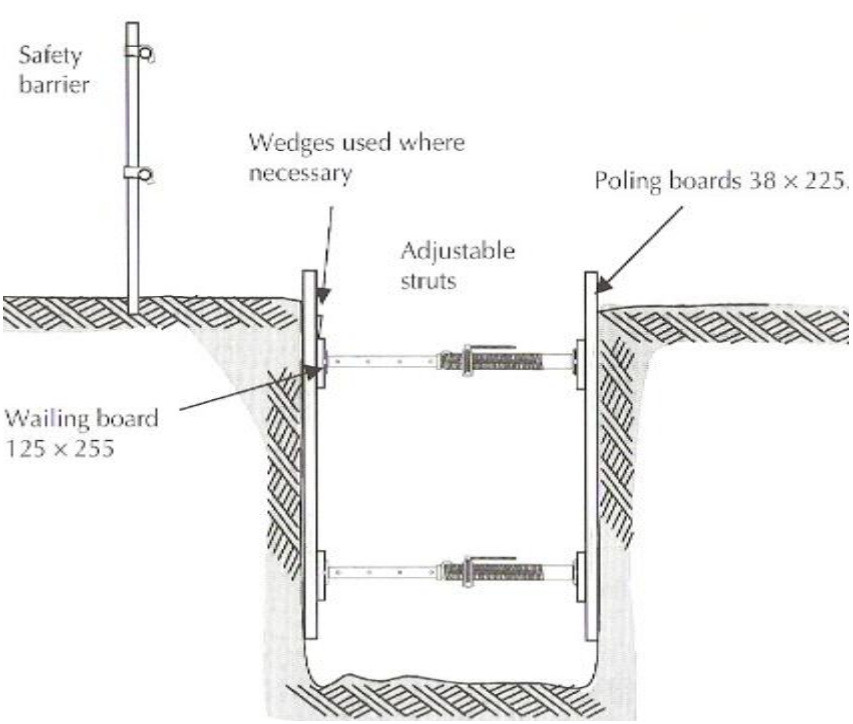
POLING BOARDS -Up to 2m long with 200mm x 38mm cross section. They are place against the side walls of the excavation VERTICALLY.

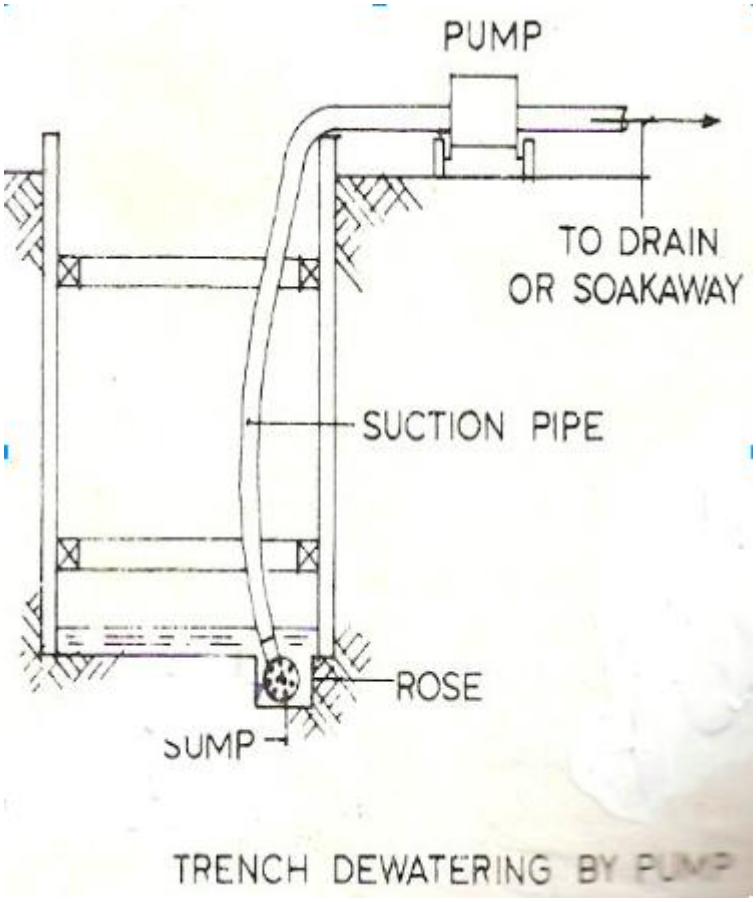
WAiLINGS - HORIZONTALLY placed boards of cross section 150mm x 50mm, which support the poling boards

STRUTS - HORIZONTAL members cross section 100mm x 100mm which press the wailings against the poling boards. Struts should be placed up to 2m apart to allow work continue



Problem of water in the excavation

- Water is found at some levels in all soils. This level is known as the standing water table.
- Excavating below this will result in water seeping into the excavation, thereby interfering with the work by obscuring the views of the bottom of the excavation, causing side walls to erode and resulting sloppy material making excavation difficult.
- Rainfall may also result in filling the excavation with water.



Solution:

•Water is pumped away from the lowest point of the excavation, usually a shallow pit called a sump.

•This process is called dewatering

Types of Foundations

- The three fundamental principles of foundation design involve:
    - The foundation bearing down on suitable subsoil. The strip foundation is the most common solution to this scenario
    - The foundation obtaining its strength from friction with the surrounding earth. Pile foundations are an example of this principle
    - The foundation floats on the surface of poor to good soil as exemplified in raft foundations

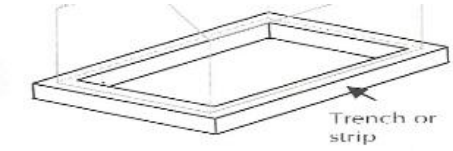
•Based on these principles there are four main types of foundation:

•Strip

•Raft

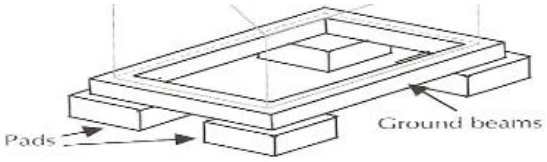
•Pile

•Pad



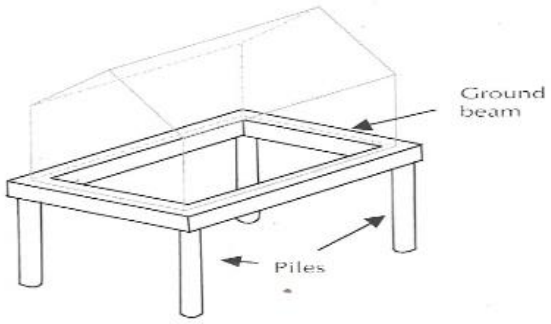
A Strip foundations

Used to transfer long continuous loads (such as walls). The width and depth of the foundation will depend on the nature of ground and building loads.



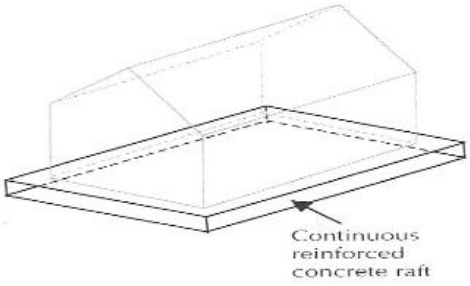
B Pad foundations

More commonly used under point loads such as columns, but can be used under ground beams to transfer continuous loads. The width and depth of each pad foundation will depend on the soil conditions and building loads.



C Pile foundations

The pile foundation takes the load of the building through made-up ground or weak soil to load-bearing strata. Ground beams transfer the building loads to the piles.



D Raft foundations

Reinforced concrete raft foundations spread the load over the whole building area reducing the load per unit area. Raft foundations are used where building loads are high or ground conditions are poor.

Four types of strip foundations

- There are four types of strip foundations:
    - Traditional strip foundation
    - Stepped strip foundation
    - Wide strip foundation
    - Deep strip foundation

Traditional strip foundation

•A continuous strip of reinforced concrete resting on the soil

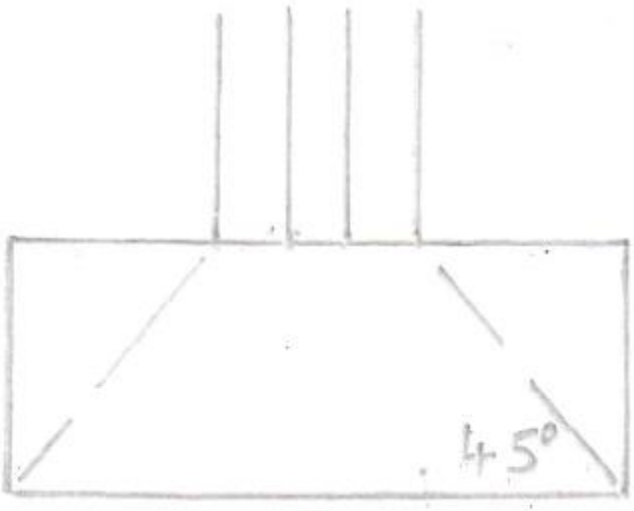
•Depth and width must be suitable for soil type and building load

•Walls are placed centrally on foundation

•Strip foundations are used on average to good bearing capacity soils

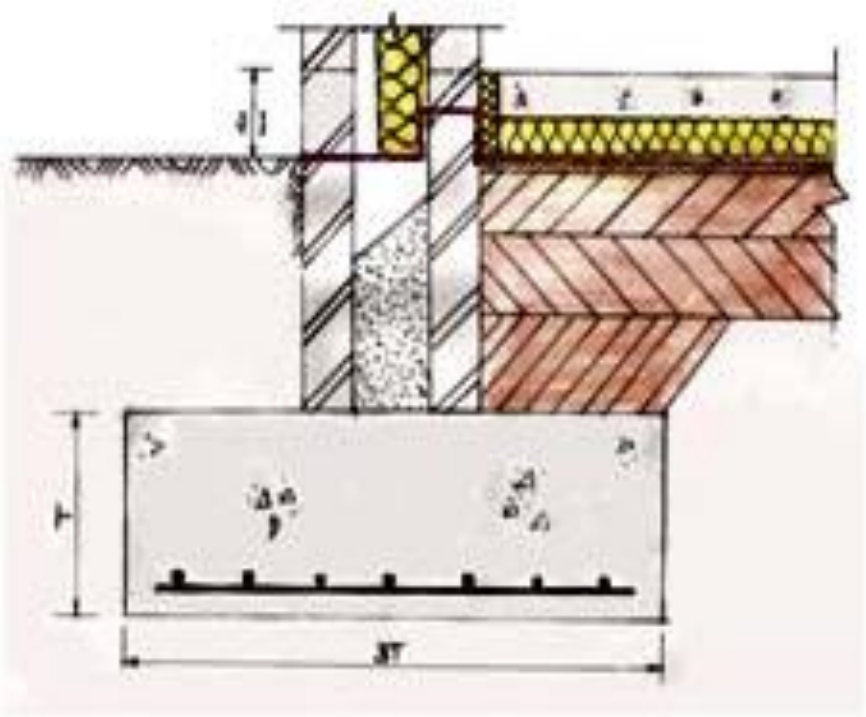
•Not suitable for very soft clay, silt, or peat, or badly made-up ground.

- The concrete thickness must not be less than the amount by which it projects from the base of the wall.
- This is as when a strip foundation is compressed between the wall and the subsoil, a weak foundation will tend to crack at an angle of 45 degrees.
- If the thickness of the strip is at least equal to the amount it projects from the wall then the bearing of the strip is not affected



Strip/Raft/Pile Foundations

Strip Foundation Detail



Strip foundation

- Reinforcement
- Hardcore
- Cavity fil

l • Sand blinding

- Radon barrier
- 600 mm min. to the bottom of the foundation to avoid frost heave
- Insulation.

My Sketch

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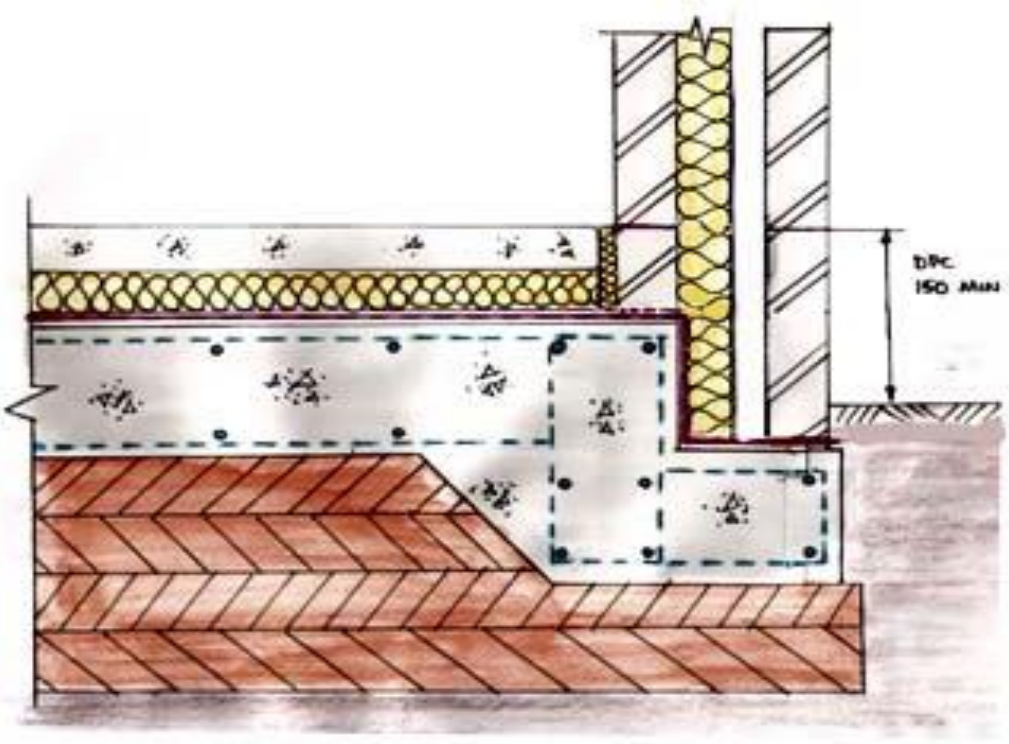
Raft Foundation

- A raft foundation is a large concrete slab covering the whole building area.
- All loads are transmitted through the raft to the soil
- Rafts are suitable for low load bearing soils, such as soft natural ground or made-up ground.
- Rafts consists of a reinforced concrete slab up to 300mm thick, with the slab thicker under load bearing walls

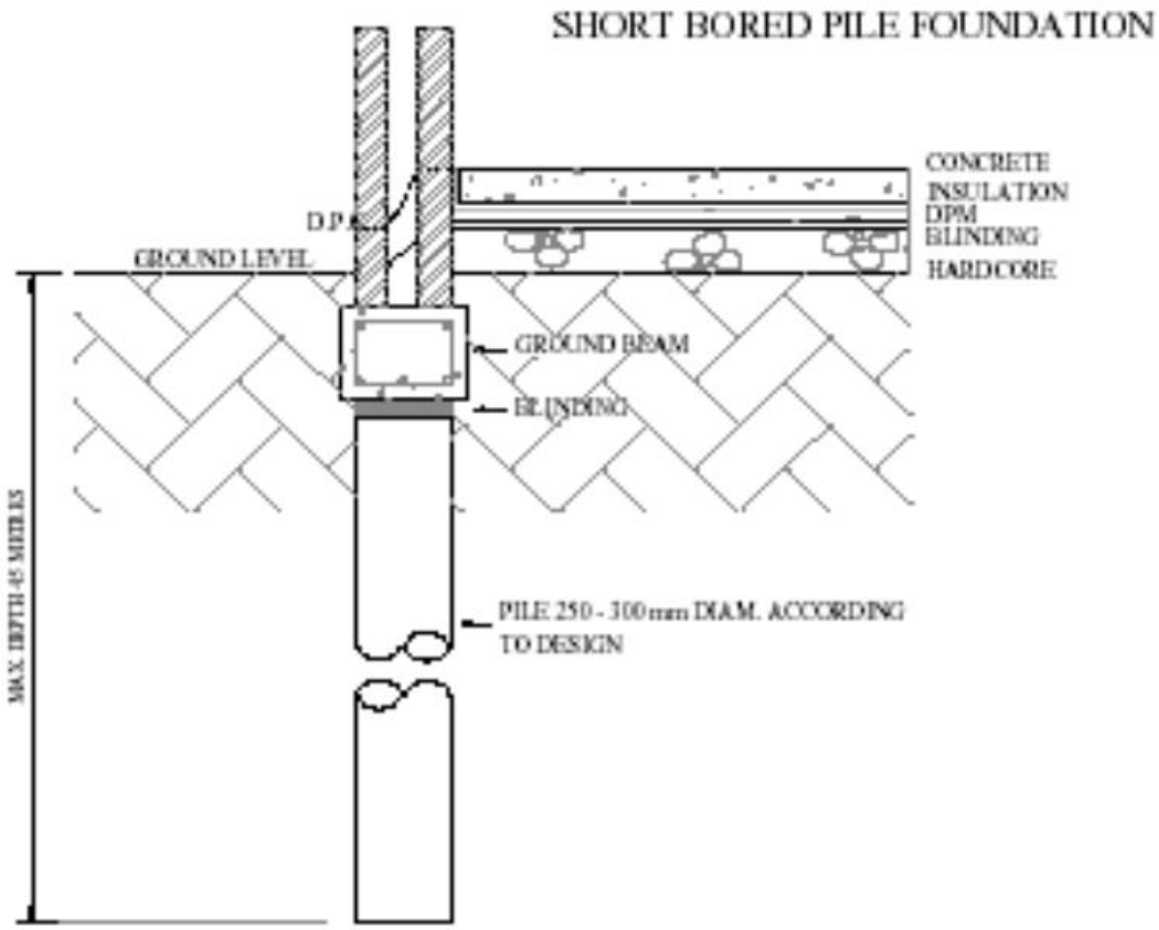


• Hardcore
• Concrete raft
• Steel mesh reinforcement
• Radon barrier
• Insulation
• DPC 150mm min. above GL

My Sketch

Short Bored Pile Foundation

- Avoid excessive excavation in subsoils of poor load bearing capacity.
- System of short concrete piles cast in holes bored in the ground and spanned by light reinforced concrete beams.
- Holes bored by mechanically operated auger to depth of 1.5-3.5m depending on ground conditions.
- Immediately filled with concrete
- Reinforcing bars placed into the top 600mm of concrete to connect the piles to the ground beams



Why choose a Strip Foundation?

Traditional strip foundation – reasons

• Suitable for moderately firm clay sub soil
• Easily constructed, easily filled and levelled
• Economical in terms of materials, especially aggregate, cement and mild steel
• Economical in terms of labour

Why choose a Raft Foundation?

Raft foundations – reasons

• Suitable for soils of poor load-bearing capacity
• Faster to set out and remove – saves on labour costs
• Reduction in settlement as the loads are spread evenly over the entire area of the house
• Mesh reinforcement reduces the risk of differential settlement
• Allows for a change of internal layout as load-bearing walls may be positioned anywhere on the raft.

How do you ensure maximum strength of concrete in you foundation?

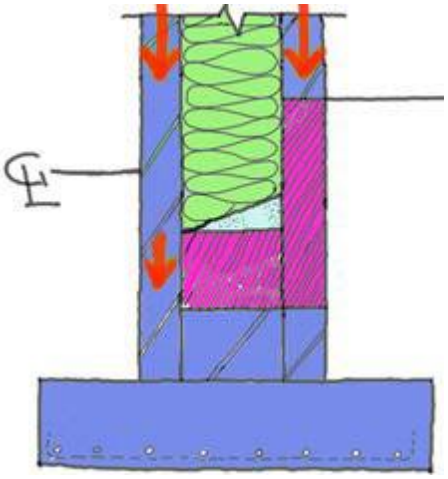
Correct site preparation. The bottom of the trench should be level and free of loose soil particles
• Use of good quality materials – clean aggregates correctly sized
• Correct batching of fine and coarse aggregates, batching by weight is the most accurate, correct water /cement ratio
• Correct placement of reinforcement - should be designed by structural engineer Reinforcement – minimum cover of 75 mm to prevent corrosion
• Concrete should be allowed cure before any blockwork is placed on the foundation (28 days recommended)
• Concrete should be protected from extreme heat or cold during the curing process
• Too high a water / cement ratio (ideal 0.6) - mix too wet - greatly weakens the concrete
• Use sulphate resisting cement where necessary
• Correct vibration/compaction of the concrete to ensure that there are no air voids in the foundation
• Avoid excessive vibration as this may lead to a segregation of the aggregates
• Placement of concrete – should not be dropped from a height.

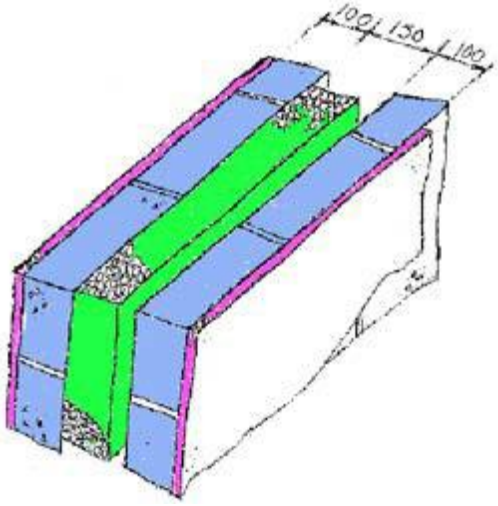
2013 Exam Paper Q8

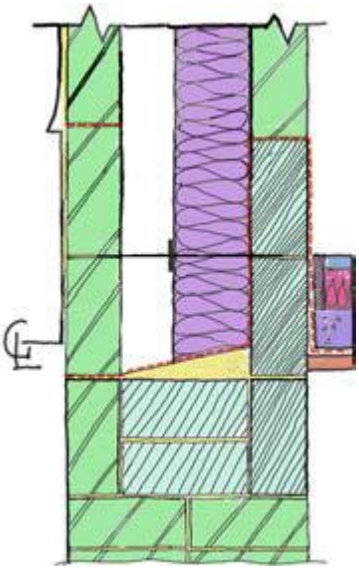
External Walls

Function of the external wall

- keep the occupants safe, dry and warm – shelter from the elements
- support the floors/upper floor(s) and roof
- anchor roof to walls
- spread evenly the superimposed loads over the foundations
- provide robust openings for doors and windows
- have sufficient structural integrity to avoid cracks or other failure under load
- provide low-maintenance climate-proof exterior surfaces
- prevent the transfer of heat to the outside or to the inside of the dwelling
- insulate evenly against the formation of cold bridges
- prevent the formation of condensation and dampness
- prevent interstitial dampness
- prevent the uncontrolled passage of air through the structure
- stop the ingress of water
- prevent access of vermin to the building and the roof space
- be aesthetically pleasing and be in keeping with the surroundings of the dwelling.







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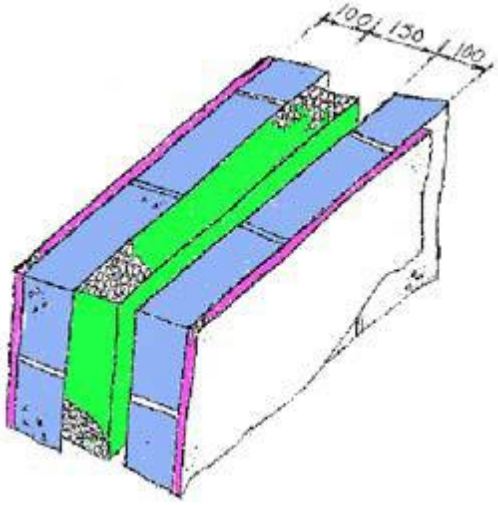
Different types of external walls

- concrete block with partial-fill insulated cavity
    - concrete block with full-fill wide insulated cavity
    - timber frame with insulated inner leaf and weatherproof external cladding
    - timber frame with concrete block external leaf and insulated inner leaf
    - light steel frame or combination wood and steel frame with insulated external cladding
    - solid concrete block with external insulation and weather proof exterior finish
    - timber frame with external insulation and weather proof external rain screen
    - solid stone walls with breathable insulation and plaster
    - straw-bale
    - cob
    - rammed earth.



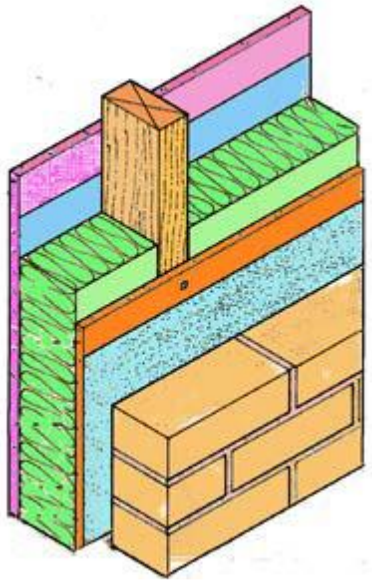
Evaluate two different external walls

Concrete block with insulated cavity

• robust inside and outside
• readily takes a range of economical, easily applied finishes
• provides a heat sink in the blockwork of the inner leaf
• needs relatively more heat to bring the internal temperature up from cold
• the insulating materials are protected from accidental damage
• materials and skills widely available – traditional skills of blocklaying
• convenient and robust fixing for cills, windows, door frames and other components.

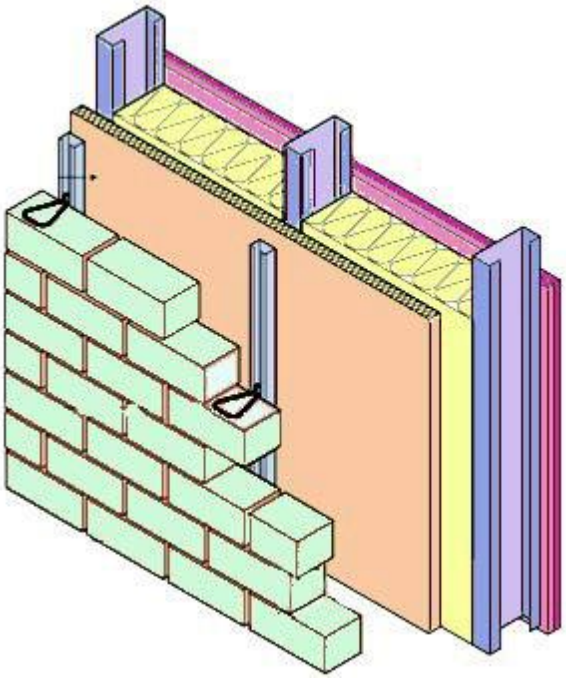
Timber frame with insulation and weather proof external cladding *- such as*

• easily accommodates greater thicknesses of insulation
• uses of sustainably produced materials – low embodied energy
• wood aids carbon sequestration • reduces use of concrete – less CO2
• quicker heating of living spaces - using less energy
• allows wide choice of rain screens and external finishes
• cement board can be used as external rain screen
• high air-tightness standard, particularly if sections are manufactured off-site
• services more easily accommodated within the service cavity
• quick to erect - saving on erection and drying-out time, can be assembled off- site



Light steel frame or combination wood and steel frame with external insulated cladding - *such as*

- speedily erected
- high insulation values possible
- more complex detailing required around openings, particularly in the fixing of door and window frames and at cills
- mounting of fittings, such as light fittings, rainwater goods etc, on external surface more exacting
- exterior finishes available more limited.



Q2 2015 Exam Paper