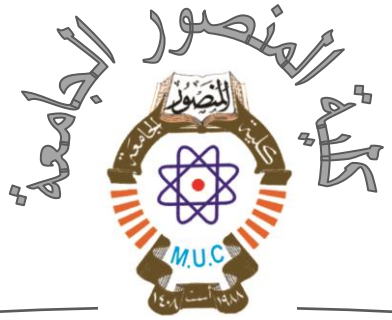


Al-Mansour University College

قسم الهندسة المدنية | Civil Eng. Dept.

المرحلة الثانية | 2nd. Stage

Building Construction

2022 - 2023

1

انشاء مباني

Lec. Eng. Basher Faisal

❖ ***Building Construction Steps***

1. **Project target:** Each project must have a target such as: Residential buildings, commercial buildings, offices, schools, a factory, a bridge, dam, roads, etc.
2. **Budget:** Any project must have a budget for design and also for construction.
3. **Location:** Every project must have a location i.e, site and utilities such as water supply, electric power, sewage drainage, and so forth.
4. **Project requirements:** Project documents must be prepared which should include information about cost, construction time, construction materials, etc.
5. **Engineering design:** This includes all architectural, civil and structural design as well as electrical, mechanical and plumbing and drainage design. The design drawings should also include site plan, projection of buildings on plan and all required details.
6. **Geotechnical investigation:** Before beginning of structural design, soil investigation of the site is required. A geotechnical report needs to be issued by the soil mechanics lab with recommendations for type of foundations and method of construction. For local houses such investigation is not required.

b. Load bearing walls building:

In these buildings, brick or block walls may carry the floors and load is transferred to the foundation through the load bearing walls.

c. Framed and bearing wall buildings:

With this type of buildings, steel and reinforced concrete columns and beams are in one part of the building, while the other part consists of load bearing walls.

d. Steel frame buildings:

This type of buildings is composed of steel frame with steel beams and columns which transfer the loads of floor slabs to the foundation.

- **Advantages of steel framed buildings:**

1. High tensile and compressive strength which provides smaller steel section than that of reinforced concrete elements.
2. Load from steel structure on the foundation is less than that from reinforced concrete skeleton structure, hence economy in foundation cost.
3. Construction of steel skeleton building is usually faster than cast in site reinforcement concrete building.

- **Disadvantages of steel skeleton buildings:**

1. Steel structure is weak against fire and it must be well protected from fire.
2. Steel is subject to rusting and requires a continuous maintenance.
3. The shaping of a steel frame building is rather limited when compared to concrete framed building.
4. Steel structure is imported from abroad and hence the cost is usually quite high.

❖ ***Earthworks***

Every construction project has specific earthwork which is classified into two types:

a. Excavations
b. Earth filling

a. Excavations:

Excavation includes trenches, foundations, pits, basements and so forth. Excavation is done either by hand or done mechanically or may be done by both ways depending on many factors such as soil conditions, shape of cut section and ground water level.

Control of Ground Water

The Control of ground water during excavation is quite important when the water table in the site is high.

Methods of Lowering Water Table.

1- Direct Dewatering:

It's the cheapest one. This is done by making trenches at lowest level of excavated area at the sides and leave the water to drain out by sloping outside the excavated area.

2- Dewatering by Pumping:

This method must be done with great care to avoid washing away of soil fines which will weaken the bearing capacity of the soil. Level of ground water is lowered by making trenches within the excavated area and placing sump pits at the sites.

3- Dewatering by Well /point System.

This method is done by placing group of metal pipes with 40 mm dia. around the excavated area with filter and valve at the end of each pipe. The pipes are placed vertically at the required depth with suitable spacing between them. All pipes are joined together with horizontal pipe which is connected to the pump that sucks and pumps the water outside.

There are some advantages by using this system.

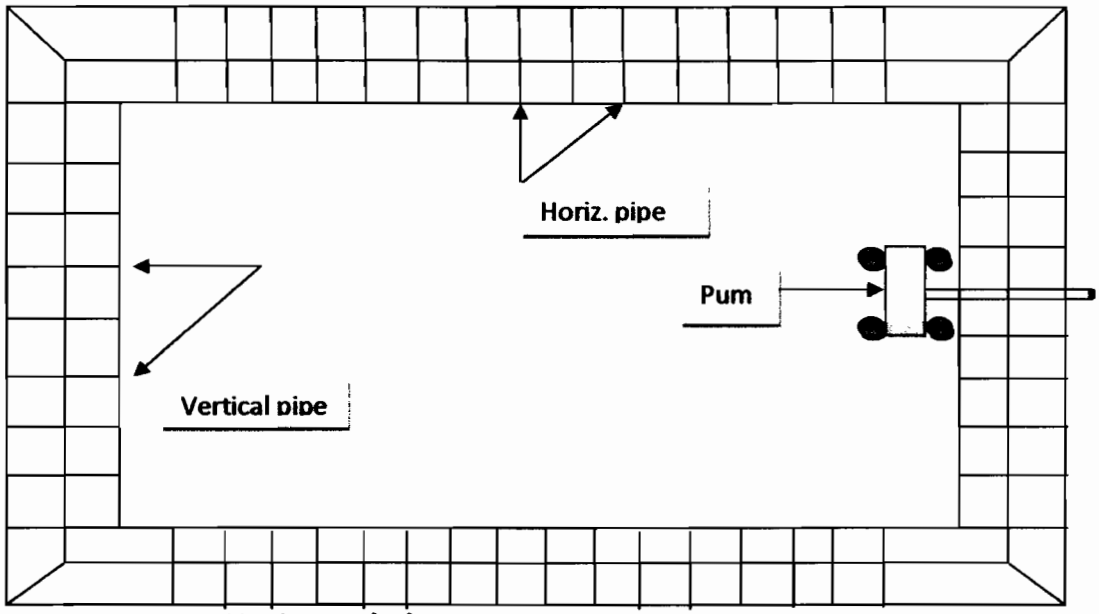
1- Ability to use more than one cycle of pipes around the excavated area for water discharge.

2- Ability to locate space between the pipes and their depth.

3- Ability to lower the water within the excavation.

4- This system is expensive compared to other methods.

5- This system is preferred to be used in sandy soil rather than in other type.



Horizontal Plan.

Filling the Earth and Compaction of Soil.

1- All building's foundation need to be back filled with soil after completing the casting of concrete foundation.
2- Ground level may need to be raised to a certain level, such as the ground floor slab area.
3- Back filling inside the building, including floor slab area, shall be placed and compacted in layers not exceeding 20 cm.
4- For landscaping and planting, only grass, bushes and trees which usually grow fast are to be used.
5- For interior roads and parking areas filling with sub-base shall be in layers of 20 cms. Compacting shall be with machine rollers to get the required dry density and a compacting of (90-100)% based on proctor test.
6- Backfilling and compaction soil shall not commence before the approval of the engineer and under his supervision.

Foundations

Foundation is that part of a building which is normally placed under natural ground level and bears the loads from the superstructure.

Factors Affecting on the depth of Foundation.

1- Types of soil and its layers which can carry the loads from the superstructure of the building.
2- Climate conditions and how to avoid the effect of temperature variation, hence top of the foundation must be at a depth not less than 30 cm.
3- Ground water and how to construct foundation above the water table or control the water table if necessary.
4- Location of foundation within the building and whether it has a lift, basement or shelter etc.
5- The foundation of adjacent building and it is effect on the depth of the new building foundation.
6- Underground services and their effect on the depth.
7- Depth of foundation such that it will not affect the existing trees which are to be retained.

The Soil Investigation.

Before starting any structural design of a building, it is necessary to carry out geotechnical investigation of the site by a specialized soil lab.

The soil technical report should contain the following:

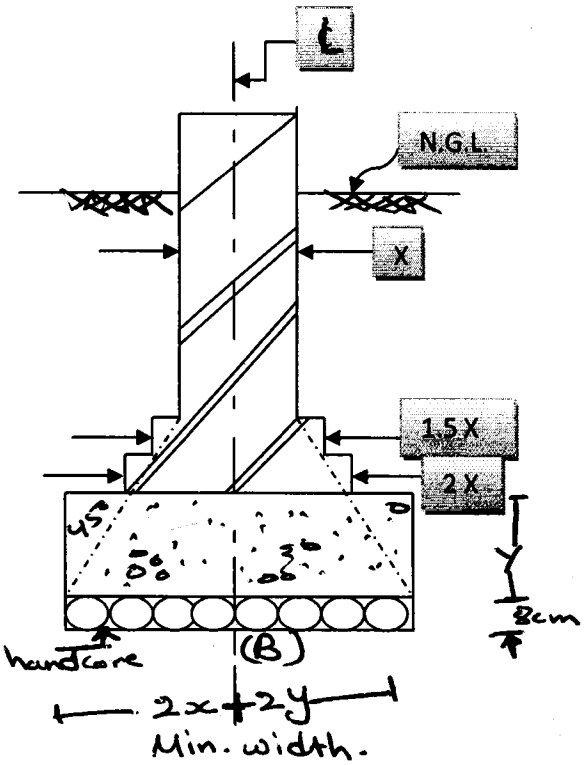
a- The physical and chemical properties of soil layers.
b- Recommendation of types of footing and its depth.
c- The bearing capacity of soil layers at different levels.
d- Recommendations for soil improvement if required and any necessary precautions to protect the footing.

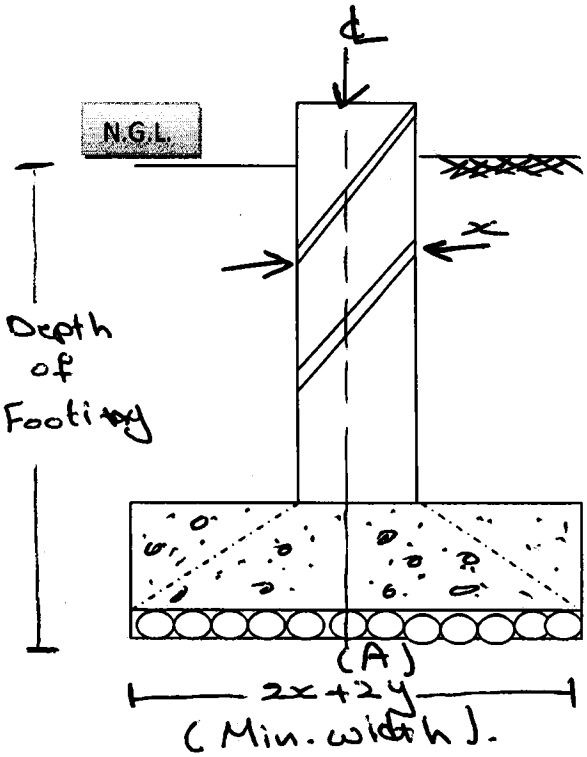
Expected Bearing Capacity of different Types of Soil.

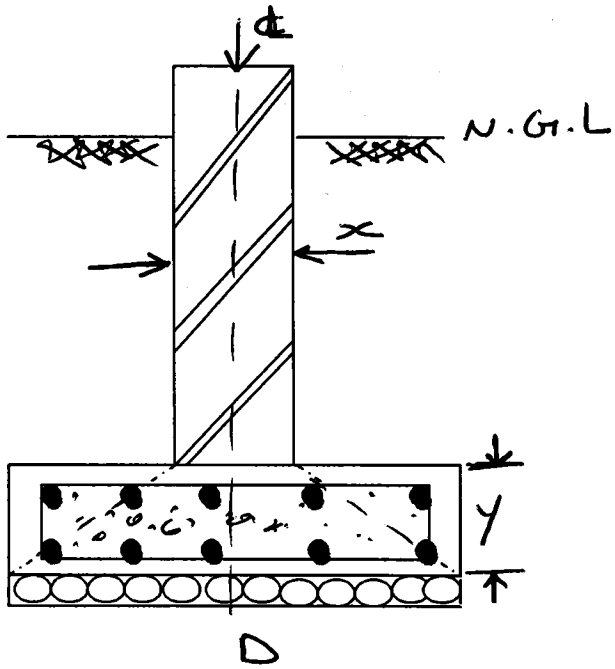
- Compacting gravel or rock soil	> 600 kN/m^2
- Compact Sand	> 250 kN/m^2
- Clay, stiff	150-250 kN/m^2
- Clay,firm	75-150 kN/m^2
- Loose Grave	< 200 kN/m^2
- Loose sand	<100 kN/m^2
- Soft Site , clay	~ 75 kN/m^2
- Very soft silt and clay	< 75 kN/m^2

Soil Classification According to bearing capacity :

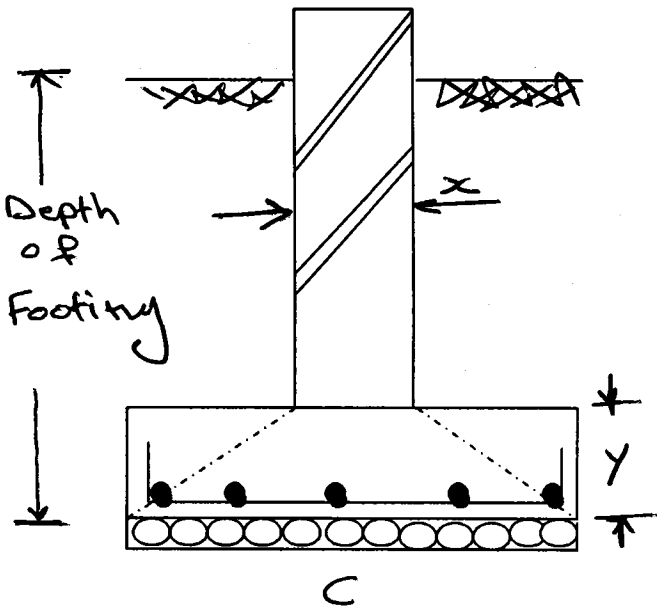
1- Incompressible Soil with high B.C.
2- Compressible Soil.







(Top and Bottom Rein.)



(Bottom Reinf.)

Wall Footing.

i. Hand Excavation:

1. This is done by using simple tools. This type of excavation can be used for small jobs such as continuous tranches for houses walls and also for shallow isolated or combined footings or strip footings.
2. Hand excavations are not used in rocky soil. In the usual way, the hand excavated soil is carted away to the tip of the pit or the trench, while for large quantities of soil; the excavated soil may be carried out of the site.
3. Sides of trenches and pits are important to be stable for safety of the workers and to avoid the spilling of lifted soil back into the trench or pit
4. In loose, wet or sandy soil, the sides of trenches may sometimes be supported by open timbering, i.e, close-boarded timbers or sheeting, but this may raise the cost stabilization of the sides of excavation.

ii. Mechanical excavation:

1. This type of excavation is used for large excavated earth and when all soil is required to be carried away from the site. The common equipment to be used is the industrial tractor with shovel and blade attachment. This method can deal with most of earth moving

Types of Wall Footings:

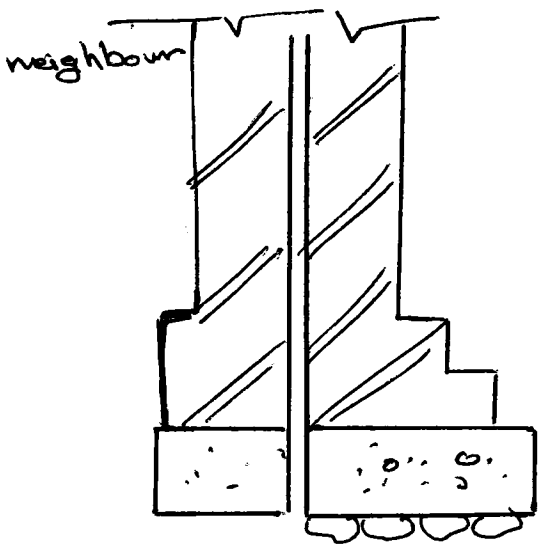
a- Figure (A) shows plain concrete footing. In this case, the width of footing (whose thickness is Y) is equal to (X+2Y) with minimum thickness = 20 cm.

b- Figure (B) shows the case of footing's width is less than (X=2Y) based on the bearing capacity of soil, then brick courses are constructed, or the footing may need to be increased.

c- Reinforcing steel may need to be added in both directions and placed at the bottom of the footing whose depth must be at least (25cm) as shows in fig. (C) Instead of using stepped brick courses on the concrete footing.

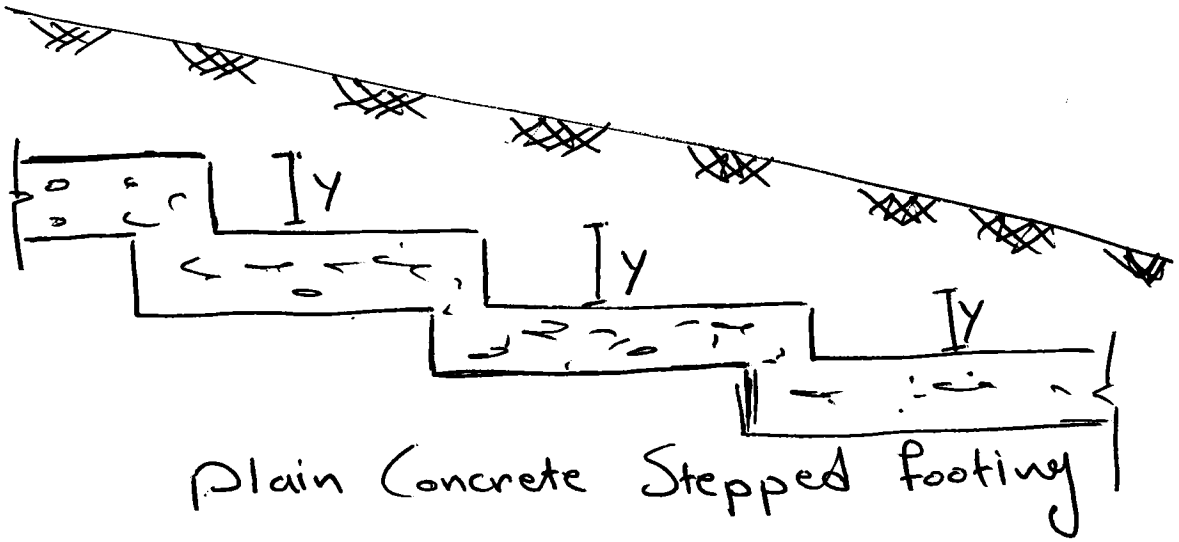
d- Two layers of reinforcement (fig. D) in the footing (top & bottom) may need to be used in the following cases.

1- Large window or door.
2- Expected differential settlement of footing due to different loadings on parts of wall.
3- The presence of refill soil under footing.
4- Presence of high water table and possibility of ground movement.
5- In case of Wall footing adjacent to existing neighbor wall footing, the figure on the right shows the usual footing next to the neighbor.

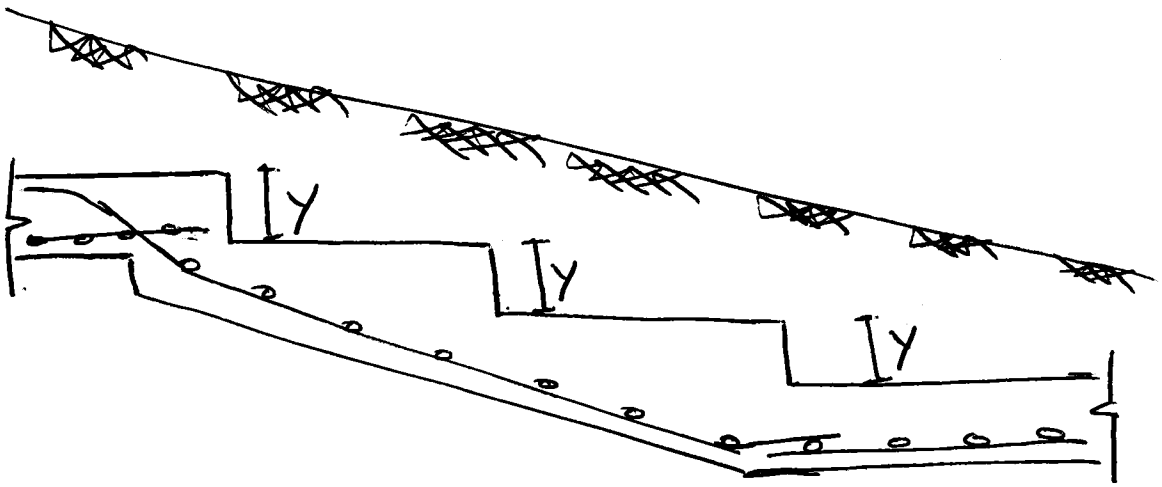


Wall Stepped Footing:

Stepped footing is used when the site is not flat. In this case the footing should be placed on good soil with the same thickness as that of flat footing.



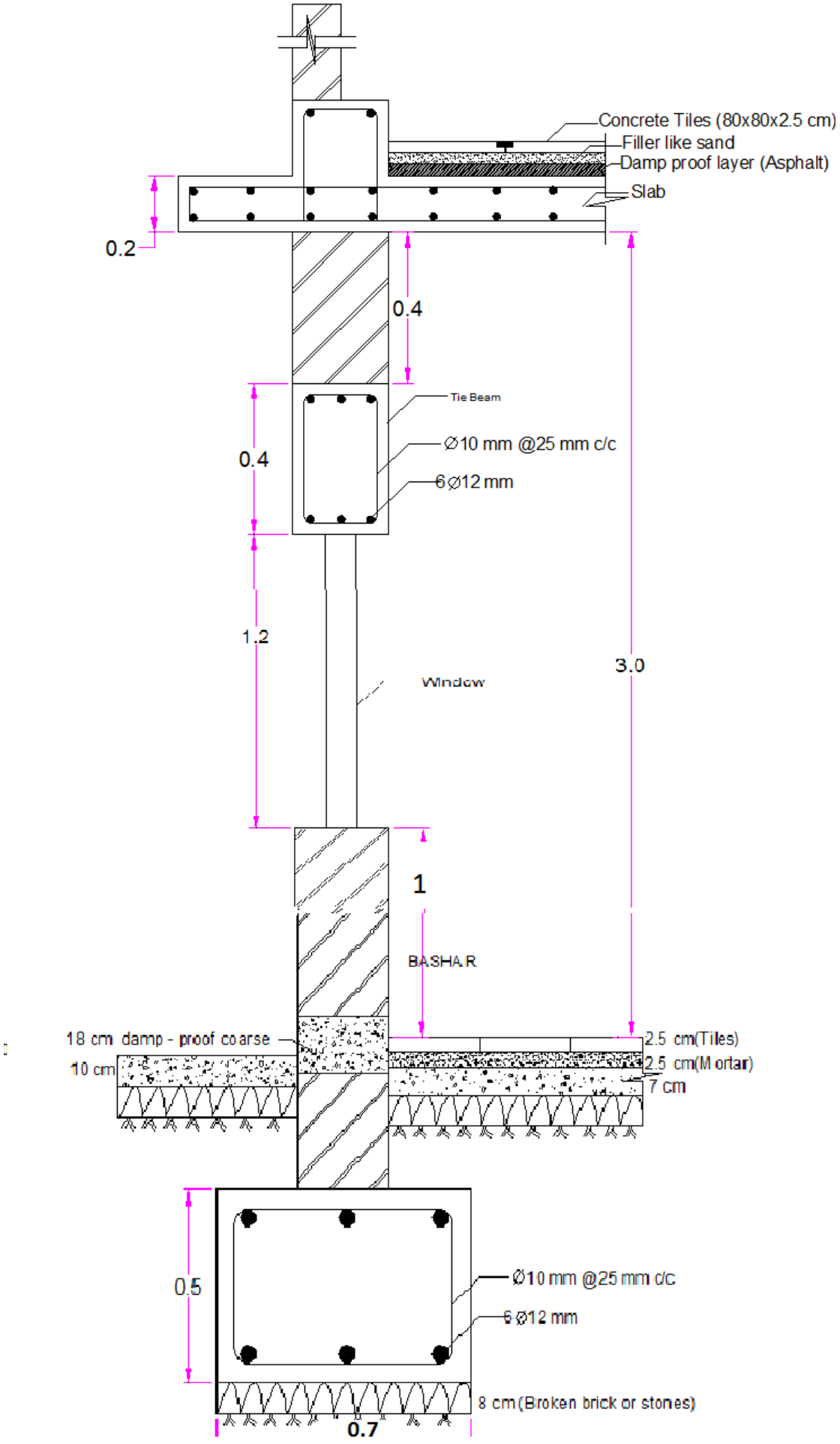
Plain Concrete Stepped footing



Reinforced Concrete.

Stepped footing

Section in continues foundation and bearing wall

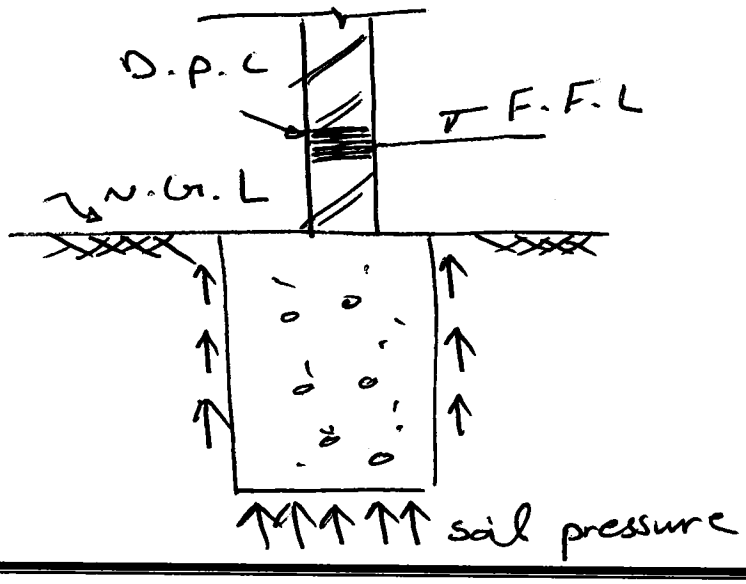


2- Strip Footing:

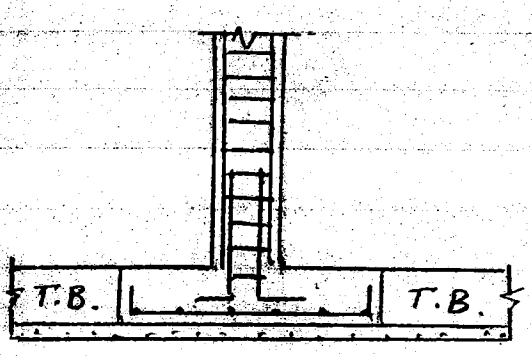
This type of footing is used sometimes instead of the common wall footing to make use of the friction force between the sides of the footing and the soil. This type of footing is commonly cast without steel reinforcement, but light reinf. sometime required especially in locations of large opening and concentrated loads.

Features of the Strip Footing.

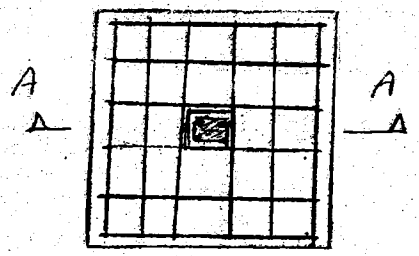
1- Construction of the footing is fast since it is made of one material hence is saves time when compared to the common wall footing.
2- It acts as a barrier (between both sides of the footing) for ground water and when D.P.C. material is added to the concrete mix. This footing will prevent dampness from spreading to the wall.
3- This footing acts as a deep beam to prevent differential settlement and bending moments in locations of large openings, but in this case some steel reinf. of footing is required.



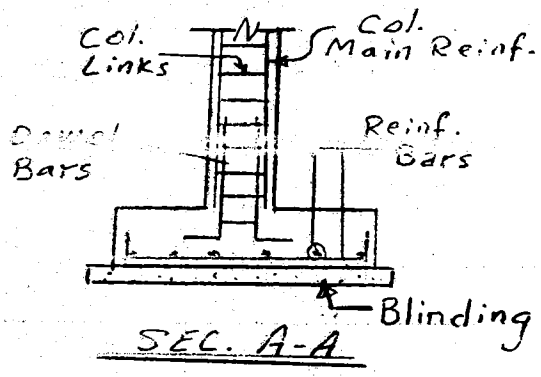
Isolated Footing



Tie Beam same Level with Footing



PLAN



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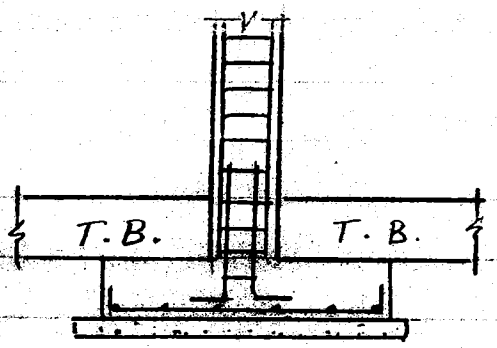
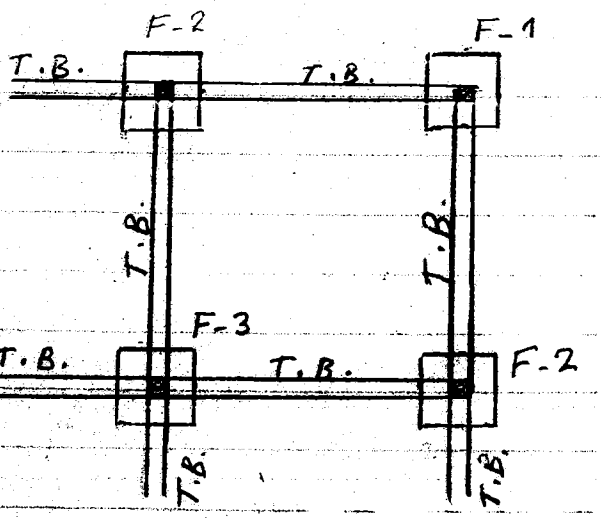
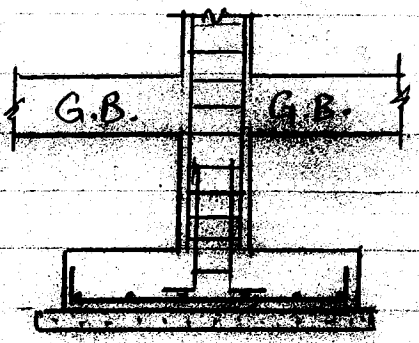


Tie Beam on Top of Footing





Ground Beam at Ground Floor Level

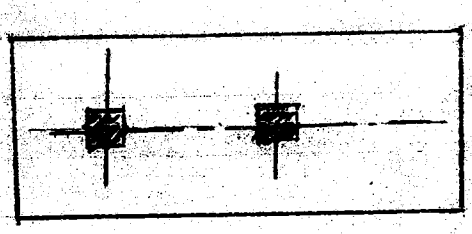
4- Combined Footing :

This is a single footing carrying two R.C. columns close to each other in a framed skeleton building, as shows in the next sheet.

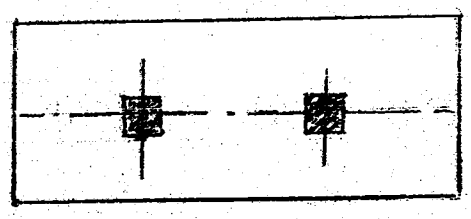
The footing may be of symmetric location of columns on it when the column loads are equal. If the loads are not equal, the columns' will not be symm.

When one column is on the edge of site & adjacent to neighbor , the shape of the footing may be as shown in the last two figures of next sheet.

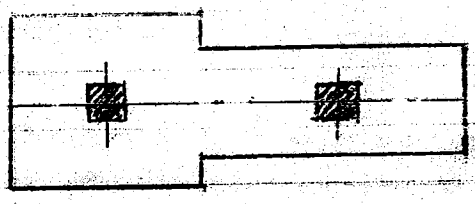
Types of Combined Footings



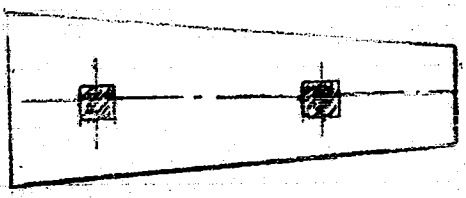
Combined Footing-
Rectangular Shape
(Not Symmetric)



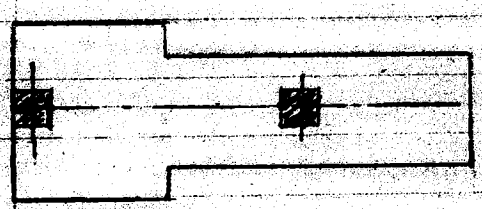
Combined Footing-
Rectangular Shape
(Symmetric)



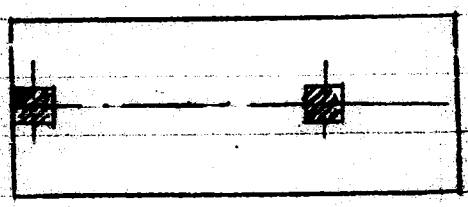
Combined Footing-
Two Rectangular Shape



Combined Footing-
Trapezoidal Shape



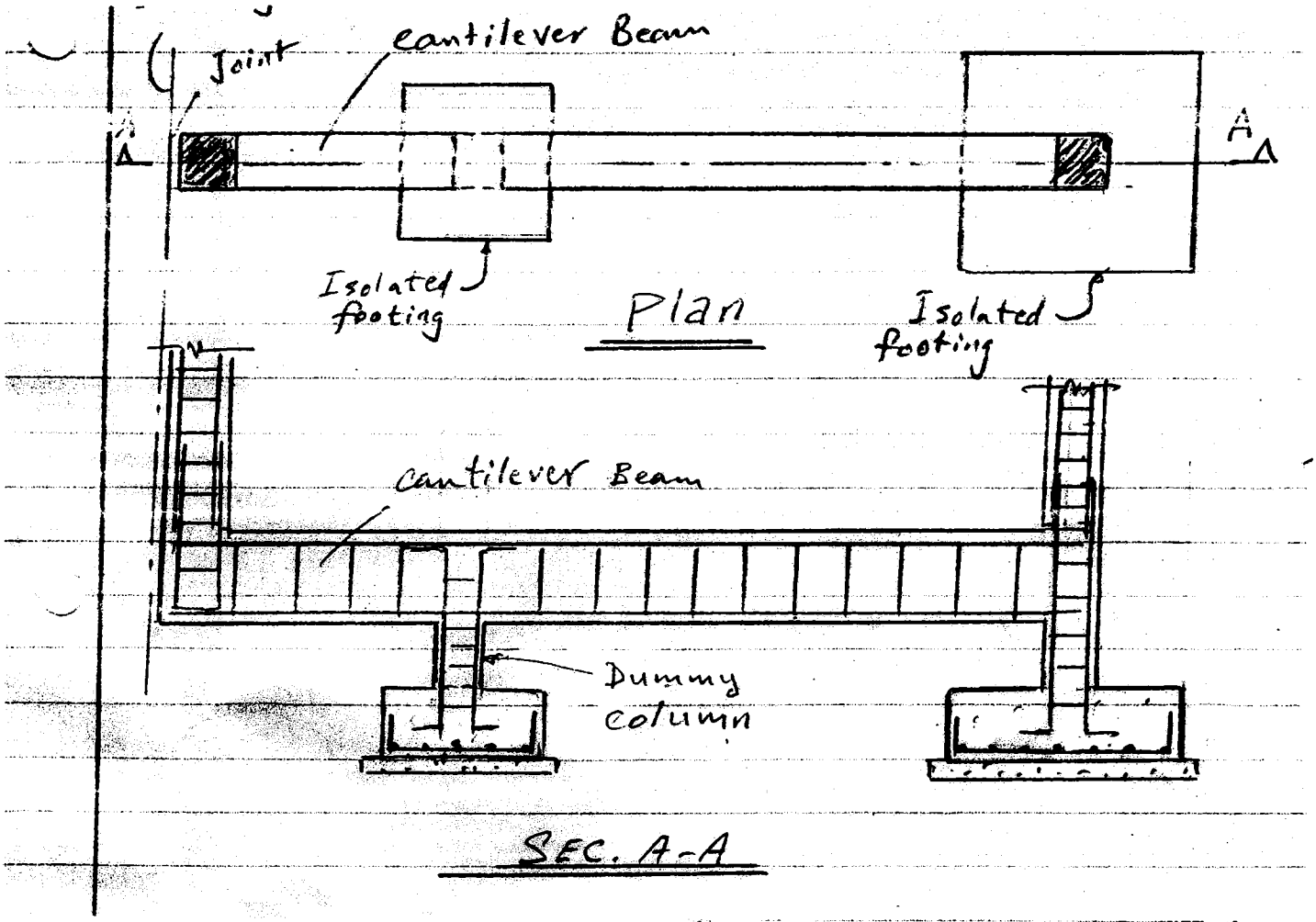
Combined Footing-
Two Rectangular shape-
One Column at site
Boundary



Combined Footing-
Rectangular Shape-
one Column at site
Boundary

5- Cantilever Footing.

If a concrete skeleton building is to be constructed adjacent to an existing building, it is sometimes necessary to use a cantilever footing for the column next to the existing building so that the pressure on the soil will not be overstressed.



8- Raft Foundation.

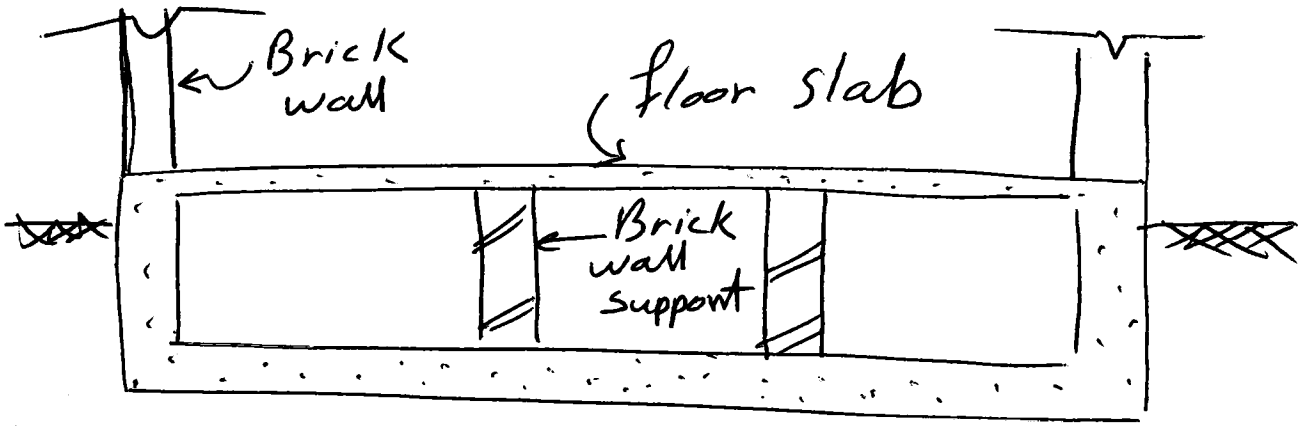
This type of foundation consists of reinforced concrete under the entire building area. It is used when the other types of foundations are not enough to provide the required necessary area to support the loads from the superstructure. The thickness of the raft is determined by the designer and it usually ranges from (40-80)cm based on the column loads of the building.

Normally a raft foundation is required for frame skeleton buildings when there is a basement in the building.

9- Floating Raft.

This type of foundation is used for heavy buildings with limited area and with poor soil bearing capacity. It acts as a ship when properly such that if differential settlement takes place.

See the sketch below for details.



10-Pier Foundation:

Pier foundation consists of one, two or more piers with different shapes of X-section such as square, rectangle or circle for some hydraulic structures like dams. The piers or caissons are of large sections which are hollow and may be filled with sand and gravel for the parts above water.

11-piles Foundation:

These are parts of a structure which are under the ground surface.

Uses of piles:

1- When the soil cannot carry the load from superstructure by using the other types the foundation.
2- When the soil is clay with seasonal shrinkage.
3- When the structure is inside water such as seaports.
4- When it is not possible to excavate deep due to the presence of existing adjacent buildings. Sheet piles will be needed to support the foundation of adjacent building.
5- When it is required to resist soil side pressure for deep excavation, sheet piles will be required.
6- When it is required to resist lateral forces, piles are used, these are called (anchor piles) or batter piles as in seaports, and bridge piers.
7- In seismic regions, piles may be used which have good resistance to earthquake.

Classification of Piles

Piles may classify according to the following types:

1- Types of piles according to method of load Transfer to soil.

a- Friction Piles:

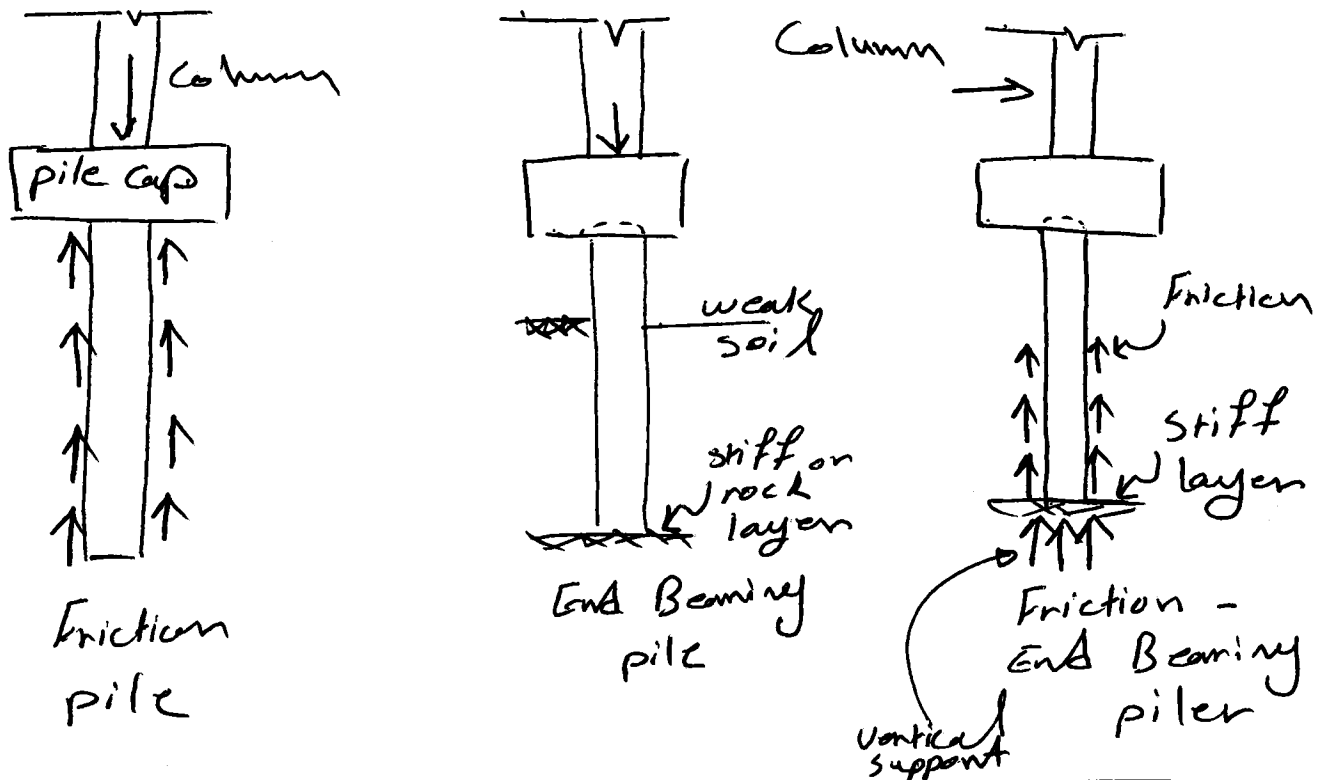
These piles transfer the load between piles surface area and the surrounding soil.

b- End- bearing Piles:

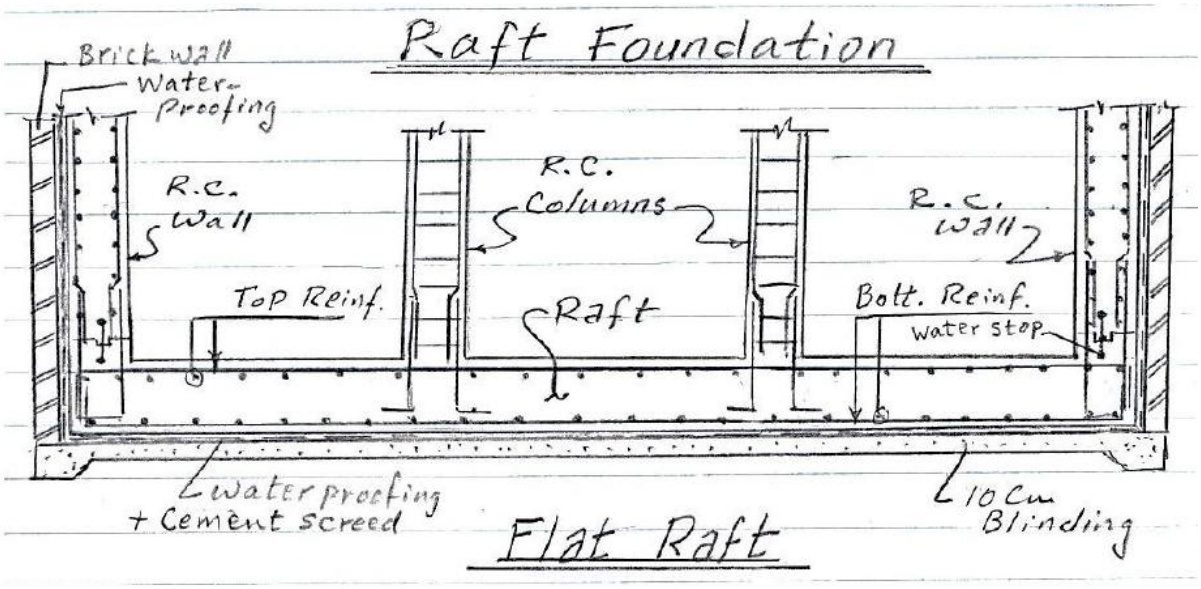
These piles work as columns which transmit the load at its ends to stiff soil or rock layer.

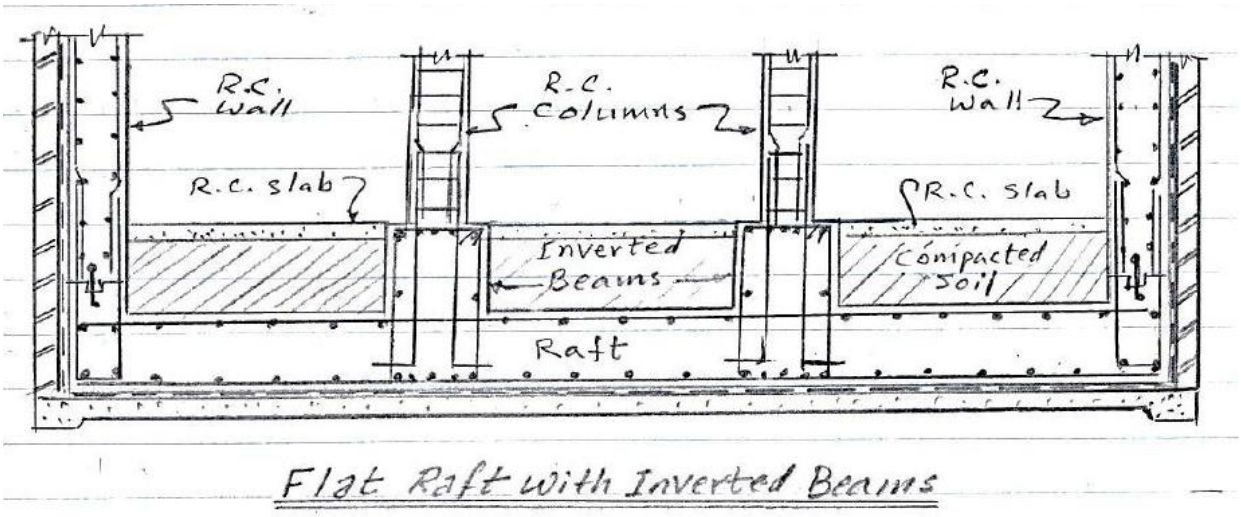
c- Piles of Combined Effect:

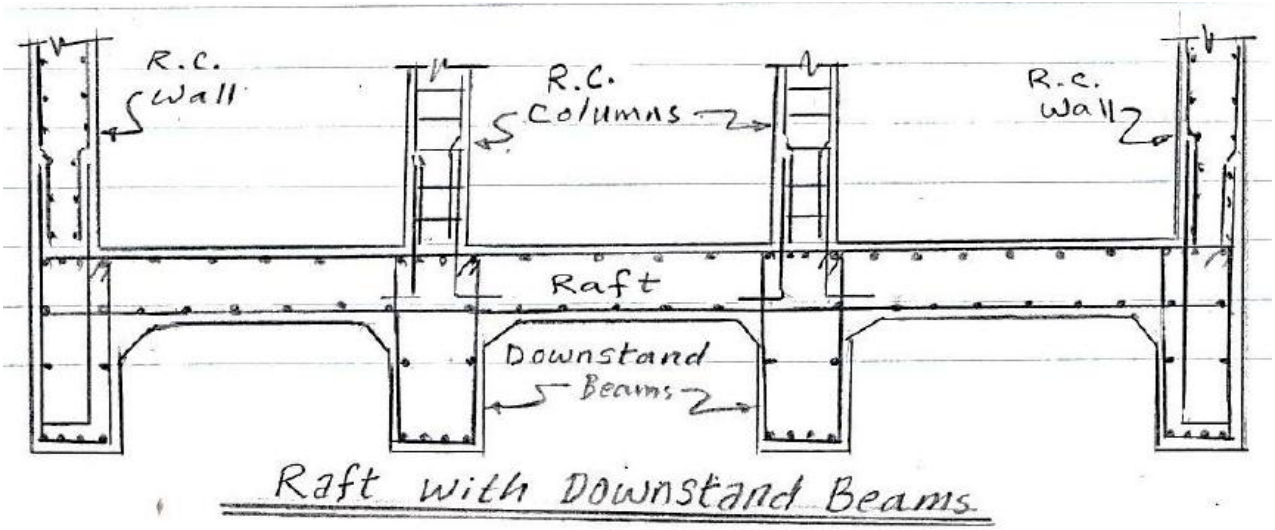
These piles transmit the loads to the soil by surface friction and end bearing of piles. In fact, most piles used are of this type.

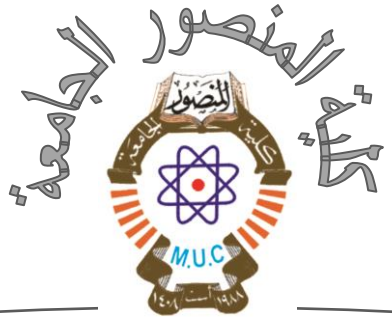


TYPES OF RAFT FOUNDATION









Al-Mansour University College

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المرحلة الثانية | 2nd. Stage

Building Construction

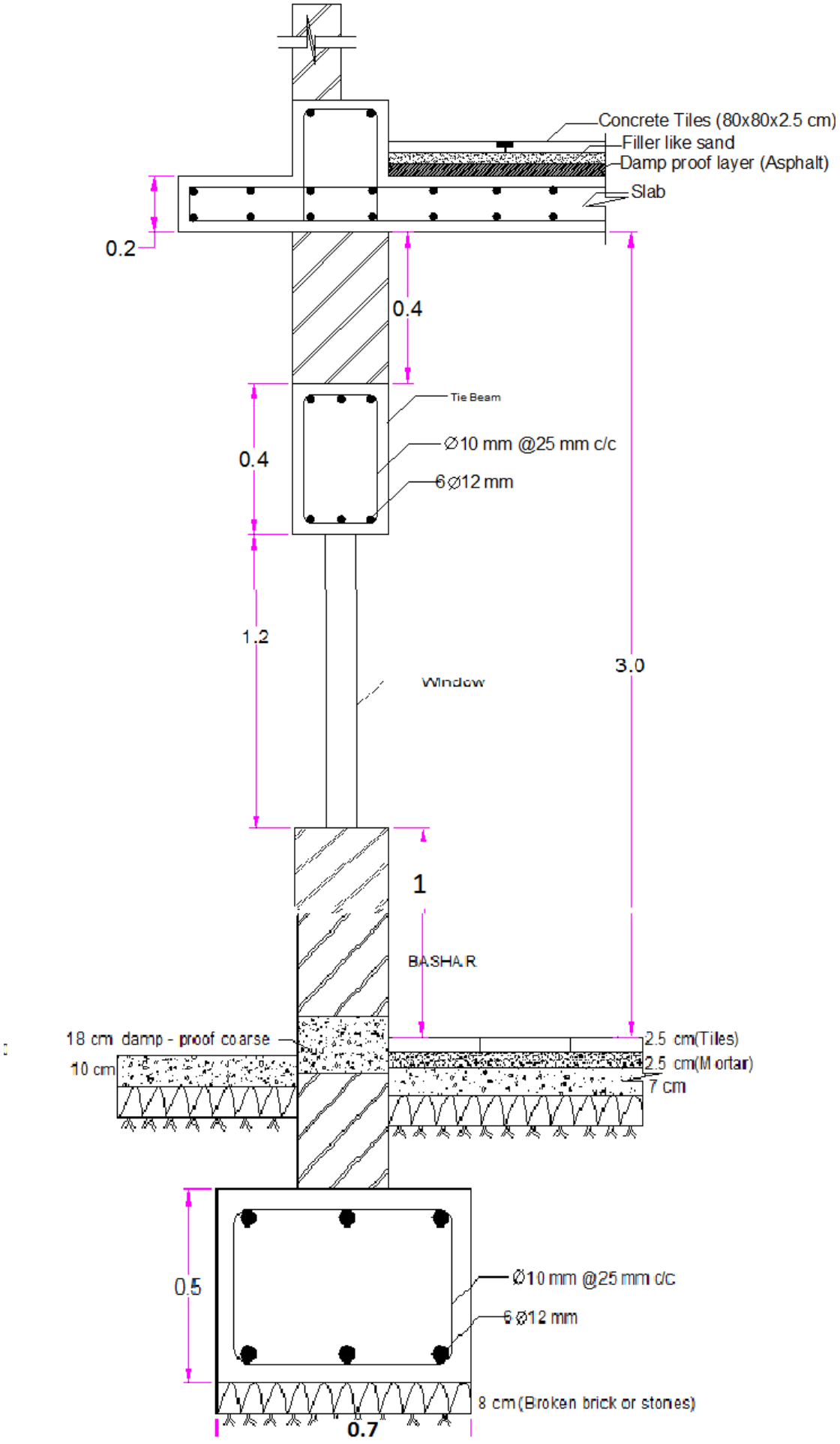
2022 - 2023

2

انشاء مباني

Lec. Eng. Basher Faisal

Section in continues foundation and bearing wall



Sustainable building

A green or sustainable building is a building that, because of its construction and features, can maintain or improve the quality of life of the environment in which it is located.

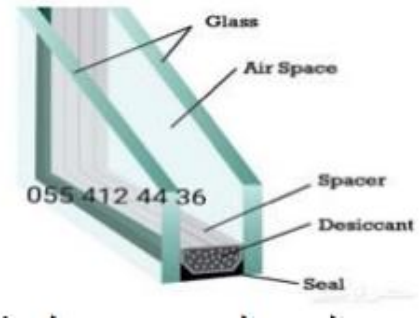
The characteristics of a sustainable building

Sustainable Building Features are:

- Energy Efficiency.
- Renewable Energy Generation.
- Water Efficiency.
- Stormwater Managment.
- Superior Indoor Environment.

Energy Efficiency:

One of the best ways to reduce heat energy loss is to utilize a high performance building envelope to minimize heat transfer between the interior and exterior of the building. The building envelope is the exterior ‘shell’ of the building, and includes the walls, roof, windows, and doors. High performance envelopes generally employ windows and wall insulation with higher R-values than conventional buildings. An R-value measures a material’s ability to prevent heat flow, where a low-value material like metal transfers heat much easier than a high-value material, like the fabric in your oven mitts. Insulated envelopes are effective at conserving energy throughout the entire year as they keep the heat in during the winter and keep it out during the summer.



شكل (1) نسب استهلاك المياه المنزلية

Stormwater Management:

One of the reasons why stormwater management is so important for green buildings is because conventional development utilizes an abundance of hardscapes; impermeable surfaces like roof tiles and pavement that prevent water from being absorbed into the ground. This is why developed areas are much more prone to flooding than natural areas. Plant species and greenspaces naturally absorb and retain water, slowing down the flow and preventing it from accumulating in large volumes. When stormwater is not properly managed, runoff containing pollutants can contaminate soils or nearby waterways. Additionally, flooding caused by water accumulated in large amounts can erode soils and damage ecosystems. It can also cause significant damage to human property, and harm human health and wellbeing. Reduce the risk of your home's basement flooding. Taking action before it is needed will help to mitigate the costs that would occur in the event of a disaster.

Superior Indoor Environment:

The indoor air quality is perhaps the most important of these features. Particularly in buildings with tight envelopes and limited air leakage, contaminants will persist inside the building for long periods of time. This means that the people inside are constantly exposed to the pollution, leaving them at a greater risk of health complications because of it. If the building is not properly sealed against moisture, mold or mildew is likely to begin growing. The spores of these fungi can cause allergic reactions and severely reduce indoor air quality. It is recommended that a mechanical HVAC (Heating, Ventilation, and Air Conditioning) unit is used to maintain the indoor air and environmental quality. The HVAC system acts as the 'lungs' of your green building, allowing the tight building envelop to conserve energy and maintain a comfortable temperature, while also supplying the interior with clean, fresh air to maximize comfort.

Example of Sustainable building

The Sanko Headquarters development in Istanbul, Turkey, is the winning design of the competition for Sanko Holding, one of the oldest banking groups in Turkey. The site has been recessed to create parking for the users to maximize the ground level for pedestrian activities with the main entrance to the building is from the South-East corner.

The basic mass has been formed by extruding the site based on the maximum usable volume. The volume was stretched and modelled to create a dialogue with the surrounding area. The form, along with the fenestrations, appears to be shaped by the forces of nature. The central void extends from the ground up to the roof of the building for an implosion of light. Each floor, from the upper floors right down to the auditorium, hosts different greenery which improves the quality of the ambient air.