Lecture 1

Construction Buildings

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Construction:

Construction means the process or act of construction or how a thing is constructed.

Building Construction steps:

1- A- Specify the project target, each project has a specific target and use such as schools, offices, roads, bridges,….. Etc.

B- Site & utility supply, electrical power and sewage drain lines ….etc.

C- Any project must have a budget which plays an important role in design and construction.

2- Project requirement: After specifying the idea, target, uses. We must prepared the project including several activities such as necessary information about costs , construction time and materials required to preliminary design and specifications.

3-Engineering design:

It includes all site plans, building plans, detail drawings, and architectural, civil, electrical, and mechanical drawings. The drawings must satisfy the specifications and codes and depend upon the soil investigation report (Limit type of soil and soil bearing capacity to choose the appropriate foundation type), forms of contract, the bill of quantities for each item, and schedule which include all the work categories and the execution time.

4-Implementing the project (Execution of project):

There are many ways to implement the project such as the bidding method where the entire work is assigned to a specialized contractor or implemented the work in a direct manner.

Type of buildings
According to execution method

Site execution

-This type of implementation is the most common
-construction materials in site location.
-The architectural has a wide rang in selecting the building style and finishing materials.

Dis advantage

This type are lost of raw materials and more implementing time
It needs more workers and prepare all

Precast or prefabricated buildings

-Precast panels are fabricated in special factories outside the site location, then transferred to the site and composed together according to specified engineering details
-Precast panels include slabs, beams, columns, walls…etc. These panels may be concrete, steel or composite.
- This type of execution is characterized by high or good quality control, less number of workers, and minimizing the project execution period. The precast buildings are lighter than the traditional buildings.

Type of buildings
According to the structural design

Bearing wall

In this type of construction, the loads of the ceilings are transported to the foundations by bearing walls that can not be lifted after construction. This type of construction is use in a traditional building with few stories because multiple stories mean increasing the thickness of walls causing decreased in the net area of the floors and large loads on foundations.

Framework

In this type of construction the loads of the ceilings and walls transporting to the foundations by columns and beams, These frames shall be either metal or concrete or a composite of metal and concrete.

Bearing wall & Framework

There shall be a frame of concrete or metal columns in a part of the building and bearing walls in the other parts. This type of construction follows structural architectural and economical requirements.

Types of framework construction according to material:

1- **Metal Framework:**

This type of construction characterized by:

- Fast installation and lift when needed.
- can be used after lifting.
- The metal's ability to carry high compressive and tensile stresses make the area of the section low compared with other materials which reduce the loads on the foundations and provides area occupied by columns, therefore metal frames are preferred in multistory building and building with large spaces.
- **Disadvantages of metal frames are:**

1-need for fire protection.

2-continuous maintenance for possible weather impact.

3-the commitment of the designer to the standard part produced.

2-Concrete frame:

Concrete frame shall be either cast in place or precast.

Advantages of Concrete frames:

- All of its materials are locally manufactured.
- Availability of construction workers.
- Concrete gives the designer the freedom to produce desired shapes.
- Good fire resistance.
- High durability.

Disadvantages of Concrete frames:

- It take longer time compared with metal frame.
- Heavyweight.
- Need to control the quality of the production and implementation.
- They are permanents and can not be lifted.

Role of engineer during construction:

After the award of the construction contract, the architect or engineer generally continues to assist the client in relations with the contractor.

1- Site Observation:

As part of their ongoing services during construction, and depending on the scale and complexity of the project, architects and engineers may make periodic site visits or maintain full-time representation on-site during a portion or all of the construction period. The professional's role is to expedite day-to-day communication and decision-making by having on-site personnel available to respond to required drawing and specification clarifications. Site-observation requirements for the project should be discussed with the client at the onset of the project and be outlined in the architect-client agreement. Many clients prefer periodic or regularly scheduled site visits by the design professional. A provision for additional or full-time on-site representation,

The client and the architect and engineer should agree on the appropriate amount of site visitation provided in the architect's basic services to allow adequate site-observation services based on a specific project conditions.

If periodic site observations are made, the architect should report such observations to the client in written form. This should call attention to items observed that do not meet the intent of the construction documents. It is normally left to the client to reject or replace work unless such defective work involves the life safety, health, or welfare of the building occupants or is a defect involving structural integrity. If the architect provides full-time site observation services, daily or weekly reports should be issued to the client outlining items observed that are not in accordance with the construction documents or design intent.

2-Site Record Keeping:

Depending on contractual requirements for service during the construction phase, the architect may establish a field office. In this event, dual record keeping is suggested between the site and the architect's office so that records required for the daily administration of construction are readily accessible on-site. Contractor correspondence, field reports, testing and balancing reports, shop drawings, record documents, contractor payment requests, change orders, bulletin issues, field meeting minutes, and schedules are used continually during construction. Computer systems and electronic mail make the communication process somewhat easy to control.

3-Inspection and Testing:

Technical specifications require testing and inspection of various materials and building systems during construction to verify that the intent of the design and construction documents is being fulfilled under field conditions. Testing is required where visual observations cannot verify actual conditions.

Subsurface conditions, concrete and steel testing, welding, air infiltration, and air and water balancing of mechanical systems are such building elements that require inspection and testing services. Normally, these services are performed by an independent testing agency employed directly by the client so that third-party evaluation can be obtained. Although the architect does not become involved in the conduct of work or determine the means or methods of construction, the architect has the general responsibility to the client to see that the work is installed in general accordance with the contract documents. Other areas of inspection and testing involve establishing and checking benchmarks for horizontal and vertical alignment, examining soils and backfill material, compaction testing, examining subsurface retention systems, inspecting connections to public utilities, verifying subsoil drainage, verifying structural column centerlines and base-plate locations (if applicable), checking alignment and bracing of concrete formwork, verifying concrete strength and quality, and other similar items

4-Payment Requests:

The contractor normally submits a consolidated payment request monthly to the architect and client for review and certification. The payment request should be subdivided by trade and compared with the schedule of values for each trade that would have been submitted with the subcontractor bid if required by the instructions to bidders and bid form. The architect should review the payment request concerning the percentage of completion of the pertinent work item or trade. Some clients or lending institutions require that a partial waiver of lien be submitted for each work item or trade with each payment request. This partial waiver of lien can either be for the prior monthly request, which will indicate that the prior month's payment has been received, or in certain cases for the current monthly request. If the latter procedure is followed, the waiver may require revision, depending on the architect's review, if a work item or trade-payment the request is modified. The architect is not expected to audit the payment request or check the mathematical calculations for accuracy.

5 Change Orders:

Contractor's change-order requests require the input of the architect, engineer, and client and are usually acted on as part of the payment request procedure. A change order is the instrument for amending the original contract amount and schedule, as submitted with the bid and agreed on in the client-contractor contract. Change orders can result from departures from the contract documents ordered during construction, by the architect, engineer, or client; errors or omissions; field conditions; unforeseen subsoil; or other similar conditions. A change order outlines the nature of the change and the effect, if any, on the contract amount and construction schedule.. Change orders are also used to permit a material substitution when a material or system not included in the contract documents is found acceptable by the client and architect. For material substitutions proposed

6-Project Closeout:

Project closeout involves all parties, including subcontractors and material suppliers. It should be addressed early in the construction phase so that the closeout can be expedited and documented in an organized and meaningful manner. At this point in the construction process, the attention of the contractor and architect is focused on accomplishing the necessary paperwork and administrative functions required for the final acceptance of the work and issuance of the contractor's final consolidated application for payment and final waiver of lien.

Homogeneous Linear ODEs of high - Order with constant coefficients

If the coefficient functions P, Q, and R are **constant functions**, that is, if the differential equation has the form:

$$\boldsymbol{a_o \frac{d^n y}{d^n x} + a_1 \frac{d^{n-1} y}{dx^{n-1}} + \cdots\cdots + a_{n-1} \frac{dy}{dx} + a_n y = 0}$$

- Assume $\frac{d}{dx} = D$, $\frac{dy}{dx} = Dy$, $\frac{d^2y}{dx^2} = D^2y$, $\frac{d^3y}{dx^3} = D^3y$, …….
- Put $D = m$

$$a_o D^n y + a_1 D^{n-1} y + \cdots\cdots + a_{n-1} Dy + a_n y = 0$$

$$a_o m^n y + a_1 m^{n-1} y + \cdots\cdots + a_{n-1} my + a_n y = 0$$

$$y\,(a_o m^n + a_1 m^{n-1} + \cdots\cdots + a_{n-1} m + a_n) = 0$$

$$y \neq 0$$

$$a_o m^n + a_1 m^{n-1} + \cdots\cdots + a_{n-1} m + a_n = 0$$

Solve to obtain the values of roots:

1. When the roots m_1, m_2, m_3, ……., m_n are different roots, then the general solution is:

$$\boldsymbol{y_c = c_1 e^{m1x} + c_2 e^{m2x} + c_3 e^{m3x} + \cdots\cdots}$$

2. If the roots are equal ($m_1 = m_2 = m_3 = \cdots\cdots$), the general solution is:

$$y_c = c_1 e^{mx} + c_2 x e^{mx} + c_3 x^2 e^{mx} + c_4 x^3 e^{mx} + \cdots\cdots)$$

$$\boldsymbol{y_c = (c_1 + c_2 x + c_3 x^2 + c_4 x^3 + \cdots\cdots)e^{mx}}$$

3. If the roots are complex (conjugate) number say $\alpha \mp i\beta$, then the general solution is:

$$y_c = c_1 e^{\alpha x} cos\beta x + c_2 e^{\alpha x} sin\beta x$$

$$\boldsymbol{y_c = e^{\alpha x}(c_1 cos\beta x + c_2 sin\beta x)}$$

Example: Solve the Ordinary differential equation (ODE):

$$\frac{\boldsymbol{d^3y}}{\boldsymbol{d^3x}} - \mathbf{2}\,\frac{\boldsymbol{d^2y}}{\boldsymbol{d^2x}} - \frac{\boldsymbol{dy}}{\boldsymbol{dx}} + \mathbf{2}\,\boldsymbol{y} = \mathbf{0}$$

$$D^3y - 2D^2y - Dy + 2\,y = 0$$

$$m^3y - 2m^2y - my + 2\,y = 0$$

$$\text{y}\,(m^3 - 2m^2 - m + 2) = 0$$

$$\text{y} \neq 0$$

$$m^3 - \ 2m^2 - m + 2 = \mathbf{0}$$

$$m^2(m-2) - (m-2) = 0$$

$$(m-2)(m^2-1) = 0$$

$$m_1 = 2$$

$$m_2 = 1$$

$$m_3 = -1$$

$$\boldsymbol{y_c = \ c_1\, e^{2x} + \ c_2\, e^{x} + \ c_3\, e^{-x}} \quad \textbf{(General Solution)}$$

Example: Solve the Ordinary differential equation (ODE):

$$\frac{\boldsymbol{d^3y}}{\boldsymbol{d^3x}} - \frac{\boldsymbol{d^2y}}{\boldsymbol{d^2x}} + \frac{\boldsymbol{dy}}{\boldsymbol{dx}} - \boldsymbol{y} = \mathbf{0}$$

$$D^3y - \ D^2y + Dy - y = 0$$

$$\text{y}\,(m^3 - m^2 + m - 1) = 0$$

$$\text{y} \neq 0$$

$$m^3 - m^2 + m - 1 = \mathbf{0}$$

$$m^2(m-1) + (m-1) = 0$$

$$(m-1)(m^2+1) = 0$$

$$m_1 = \ 1$$

$$m_2 = i$$

$$m_3 = -i$$

$$y_c = c_1\, e^{x} + c_2\, e^{0x} cosx + c_3\, e^{0x} sinx$$

$$\boldsymbol{y_c = c_1\, e^{x} + c_2\, cosx + c_3\, sinx} \quad \text{(General Solution)}$$

Example: Solve the Ordinary differential equation (ODE):

$$\boldsymbol{\frac{d^4y}{d^4x} - 4\frac{d^2y}{d^2x} + 4y = 0}$$

$$D^4y - 4D^2y + 4y = 0$$

$$\text{y}\,(m^4 - 4m^2 + 4) = 0$$

$$\text{y} \neq 0$$

$$m^4 - 4m^2 + 4 = 0$$

$$(m^2 - 2)(m^2 - 2) = 0$$

$$(m^2 - 2) = 0 \rightarrow m_1 = \sqrt{2}$$

$$m_2 = -\sqrt{2}$$

$$(m^2 - 2) = 0 \rightarrow m_3 = \sqrt{2}$$

$$m_4 = -\sqrt{2}$$

$$\boldsymbol{y_c = (c_1 + c_2\, x)e^{\sqrt{2}x} + (c_3 + c_4\, x)e^{-\sqrt{2}x}} \quad \textbf{(G. S.)}$$

Example: Solve the Ordinary differential equation (ODE):

$$\boldsymbol{\frac{d^4y}{d^4x} - 16y = 0}$$

$$D^4y - 16y = 0$$

$$\text{y}\,(m^4 - 16) = 0$$

$$\text{y} \neq 0$$

$$m^4 - 16 = 0$$

$$(m^2 + 4)(m^2 - 4) = 0$$

$$(m^2 + 4) = 0 \rightarrow m_1 = 2i$$

$$m_2 = -2i$$

$$(m^2 - 4) = 0 \rightarrow m_3 = 2$$

$$m_4 = -2$$

$$\boldsymbol{y_c = c_1 e^{2x} + c_2\, e^{-2x} + c_3 cos2x + c_4\, sin2x} \quad \textbf{(G. S.)}$$

Example: Solve the Ordinary differential equation (ODE):

$$\boldsymbol{\frac{d^7y}{d^7x} + 18\frac{d^5y}{d^5x} + 81\frac{d^3y}{d^3x} = 0}$$

$$D^7y + 18D^5y + 81D^3y = 0$$

$$\text{y}\,(m^7 + 18m^5 + 81m^3) = 0$$

$$\text{y} \neq 0$$

$$m^3(m^4 + 18m^2 + 81) = 0$$

$$m^3(m^2 + 9)(m^2 + 9) = 0$$

$$m^3 = 0 \rightarrow m_1 = 0$$

$$m_2 = 0$$

$$m_3 = 0$$

$$m^2 = -9 \rightarrow m_4 = 3i$$

$$m_5 = -3i$$

$$m_6 = 3i$$

$$m_7 = -3i$$

$$\boldsymbol{y_c = c_1 + c_2x + c_3x^2 + c_4 cos3x + c_5\, sin3x + c_6 cos3x + c_7\, sin3x}$$

(General Solution)

Lecture2

site preparation

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Construction site preparation

It is important to prepare a construction site before the main construction activities started.

This site may have lots of obstructions like old buildings or structures, big trees, sloping ground, loose soil, and underground services.

Steps of site preparation:

1- Soil testing and report analysis:

It is important before planning and designing any construction project.
Without knowing the properties of soil we cannot design any structure.

Purpose of soil testing:

1. To evaluate the general suitability of the site for the proposed project.
2. To enable an adequate and economical design to be made.
3. To obtain physical and mechanical properties of soils for design and construction.
4. To obtain groundwater conditions.
5. To disclose and make provisions for difficulties that may arise during construction due to ground and other local conditions.
6. To determine the suitability of construction materials.

Depth of Soil Investigation:

before determining the actual method of obtaining the required subsoil samples the depth to which the soil investigation should be carried out must be established. This is usually based on the following factors …

1. Proposed foundation type.
2. Pressure bulb of the proposed foundation.
3. Relationship of proposed foundation to other foundations.

2- Demolition of old structure:

If there is any old structure, you should be prepare a plan to demolish it with the help of the demolition team.

Demolition must include some questions:
-Which structure on-site needs to be demolished?
-What is a structure on-site which requires repairs, not demolition?
If the structure is required partly demolition, you should make sure the remaining part of the structure remains safe as per building rules and regulations.
For example, if any part of the building needs cracking then the necessary care should take to support other structures connected with it. In this stage, the presence structural engineer or any other competent professional might be necessary to monitor any movement or cracking.
Without a doubt, Systematic planning and work will help determine methods and procedures to identify hazards, ensure safe disposal of materials, and comply with legislation requirements.

3- Under ground service and wire mapping

While doing construction site preparation work and excavating in urban areas, near telecom service, or near to railway lines care should be taken no service line or underground wire break and disturbed due to work.

Therefore, as a precautionary measure, you should conduct an advance survey of underground assets or wire running below the ground before starting any construction excavation.

Write a letter to the telecom department, natural gas supply department, and electrical department to aware them of your work area. This department receives your letter and verifies if service assets are running underground in your workplace.

If they found any wire below your work area they will shift the wire from that location to any other so that no damage will happen due to work on site.

4- Site surveying and layout:

At this point placed the building plan and fix the exact position of the building. With the help of survey pegs or physical markers, a surveyor will locate the boundaries of the new building. Other engineering surveys will assure that the building structure is built in the proper place and as designed, while the second one helps to obtain data concerning topography, drainage, and man-made features of the area. A site layout plan is essential to have all of the important data at hand: where the new building will be located, access roads for construction vehicles, storage areas for supplies, the locations for drainage systems, etc. Having the site set out at hand, you now know which area needs to be cleared of vegetation and rocks.

5- Site clearing:

Construction site preparation work involves removing any underbrush, trees, and rocks to a distance of approximately three meters from the building zone. Top soil quality is not good for structure, then removed it and replaces with a suitable type of soil. The site should be clear such it looks flat and clear without any undulation.

6- Site Excavation and earthwork:

As the layout of the building plan is transferred to the ground, the excavation work begins and the soil is removed to a required depth in which the foundation of the structure is placed.

There are different types of machinery used to excavate and transport soil at the project site. The type of machinery used for excavation is based on the soil type, how long the distance the soil needs to be transported, the soil site's ability to carry the load, and site accessibility.

In case hard soil like rock is available on the construction site blasting, drilling, and machinery like boulders, backhoe, shovels, and scooper are involved to excavate and transport blasted and drilled materials when rocks are present at the site.

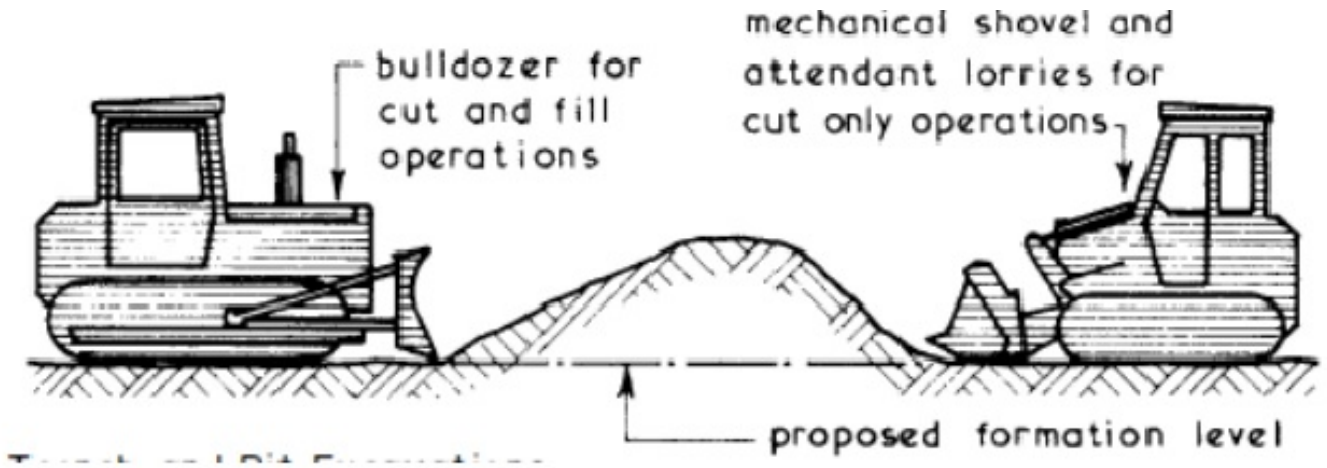
Types of Excavation

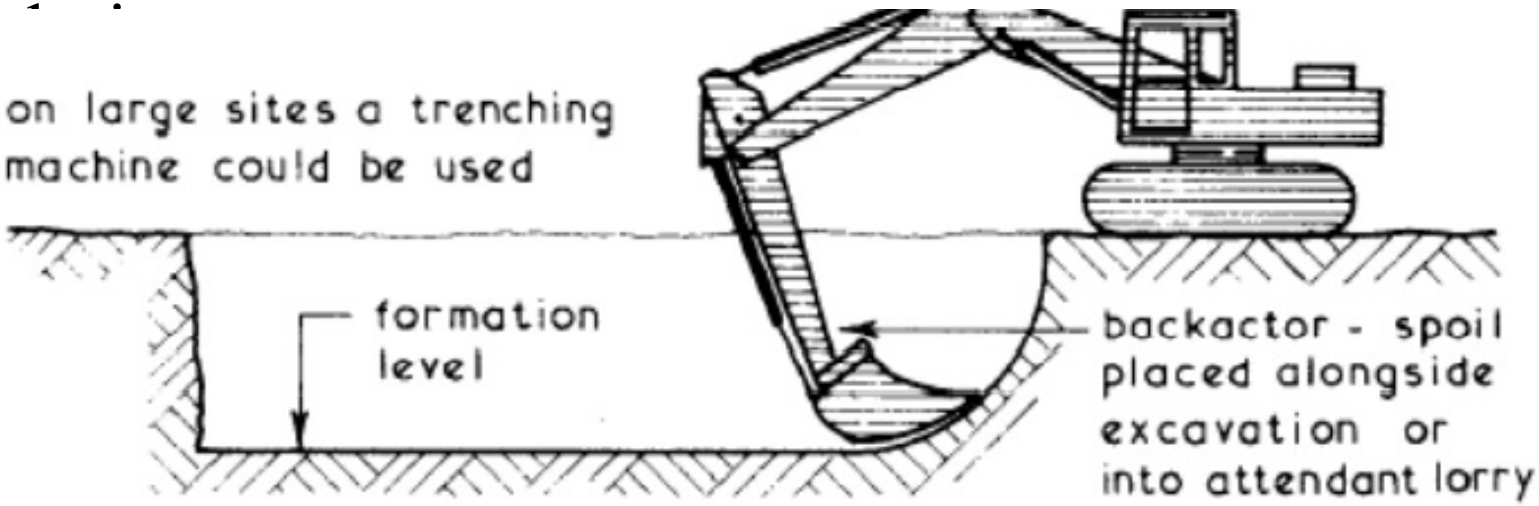
- Reduced Level Excavations:

On small sites, could be used hand processes and mechanical methods dependent on the design.

- Trench and Pit Excavations:

if the depth of excavation exceeds 1_200ft should be used mechanical methods dependent on the





7- Compaction of construction project site:

The soil at the base of the foundation must be compacted to the required degree

Compaction of soil at the base of the foundation is essential because it decreases settlement and consequently prevents undesired incidents.

-There are different methods are use to compaction of soil like:
Tamping, rolling and vibration.

-There is various machinery available on construction sites such as:
smooth wheel, rollers, rubber tires, and tamping plate.

Benefits of compaction:

- Improving the shear strength.
- Reducing soil permeability and compressibility.

Safety measures at the construction site:

Safety Measures at Construction Site involves precautionary measures to make the construction site workplace safe and try to reduce accidents.

Safety measure at construction site including:

1- Safe access on site.
2-Working at Hight.
3-Lethal Ladders.
4- Construction Site Safety on Roof.
5- Safety in Excavation Work.

6- Construction Site Safety While Working near Sewage.

7-Electricity.

8-Goods Hoist.

9- Crane Safety.

Safety measures:

- Wear helmet to protect head against falling construction elements.

- Keep safety gloves for protection against cut and abrasions heat chemicals etc.

- Wear high visibility clothes for easy to visible on construction site night.

- Wear safety goggles and boots to prevents eyes, feet on construction.

- Follows the construction regulatory signs.

Lecture3

Foundation Of structure

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Foundation:

foundation is that part of the building that is usually construed under the ground level and a certain depth to transfer loads from the structure to the subsoil.

Function of foundation:

- It carries the weight of the building, transferring the loads safely to the ground.
- It spreads the weight of the building, to an acceptable level of force exerted on the ground.
- It provides a flat level surface on which to build on

Basic Design Procedure:

Assessment of site conditions in the context of the site & soil investigation report

Calculation of anticipated structural loading

Choosing the foundation type, should consider:
- **Soil condition**
- **Type of structure**
- **Structural loading**
- **Economic factors**
- **Time factors relative to the proposed contract period**
- **Construction problem**

Sizing the chosen foundation in the context of loading, ground bearing capacity & any likely future movement of the building/structure

The factors that effect to depth foundation:

Depth of foundation is influenced by the following factors:

1. Types of soils and its layer which can carry loads of buildings.
2. Climate situation and how to avoid the effect of freeze and extension and contraction, so the foundation must be not less than 30cm depth to avoid these effects.
3. Groundwater level and how to construct foundation above water table level
4. Foundation location on the building and if there is a basement, shelter, car park …etc. in the building.
5. Existing building foundation close to the new foundation.
6. Underground services and their relationship with the depth of the foundation.
7. Provision of existing trees.

Types of soil:

Soil can be classify according to its bearing capacity into two types:

1. Soil not able to compact: Like rock soil with high bearing capability which can be constructed over it without foundation if it empty of cracks, pockets and high porosity when they present cause slip and settlements.
2. Soil able to compact: Include all other types except rock soil and need foundation to distribute loads according to their bearing capability

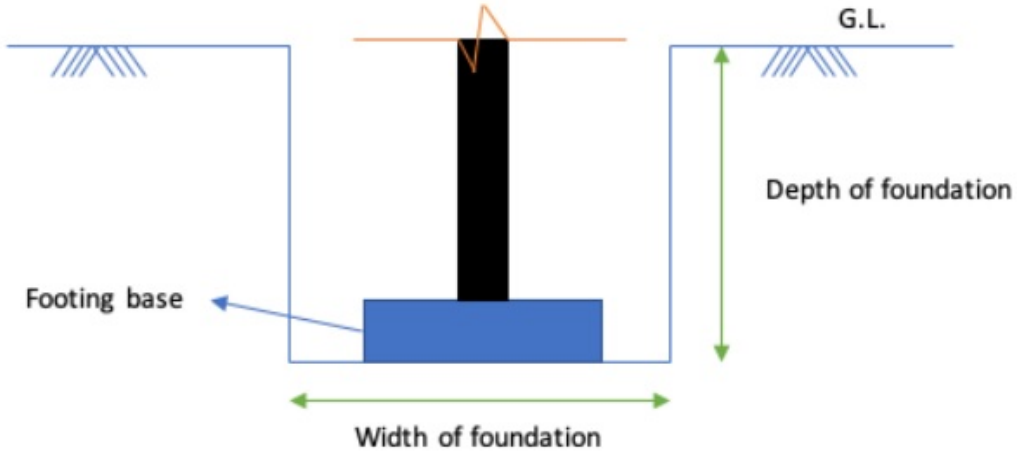
Basic foundation types

Foundations may be classified based on where the load is carried by the ground, into two categories:-

- Shallow foundation.
- Deep foundation.

Q: What is Shallow foundation?

If the width of the foundation is greater than or equal to the depth of the foundation, it is a Shallow Foundation. Alternatively, “If the depth to width ratio of the foundation is less than equal to 2, it is called as a Shallow Foundation.



Q: What is deep foundation?

If the width of the foundation is smaller than the depth of the foundation is called the Deep Foundation." Alternatively, If the depth to width ratio of the foundation is greater than two is called the Deep Foundation.

Types of shallow foundation:

1. Isolated or spread footing.
2. Combined footing.
3. Continues footing.
4. Wall footing.
5. Cantilever footing or balanced footing.
6. Raft or mat footing.
7. Steeps footing.

Isolated footing:

Isolated footings (also known as Pad or Spread footings) are commonly used for shallow foundations in order to carry and spread concentrated loads, caused for example by columns or pillars. Isolated footings can consist either of reinforced or non-reinforced material. For the non-reinforced footing however, the height of the footing has to be bigger in order to provide the necessary spreading of load.

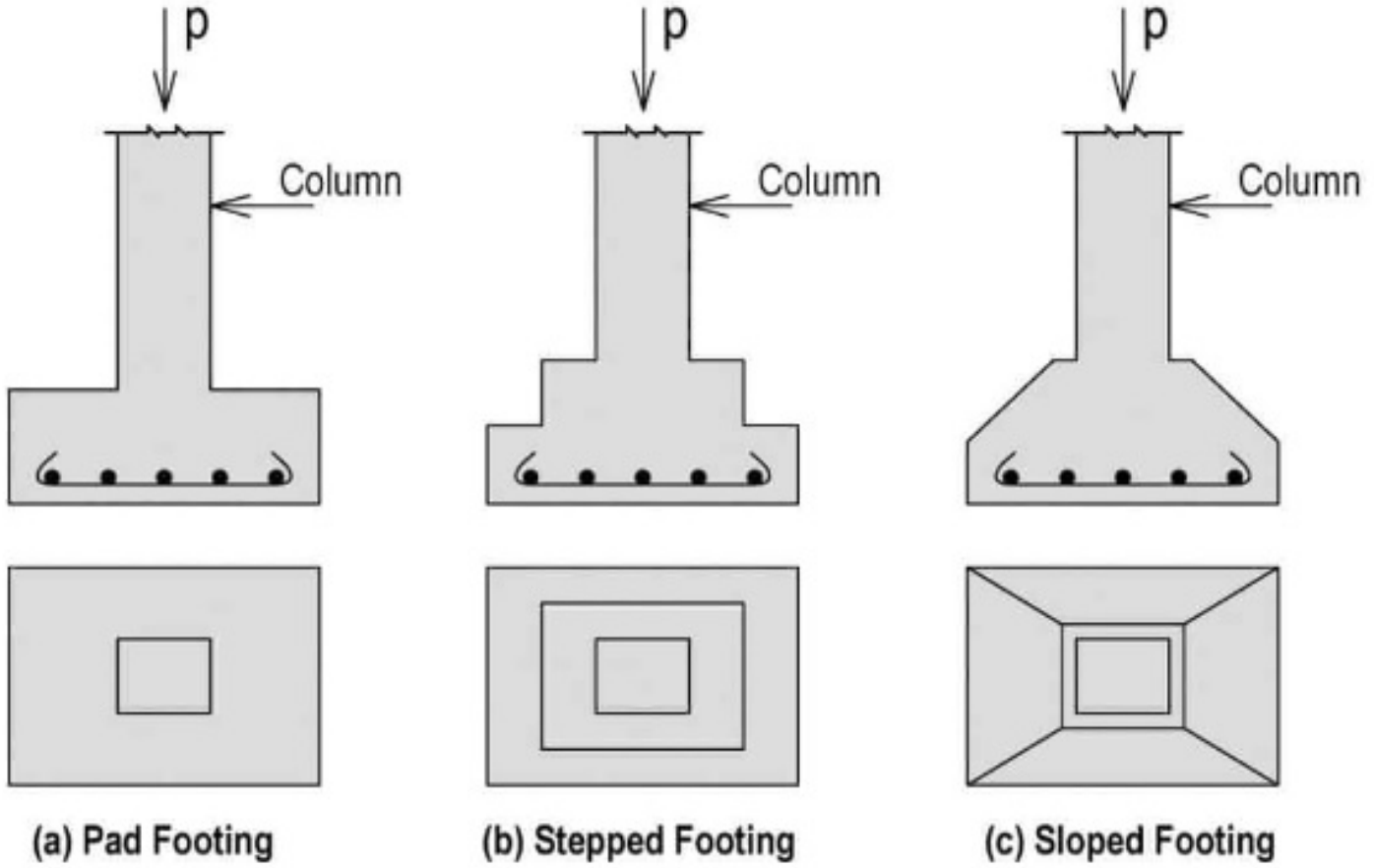
-The footing whose base is extended or spread to distribute the load of the structure over a large area of sub-soil.
-It is used where soil is in good condition.
-It is used for 2-3 floors buildings.
-An advantage of this type of footing foundation is that the footing can be located at the different foundation levels, to distribute the structure's load advantageously over the site, holding the differential settlement within certain limits.
-It is often thought that this type of foundation becomes more economical than the continuous-strip foundation when the required foundation depth is greater than 1.5 m.

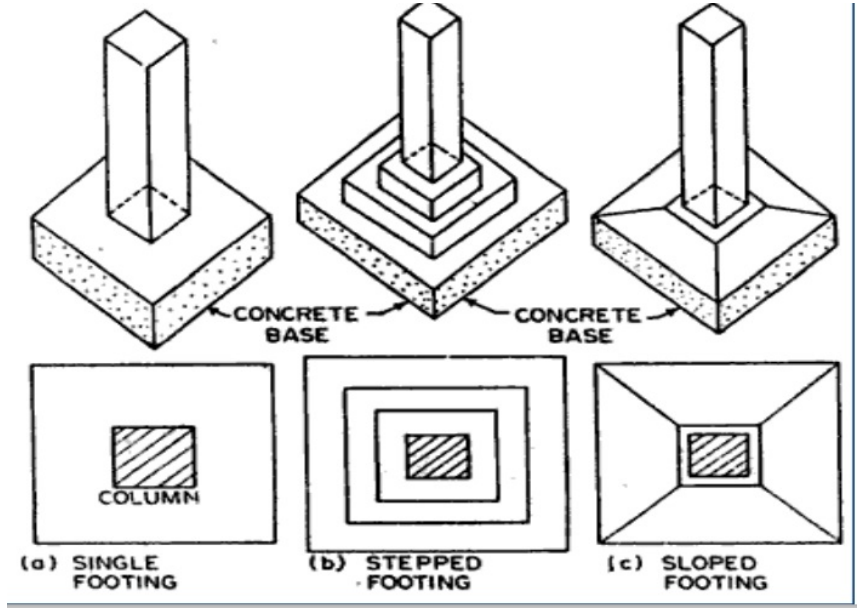
Types of spread footing:

1.Single footing.

2. Stepped footing.

3. Slopped footing.




CONCRETE BASE
CONCRETE BASE
COLUMN
(a) SINGLE FOOTING
(b) STEPPED FOOTING
(c) SLOPED FOOTING

Advantage of spread footing:

- It decreases cracking bring out by settlement.
- It balances soil around the base of the structure.
- Easy construction of basements.

Disadvantage of spread footing:

- It is restricted to certain soil structures only and cannot be utilized for all forms of soil.
- This type of foundation is regularly put through torsion, moment, and pullout.
- Settlement is a huge problem in this type of foundation.

Combined footing:

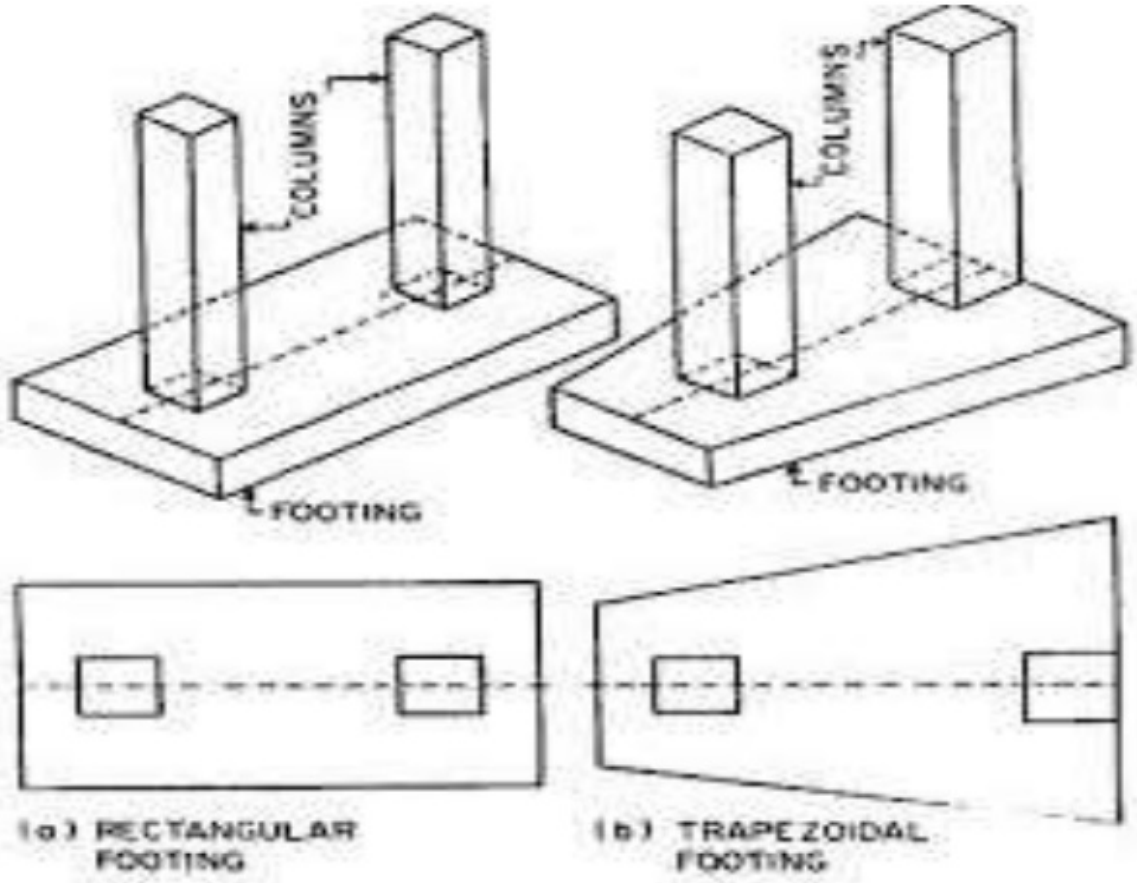
- It is a single foundation with two concentrated weights of two columns that are close to each other.

- Combined footings are used when the columns are so close to each other that their individual footings would touch each other or overlap. In fact, it is often thought to be more economical to provide a strip footing whenever the distance between the adjacent individual footings is less than their dimensions.
- They are also used when the foundation soil is erratic and of relatively low bearing capacity.

Types of combined footing:

1.Rectangular:- when columns carry equal load.

2.Trapezoidal:- when columns carry unequal load.



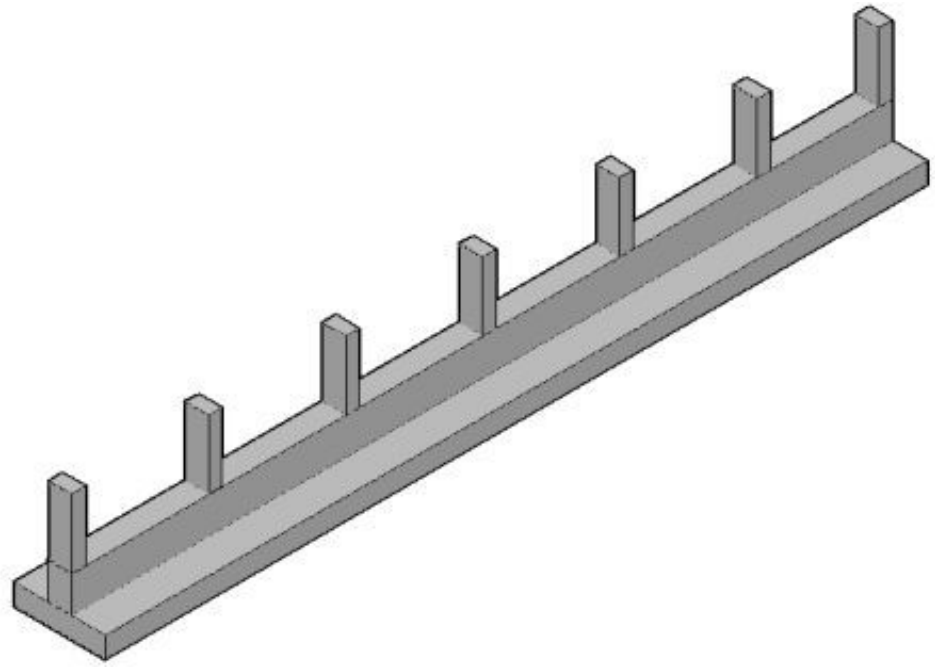
Continuous footing:

-It is a footing for several columns located on the same axis and the concentrated weights of these columns are distributed over a rectangular area of fixed width and length equal to the sum of the lengths of the centers of the columns plus adding a suitable length in one or both sides where it is not possible to add a length at the end of which the column is adjacent to the borders of an adjacent segment.

-It used where the soil has good bearing capacity

To resist the load occurrence on the structure

- It is used when found under ground water

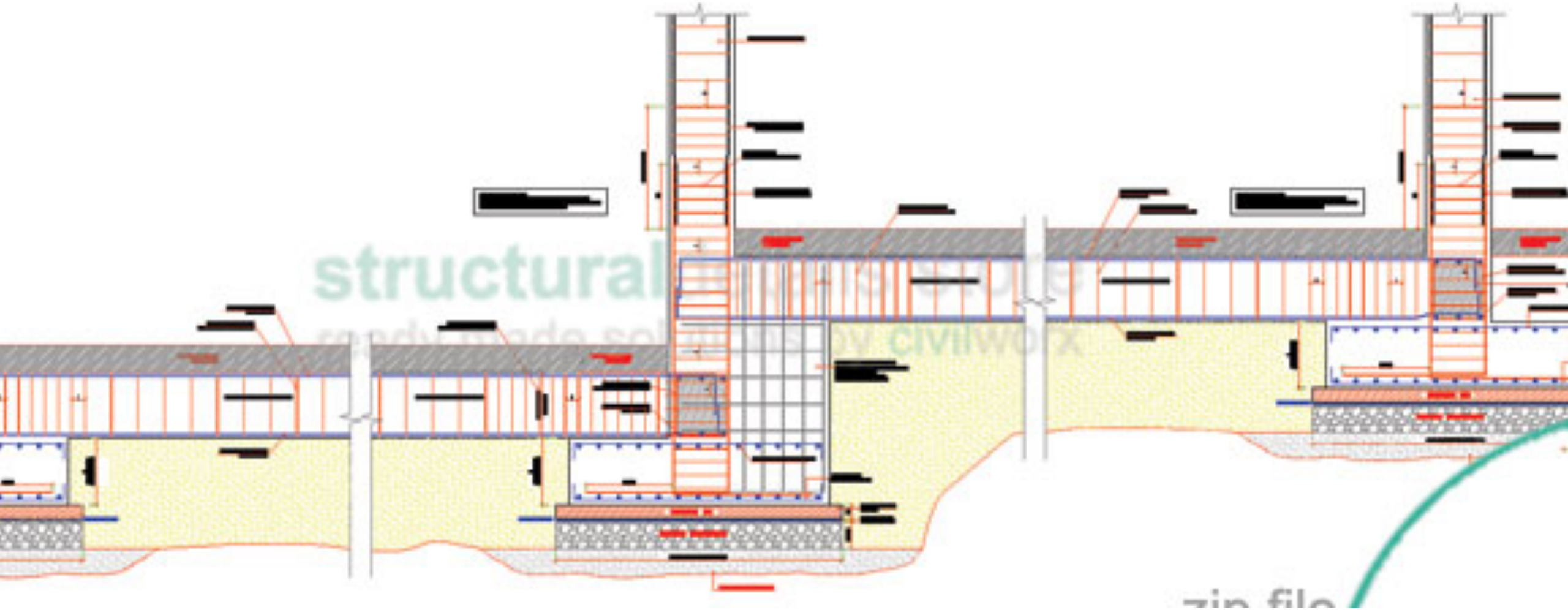


Difference between the combine footing and continuous footing:

Continuous footing	Combined footing
The design of this footing is to connect the all column in the same arises to distribute the load	Two column is placed at a distance less than 2 m it was designed as a combined footing
The columns will not divide the load occurrence	The columns divide the load occurrence
The shape of the footing is in rectangle shape	The shape of the footing is in rectangle or trapezoidal shape

Stepped footing:

- It is used when the site has a slope, which makes the craters and cut & fills above the foundation in large quantities if want to make it at one horizontal level.
- The foundation needs to be seated on the right layer of soil to support it, and accordingly, the slope of the site can determine the horizontal distance between one the gradient to another.
- It is preferable to change the level of the foundation at the gradient site to equal to the thickness of the foundation and the formation distance is equal to this thickness as well, to obtain a uniform, non-sharp gradient with acceptable depths of cut & fill occurrence.



Wall footing :

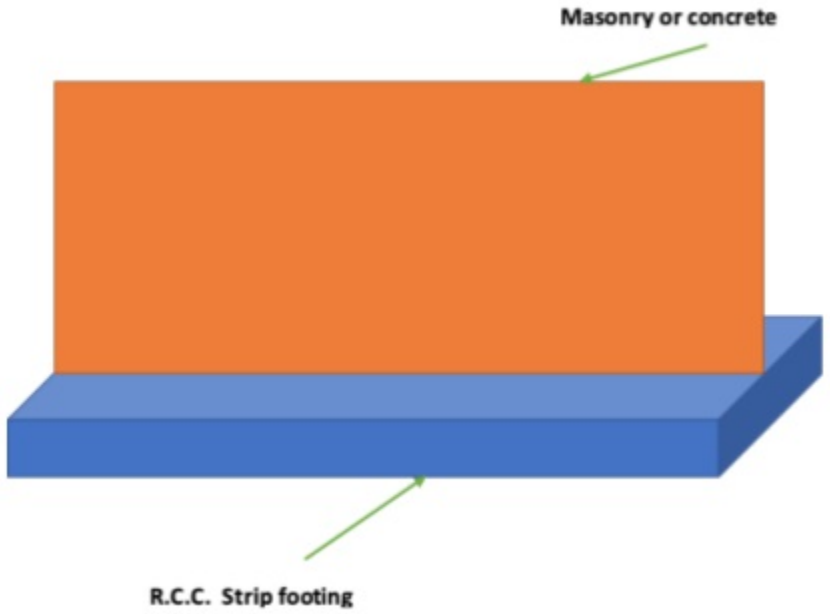
-Wall footings are used to support structural or nonstructural walls to transmit and distribute the loads to the soil in such a manner that the load-bearing capacity of the soil is not surpassed. In addition to avoiding excessive settlement and rotation and maintaining sufficient safety against sliding and overturning.

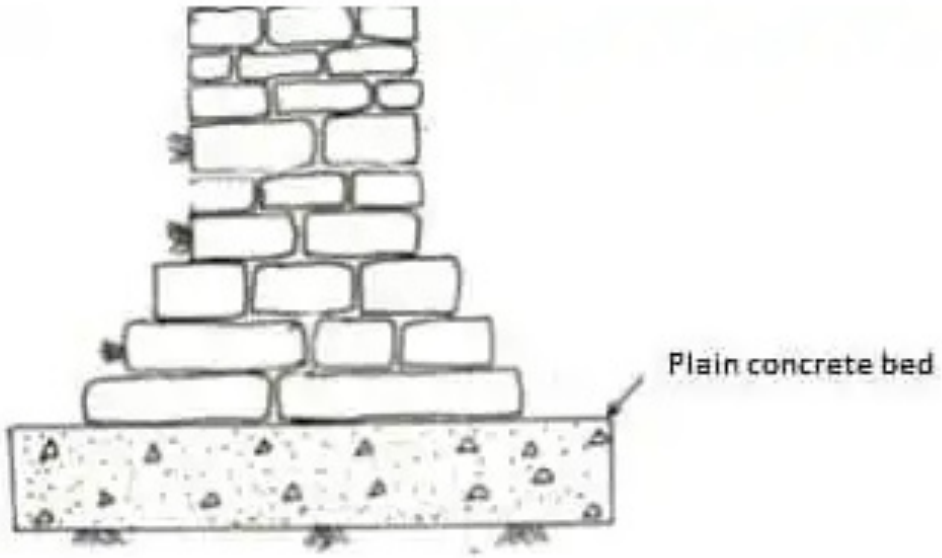
-Used in low rise construction such as building houses, house extensions where the soil is not strong enough.

-The size of the footing and the thickness of the foundation wall is specified based on the type of soil at the site. The width of the wall footing is generally 2-3 times the width of the wall.

Wall footing

-The wall footing can be constructed from stone, brick, plain concrete, or reinforced concrete. Economical wall footing can be constructed provided that the imposed load needed to be transmitted is of small magnitude and the underlying soil layer is of dense sand and gravel.



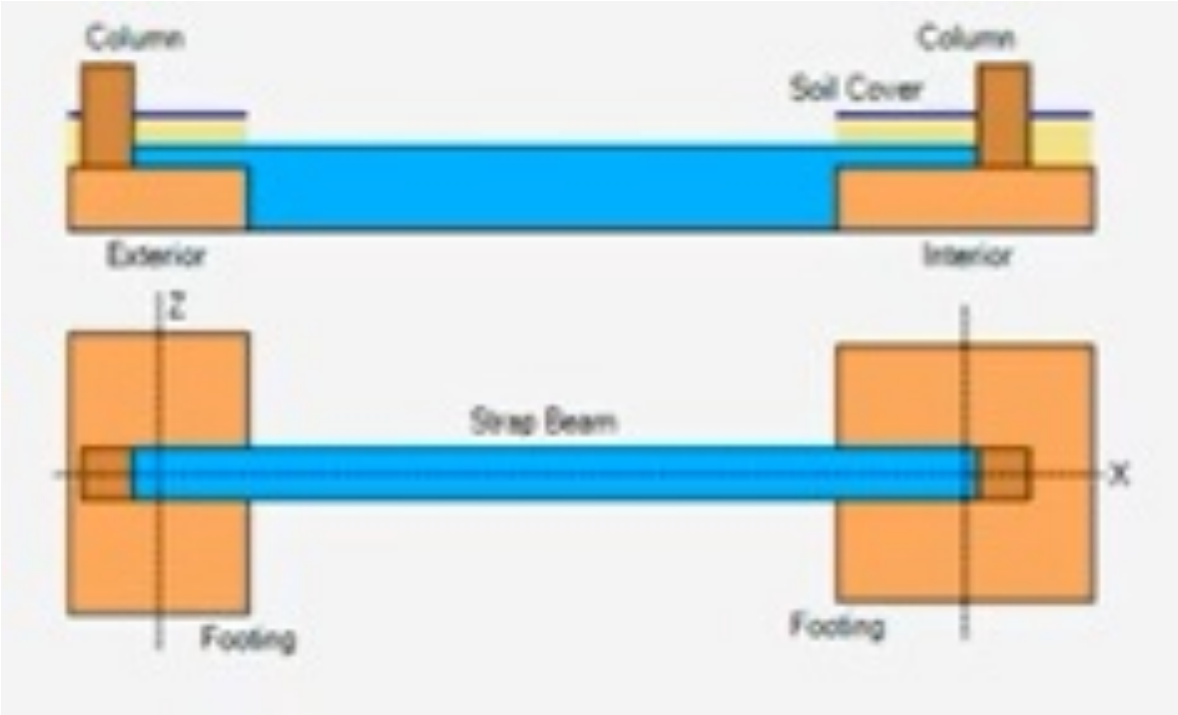


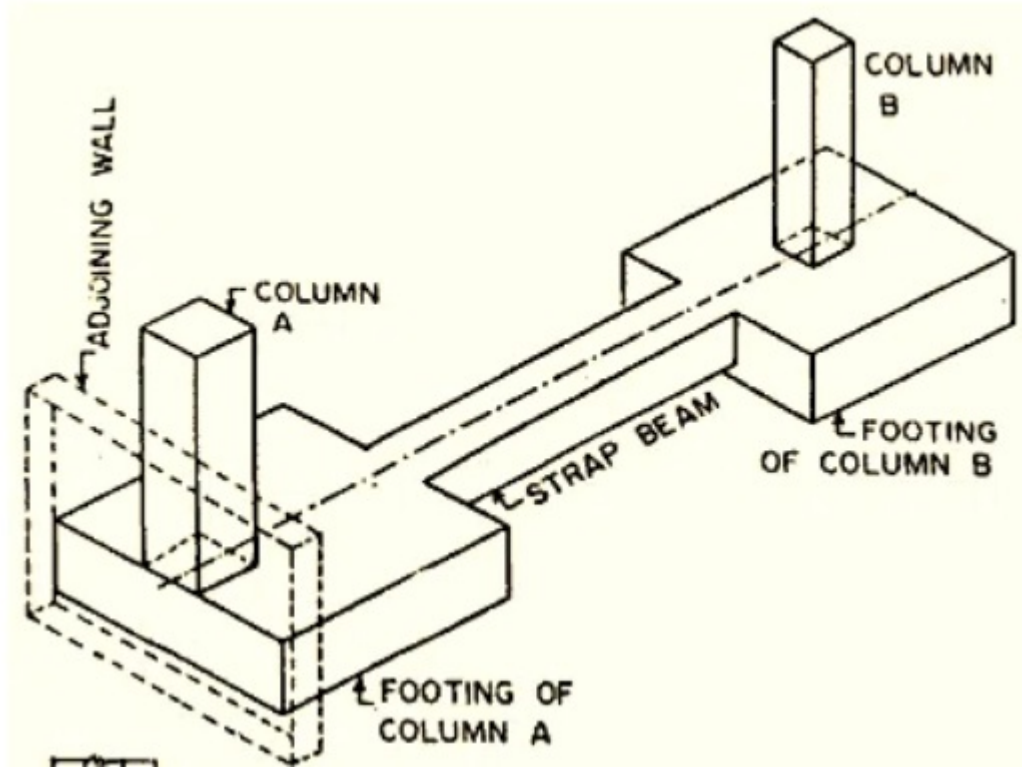
Cantilever footing or balance footing:

Consist of two single footings connected with a beam or a strap and support two single columns.

The cantilever lintel transports the load of the outer shaft that has an asymmetric single base to the base of the inner shaft that has a symmetrical single basis. The cantilever foundation of the outer beams works when adjacent to the boundaries of adjacent buildings. As shown in Figure:

This footing is best suited when a column is near a property line and due to space restrictions, an eccentric footing is necessary


Column
Column
Soil Cover
Exterior
Interior
Z
Strap Beam
X
Footing
Footing


COLUMN B
ADJOINING WALL
COLUMN A
STRAP BEAM
FOOTING OF COLUMN B
FOOTING OF COLUMN A

Mat or raft footing:

A raft or mat foundation is a large continuous rectangular or circular concrete slab that carries the entire load of the superstructure and spreads. it over the whole area beneath the building. It is useful in controlling the differential settlement.

-It is a reinforced concrete casting under all the areas of the building.

-The thickness of the raft foundation varies with the different loads on it and ranges from 20 cm to 60 cm.

The hidden beams are used in the cast of the foundation or the deep beams in one or two directions. It is preferable that the deep beams be turned upward to facilitate the spreading of the moisture

-proof layers under the foundation when the basement is to be used as a basement in sites where the groundwater is high or variable in the seasons of the year Different.

-It is require to use of anti-moisture layer to isolate the foundation concrete from the soil containing salts and acids that cause corrosion and fragmentation of concrete.

-It is preferable to use the raft foundation for multi-story building, especially when a basement is intended to be made in the footing of the structure to benefit from it for civil defense purposes or as a place for central air conditioning machines or as a private parking lot, provided that the raft foundation is the most economical alternative.

-The raft foundation works with an unturned beams when the groundwater level is low and there is no need for moisture inhibitor.

Functions of Mat Foundation

1-Transfer superstructure loads and spread it over the entire area of the building foot print.

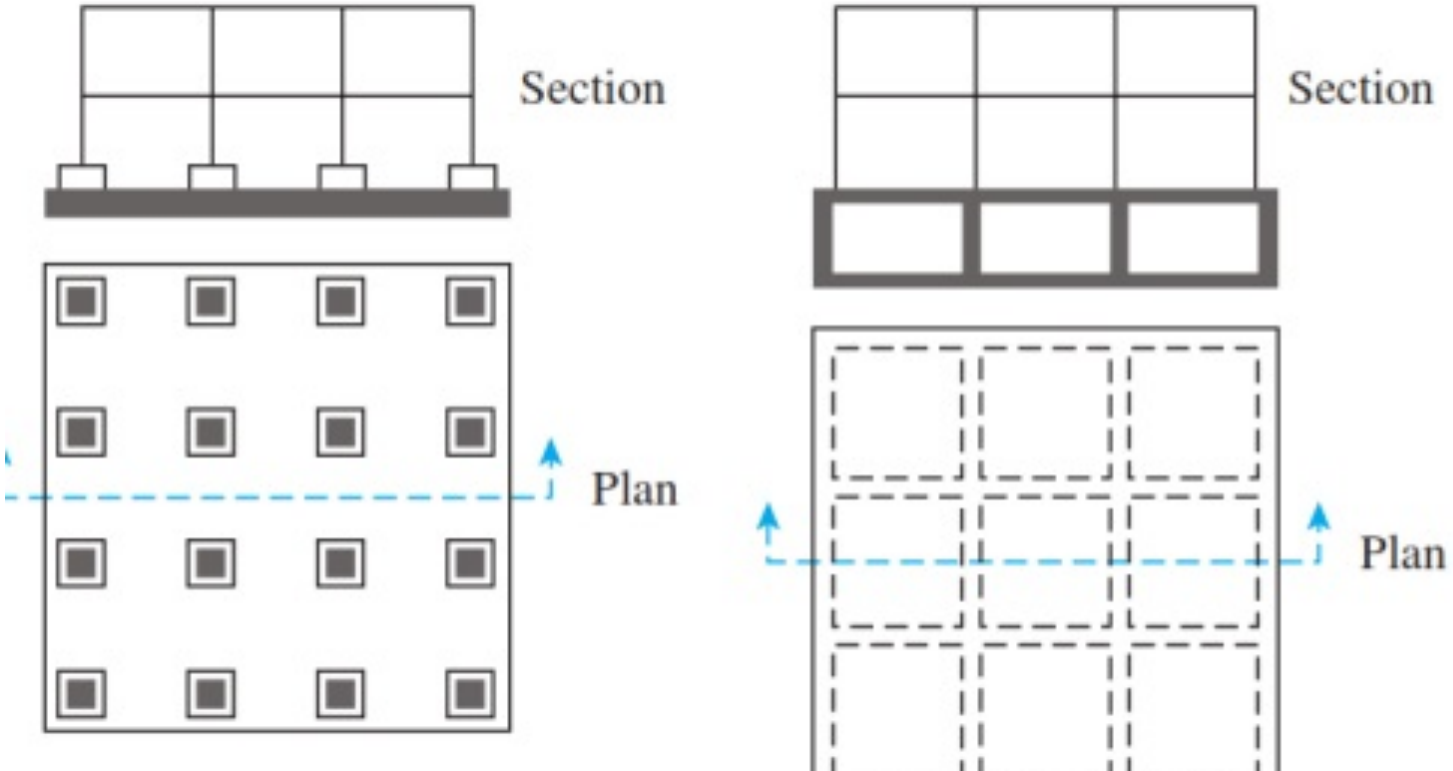
2-Reduce differential settlement of structures constructed over weak soil.

Uses of Mat Foundation:

1- The base soil has a low bearing capacity, and where there is a large variation in the loads on the individual columns.

2- It is commonly used when the column loads are so large that more than 50% of the construction area is covered by the conventional spread footings.

3-It is common to use mat foundation when the structure contains basement.



Lecture4

Foundation Of structure

Dr. Omar A. Khalaf

Deep foundation:

deep foundations are those found too deeply below the finished ground surface for their base bearing capacity to be affected by surface conditions, this is usually at depths of 3 meters below finished ground level.

Deep foundations used when :

-The upper soils are so weak and/or the structural loads so high that spread footings would be too large.

-The foundation must penetrate through water

- A large uplift capacity is required.
- A large lateral load capacity is required.
- There will be a future excavation adjacent to the foundation, and this excavation would undermine shallow foundations.

Types of deep foundation:

- Pile Foundation:

Pile: this is the element of construction placed in the ground either vertically or slightly inclined to increase the load-carrying capacity of the soil.

Pile foundation, a kind of deep foundation, is actually a slender column or long cylinder made of materials such as concrete or steel which are used to support the structure and transfer the load at desired depth either by end bearing or skin friction.

The reasons for use piles as foundations are:

1. When the soil is poor and cannot carry the load with other types of foundation
2. When the soil is clay and has seasonal shrinkage and swell according to the moisture content and ground water movement
3. When the structure construct above water like water intake
4. When we cannot excavate deep because of the existing building foundation close to new building
5. When we need to equilibrium to tensile or lateral forces then the piles called (anchor piles) when it is vertical and (batter piles) when it is with slope
6. For earthquake region
7. When ground water not deep from natural ground level
8. When it need to support existing building foundation by used jacked piles
9. When it need to support side pressure like soil or water by used sheet piles

Classification of piles:

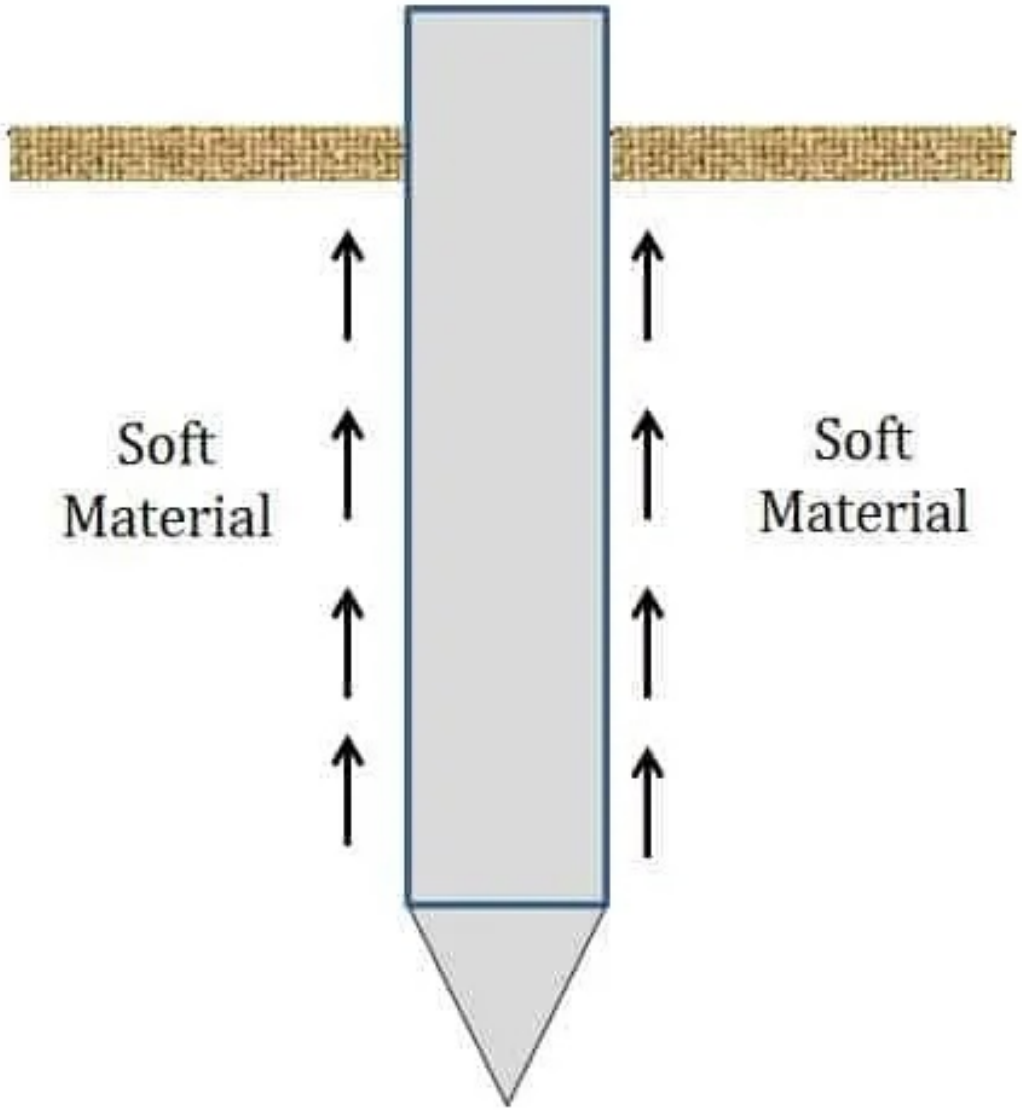
Piles can be classified according to:

1. The method it transmits the load to the subsoil:

a. Friction pile: It is the piles that transfers its load to the soil by friction between its side surfaces and the adjacent soil.

b. Bearing pile: It is the pile that transports its load to the soil and acts as a column based on a rocky layer or strong soil.

c. Combine work pile: It is the pile that transfers its load to the soil by surface friction and vertical support and in varying proportions depending on the nature of the soil composition and its properties, knowing that the most used piles are of this type.



Friction Pile

2. Material used:

a. Wooden piles:

- Are resistant if they remain surrounded by fixed climatic and underground conditions. Where they differ, wood must be treated with special preparations to strengthen it and increase its resistance to insects, erosion, thermal change, moisture and salts.

-Metal clips are usually added on both ends of the substrate to keep it from being smashed while knocking on the metal hammers, as well as facilitating penetration into the soil layers.

-The wooden piles shall be required to pound vertically, given that the permissible slope is equal to 25 mm per 16 meters of the pile length.

B- Metal piles:

-It is in the H section, quadrilateral, hexagon, or octagon, or in a square or tubular section, etc.

-It is preferred that it be in a section with a large circumference, in order to increase its area of contact with the soil and increase its bearing to loads.

- It is available in standard sections, lengths and weights, which requires reference to the details of the facility when in use.

-it has a problem of corrosion of mineral as a result of salts and acids of soils, therefore it is necessary to preserve it and increase its duration by one of the following procedures:

1-Electing high yield steel substrates. 2- Election of steel piles containing 0.2% to 0.35% of copper, as copper is the largest corrosion-resistant steel. 3- Use the piles with a section larger than the required design. 4-Coating the piles with preservatives. 5- Maintaining the piles section using cathodic protection.

C. Concrete piles: Concrete piles can be broadly classified into two types:

- Precast concrete piles: These are cast at a suitable place, cured, and afterward driven like a timber pile.
- Cast-in-situ piles: These are cast at the place where they have to rest finally. They may have a casting that also remains intact.

Advantages of precast concrete piles:

-Best concrete can be prepared by proper workmanship. Any defect can immediately be repaired.

-The reinforcement remains in the proper position and does not get displaced.

-The concrete has only to withstand loads after complete curing has taken place.

-They can be cast before hand and a quick driving progress can be ensured.

-They are more convenient through wet conditions.

-They are more suitable when a part of their length is to remain exposed.

Concrete pile

cast-in-situ piles

Precast piles.

Piles cast-in-situ concrete	Piles precast concrete
Piles cast in place with various section and long that mean less cost and wastage material	piles cast in factories with stander section and long that mean more cost if there were any increase of long .
They are no need to transport	They are heavy and difficult to transport.
Good quality concrete cannot be easily obtained	Good quality concrete can be easily obtained
The reinforcement is liable to get displaced	The reinforcement remains in the position and doesn't get displace
There is no shock because it cast in place	The shock of driving make them weaker
They cannot use it underwater.	They used when found water

Sheet piles:

Sheet piling is an earth retention and excavation support technique that retains soil Using sheet sections with interlocking edges. Sheet piles are installed in sequence To design depth along the planned excavation perimeter or seawall alinment

Use of sheet piles:

- Retaining walls
- Bridge abutments
- Tunnels
- Pumping station
- Water treatment plants
- Basements
- Underground car parks
- Slope stabilization

Caisson foundation:

Caisson is a watertight structure which it is generally made up of timber, steel, and reinforced cement concrete (R.C.C) and constructed in connection with the excavation for the foundation of piers, bridges, and dock structures etc.

-The word Caisson means a box-type structure.

It is a large diameter foundation which is generally adopted in the underwater Construction.

Caisson foundations, also known as pier foundations, are prefabricated hollow substructures designed to be constructed on or near the surface of the ground, sunk to the desired depth and then filled with concrete, thus ultimately becoming an integral part of the permanent structure.

Uses of Caisson foundation:

- It is used in the construction of piers of the bridges in the water bodies.
- construction of large and Multi-Floor Buildings.
- Caissons are used in the construction of railway bridges.
- provide access to the shaft and tunnels.

Lecture 5

Walls construction

Dr. Omar A. Khalaf

Walls:

Walls are essential structural components of any building.

A wall can be defined as a vertical load-bearing member, the width of which exceeds four times its thickness.

Purposes of walls:

- Delineate boundaries.
- Support roofs and floors.
- Protect privacy.
- protect any users of the building from rain, sun, and wind.
- Prevent the spread of fire.

Type of walls according to function:

- Load bearing.
- Non- load bearing (partition wall).
- Retaining Wall.
- Shear wall.

Load bearing:

They are parts of the building where beams and columns are not used, load from the roof and the floors are transferred to the foundation through the wall.

Load bearing walls are thicker than non load bearing.

Non- load bearing (partition wall):

The main purpose of the partition wall is to Divide floor area into different utilities.

- They provide privacy and do not carry the weight from the roof or the floor, they just have to carry their self – weight.
- The thickness of partition walls are less than the bearing wall.
- You can remove the partition wall at any time without affecting the building structure.

Retaining wall:

At times the level of the ground on its two faces might be uneven. In such cases, in order to restrain the level of the soil to the slop, we construct a retaining wall.

Shear wall:

Shear wall is usually built to resist lateral forces caused due to earth pressure hydrostatic pressure, wind , and earthquakes. A shear wall help to considerably reduce the lateral sway. They are thin walls and light in weight.

Shear wall

Retaining wall

Difference between a load- bearing wall and a non- bearing wall

Load bearing walls	Non- load bearing walls
They carry loads from roof, floor , self- weight. Transfer load from roof to foundation	They carry self weight only. Function divided the area in to different services
They are thick and hence occupy less floor area.	These walls are thin and hence occupy more floor area.
The materials required to construct a load- bearing wall are more than that for a partition wall.	The materials required to build a partition wall is less.
Blocks, Brick and stone used for the construction.	Stones are not used for the construction of partition walls. You may use materials like brick, light block(cavity), timber, glass, clay block

Basic characteristics of a wall :

- A wall should be strong enough to carry its weight and the load bearing wall should also be capable of carrying and transferring the weight of the roof and floor to the foundation.
- The wall should be strong enough to resist the impact to which the occupation of the building is likely to subject them.
- The load-bearing wall should be able to support the openings for doors, windows ventilators etc.
- The partition wall should be stable and support wall fixtures, wash basins, etc.
- It should be fire resistant.

Brick wall

Bricks can be classified by different methods:

1. According to the raw materials:
   a. Clay bricks
   b. Sand lime bricks
   c. Concrete bricks
   d. Glass bricks
2. According to the shape:
   a. Solid
   b. Perforate
   c. Hollow
   d. Cellular
   e. Bricks with openings

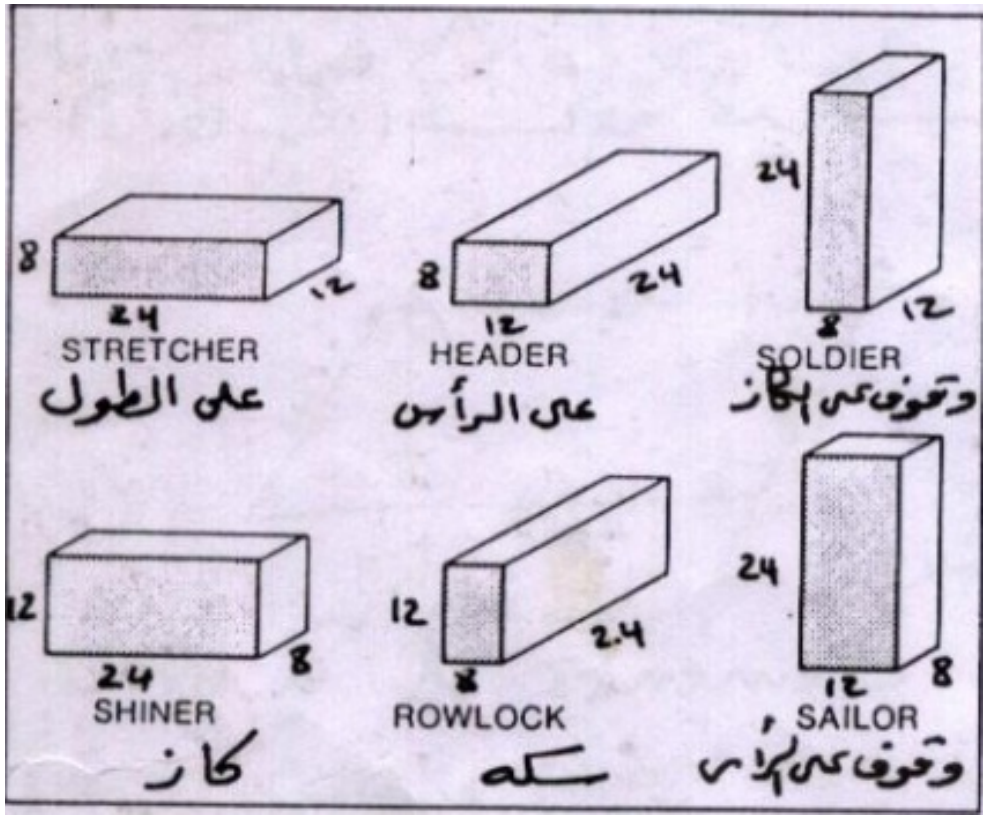
Bricks work :

The bricks of the oldest building materials known to and used by humans.

Brick is manufactured in several sizes and shapes. the usual size used in

Iraq 24*12*8 cm.

There are six possible positions in which a brick may be placed



Brick frequently must be cut to fit into corners and other places where a whole brick cannot be used.

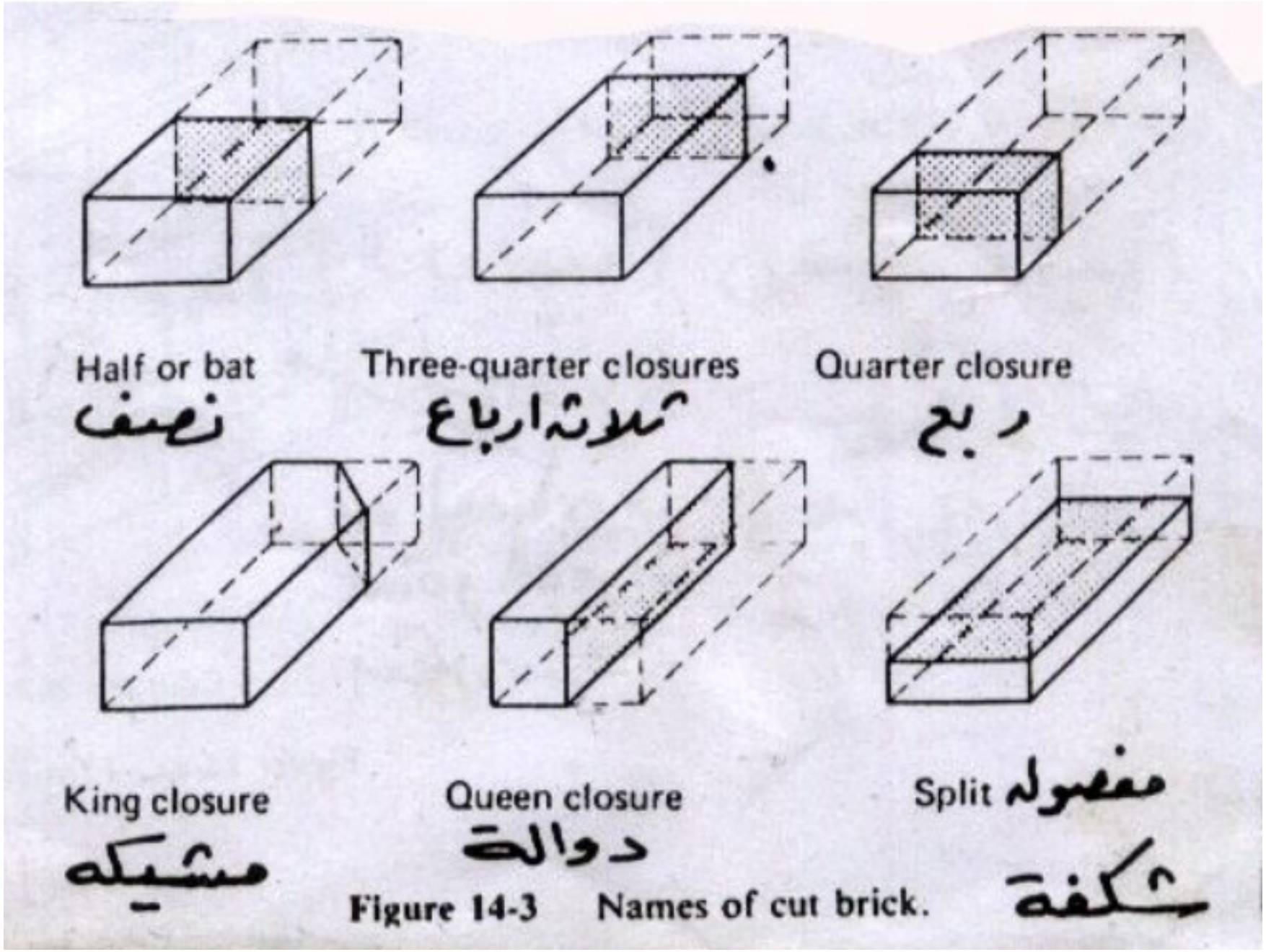
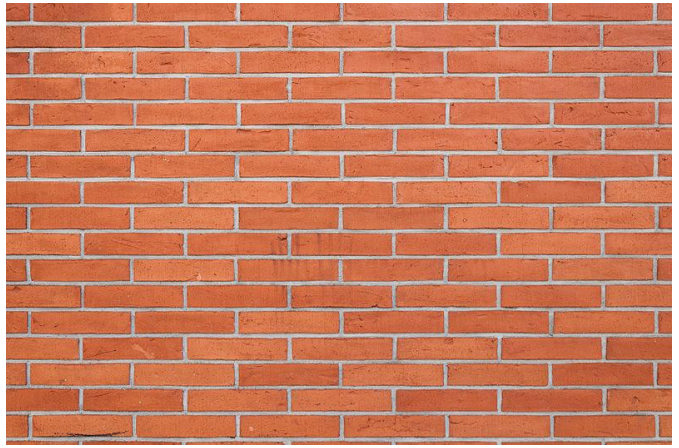


Figure 14-3 Names of cut brick.

Types of bonds in bricks in masonry wall construction :

The most commonly used types of bonds in brick masonry are :

- Stretcher bond
- Header bond
- English bond and
- German bond (Flemish bond)



Stretcher bond:

A stretcher bond is a term that refers to the lengthier face of the brick. in stretcher bond masonry all the bricks are arranged in stretcher courses, however, care should be taken in arranging vertical joints.

This pattern is preferred only for walls with half brick thickness.

this type of structure is adopted for the construction of partition walls

Bat is the term that refer to cut the brick in to equal parts

Queen is the term that refer to cut the brick in to equal parts in longitudinally .

Stretcher bond wall systems are often considered the easiest to build because of their simplistic pattern approach. There is no requirement of bricklaying a full-brick thickness to the wall. The bricks are laid with mortar joints between them, and stacked in alternation on every layer.

The bricks are laid starting from the ground or foundation and working upward until the desired height is reached. The wall structure is tied to both the foundation and itself, with vertical support ties running throughout the height of the wall. Horizontal ties are placed between the layers of the wall running from each wall to the wall opposing it.

Lecture

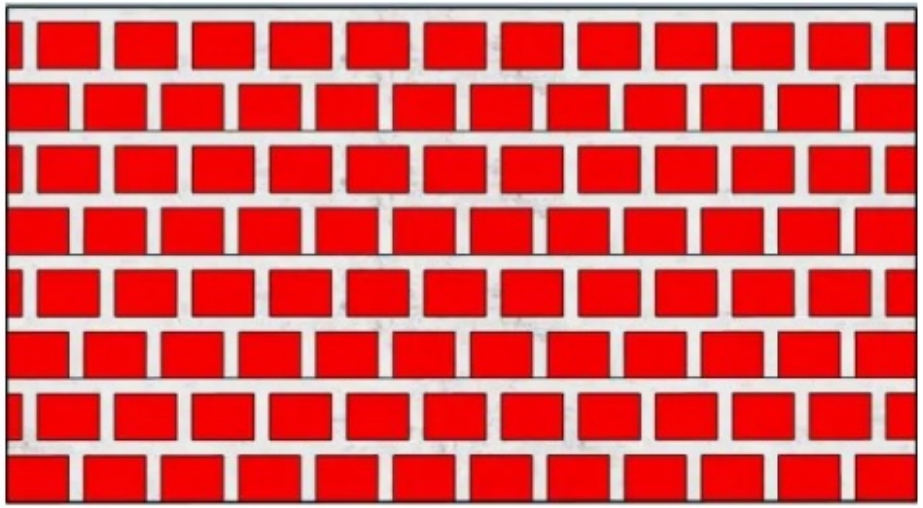
6

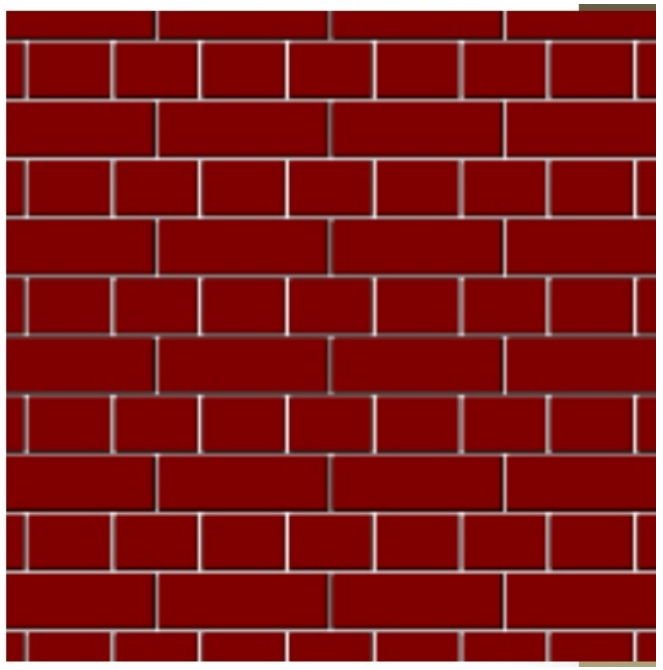
Walls construction

Dr. Omar A. Khalaf

Header bond:

A header is the shorter face of the brick. in header bond brick all the bricks are constructed in the header courses corresponding to a half-width of the brick. the three- quarter brick beats are utilized in alternate courses as a bat. header bond is used for the construction of walls with one brick thickness walls.





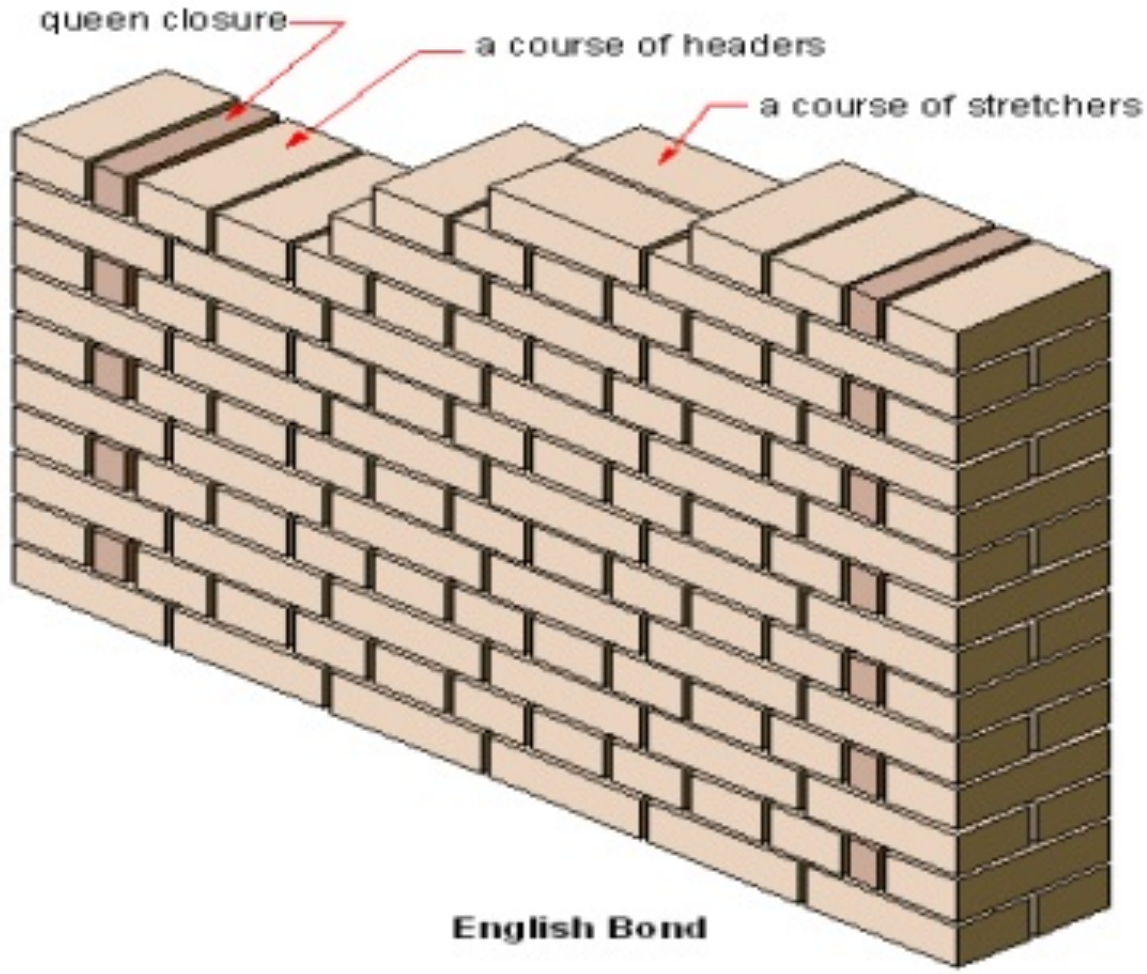
English bond:

-The strongest bond.

-This bond maximizes the strength of the wall

-The pattern on the face of the wall shows distinctive courses of headers & stretchers.

-For the breaking of continuity of vertical joints, the queen closuer is used at the beginning and end of a wall after the first header in each heading course. A queen closuer is a brick cut lengthwise into two halves and used at corners in brick walls.



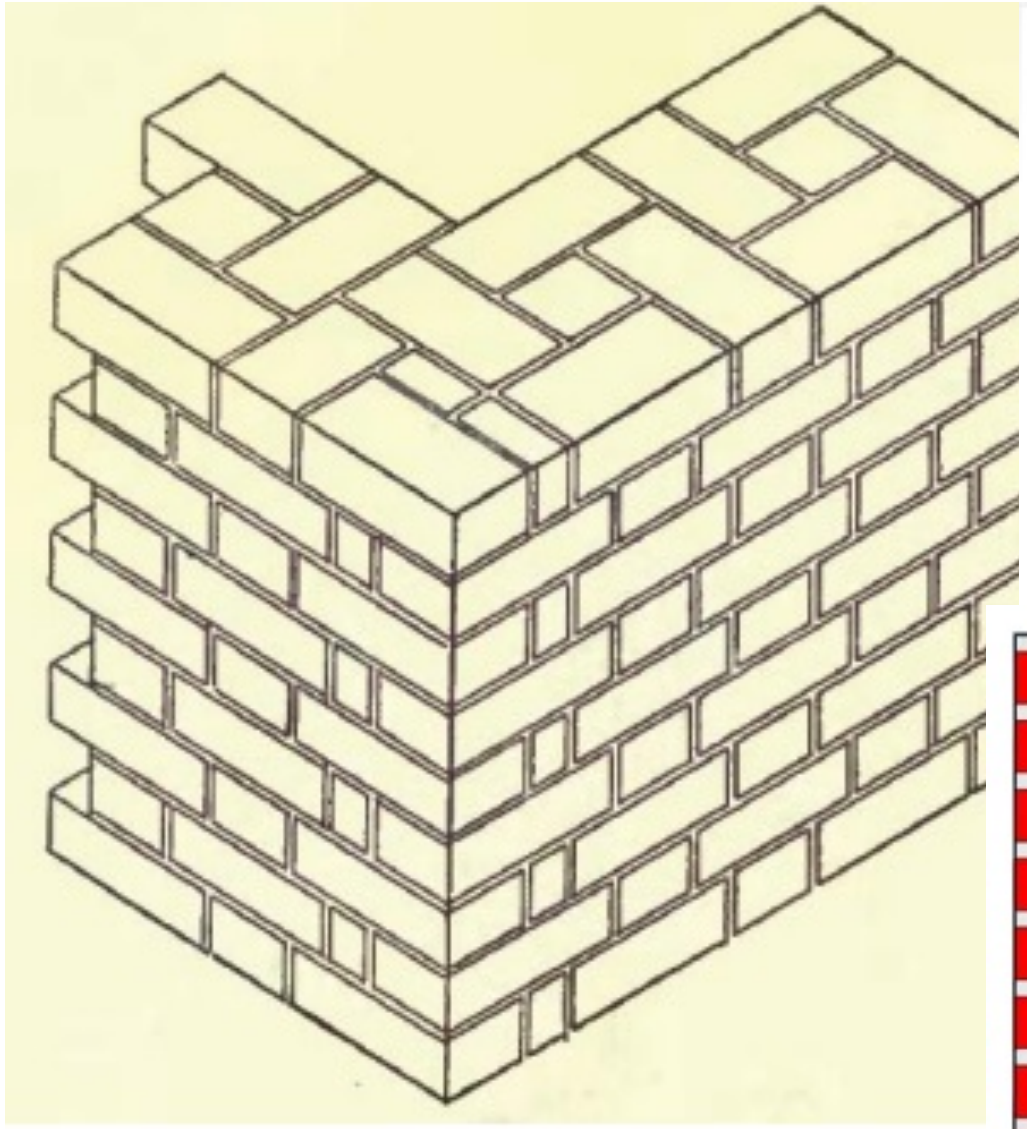
Flemish bond:

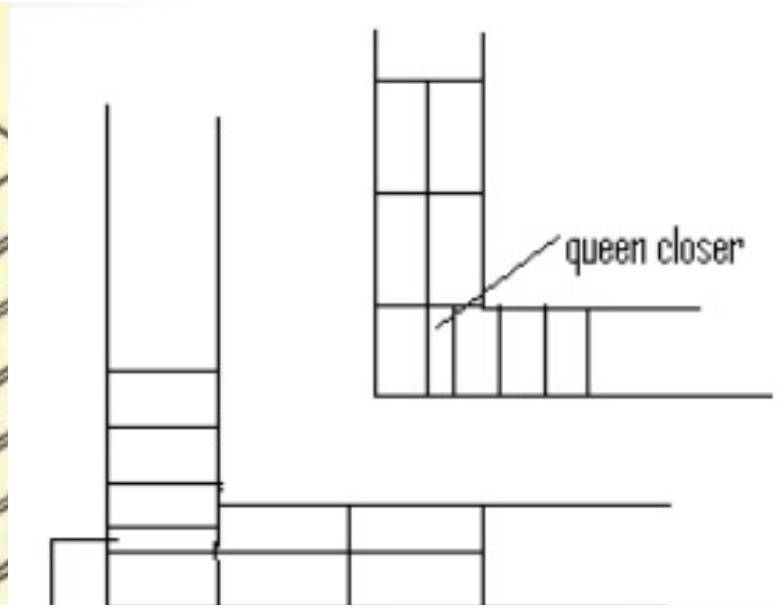
-Not such a strong as English bond

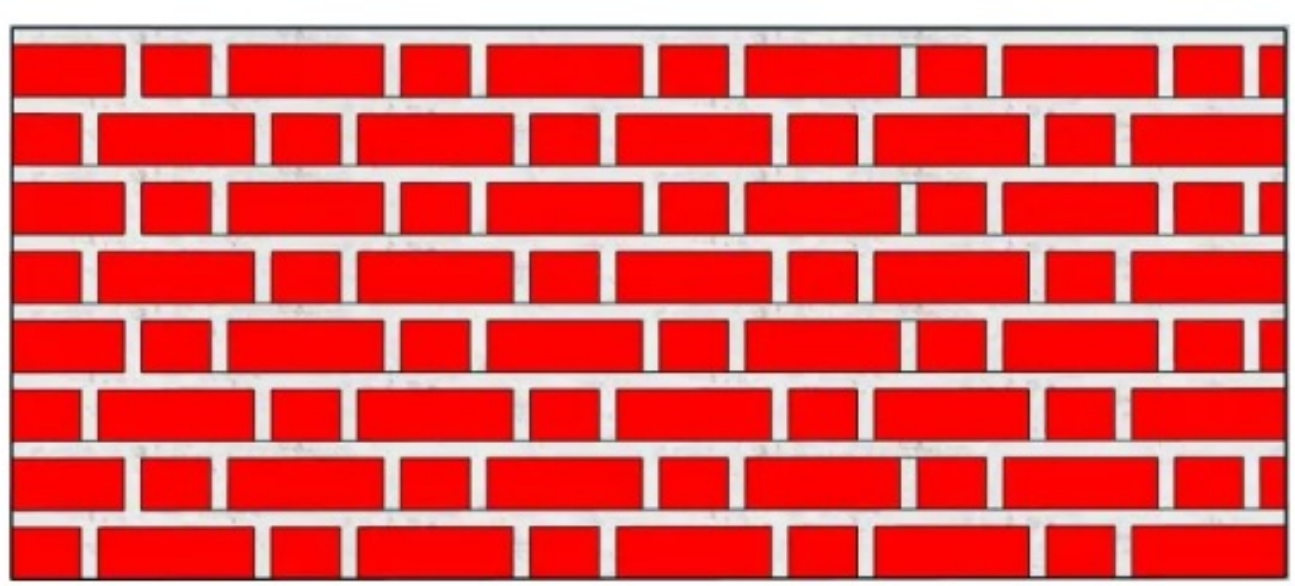
-Decorative pattern on the face of the wall, created by laying alternate headers and stretchers in a single same course.

The very next course of brick is laid in such a way that the header lies in the center of the stretcher in the course below, i.e. the alternate headers of each course are centered on the stretcher of course below. Every alternate course of this bond starts with a header at the corner.

This bond is difficult to construct and requires high skill to lay it perfectly as all vertical mortar joints need to be aligned vertically for best and great effects.

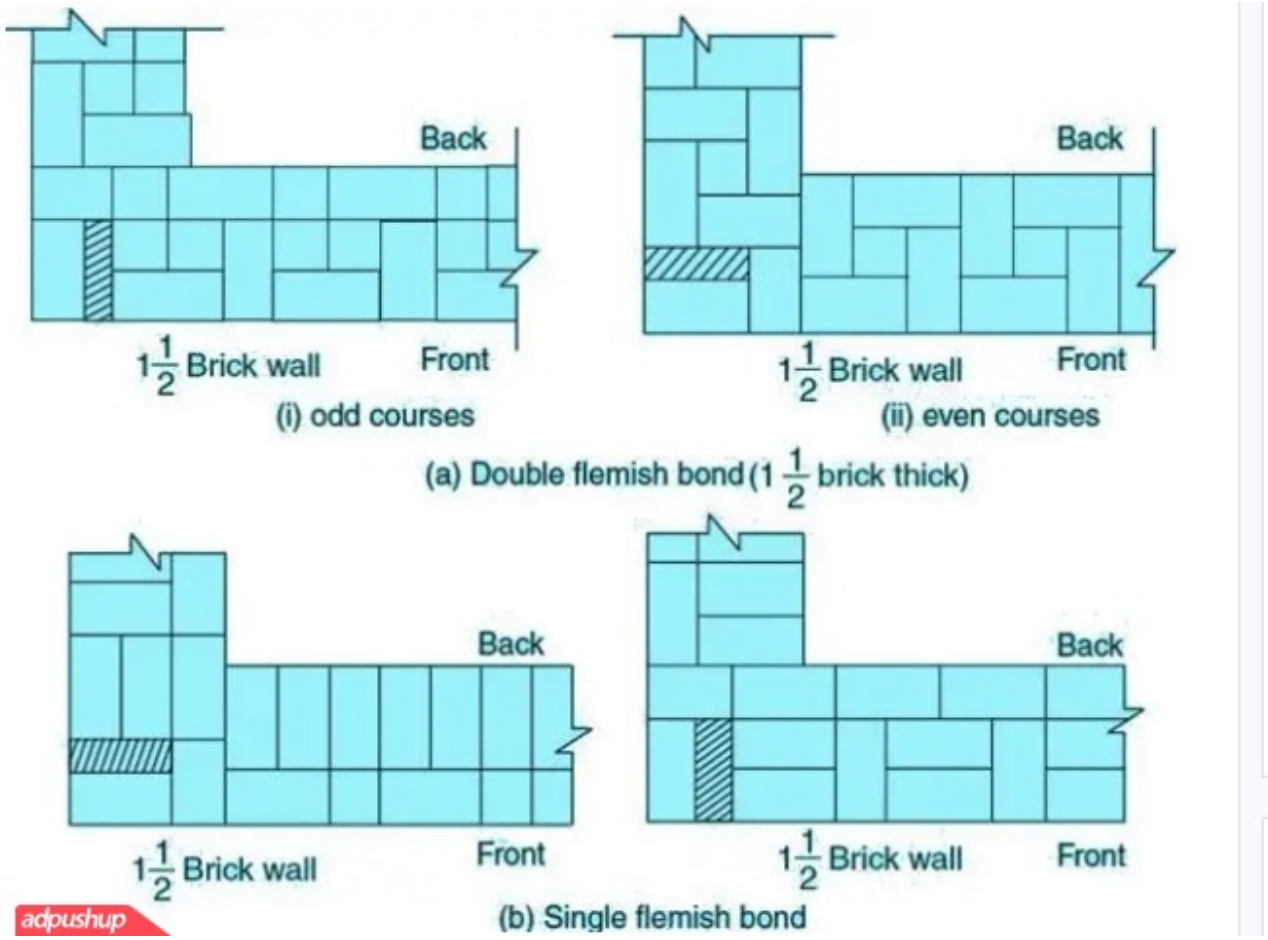






Flemish Bond

There are two types of Flemish bonds, Single Flemish Bond is a combination of English bonds and Flemish Bond. The front exposed surface of the wall is composed of a Flemish bond and another back surface is composed of an English bond in every single course while Double Flemish Bond takes a similar kind of appearance both in the front as well as the back of elevations.



Difference between English bond & Flemish bond :

1- English bond is much stronger than a Flemish bond for the walls are thicker than 1½ brick.

2- Flemish bond shows the more attractive and pleasing visual aspect of masonry work.

3- Flemish bond is economical as it utilizes broken brickbats, although it requires some extra mortar for additional joints.

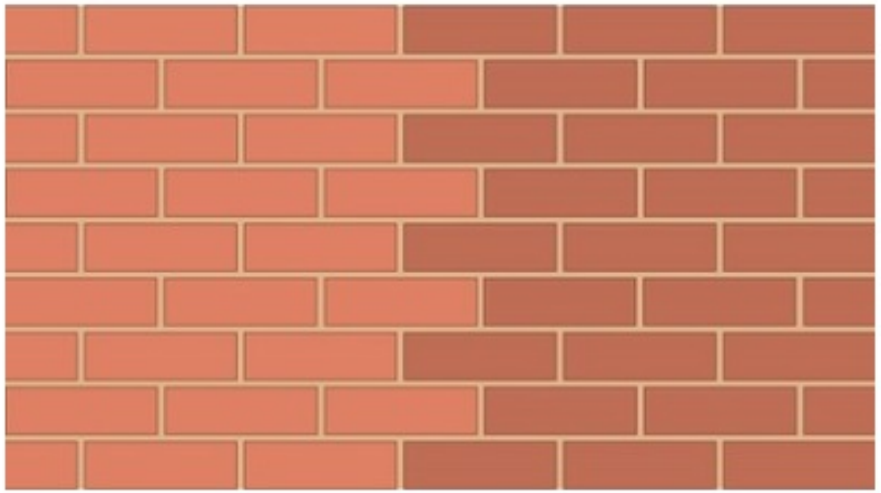
4- The uses of the Flemish bond are a bit difficult compared to the English bond.

5- Flemish bond required more skilled labor and supervision.

Complete and connect wall:

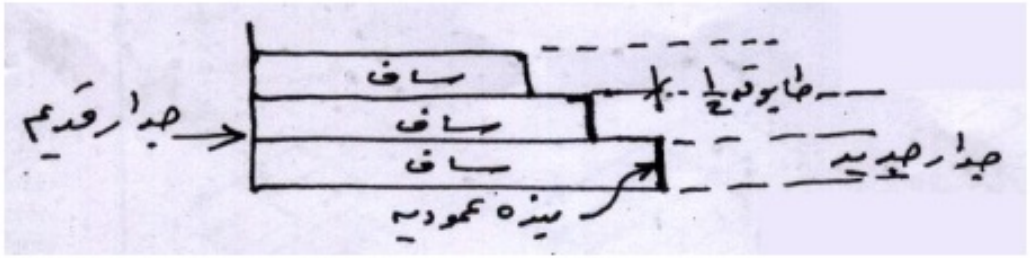
For the purpose of completing a wall that is under construction, or is left behind, or linking a new wall with an old wall, one of the following methods is used:

Teething : This type of construction is used when the building is left before the completion of the wall for some reason, then every brick along the length is left in the place of stopping by a quarter of its length from the brick that is on the head in the course below it, thus the end of the wall is in the form of teeth that facilitate the fastening of the wall when it is to be completed.



Traditional 'teething out' method

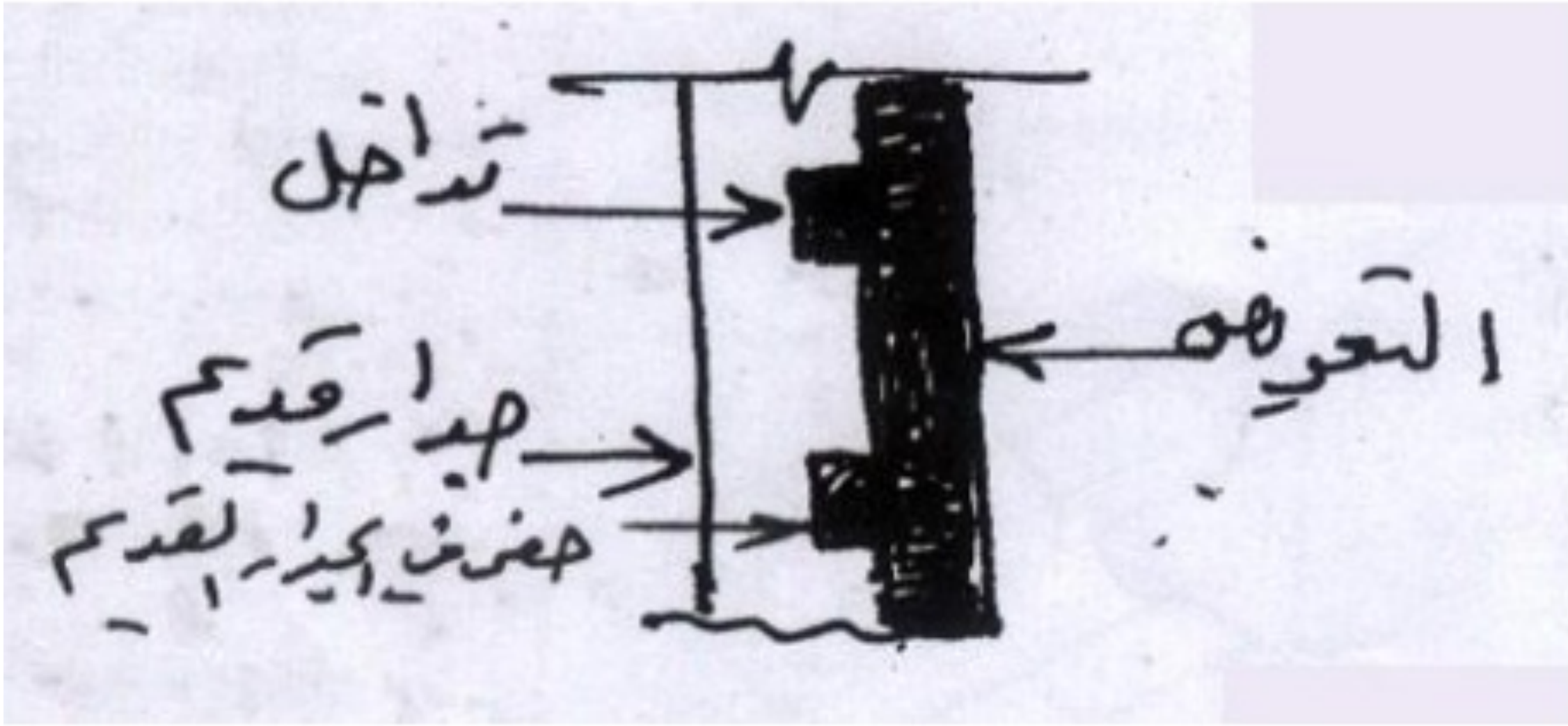
Tracking: It is a method in which construction is included when it is left unfinished, and when the height of the wall reaches a height, the building above it cannot be crossed and hardened and bonded well, as the wall is not built in one step but rather in stages to allow



the hardening of the joining mortar. Each course shall be less off the course with a distance of 1/4 or 1/2 brick in order to prevent the occurrence of bonds on one straight line and forming a weak area in the wall

Thickening:

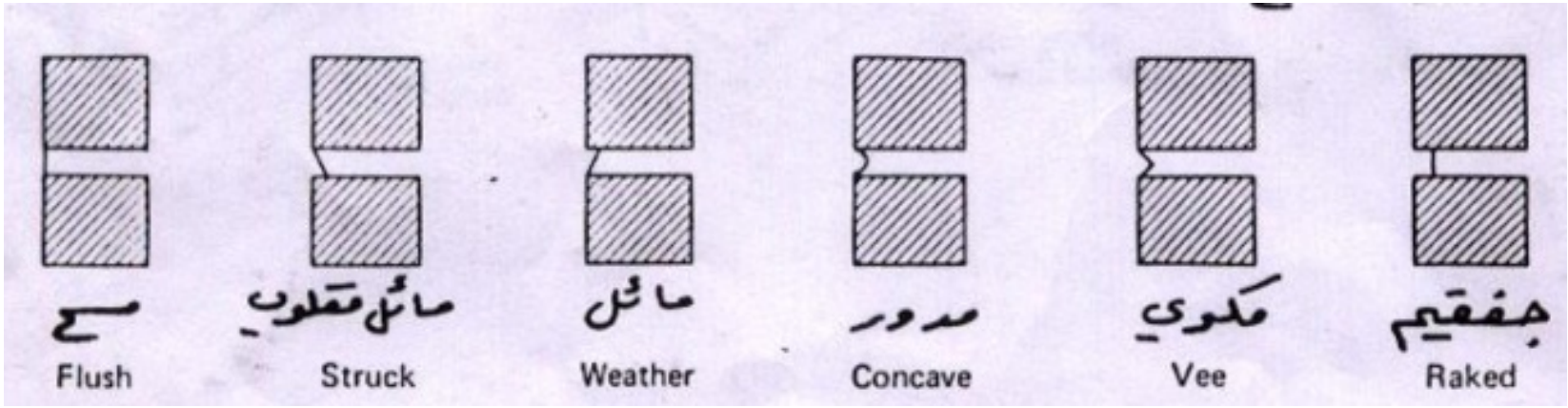
It is used when it is necessary to expose the thickness of the old wall, and this is done by digging the old wall with dimensions (1/2 * 2 * 2) brick for each (1 square meter) of the wall, where it is cleaned and rinsed with water well before building the exposure to ensure the consistency of the mortar with the old construction.

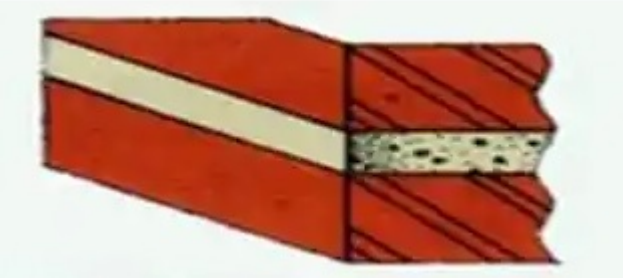

تداخل
جدار قديم
حفر في الجدار القديم
التعرض

Pointing & joints

When the joints between the building brick are finished with cement mortar along with other materials, this process is called seaming and the seam is carried out when the brick wall is left as it is and without being scolded by any substance. The seaming may be after completion of the construction and is called pointing and when during construction it is called jointing.

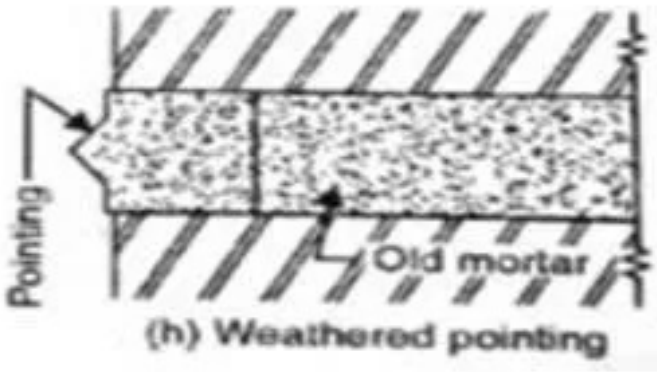
Pointing is the finishing of mortar joints in brick or stone masonry construction. Pointing is the implementing of joints to a depth of 10 mm to 20 mm and filling it with better quality mortar in desired shape. It is done for cement mortar and lime mortar joints.

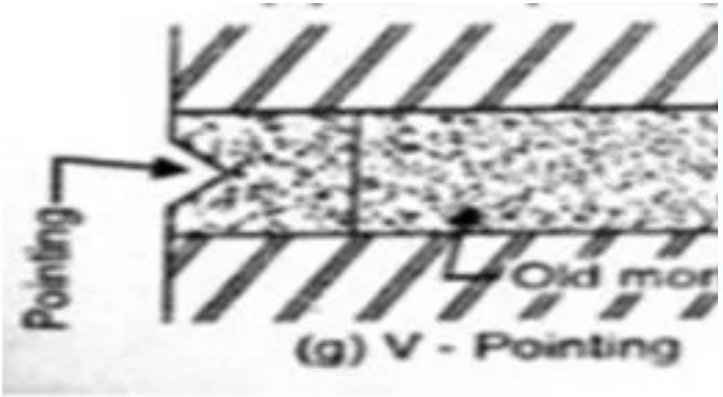




Flush pointing

Struck pointing





Concrete block work:

Concrete blocks are often used to build load-bearing walls, and they may be used as partitions to divide spaces sometimes in structural buildings. They are two types:

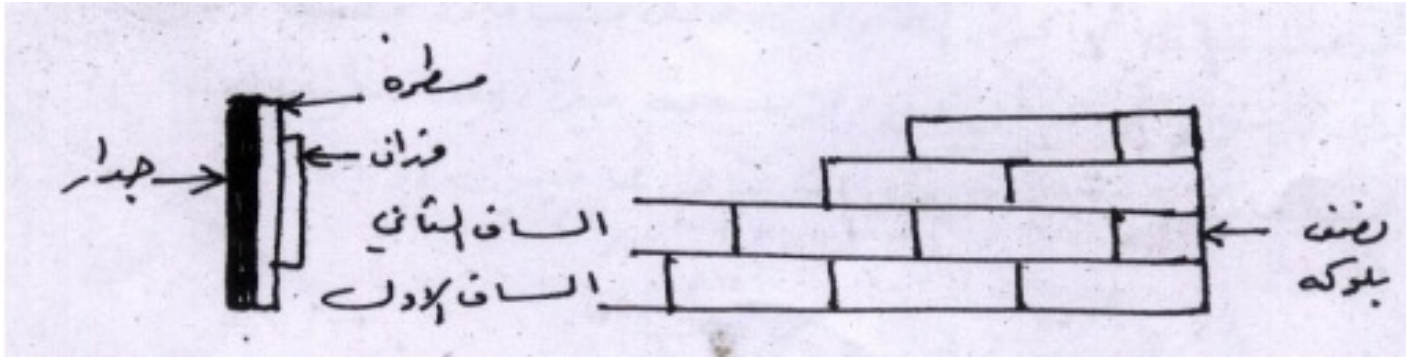
- Solid concrete block
- Hollow concrete block

They are of different shapes and sizes and according to the location they are used in construction, but what is commonly used today in Iraq is the block with dimensions (15 * 20 * 40) cm.

Construction method:

1- The cement mortar (1: 3) is laid with a thickness of 1 cm on the surface of the cubing, then the corners are placed and adjusted by the hand level, and the staff.

2- Connecting two threads between each corner to adjust the face of the wall.
3- Building a course on the stretcher (the first course), then half a block is placed at the beginning of the second course, then the blocks are placed on the stretcher, and so on. Every course is adjusting the face of the wall with the thread and adjusting the verticality of the hand level as shown below:



4- The wall is not built in one step, but it is done in stages to allow cement mortar to harden. When the building is left to complete it
at another time, the blocks will be laid out as previously explained in the brick building.
5- Building walls of blocks is usually done to a height of 3 meters.