First: General introduction .

Second: Estimation of buildings construction work, and this includes:

a) Cleaning and preparing the work site for project planning.
b) Excavations for the foundations.
c) Crushed stone layer under the foundation of a 8 -10 cm thickness.
d) Placing the concrete for foundation.
e) Stone blocks or bricks under DPC.
f) Pour DPC of 10 cm thickness.
g) Walls building with clay brick or concrete block.
h) The wooden forms work.
i) Casting concrete for roofs and beams.
j) Finishing work: cement rendering, plastering with gypsum, floors tiling, ceramic work, doors, windows, etc.
k) Tiling for floors.

Third: The Culvert Box.

Fourth: Water Tank.

Fifth: Channels.

Sixth: Preparing bills of quantities for different construction items.

First: General Introduction:

The Estimation: is the art of estimating quantities for construction activities in terms of price and duration of construction closer to a reasonable one, usually before starting to work in order to monitor the amount of money expected to be expend.

Estimating can be divided into two parts:

1) **Total Estimate or approximate**: Estimate construction as a whole on the basis of the m^3 or m^2 of the construction. This type is placed on an urgent basis or for roughly estimate, the project owner may wish to know the approximate cost of the project before making a decision to create it, and this kind of Estimating is not always sufficient for all bidding type.

2) **Detailed Estimate**: Estimate every part of the building in a detail, and after estimating the price of materials, equipment and workers' wages, and additional

expenses, fixed estimate profit. This type needs to be done by contractors before bidding and Contracting for important projects.

Factors affecting the cost of engineering work:

1) the work site.

2) the availability of skilled labor.

3) the general economic situation .

4) holidays, events and various holidays.

5) the weather in the period of work.

6) preparations.

7) additional expenses and permanent .

8) The availability of materials and machines used .

Bill of quantities:

A table is placed by the estimator for the activities that must be performed sequentially, which is determined by the prices of the work (by Contractor) and received acceptance by the owner. Below is a simplified table:

No	Activity	Unit	Quant.	Price	Sum
1	Site cleanup and planning	Lump sum			
2	Excavations for the foundations	m^3	---	---	---
3	Crushed stone laying under the foundation	m^2	---	---	---
:		:	:	:	:

Second: Estimates construction work for buildings:

1) Site Clean and planning work:

It is one of the first activities of the construction work of the buildings may be this activity expensive and significant , especially in the case of a construction rubble or waste, trees at the work site , it may require heavy machinery to handle theme out the site before it would be ready for planning .

2) Excavation:

This work includes excavating the foundations, water tanks, trenches and septic tank, or may be the excavations for the purpose of removing the surface layer of the upper natural soil that may be contain wastes or organic materials. Wherever it was necessary, the contractor should excavate up to appropriate depth according to site conditions, this excavations measured in m^3.

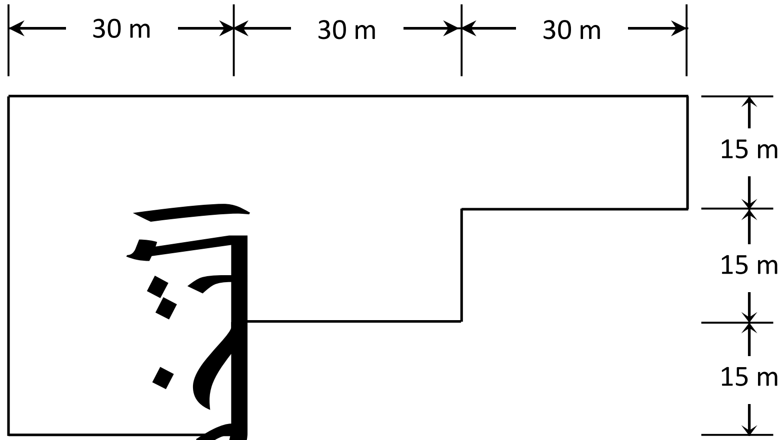
- Excavations depth specified by project drawings and the pre-defined dimensions, and the Contractor shall use proper equipment such as Shovel, Bulldozer... etc.
- Excavations may not be limited to the borders of the project workspace as planned, but sometimes there is a need for additional excavation outside the boundaries of the project area up to 1.0 to 1.5 m for general purposes.
- after the completion of excavations there is a need for soil filling according to the specifications, which include the following:

1) Soil filling must be in layers not more than 20-25 cm thick after compaction.

2) Moisture content should be not less than (10-15 %) during compaction.

3) For each 500 m^2 of compacted soil, Samples for compaction test should be taken with rate not less than 95 %.

Example 1) Estimate the excavation needed for the raft foundation under the building below, note that the extra excavation of 1.5 m from all sides required, the excavation depth is 0.8 m.



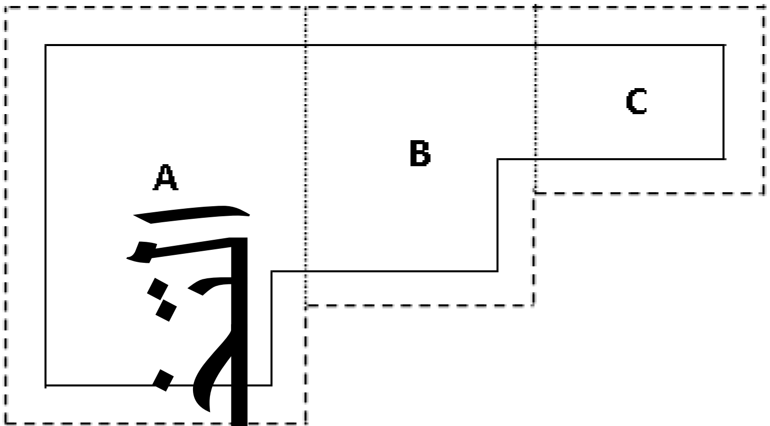
Solution: we draw the outer limits of drilling in the form of a dashed line is 1.5 m on all sides, and then we divide the total area to the secondary areas as shown in the figure below , and then we calculate the volume of the excavation dirt .

Sec.	L_1 (m)	L_2 (m)	Area=L_1*L_2 (m^2)	Vol.=Area*D (m^3)
A	33	48 (45+2*1.5)	1548	1267.2
B	30	33 (33+2*1.5)	990	792
C	30	18 (15+2*1.5)	540	432

D = 0.8 m

D is the depth of excavation

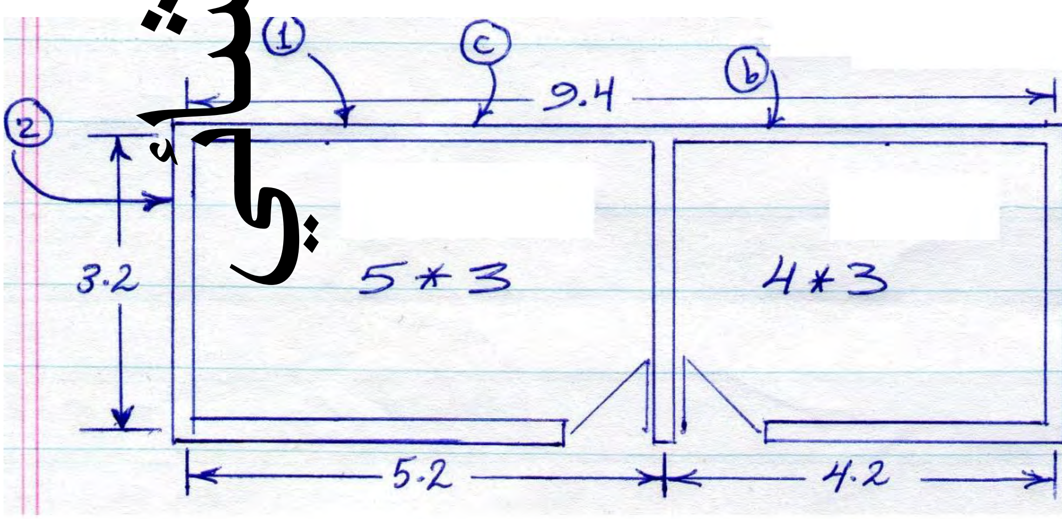
The volume of the excavation dirt = 2491.2 m 3



Excavations for the tab foundations:

For small size buildings, for example: homes, or small workshops, are usually adopt tab foundations under the walls only to procure this type of building.

Example 2) Estimate the volume of the excavation necessary to implement the tab foundation for two shown rooms below, note that the wall thickness (0.2 m) and the base width (0.6 m) and excavation depth (0.8 m).



Solution: to estimate the volume of the foundation excavation, there are two ways:

1) Individual wall method

In this way the building is divided into a set of horizontal and vertical walls, the foundation width is added to the walls of horizontal and vertical walls, or vice versa, and as follows:

The first case: Added to the horizontal walls and deduct from the vertical walls:

Item	Wall length (m)	No.	Total length (m)
1	4.9 + 6.0	2	26
2	2.2 – 6.0	2	8.7
	Foundation length		28.7

Item	Wall length (m)	No.	Total length (m)
a	2.2 + 6.0	2	11.9
b	9.2 – 6.0	2	8.2
c	2.2 – 6.0	2	4.2
	Foundation length		28.7

2) The center line method:

In this method, the lengths of the centers are collected, all walls of the building are then applied to the following rule:

The total length of the foundation = sum of the centerlines length – (number of interior walls * the excavation width)

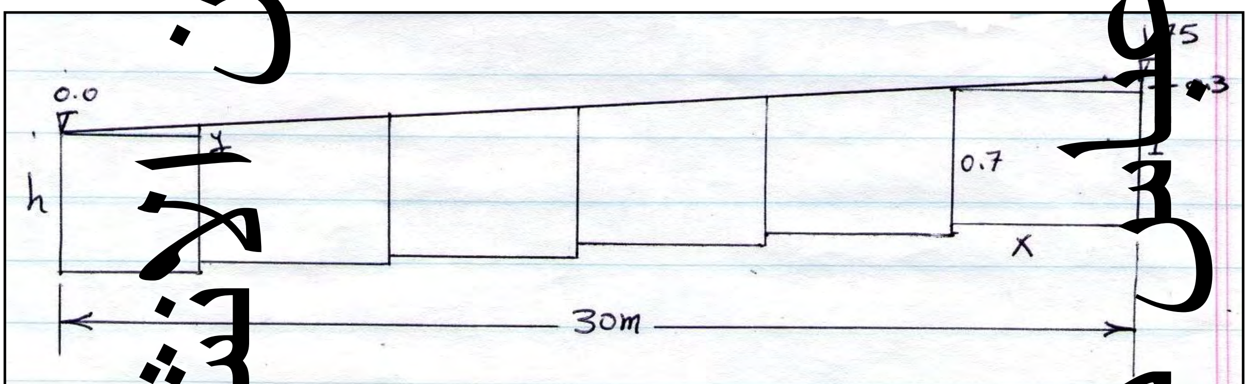
For above example:

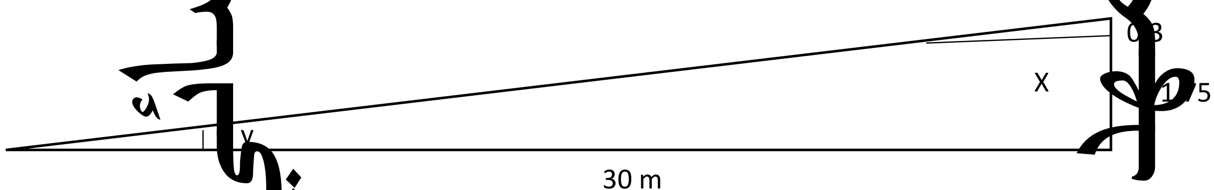
The total length of the foundation = (9.4+9.4+3.2+3.2+ 3.2) – (1 * 0.6) = 27.8 m

For both methods, the volume of excavation = 27.8 * 0.6 * 0.8 = 13.344 m^3

Excavation for The Tab foundation with slope surface:

Example 3) Estimate the volume of excavations for tab foundation with width of 60 cm as in the section below knowing that the depth does not exceed 1.0 m and not less than 0.7 m.





$$\frac{x}{0.3} = \frac{30}{1.75} \Rightarrow x = 5.1m$$

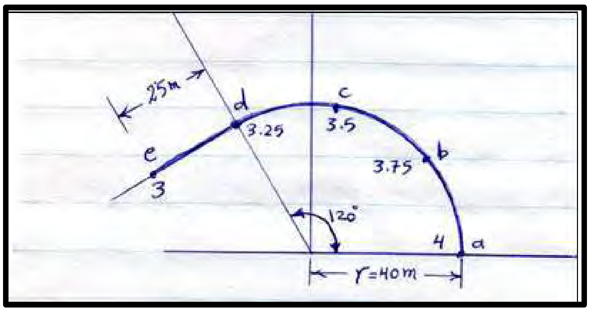
No of strips = 30/5.1 ≈ 5 strips at a distance of 5.1 m + 1 at a distance of (30 – 5*5.1) = 4.5 m

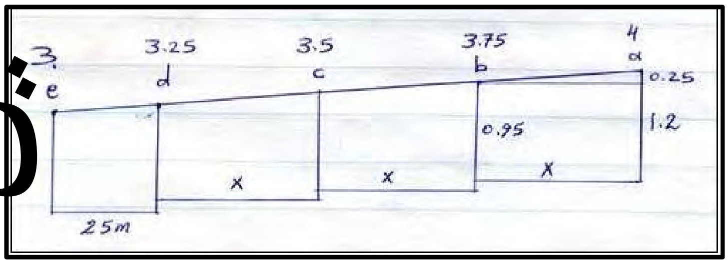
$$\frac{y}{4.5} = \frac{1.75}{30} \Rightarrow y = 0.2625m$$

$$\therefore h = 1 - 0.2625 = 0.7375m$$

Excavations volume = {5*5.1*(1+0.7)/2 +4.5*(1+0.7375)/2}*0.6=15.35 m 3

Example 4) abcde part of a mountain road, required to estimate the volume of excavation for the foundation of 1.2 m width. The depth should not exceed 1.2 m and not less than 0.9 m. The distances between the points a, b, c, d should be the same.





Solution:

$$ad = r\theta$$
$$= 40 * 120 * \frac{\pi}{180}$$
$$= 83.78m$$
$$\therefore x = \frac{83.78}{3} = 27.93m$$

Slope difference = (4-3)/4 strips = 0.25 m

Short side = 1.2 – 0.25 = 0.95 m

Excavation volume = {3*[27.93*(1.2+0.95)/2] + [25*(1.2+0.95)/2]}*1.2= 140.34 m^3

3) Crushed Stone Sub-Base (m^2):

It is usually after the completion of excavation for foundations placing a layer of crushed stone or brick with a thickness of 8 cm or 10 cm, taking into account as compacted as possible. The benefits of this layer are:

1 - Disperse the pressure of structure load.

2 - Prevent the penetration of the concrete mixing water directly to the soil.

The amount of crushed stone = Length * foundation width

For Example 2, the amount of crushed stone = 27.8 * 0.6 = 16.68 m^2

The volume of the crushed stone layer = 16.68 * 0.10 = 1.668 m3

4) Casting the concrete for foundations:

Concrete is a combination of three main materials; cement , sand and gravel , if the mixing of these three components mixed with water to prepare the concrete , the mixture loses about a third of its total volume. The mix usually based on volumetric proportions, and as following:

Cement	Sand	Gravel
1	1.5	3
1	2	4
1	3	6
1	4	8
1	5	10

It is very critical to determine the proportions of concrete mix used in construction work. The ratio commonly used in ordinary buildings are volumetric ratios, but it can be weight based ratio and this is more accurate. Some of the construction activity and their corresponding mixing ratios are as following:

1) Weak concrete (lean concrete) work: used as a pre-leveling layer or for filling under the reinforced concrete of foundations, which are used by mixing 1:4:8 or 1:5:10.

2) Normal concrete works: used for unreinforced foundations or floors, or for levelling under the final reinforced foundation. Commonly it is used by mixing 1:3:6, and take into account the use sulphate resistant cement when soil conditions or groundwater require that.

3) Reinforced concrete for roofs, beams, columns and other structural members. Mixing ratio commonly used is 1:2:4 may be used by 1:1.5:3 for columns.

4) Reinforced concrete in contact with water, such as water tanks, swimming pool and retaining walls are used with mixing ratio of 1:1:2 or 1:1.5:3. This type required the addition of water-proof or damp-proof agent to the mix and the use of a water-proof at the structural joints.

In order to Estimate the quantities involved in the 1:1.5:3 concrete mix, it can be used to approximate the following equation:

Vol. = 0.67 (C + S + G)

Where:

Vol. = Volume of concrete after the addition of water to the components.

C = the volume of cement, S = the volume of sand, G = the volume of gravel.

The number 0.67 indicates a contraction in the volume of concrete components after the water addition, this contraction is about third of the volume or 0.33. Accordingly, the net volume after volume reduction is two-thirds total volume before the mixing process or approximately 0.67 of the total volume. So when mixing the cement, sand and gravel, by 1:2:4, to obtained one cubic meter of concrete, we can Estimate the material involved in the installation of this volume are as follows:

1 = 0.67 (C + 2C +4 C)

C = 0.21 m3 volume of cement

S = 2C = 0.42 m3 volume of sand

G = 4C = 0.84 m3 volume of gravel

Cement density = 1400 kg/m3

Cement weight = 1400 * 0.21 ≈ 300 kg

Packaging weight of standard cement bag is 50 kg i.e. number of bags 300/50 = 6 bags

For the purpose of the work; adopt some approximation as follows:

The amount of cement = 300 kg or 6 bags

Volume = 0.5 m3 of sand Volume = 1 m3 gravel

This approximation valid only for mixing ratio of 1:2:4 for the purpose of ease accounts

Example 5) Estimate the amount of construction materials (cement, sand, gravel) needed to cast the foundation of the two rooms in the example (2) for 1:2:4 mix assuming that the thickness of the foundation is 0.40 m and knowing that the width was 0.60 m.

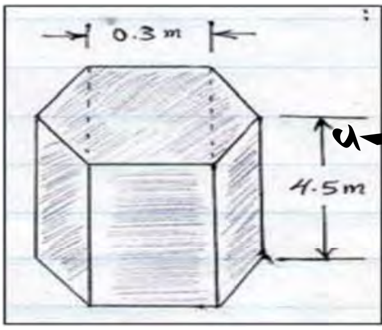
Vol. = L*W*D = 27.8 * 0.6 * 0.4 = 6.672 m3

Amount of construction materials will be as follows:

Cement (6 bags/1 m^3) = 6 * 6.672m^3 = 40.032 bag ≈ 40 bag *50 kg = 2 tons

Sand = 0.5 m^3 * 6.672 = 3.336 m^3, gravel = 1 * 6.672 = 6.672 m^3

Example 6) Estimate the amount of cement in tons, gravel and sand in cubic meters needed to cast 30 columns of height 4.5 m note that the section of the column hexagonal and each side 30cm, the mixing ratio of 1:1.5:3.



Solution:

Vol. = No. of columns * Area * h, $A = \frac{3\sqrt{3}}{2} * a^2$

$Vol. = 30 * 3 * \frac{\sqrt{3}}{2} * 0.3^2 * 4.5 = 31.567\ m^3$

31.567 = 0.67(C+1.5C+3C)

C=8.567 m^3

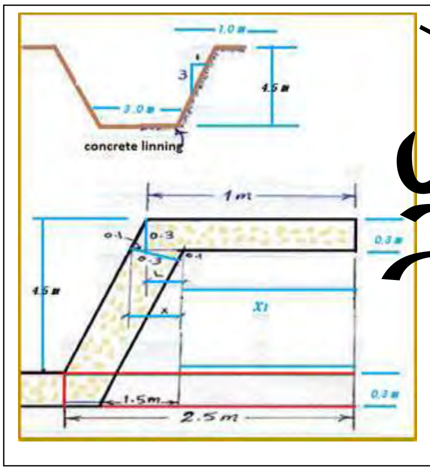
Cement = 1400 Kg/m^3 * 8.567 = 11.99 ton

Sand = 1.5C = 1.5 * 8.567 = 12.85 m3

Gravel = 3C = 3 * 8.567 = 25.69 m3

Example 7) Estimate the amount of construction materials required for the lining of the channel of the shown cross section using a layer of concrete with thickness of 30cm, note that the length of the channel is 3.0 km and Concrete Mixing ratio of 1:2:4.

Solution:



$x = \sqrt{0.3^2 + 0.1^2} = 0.316m$

$L = x - 0.1 = 0.216m$

$x_1 = 1 - L = 1 - 0.216 = 0.784m$

$A = 0.3 * 2.5 + \frac{2.5+1}{2} * 4.5 - \frac{1.5 + 2 * 0.784}{2} * 4.5 = 1.722m^2$

$Total\ A = 1.722 * 2 + 0.3 * 3 = 4.344m^2$ *

$Vol. = 4.344 * 3000 = 13032m^3$

Cement = $\frac{13032 * 300}{1000} = 3909.6\ ton$

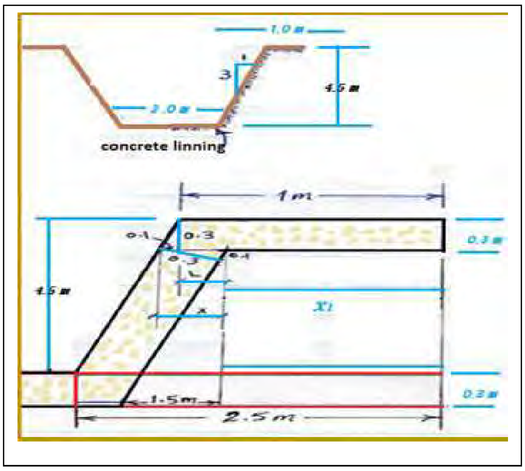
Sand = $0.5 * 13032$ = 6516 m^3

Gravel = $1 * 13032$ = 13032 m^3

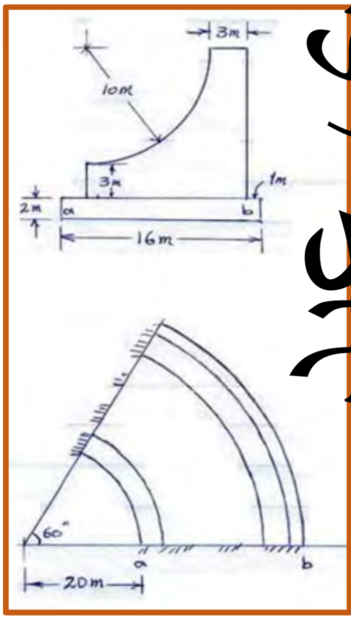
* The method of calculating the area very accurate but lengthy and complex and therefore there is another way , namely:

$$A=\left(3+1*2+2*\sqrt{4.5^2+1.5^2}\right)*0.3=4.346\ m^2 \qquad ,error=3.346-3.344=0.002$$

$$\therefore error=\frac{0.002}{4.344}*100=0.046\% \quad very\ little$$



Example 8) The figure (a) represents small concrete dam and figure (b) the projection of the dam in the construction site. Estimate the amount of construction materials needed to implement the dam by mixing 1:2:4.



Solution:

$$A=16*2+13^2-\frac{\pi*10^2}{4}=122.46\ m^2 \ ,.... \quad x=\frac{[4*a]}{3\Pi}$$

$$A*\bar{x}=\sum ax, \quad ,.... \quad \bar{\chi} \quad represent-center-of-total-area-from-edge$$

$$122.46*\bar{x}=16*2*8+13^2*8.5-\frac{\pi*10^2}{4}*(0.424*10+2)$$

$$\therefore \bar{x}=9.819\,m$$

$$s=arc-of-rotation-from-edge-to-centroid-point$$

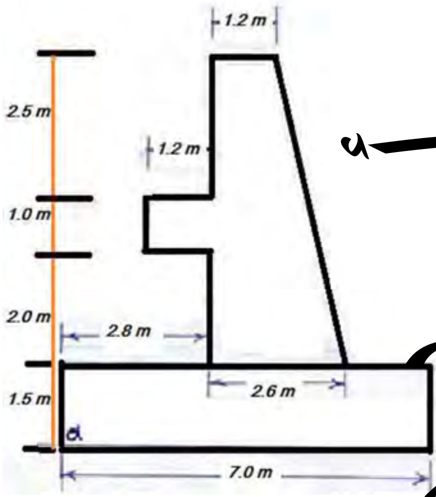
$$Vol.=S*\theta*A=(20+9.819)*\frac{60*\pi}{180}*12246=3823.983\,m^3$$

$$cement=\frac{3823.983*300}{1000}=1147.194\,ton$$

$$sand=3823.983*0.5\cong 1912\,m^3$$

$$gravel=3823.983*1\cong 3824\,m^3$$

Example 9) Estimate the amount of construction materials needed to construct the retaining wall shown in the figure, knowing that the length of the wall 22 m and the mixing ratio is 1:1.5:3.



Solution:

$$A = 7*1.5 + \frac{2.6+1.2}{2}*5.5 + 1.2*1 = 22.15m^2$$

$$Vol. = 22.15*22 = 487.3m^3$$

$$487.3 = 0.67(C + 1.5C + 3C), \therefore C = 132.239m^3$$

$$cement = \frac{132.239*1400}{1000} = 185.134ton$$

$$sand = 1.5*C = 198.3m^3$$

$$gravel = 3*C = 396.7m^3$$

Example 10) Solve example 9, considering that the retaining wall curved with central angle of 60° and the heading point is 25 m from the point a.

Example 11) Estimate the amount of cement, sand and gravel needed to cast ten foundation for a square- column, note that the basement is semi- quadrant-pyramid-shaped, the side length of the upper base of 60 cm, the lower is 120 cm, the height is 120 cm with mixing ratio of 1:2:4.

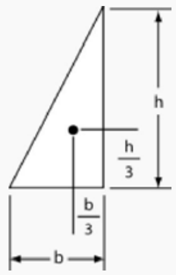
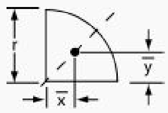
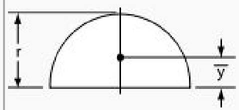
Solution:

$$Vol. = 10*\frac{H}{3}\left(A_1 + A_2 + \sqrt{A_1 * A_2}\right) = 10*\frac{1.2}{3}\left(0.6^2 + 1.2^2 + \sqrt{0.6^2 * 1.2^2}\right) = 10.08m^3$$

$$cement = 10.08*\frac{300}{1000} = 3.024ton$$

$$sand = 0.5*10.08 = 5.04m^3$$

$$gravel = 1*10.08 = 10.08m^3$$

Shape	Figure	$\bar{x}$	$\bar{y}$	Area
Right-triangular area		$\frac{b}{3}$	$\frac{h}{3}$	$\frac{bh}{2}$
Quarter-circular area		$\frac{4r}{3\pi}$	$\frac{4r}{3\pi}$	$\frac{\pi r^2}{4}$
Semicircular area		0	$\frac{4r}{3\pi}$	$\frac{\pi r^2}{2}$

CRUSHED STONE OR BRICK LAYER (PAVING WORKS):

A: PAVING LAYER USING CRUSHED STONES:

We can implement Crushed stone layer through the building with stone and mortar, where the mortar is a mixture of cement and sand by certain proportions according to the nature of the construction mixed with water to obtain semi-liquid cohesion binder to fix the building parts. It can be used to plaster the walls from the outside as well. The common mixes proportions for mortar are:

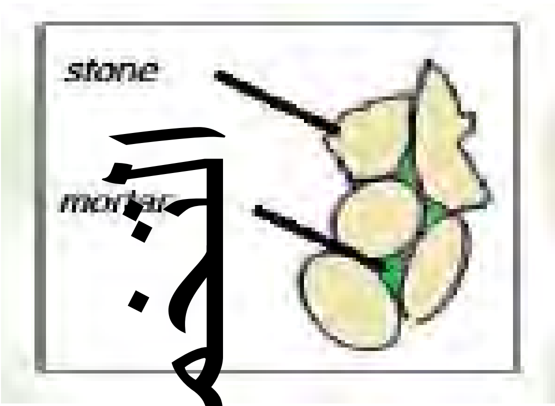
Cement	Sand
1	2
1	3
1	4

Dry materials in the mortar lose 25 % of its volume after mixing with water. To figure out the amount of cement and sand for 1:3 mortar mix we follow this formula:

$Vol. = 0.75(C+S)$ »» $1 = 0.75(C+3C)$ »» $C = 0.333\ m^3$

$Cement = 1400*0.333 = 466.67kg,\ Sand = 3*0.333 = 1m^3$

Construction with stone relatively slow and require large amounts of cement mortar , as well as to skilled worker and be costly in terms of transport , but as a structural material is relatively cheap .



Stone diameters are (10-35) cm.

The volume of voids when construction with stone is up to (25-30) % of the total volume.

So, volume of cement mortar at 1:3 mix will be (0.25-0.3) m^3 for each 1.0 m^3 of stone construction.

B: PAVING LAYER USING BRICKS:

The bricks relatively considered as a good construction materials because it is a good insulator of heat and relatively cheap in the middle and southern regions of Iraq , the only obstacle is its low productivity .

- Standard dimensions of bricks are (23 * 11 * 7) cm, and may be designed with other dimensions.
- Thickness of cement mortar 1 cm.
- Dimensions of the bricks after building becoming (8 * 12 * 24) cm.

• The number of bricks in 1 m^3 $= \frac{construction\ volume}{volume\ of\ one\ brick} = \frac{1}{0.24*0.12*0.08} = 435$ bricks.

• The number 435 is the theoretical number of bricks, while for the purpose of estimation and considering the amount of bricks that damage through transporting, handling or during construction, the practical number will be 440 to 450 bricks.

• The amount of cement in mortar (1:3 mix) for 1 m^3 bricks construction, follow this estimate:

The actual volume of the bricks in 1 m^3 = 435 * 0.23 * 0.11 * 0.07 = 0.77 m^3.

Volume of cement mortar = 1 - 0.77 = 0.23 m^3.

0.23/0.77 = (4*C) »» C = 0.0077 * 1400 = 107.3 kg

Construction with bricks needs to (1 Building foreman + 4 workers) and the productivity of labor is up to (3-5) m3 / day .

For the purpose of estimates the amount of bricks will be adopted number 450 for each 1 m3 bricks building, but for the purpose of estimates the amount of cement mortar will be use the number 435 bricks .

C: PAVING LAYER WITH CONCRETE BLOCKS:

• Concrete blocks are structural material commonly used particularly in the northern area of Iraq, and is characterized by a relatively cheap price, but it is heavy building material of weak thermal insulator.

• Dimensions for standard Concrete blocks is normal (20 x15x40) cm

• The thickness of the cement mortar = 1 cm.

- Dimensions of Concrete blocks after construction becomes =(21x16 x41)cm.
- The number of Concrete blocks in 1 m3 of construction = $n = \frac{building\ volume}{one\ block\ volume}$

= 1/ (0.21 x 0.16 x 0.41) = 72.6 = 73 Concrete blocks.

- Actual volume of concrete blocks in 1 m^3 = 73*0.4*0.15* 0.2 = 0.876 m^3
- Volume of cement mortar = 1 - 0.876 = 0.124 m^3
- For the purpose of estimate the amount of concrete blocks adopt of the number 75 Concrete blocks 1 m^3 of construction , but for the purpose of estimate the amount of cement mortar will be adopted the number 73 Concrete blocks for each 1 m^3 of construction.

Example 19):

in Example [illegible] considered the Crushed stone layer width 0.4 m and a height of 0.6 m , and the cement mortar of mixing ratio 1:3, estimate:

1) The amount of stone, cement and sand needed for paving if the volume of voids is 25 % of the total construction.
2) The amount of bricks, cement and sand needed for paving.
3) The amount of the Concrete blocks, cement and sand needed for paving.

Solution:

Total length of paving layer = L – 0.5 *T * W

L= length of central lines, W= paving width, T= no of intersections

= (2 * 9.4 + 3.2 * 3) – (0.5 * 2 * 0.4) = 28 m

Paving volume = 28 * 0.4 * 0.6 = 6.72 m^3

1) voids ratio = 25%, volume of stone 75 % of the total paving layer amount of stone = 0.75 * 6.72 = 5.04 m^3

The volume of cement mortar = 0.25 * 6.72 = 1.68 m^3

Vol. = 0.75 (C + S)

1.68 = 0.75 (C +3 C) »» C = 0.56 m3

Cement = 0.56 * 1400 = 784 kg, use 16 bag

Sand = 0.56 * 3 = 1.68 m3

2) The amount of bricks = 450 * 6.72 = 3024 bricks

The actual volume of the bricks = 435 * 6.72 * (0.07 * 0.11 * 0.23) = 5.18 m 3

volume cement mortar = 6.72 - 5.18 = 1.54 m 3

1.54 = 0.75 (C +3 C) »» C = 0.513 m3

Cement = 0.513 * 1400 = 718.67 kg, use 15 bag

Sand = 0.513 * 3 = 1.54 m3

3) The amount of the Concrete blocks = 75 * 6.72 = 504 Concrete blocks

The actual volume of the blocks = 73* 6.72* (0.4 * 0.2 * 0.15) = 5.89 m 3

volume cement mortar = 6.72 - 5.89 = 0.83 m 3

0.83 = 0.75 (C +3 C) »» C = 0.277 m3

Cement = 0.277 * 1400 = 387.33 kg, use 8 bag

Sand = 0.277 * 3 = 0.83 m3

6) Damped proofing concrete (DPC):

- Damp proofing in construction is a type of moisture control applied to building walls and floors to prevent moisture from passing into the interior spaces. Damp problems are one of the most frequent problems encountered in homes.

- Damp proofing is accomplished by several ways including:

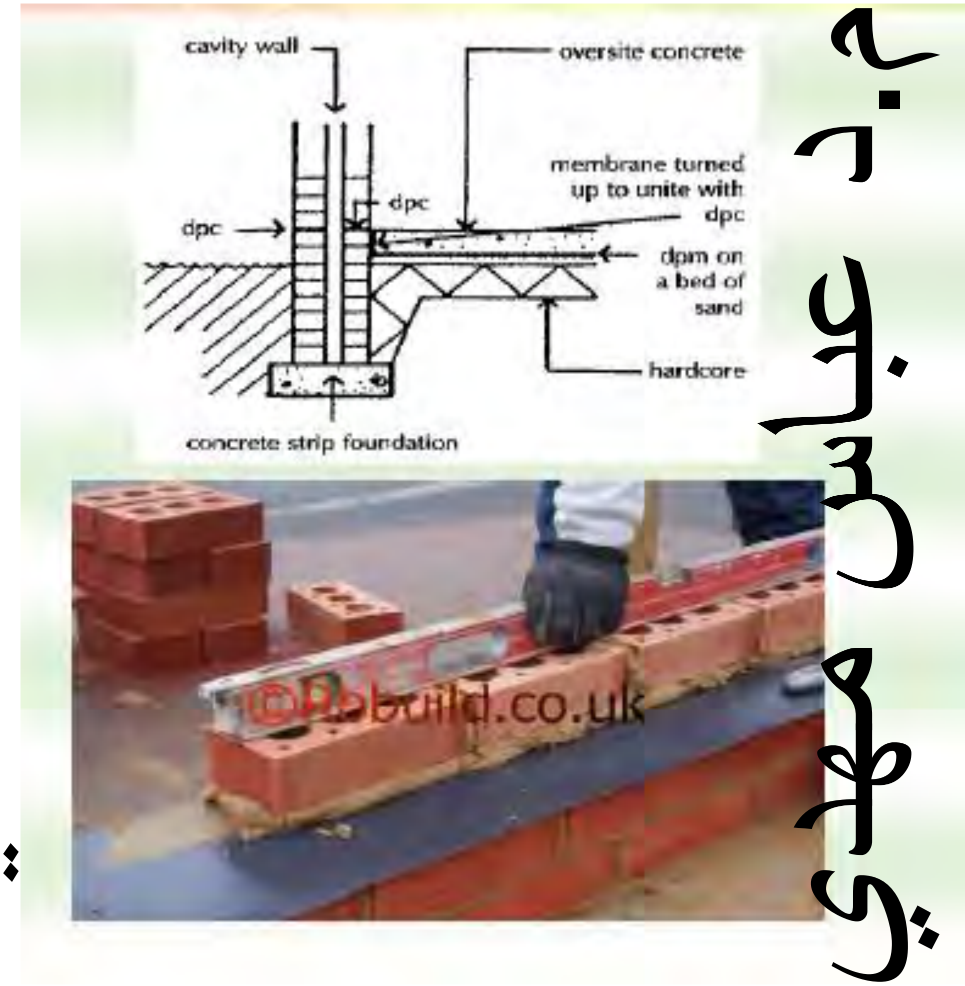
- A damp-proof course (DPC) is a barrier in a masonry wall designed to resist moisture rising through the structure by capillary action such as through a phenomenon known as rising damp. The damp proof course may be horizontal or vertical. A DPC layer is usually laid below all masonry walls, regardless if the wall is a load bearing wall or a partition wall.
- A damp-proof membrane (DPM) is a membrane material applied to prevent moisture transmission. A common example is polyethylene sheeting laid under a concrete slab to prevent the concrete from gaining moisture through capillary action.
- Integral damp proofing in concrete involves adding materials to the concrete mix to make the concrete itself impermeable.

- **Surface coating** with thin water proof materials for resistance to non-pressurized moisture such as rain water or a coating of cement sprayed on such as shotcrete which can resist water under pressure.
- **Cavity wall construction**, such as rainscreen construction, is where the interior walls are separated from the exterior walls by a cavity.
- **Pressure grouting** cracks and joints in masonry materials.

Materials widely used for damp proofing include:

- Flexible materials like butyl rubber, hot bitumen, plastic sheets, bituminous felts, sheets of lead, copper, etc.
- Semi-rigid materials like mastic asphalt
- Rigid materials like impervious bricks, stones, slates, cement mortar or cement concrete painted with bitumen, etc.
- Stones

- Mortar with waterproofing compounds
- Coarse sand layers under floors
- Continuous plastic sheets under floors



Damp proofing (waterproofing) layer:

It is a concrete (1:2:4) using sulphate resistance cement and waterproofing admixture, mixed with concrete according to the manufacturer instruction. The side benefits of DPC is to correct the levels of construction as well as useful in swelled soil, in this case the DPC should reinforced with increasing its thickness. Conventional thickness of DPC usually up to 10 cm and preferably be higher than the floor level of 6 cm and casted under all walls of the building, it measured in m-length or m3.

Example 20):

Estimate the amount of materials needed for casting (1:2:4) DPC in example 2.

Solution:

DPC length = L – 0.5 (T) * W = (9.4 * 2 + 3.2 * 3) – 0.5 * 2 * 0.2 = 28.2 m

Vol. = 28.2 * 0.1 * 0.2 = 0.564m3

Cement = 0.564 * 6 = 3.384 bag

Sand = 0.564 * 0.5 = 0.282 m3

Gravel = 0.564 * 1 = 0.564 m3

WALLS CONSTRUCTION

BRICKS WALLS:

There are several type of walls building with bricks, but in general can recognize the two following cases:

The first case: building a wall with thickness not equal to one dimension of the brick or in the case of building walls adopting the British or German method of connecting or other that there may be a dual linkage. Follow the same method used in the estimate the number of bricks and mortar cement for the purpose of paving layer.

Second case: in the case of partitions building, where the partitions is that part of the building necessary to divide large spaces into smaller spaces, varies according to the thickness of bricks dimensions used in construction:

a) If the thickness of partitions 11 cm shall be apparent face of the brick is nominally 8 cm x 24 cm , and therefore the number of bricks in the section area of one square meter is [**1 / (0.24x0.08)= 52.08 = 53**] brick, for the purposes of estimating,

use 60 bricks per 1 m2 of the partitions. To estimate the volume of the cement mortar shall be as follows:

_Mortar Volume = Partition volume - actual volume of bricks
= (1 * 0.11) - 53 * (0.07 * 0.11 * 0.23) = 0.016137 m3

b) If the partition thickness 7 cm the apparent face of the brick is 12 cm x 24 cm, and therefore the number of bricks in the section of one square meter area is
[1/ (0.24* 0.12) = 34.7 = 35] bricks,

for the purposes of estimating use 40 bricks per 1 m^2 of the partition. To estimate the volume of the cement mortar: Mortar volume = partition volume - the actual volume of bricks

$$= (1 * 0.07) - 35 * (0.07 * 0.11 * 0.23) = 0.008015\ m^3$$

1) Concrete Blocks Walls:

- The blocks are a concrete mass of mix 1:2:4 in the form of a parallelogram and the surface is rough to help the adhesion of mortar cement.
- It be either solid or hollow, and the hollow type is better as the weight lighter, sound and thermal isolation.

- The lengths of the Concrete blocks are usually 40 cm, with cross sectional area of 10 * 20 cm, **15 * 20 cm**, 20 * 20 cm, or 25 * 20 cm.
- The first two types used for partitions, and the others for wall bearing. In general, there are two ways for wall building using Concrete blocks:
- The first way : building the walls of a thickness of 20 cm and in this case, the apparent face of concrete blocks is (16 * 41) cm, therefore the number of blocks needed to build a wall of area 1 m2 = [1 / (0.41x0.16)] = 15.2 = 16 blocks.
- It is the most commonly used locally.
- To estimate the volume of cement mortar:

Mortar volume = wall volume - the actual volume of the Concrete blocks

$$= (0.2 * 1) - 16 * (0.4 * 0.2 * 0.15) = 0.008\ m^3$$

- The second way: building the walls of a thickness of 15 cm and in this case, the apparent face of Concrete blocks is (21 * 41) cm. The number of Concrete blocks needed to build a wall of (1 m2) area is [1 / (0.41x0.21)] = 11.6 = 12 blocks.

- This kind of construction is also common and known locally. To estimate the volume of cement mortar :

Mortar volume = wall volume - the actual volume of the Concrete blocks

= (0.15 * 1) - 12 * (0.4 * 0.2 * 0.15) = 0.006 m^3

Example 21):

Estimate the amount of Concrete blocks, cement and sand required to build the walls in Example 2 by mixing 1:2 and a height of 2.5 m, every room has a door with dimensions of 2.5 * 1.0 m, and window of dimensions 1.5 * 2.5 m.

Solution:

Walls length = L – 0.5 * T * W = (9.4 * 2 +3.2 * 3) – 0.5 * 2 * 0.2 = 28.2 m The

volume of the walls = 28.2 * 0.2 * 2.5 = 14.1 m^3

Volume of the doors and windows = 2 * 0.2 * (1 * 2.5 + 1.5 * 2.5) = 2.5 m^3 Net

volume of construction = 14.1 – 2.5 = 11.6 m^3

Number of concrete blocks = 80 * 11.6 = 928 blocks

Mortar volume = construction volume - the actual concrete blocks volume

= 11.6 - 928 * (0.4 * 0.2 * 0.15) = 0.464 m 3

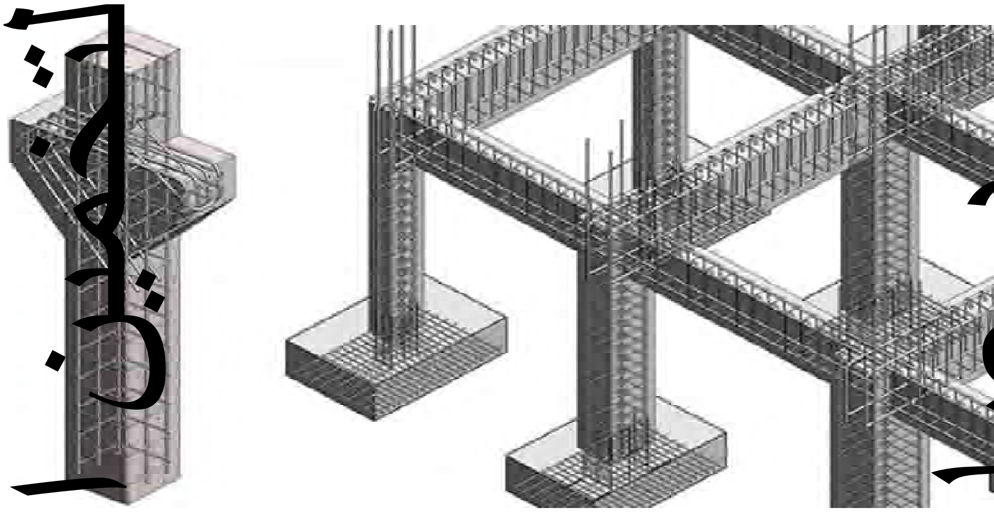
0.464 = 0.75 (C +2 C) »»» C = 0.206m3

Cement = 0.206 * 1400 = 288.7 kg

Sand = 2C = 2 * 0.206 = 0.412m3

Reinforced Concrete

Reinforced Concrete is the material that is indispensable in any structural work, and steel reinforcement is added to the concrete because the concrete does not bear the tensile forces in addition to increase the strength of pressure. Reinforced Concrete is of a great importance because it is the most expensive construction item.



The specifications below for steel bars:

Bar Diameter (Φ, mm)	Bar Weight (kg/m)
6	0.222
8	0.395
10	0.617
12	0.888
14	1.21
16	1.58
18	2
20	2.47
25	3.86

Example 12) How much the weight in tons of 1000 bars of (Φ8) and 2000 bars of (Φ14) knowing that the length of the one bar 12.0 m.

Solution:

Steel bars of (Φ8), 12.0 m length = 0.395 Kg/m * 12,0 m = 4.74 kg/bar

□ 1000 bars of (Φ8) = 4.74 kg/bar * 1000 bar ÷ 1000 Kg/ton = 4.74 tons

Steel bars of (Φ14), length 12:00 = 1.21 Kg/m * 12,0 m = 14.52 kg/bar

□ 2000 bars of (Φ8) = 14.52 kg/bar * 2000 bar ÷ 1000 Kg/ton = 29.04 tons

Example 13) How much the mass of steel bar of 12.0 m length and diameter of 30 mm , knowing that the mass of (Φ8) mm bar diameter is 0.395 kg/m.

Solution:

First bar unit weight = Second bar unit weight

$$\frac{w_2}{v_2} = \frac{w_1}{v_1} \Rightarrow \frac{0.395}{\frac{\pi}{4} * 8^2 * 1} = \frac{x}{\frac{\pi}{4} * 30^2 * 12} \Rightarrow x = 66.66\ kg$$

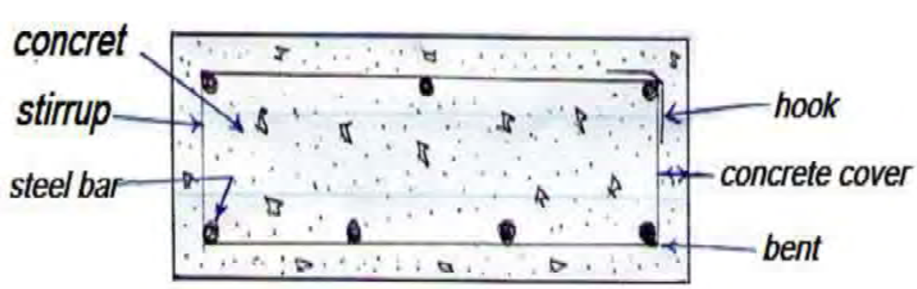
Estimating the quantities of reinforcing steel bar for the foundation:

Steel bars in general must be:

1) Free of rust (corrosion) and loose material, bends and materials that prevent bonding with concrete such as oil, grease and other.

2) Heating may not be used when bending steel bar is required, especially in large diameter.

When taking the cross-section in the strip or isolated foundation will be as the following:



Through the figure, the reinforcement is usually a group of straight bars and loops (stirrups). In the case that straight bars of insufficient length overlapping may be needed, and the length of overlap is (25-40 diameter of bar (db) but not less than 300 mm.

Meanwhile the shape of the stirrup contains bents and hooks with length of (6db) and not less than 10 cm or as listed in specific codes. Usually steel bars tied using steel wires, or binding in all points of intersection.

It is noting the number of ties reinforcement is as follows:

Number of ties (or stirrups) = (total distance / distance between ties) +1

- **For concrete cover, the minimum it will be as follows or as the code:**

Structural item		Concrete Cover (mm)
Reinforced concrete in contact with the soil		**75**
Reinforced concrete walls and slabs		**20**
Reinforced concrete columns and beams		**40**
shell and domes	**if Φ18 mm or below**	**12**
	If reinforcement greater than Φ18 mm	**20**

For steel weight estimation, adopt the following equation for approximation:

$$w = \frac{LD^2}{162}$$

Where:

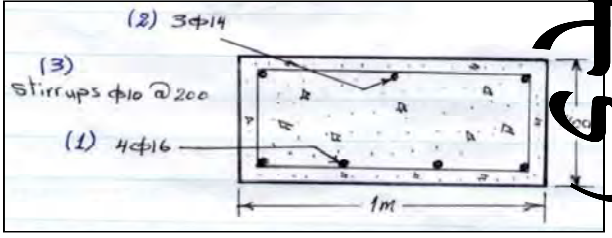
w: steel weight (kg), l: length of steel bar (m), D: steel bar diameter (mm)

This equation can be derived as follows:

$$w = Vol * \gamma_s = \frac{\pi}{4}\left(\frac{D}{1000}\right)^2 l * 7850 = \frac{lD^2}{162}$$

Where: γ_s: steel density =7850 kg/m3

Example 1[illegible]) Estimate the amount of construction materials needed for casting the strip foundation of 40 m^3 of cross-section shown in the figure below. Knowing the mixing ratio of 1:2:4.



Solution:

Cement = $\frac{40 * 300}{1000}$ **= 12 ton**

Sand = 40 * 0.5 = 20 m3

Gravel = 40 * 1 = 40 m3

Length of 100 m basis = $\frac{Vol.}{Area} = \frac{40}{1 * 0.4}$ **= 100 m in length**

$$No. of\ overlaps = \frac{100}{12m(each..bar)} = 8.33 \approx 8$$ **use the nearest smaller integer number**

From figure; 4 ϕ 16 mm, 3 ϕ14 mm, and stirrup ϕ 10 @ 200 mm

$$\langle 1\rangle l_1 = 100 + 8*0.3 = 102.4m,\ L_1 = 4l_1 = 4*102.4 = 409.6m$$

$$\therefore w_1 = \frac{L_1 D_1^2}{162} = \frac{409.6*16^2}{162} = 647.27kg$$

$$\langle 2\rangle l_2 = l_1 = 102.4m, L_2 = 3l_2 = 3*102.4 = 307.2m$$

$$\therefore w_2 = \frac{L_2 D_2^2}{162} = \frac{307.2*14^2}{162} = 371.67kg$$

$$\langle 3\rangle l_3 = 2(1 - 2*0.075 + 0.4 - 2*0.075) + 0.3 = 2.5m$$

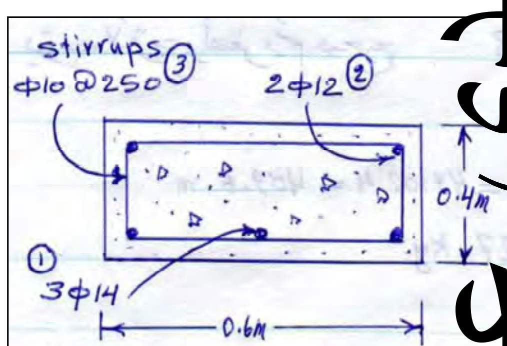
$$No.of\ stirrups = \frac{100}{0.2} + 1 = 501 \Rightarrow L_3 = 501*2.5 = 1252.5m$$

$$\therefore w_3 = \frac{L_3 D_3^2}{162} = \frac{1252.5*10^2}{162} = 773.15kg$$

$$W_t = w_1 + w_2 + w_3 = 1792.09kg$$

Example (5) Consider the foundation thickness in Ex. 2 is 0.40 m, with 5.0 cm concrete cover, estimate steel weight needed to reinforce the foundation, the cross-section is as following:

$$No.of\ overlaps = \frac{27.8}{12} = 2.3 \approx 2$$



$$\langle 1\rangle l_1 = 27.8 + 2*0.3 = 28.4m,\ L_1 = 3l_1 = 3*28.4 = 85.2m$$

$$\therefore w_1 = \frac{L_1 D_1^2}{162} = \frac{85.2*14^2}{162} = 103.08kg$$

$$\langle 2\rangle l_2 = l_1 = 28.4m, L_2 = 2l_2 = 2*28.4 = 56.8m$$

$$\therefore w_2 = \frac{L_2 D_2^2}{162} = \frac{56.8*12^2}{162} = 50.49kg$$

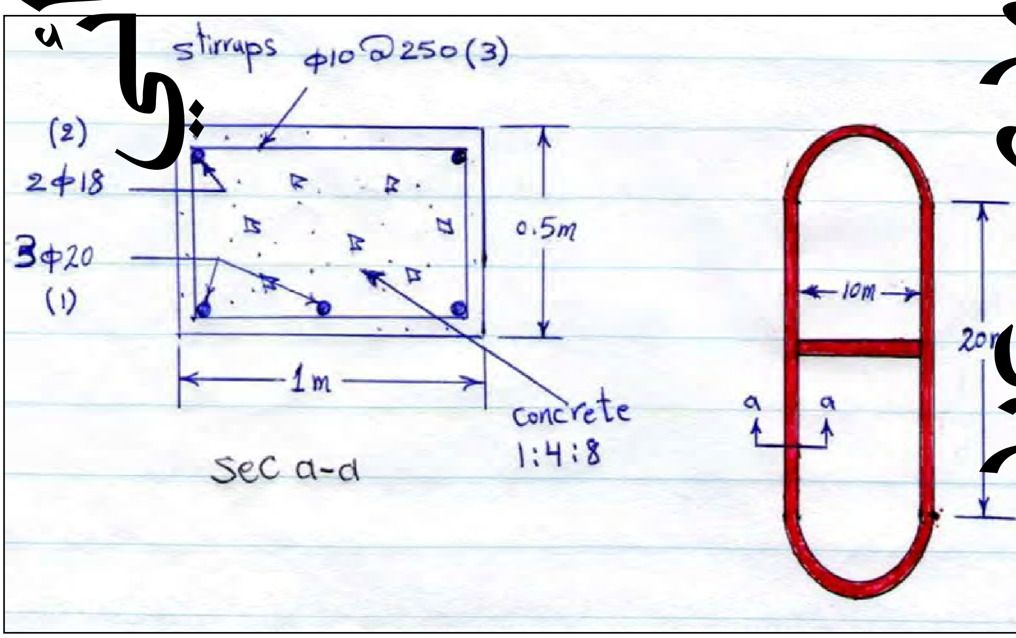
$$\langle 3\rangle l_3 = 2(0.6-2*0.05+0.4-2*0.05)+0.3=1.9m$$

$$No.of\ stirrups=\frac{27.8}{0.25}+1=112.2=113\Rightarrow L_3=113*1.9=214.7m$$

$$\therefore w_3=\frac{L_3D_3^2}{162}=\frac{214.7*10^2}{162}=132.53kg$$

$$W_t=w_1+w_2+w_3=286.1kg$$

Example 16) estimate the quantity of construction materials needed for casting the foundation in the figure below:



Solution:

The length of the foundation = 20 * 2 +10 +2 π * 5.5 = 84.56 m

Vol. = 84.56 * 1 * 0.5 = 42.28 m3

42.28 = 0.67 (C +4 C +8 C), ⇒ C = 4.85 m3

Cement = 4.85 * 1.4 = 6.8 ton

Sand = 4C = 4 * 4.85 = 19.42 m3

Gravel = 8C = 8 * 4.85 = 38.83 m3

Steel calculation:

$$No.of\ overlaps = \frac{84.56}{12} = 7.05 \approx 7$$

$$\langle 1 \rangle l_1 = 84.56 + 7 * 0.3 = 86.66m,\ L_1 = 3l_1 = 3 * 86.66 = 259.98m$$

$$\therefore w_1 = \frac{L_1 D_1^2}{162} = \frac{259.98 * 20^2}{162} = 641.93kg$$

$$\langle 2 \rangle l_2 = l_1 = 86.66m, L_2 = 2l_2 = 2 * 86.66 = 173.32m$$

$$\therefore w_2 = \frac{L_2 D_2^2}{162} = \frac{173.32 * 18^2}{162} = 346.64kg$$

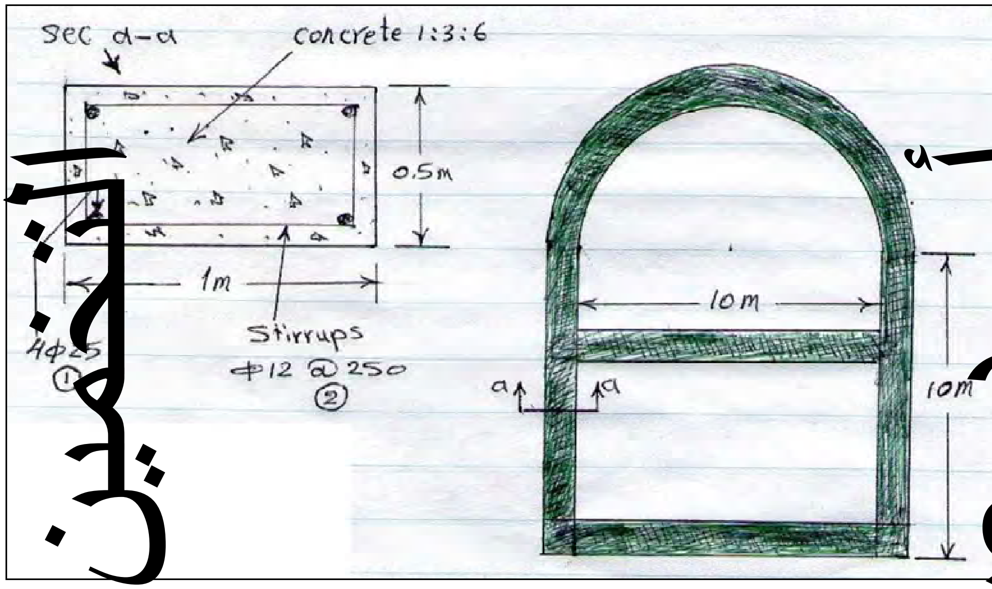
$$\langle 3 \rangle l_3 = 2(1 - 2 * 0.075 + 0.5 - 2 * 0.075) + 0.3 = 2.7m$$

$$No.of\ stirrups = \frac{84.56}{0.25} + 1 = 339.2 = 340 \Rightarrow L_3 = 340 * 2.7 = 91$$

$$\therefore w_3 = \frac{L_3 D_3^2}{162} = \frac{918 * 10^2}{162} = 566.67kg$$

$$W_t = w_1 + w_2 + w_3 = 1555.24kg$$

Example 17) estimate the amount of construction materials needed for casting the foundation in the figure below:



Solution:

Concrete mix is 1:3:6, so, Cement = 5.98 ton, Sand = 12.82 m3, Gravel = 25.65 m3

From the figure: The length of the foundation = 57.28m, No. of overlaps = 4

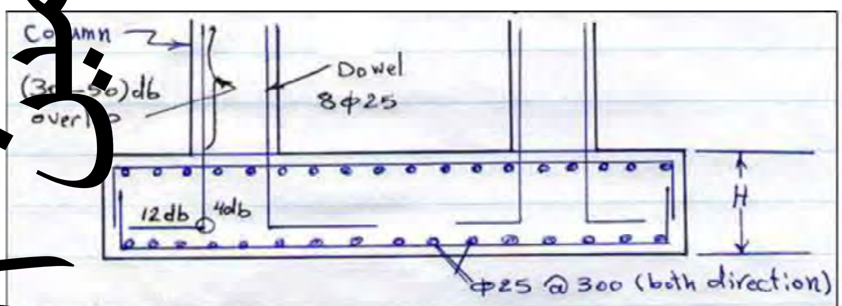
<1> L1 = 233.92 m, = 902.47 kg

<2> No. of stirrups = 231, L2 = 623.7 m, w2 = 554.4 kg

Wt = w1 + w2 = 1456.87 kg

Raft Foundation

Using the raft foundation when high weights applied on the columns and soil of weak bearing capacity, this need foundations to be of area more than half the area of structure. This foundation usually in the form of a plane reinforcing with two layers of steel bars at the top and bottom, and linked to a set of concrete columns foundations by group of reinforcing bars called dowels, and the section of the raft foundation generally as follows:



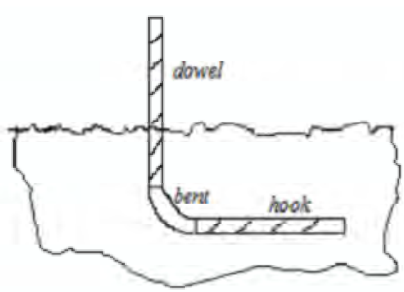
The reinforcing bars called dowels is to connect steel bar of the column with foundation reinforcement, and can calculate the length of a single dowel as follows:

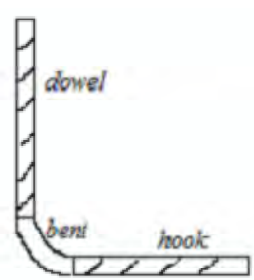
l = overlap + H - cover + 4db (bent) + 12db (hook)

= 40db + 4db + 12db + H - cover = 56db + H - cover

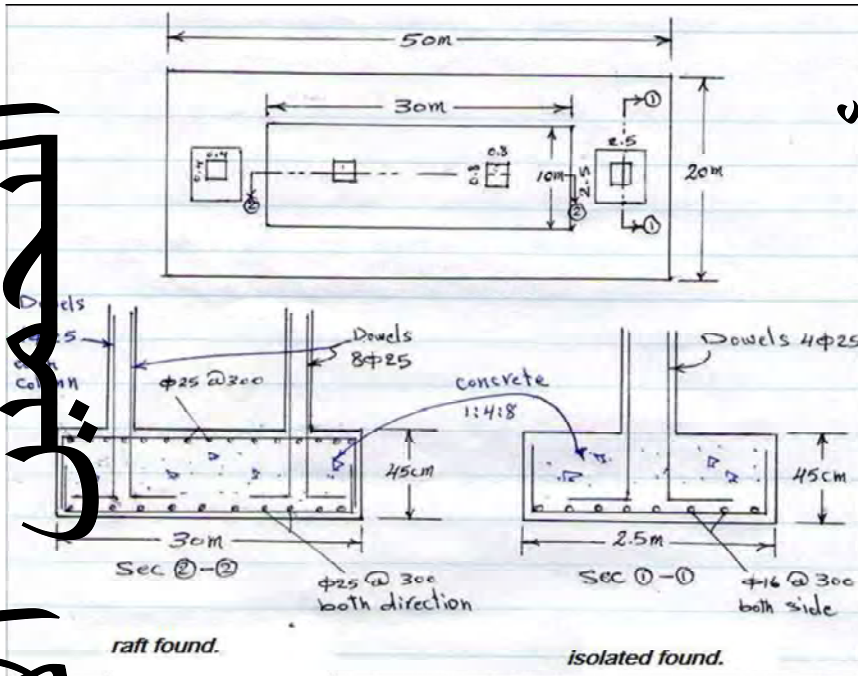
Also it is noted that reinforcement include bent and hooks, therefore an extension is added (16db) each side or (32db) to the length of steel bar considering the overlap.

* Dowels are added to the calculations of steel reinforcement.





Example 18) Estimate the amount of excavation and the amount of construction materials needed for casting the foundation described in the following diagram:



Solution:

First, the isolated foundation reinforcement:

length of steel bar 2.5-(2 * 0.075) = 2.35m

$$No.of\ bars = \frac{2.35}{0.3} + 1 = 8.83 = 9$$

$$l_1 = 2.35 + 32db = 2.35 + 32 * 0.016 = 2.862m,\ L_1 = 2.862 * 9 * 2 = 51.516m$$

$$w_1 = 2 * \frac{L_1 D_1^2}{162} = 2 * \frac{51.516 * 16^2}{162} = 162.816kg$$

$$l_2 = 56db + H - cover = 56 * 0.025 + 0.45 - 0.075 = 1.775m, L_2 = 4 * 1.775 = 7.1m$$

$$w_2 = 2 * \frac{L_2 D_2^2}{162} = 2 * \frac{7.1 * 25^2}{162} = 27.39kg$$

Second, raft foundation reinforcement

Length of longitudinal direction steel: 30 m -(2 * 0.075) = 29.85m

Length of other direction steel: 10 m -(2 * 0.075) = 9.85m

No. of bars (30) = (29.85/0.3) +1 = 100.5 = 101

No. of bars (10) = (9.85/0.3) +1 = 33.83 = 34

No. of overlaps (30) = 29.85/12 = 2.4 = 2

*l3 = 29.85 +32 db +2 * 0.3 = 29.85 +32 * 0.025 +0.6 = 31.25m, L3 = 31.25 * 34 * 2 = 2125m*

$$w_3 = \frac{L_3 D_3^2}{162} = \frac{2125 * 25^2}{162} = 8198.3kg$$

l4 = 9.85 +32 db = 9.85 +32 * 0.025 = 10.65m, L4 = 10.65 * 101 * 2 = 2151.3m

$$w_4 = \frac{L_4 D_4^2}{162} = \frac{2151.3 * 25^2}{162} = 8299.77kg$$

*l*5 = 56db + H-cover = 56 * 0.025 +0.45-0.075 = 1.775m, L5 = 8 * 1.775 = 14.2m

$$w_5 = \frac{L_5 D_5^2}{162} = \frac{14.2 * 25^2}{162} = 54.78kg$$

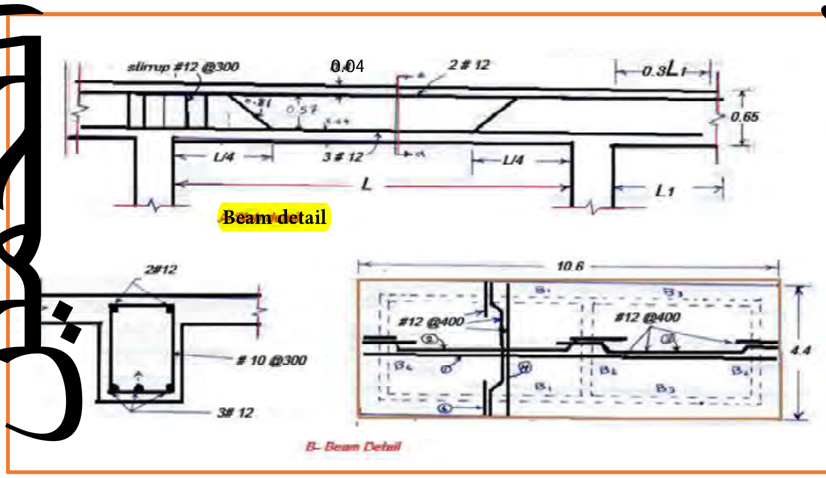
Vol. = (30 * 10 +2.5^2 * 2) * 0.45 = 140.625m3

140.625 = 0.67 (C +4 C +8 C) ……… C = 16.15m3

Cement = 22.6 ton, Sand = 64.58 m3, Gravel = 129.16 m3

9) Casting concrete for beams and slabs:

Example 24) Estimate the quantities of construction materials (cement , sand , gravel , reinforcement steel) needed to cast beams and slab for the two rooms in example 2. The reinforcement as in Fig (a,b) for the slab with concrete cover of 2 cm and beams with concrete cover of 4 cm. concrete mix of 1:2:4



Lecture 7: Wooden Form, RC for Slab and Beam Dr. Abbas M Abd

Solution:

First, the volume of concrete

Length of the beams = wall length = 28.2 m

Beams volume = 28.2 * 0.2 * 0.5 = 2.82 m^3

The volume of the slab = 10.6 * 4.4 * 0.15 = 6.996 m^3

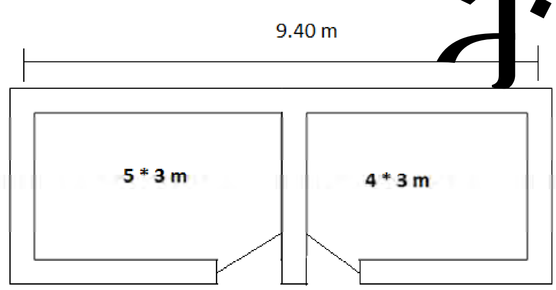
Parapet volume = (10.6 * 4.4 - 10.2 * 4) * 0.25 = 1.46 m^3

Concrete volume = 2.82 + 6.996 + 1.46 = **11.276 m^3**

Cement = 11.276 * 300/1000 = **3.3828 ton**

Sand = 11.276 * 0.5 = **5.638 m^3**

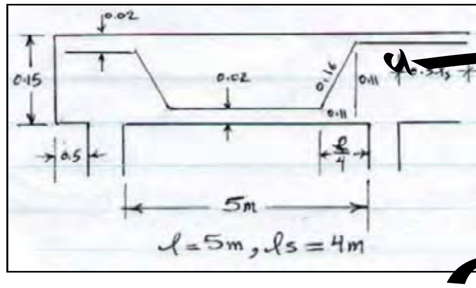
Gravel = 11.276 * 1 = **11.276 m 3**



Second: Reinforcement Calculation for the Slab:

Reinforcing the longitudinal direction (10.6 m):

Straight Reinforcement:



Clear Distance of Reinforcement = 4.4 – (2 * 0.02) = 4.36m

$$No.of\ bars = \frac{4.36}{0.4} + 1 = 11.9 \approx 12$$

$$l_1 = 10.6 - (2 * 0.02) + 32db = 10.56 + 32 * 0.012 = 10.944m$$

$$L_1 = 12 l_1 = 12 * 10.944 = 131.328m$$

$$w_1 = \frac{L_1 D_1^2}{162} = \frac{131.328 * 12^2}{162} = 116.736kg$$

Solution:

Slab = 12 * 7.4 +12 * 8 + 7.4 *7.4 +7.4 * 8 = 298.76 m^2

Beam from the inside = [(7.4+ 12) + (12 +8) + (7.4+ 7.4) + (7.4 + 8)] * 2 * 0.5 = 69.6 m^2

Beam from outside = (20 +16) * 2 * (0.5+0.15) = 46.8 m^2

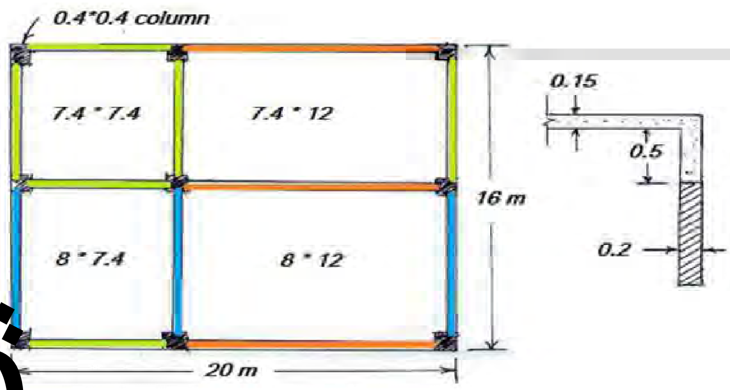
The beam from the bottom = (12 * 3 + 3 *8 + 6* 7.4) * 0.2 = 20.88 m^2

Columns = 0.4 * 4 * 5 * 9 = 72 m^2

Wooden forms = 508.04 m^2

* Small area near the columns can be neglected because it is of very small area i.e. when calculate the wooden forms area for the slab and beams has been considered that the cross-section of the column is 0.2 * 0.2 m to ease the calculations.

Example 23) The following figure shows the plane of a store, with inside height of 5.0 m, estimate the wooden forms work for the slab, beams, and columns.



Bent up Reinforcing for the Span of 5.0 m

$l_2=4+0.5-0.02+0.5l+(0.25l+0.16-0.11+0.2)*2+0.3l_s$

$l_2=7.18m$ note: l_s=second span=4 m

$L_2=12l_2=12*7.18=86.16m$

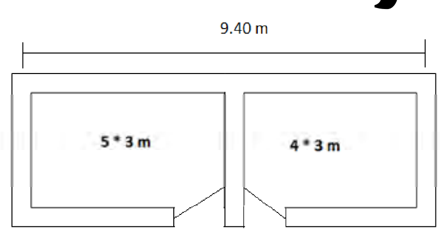
$$w_2=\frac{L_2D_1^2}{162}=\frac{86.16*12^2}{162}=76.59kg$$

Bent up Reinforcing for the Span of 4.0 m

$l_3=0.5l_s+0.16*2+2*(0.25l_s-0.11+0.2)+0.3l+0.5-0.02=6.48m$

$L_3=12\ l_3=12*6.48=77.76m$

$$w_3=\frac{L_3D_1^2}{162}=\frac{77.76*12^2}{162}=69.12kg$$

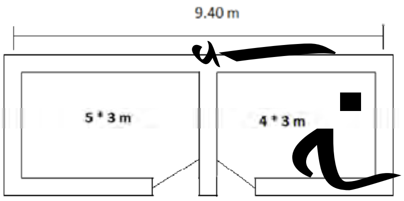


Second direction Reinforcement (4.4 m):

*Clear distance of steel bars=10.6-2*0.02=10.56m*

$$No.of\ bars = \frac{10.56}{0.4} + 1 = 27.4 \approx 28$$

$$l_4 = 4.4 - 2*0.02 + 32db = 4.36 + 32*0.012 = 4.744m$$



$$L_4 = 28l_4 = 28*4.744 = 132.832m$$

$$w_4 = \frac{L_4 D_1^2}{162} = \frac{132.832*12^2}{162} = 118.07kg$$

Bent up reinforcement (l_w=3m):

l_5=0.5l_w+0.16*2+2*(0.25l_w-0.11+0.2)+2*(0.5-0.02)=4.46m

L_5=28l_5=28*4.46=124.88m

$$w_5 = \frac{L_5 D_1^2}{162} = \frac{124.88*12^2}{162} = 111kg$$

Solution:

Slab = (4 * 3) +(5 * 3) = 27

beam inside = {(4+3)*2+(5+3)*2}*0.5= 15 m^2

Beam outside = (9.6 +3.4) * 2 * 0.5 = 13 m^2

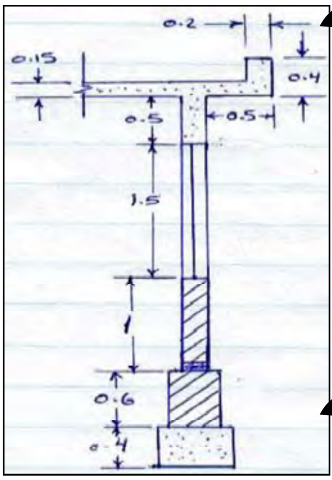
cantilever = 10.6 * 4.4 – 9.6 * 3.4 = 14 m^2

parapet outside = (10.6 +4.4) * 2 * 0.4 = 12 m^2

parapet inside = (10.2 +4) * 2 * 0.25 = 7.1 m^2

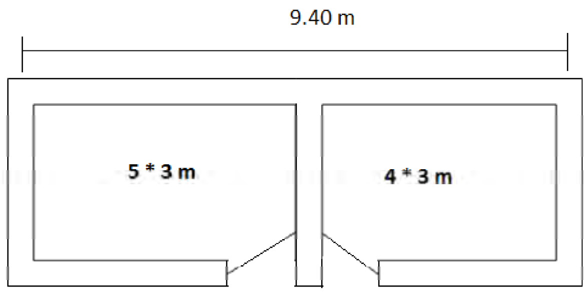
Openings = 1 * 2 * 0.2 + 2.5 * 0.2 * 2 = 1.4 m^2

»»» wooden forms = 89.5 m^2



* 0.25 is the parapet from inside and figured out through 0.4 -0.15 = 0.25 m

Example 22) estimate the amount of wooden forms in example 2 with two windows of 2.5 m in width. The cross-section of the wall is as follows:



Lecture 7: Wooden Form, RC for Slab and Beam Dr. Abbas M Abd

Additional steel bars:

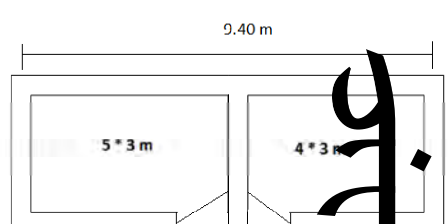
The longitudinal direction from the right: l6 = 0.5-0.02 +0.3 * 4 +0.2 = 1.88m

The longitudinal direction from left: l_7 = 0.5-0.02 +0.3 * 5 +0.2 = 2.18m

Second direction: l8 = 2 * (0.5-0.02 +0.3 * 3) +2 * 0.2 = 3.16m

L_6 = [12 * (l6 + l7)] +(28 * l8) = 137.2m

$$w_6 = \frac{L_6 D_1^2}{162} = \frac{137.2 * 12^2}{162} = 121.96kg$$



Third: Beam Reinforcement:

Straight reinforcement for all beams:

Overall beams length is 28.2 m, Suppose that the length of straight reinforcing for all beams is 28.2 m, taking into account the concrete cover.

l_9 = 28.2-(10 * 0.04) = 27.8m,

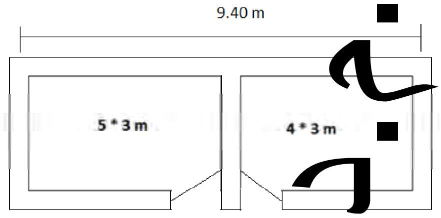
note that: (10) refers to the number of concrete covers

$L_7 = 4l_9 + (4 * 7 * 32db)$,

note that: 4 is the number of bars per beam, The 7 refers to the number of all the beams.

$L_7 = 4 * 27.8 + 896 * 0.012 = 121.952m$

$$w_7 = \frac{L_7 D_1^2}{162} = \frac{121.952 * 12^2}{162} = 108.402kg$$

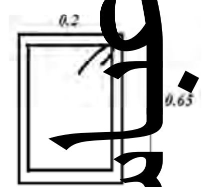


Calculations of Stirrups:

$$No.of\ stirrups = \frac{27.8}{0.3} + 1 = 93.6 \approx 94$$

$$l_{10} = (0.65 - 2*0.04 + 0.2 - 2*0.04)*2 + 0.3 = 1.68m$$

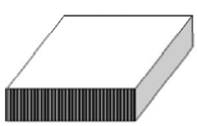
$$L_8 = 94 l_{10} = 94*1.68 = 157.92m$$



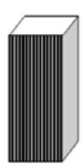
$$w_8 = \frac{L_8 D_2^2}{162} = \frac{157.92 * 10^2}{162} = 97.48kg$$

Lecture 7: Wooden Form, RC for Slab and Beam Dr. Abbas M Abd

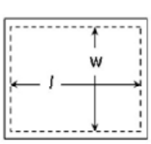
Raft foundation above GL= perimeter of the foundation * thickness



Columns = perimeter of the column * height



Slabs= w*l + perimeter of the slab * thickness



For construction with wall bearing, wooden forms used on both sides only, the bottom of beams will be on the wall, except for the doors and windows. For structural construction, the wooden forms be on both sides of the beam as well as the bottom.

- Place the first piece of wood sheathing along the string line. The width and depth of the sheathing is dependent on the amount of concrete being poured. 1-inch by 4-inch boards are generally stout enough for up to 4 inches of concrete. Thicker slabs require thicker sheathing, which may be pine boards or plywood.

- Drive sharpened stakes on the outside of the sheathing at regular intervals. A 4-inch pour normally requires a stake every 32 inches, depending on how firm the underlying soil is. Decrease the spacing for deeper pours and for loose soil. Nail the sheath to the stakes as close to the string line as possible.

- Adjust the sheathing in or out by packing soil around the stakes. Use the builder's level to ensure the sheathing is plumb. Ensure that the string line remains above the concrete forms to provide a guide for a straight line.
- Repeat these steps for each side of the perimeter. Ensure that the corners are properly joined to prevent leakage. Concrete should set for three to four days before removing the forms

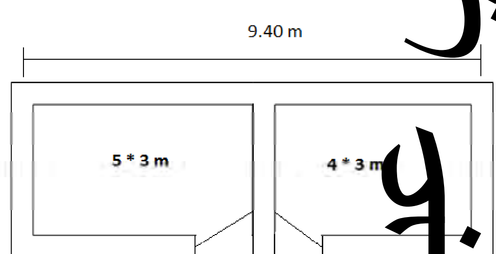
Lecture 7: Wooden Form, RC for Slab and Beam Dr. Abbas M Abd

Calculations of bent reinforcement

for beam B1: $l_{11} = 0.5l + 2 * 0.81 + 2 * (0.25l - 0.57 + 0.2) + 0.3\ l_s = 7.08m$

for beams B2: $l_{12} = 0.5l_s + 2 * 0.81 + 2 * (0.25l_s - 0.57 + 0.2) + 0.3\ l = 6.38m$

for beams B3: $l_{13} = 0.5l_w + 2 * 0.81 + 2 * (0.25l_w - 0.57 + 0.2) = 3.88m$



$L_9 = 2l_{11} + 2\ l_{12} + 3\ l_{13} = 38.56m$

$$w_9 = \frac{L_9 D_1^2}{162} = \frac{38.56 * 12^2}{162} = 34.28kg$$

W_t of φ12 = w1 + w2 + w3 + w4 + w5 + w6 + w7 + w9 = 756.158 kg

W_t of φ10 = 97.48 kg

W_T = 853.638 kg

8) Wooden Forms:

Concrete is a strong and versatile building material. With the advent of ready mix concrete, can do a lot of concrete construction. When it comes to pouring concrete, everything starts with the forms. Ensuring concrete forms are both accurate and strong will go toward finished a successful project that will stand the long test of time. For ease of use and versatility, it's hard to beat wood as the concrete framing material of choice.

Instructions

- Determine the design of your concrete project. Lay your outline on the ground. Use the tape measure to ensure correct measurement and the carpenter's protractor to verify correct angles. Drive stakes into the ground at each corner of the outline. Tie twine to the first stake and string it around the perimeter of the outline, tying it to each stake. Use the level to ensure a straight, level line.

Specification of
Brick masonry, Painting, and Plastering

GENERAL PRINCIPLES TO BE OBSERVED IN BRICK MASONARY CONSTRUCTION

The bricks used in a good work should be sound hard and well burnt with uniform size shape and color. The bricks should not absorb water more than 20% of their dry weight when immersed in water at about 24 hours.

The bricks should be laid on a full bed of mortar. They should be slightly pressed in to the bed mortar while laying so as to ensure proper adhesion.

All the joints should be properly flushed and filled with mortar so that no cavity is left in between.

No brickbats (broken) should be used in the work except when it is absolutely necessary

Brick work is generally laid in the English bond .Other types of bonds like Flemish bond, diagonal bond, Dutch bond etc are also be used

Only specified mortar of a good quality should be used in the work, the mortar ratio is 1:4 .Thickness of joints should not exceed 13mm in any case.

The bricks must be laid on proper bed with their joints pointing upwards.

Plastering should be done after about 28 days of completion of brick masonry.

Different positions of Brick

Why bond is necessary ???

- Eliminates continuous vertical joints
- Imparts strength to the masonry
- Defective arrangement reduces strength & durability
- A wall having continuous vertical joints does not act as homogeneous mass

English bond

- Heading course should never start with a queen closer
- Stretchers should have a minimum lap of ¼ their length over the header
- Even number of half brick walls present same appearance
- For odd number we see stretcher on one face and header on other
- In thick walls, the middle portion is entirely filled with header

•

FLEMISH BOND

- Every course consists of header and stretcher
- Header are centered over stretcher
- Every alternate course start with header

Comparison ??

➢English bond is stronger
➢Flemish is more attractive
➢Flemish requires more attention
➢English is economical

Strength Of
Brick Masonry Depends On:

1. TYPES & STRENGTH OF BRICKS

Defects In Brick Masonry

These may occurs due to following:

1. SULPHATE ATTAC

Crystallization Of Salts From Bricks

Corrosion Of Embedded Iron Or Steel

Shrinkage On Drying

HOW CAN WE REMOVE DEFECTS IN BRICK MASONRY?

WE CAN REMOVE DEFECTS IN BRICK MASONRY:

- Sulphate attack can be removed by suitable construction details and choosing materials.
- Efflorescence can be removed by brushing and washing the effected surface repeatedly
- Shrinkage on drying can be prevented by using good quality brick and by protecting masonry from moisture penetration
- Corrosion of embedded iron or steel can be removed by encasing the reinforcement or iron member in dense cement mortar .
-

DEFINATION OF PLASTERING:

The word “plaster” comes from the Greek language meaning “to daub on”.

This is a process of covering rough surfaces with a plastic material to obtain an even , smooth , regular ,clean & durable surface.

On the other hand we say that

A mixture of lime or gypsum, sand, and water, sometimes with fiber added, that hardens to a smooth solid and is used for coating walls and ceilings.

Plastering Tools

- Trowel
- Float
- Hawk

PLASTERING MATERIALS:

1. Cement
2. Lime or clay
3. Aggregates
4. Water
5. Accelerator
6. Admixture

SAND USED IN PLASTERING

- River Sand: Fine, round, polished, it may have impurities like pebbles , contains gravels smaller in size, suitable for plastering.
- Fine Sand: All particles i.e.100% pass through #16(ASTM) sieve used for plastering.
  Size: 1/16 in
  Fineness Modulus: 2.2-2.6

KINDS OF PLASTERING :

There are several different types of Plaster available such as :

(a) Lime Plaster
(b) Cement Plaster
(c) Mud Plaster
(d) Stucco Plaster
(e) Plaster on lath

LIME PLASTER

When lime is used as the binding materials, it is called lime plaster.

Lime plaster is type of plaster composed of hydrated lime, sand and water. Lime plaster is similar to Lime mortar, the main difference is the based on use rather than composition. Hydraulic lime is harder and stronger .Mortar for lime plaster is usually prepared by mixing sand and lime in equal proportions. Cement is small quantity added to the mixture to improve its strength.

PICTURE OF LIME PLASTER:

MUD PLASTERING:

The surface to be plastered is prepared exactly in the same manner as that for lime or cement plaster. Mud plaster is generally applied in two coats, the first coat being 18mm thick while the thickness of the second coat is kept 6mm.

•

- [ ] **STUCCO PLASTERING**

Stucco is the name given to a decorative type of plaster which gives an excellent finish. Stucco plaster can be used for interior as well as exterior surfaces. It is usually laid in three coats making the total thickness of the plaster to about 25mm .the first coat is called the scratch coat ; the second a finer coat , also known as the brown coat, and the third is called white coat or finishing coat.

PICTURE OF STUCCO PLASTER

CEMENT PLASTER

When cement is used as the binding materials, it is called cement plaster. It is especially suited for damp condition. Cement plaster is usually applied in one coat. The thickness of coat can be 12mm, 15mm or 20mm depending upon the site conditions and type of building. When the thickness of plaster is more than 15mm. 6 MM thickness of cement plaster and cement mortar 1:3 or 1:4 is recommended for cement plastering on RCC surfaces.

PICTURE OF CEMENT PLASTER

PLASTER ON LATH

Lathing may be either of wood or that of expanded metal. Wooden lath consists of thin strips of well seasoned wood, about 25mm .in width and 90 to 120cm.

PICTURE OF LATH PLASTER

SPECIAL TYPES OF FINISHING

Smooth Cast

Rough Cast

c) Pebble Dash
d) Scrapped Finish
e) Textured Finish

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Smooth Cast

It is a finish which presents levelled and smooth surface. The mortar for the finish is made by mixing cement and fine sand in ratio of 1:3.

49

Rough Cast

- It is a finish in which the mortar for the final coat contains a proportion of fairly big size coarse aggregates. The mortar for the finish is made by mixing cement fine sand & coarse aggregates in the ratio of 1 : 1½ : 3.

50 **Pebble Dash**

- It is a finish in which small pebbles or crushed stones of suitable size are thrown on to a freshly applied final coat of mortar and left exposed. Ratio:
- cement : coarse sand =1:3

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52 **Textured Finish**

In this finish, ornamental patterns or textured surfaces are produced by working with various tools on the freshly applied final coat.

53

Defects in plaster work

Cracking
Efflorescence
Falling out of plaster
Blowing of plaster
•

54 **Cracking**

a. Old surface not being properly prepared.
b. Movements in the backing either on account due to shrinkage caused by the drying of the backing material.
c. Excessive shrinkage of plaster due to the application of mortar in thick coats.
•

55

56 **Efflorescence**

It is solvable salt are present in bricks or the mortar they absorb moisture

From atmosphere and go in to solution which appears on the surface in the form of whitish substance as the moisture dries out and the salts crystallize.

Remove of efflorescence by applying a solution zinc sulphet and water and brushing off the surface when dry.

Falling out of plaster

The adhesion of the plaster to the back ground may not be perfect.

The suction of the backing materials may not be uniform.

Excessive thermal changes in plaster.

Blowing of plaster

This consists of information of small patches of plaster swelling out beyond the plastered surface

and chiefly due to improper slaking of lime particles in the plaster.

ADVANTAGES OF PLASTERING

a) Easy in application
b) No surgery is required.
c) Plaster is the most common form of interior wall finishing
d) If properly mixed and applied, a plaster coating creates a stronger and more durable.

DISADVANTAGES OF PLASTERING

a) When plaster cracks then difficult to repair.
b) Repairing is very expensive.
c) Despite the extra labor of hanging and finishing drywall, it tends to be less expensive than plastering

PAINT

❑What is paint?

Paints generally consist of three components: Pigment, Binder, and Solvent. The pigment gives colour, the binder makes sure the pigment stays where you put it and the solvent makes the paint fluid and evaporates when you have applied the paint.

❑

❑Constituents of an Oil Paint:

• *A base*
• *An inert filler or extender*

Coloring pigment

- *A solvent or thinner*
- *A drier*
-

62 **Characteristics of a Good Paint**

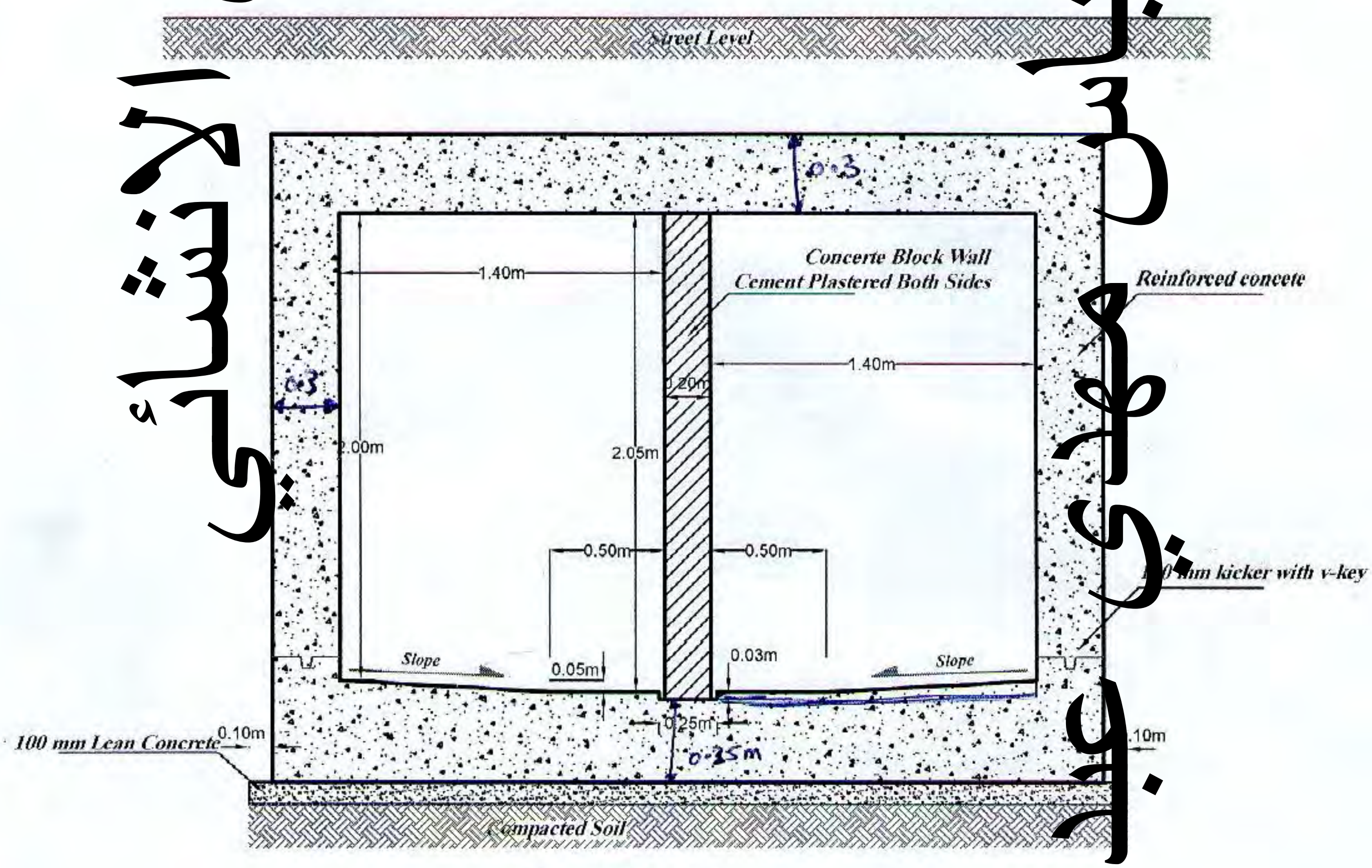
- *stick well to surface & able to seal porous substrata*
- *consistency should provide easy workability*
- *thickness should be adequate for good protection & decoration*
- *paint film should dry easily*
- *able to withstand adverse weather effect without losing gloss*
- *offer resistance to failure by checking, cracking & flaking*
- *possess good moisture resistance*
- *color should not fade*
-

63 **Types of Paints**

- ➢ *Aluminum paints*
- ➢ *Anti-corrosive paints*
- ➢ *Asbestos paints*
- ➢ *Bituminous paints*
- ➢ *Bronze paints*
- ➢ *Cellulose paints*
- ➢ *Casein paints*
- ➢ *Cement based paints*
- ➢ *Enamel paints*
- ➢ *Oil paints*
- ➢ *Rubber base paints*
- ➢

Third: Box Culvert

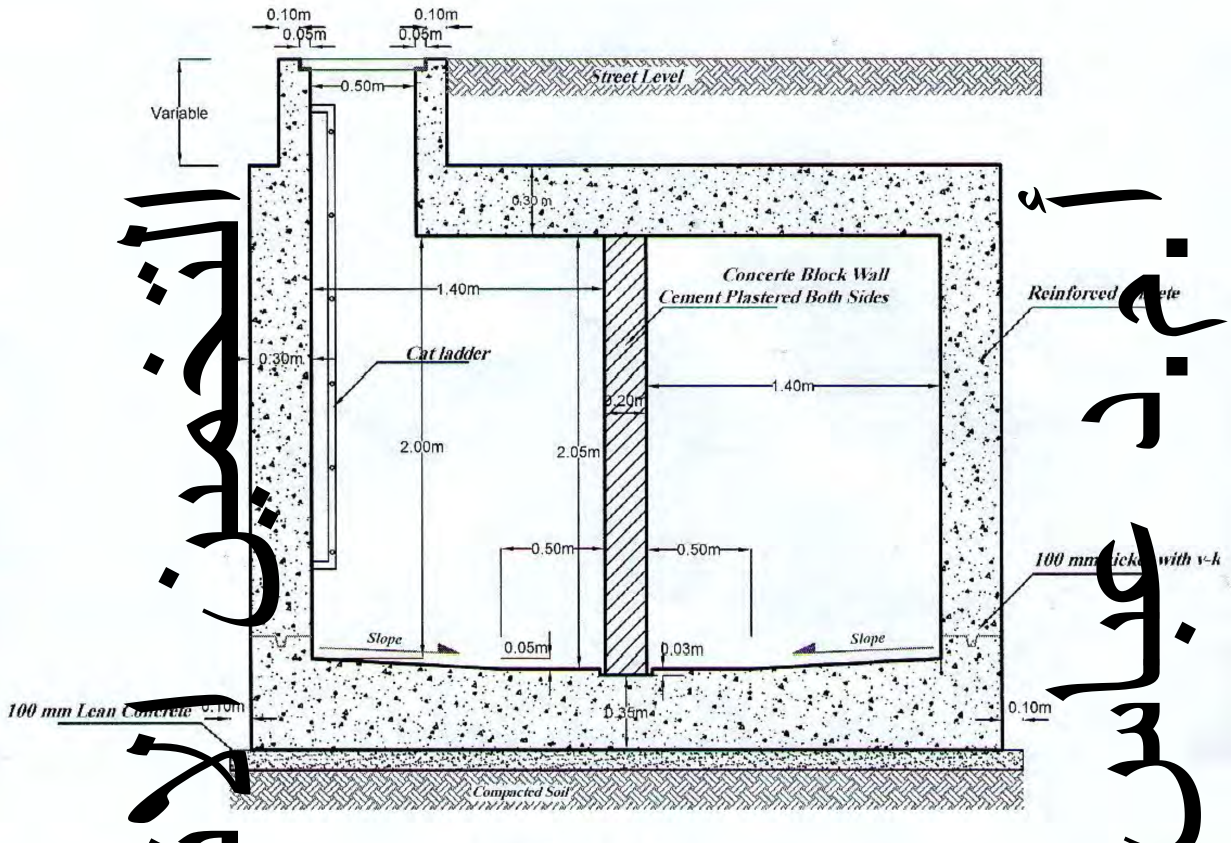
Box Culvert is a Hydraulic structure used in the case of that the natural canal stream intersect with other construction especially roads, highways project or industrial projects or in the case of changing the stream line with some deflection. The following figures show typical cross-section of the Box Culvert as in the first two figures, and third figure shows typical cross sections of the Box Culvert and the detailing of reinforcement cross section.



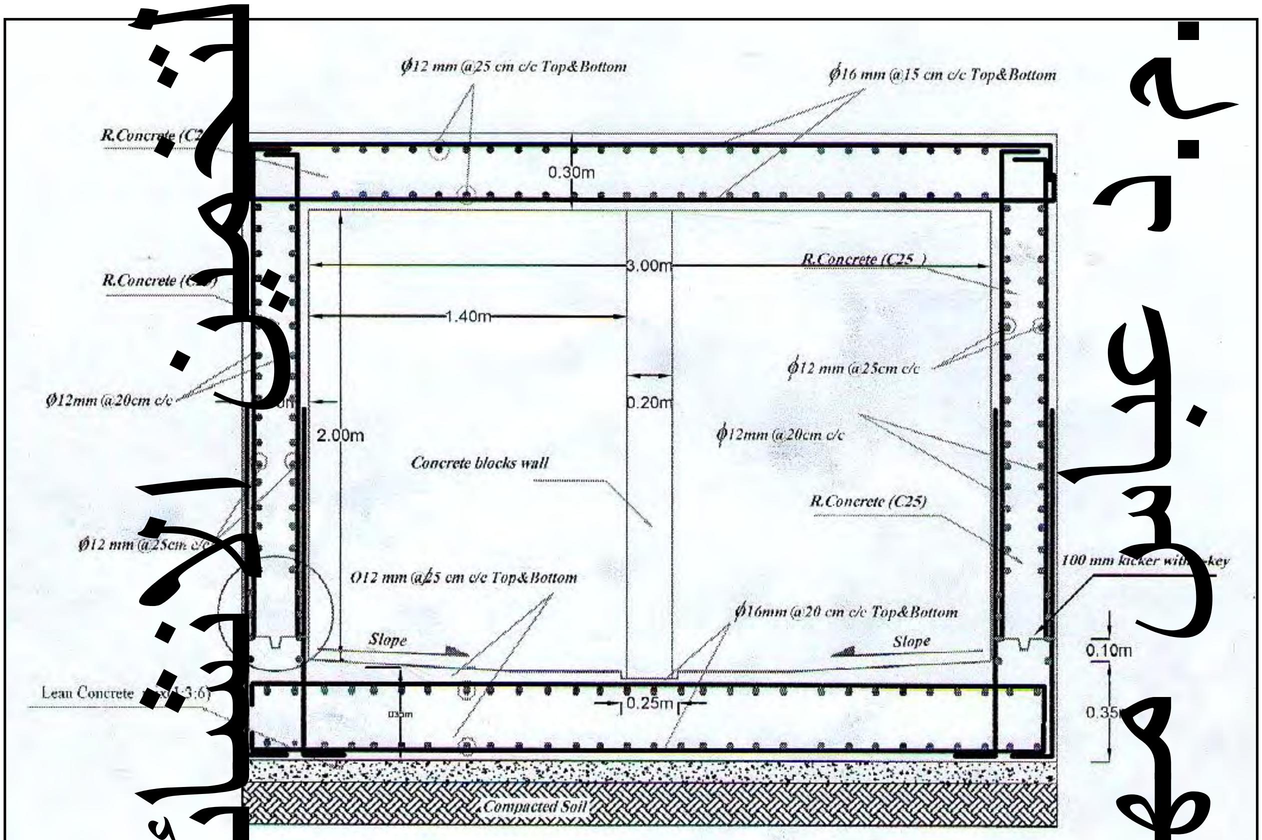
Box Culvert
Typical Cross-Section 1

التخمين الانشائي

أ.م.د عباس مهدي عبد



Box Culvert
Typical Cross-Section 2



Example: Estimate the material quantities (cement, sand, gravel, and steel reinforcement) required for constructing 10 m box culvert of the above typical cross section.

Solution:

1: concrete volume:

side walls= $(2.05+0.3+0.35)*0.3*2*10=16.2m^3$

slab = $(1.4*2+0.2)*0.3*10 \quad =9m^3$

base = $(1.4*2+0.2)*0.35*10$ } $=11.2m^3$

triangle = $0.5*(1.4*0.05)*2*10$

(side walls + slab + base/triangle) $= 36.4m^3$

if we assume that the concrete mix of 1:1.5:3, the quantities will be:

$36.4=0.67(C+1.5C+3C)$ >>>>>> $C=9.88m^3$

Cement = 13.83 ton, Sand = $14.82m^3$, Gravel = $29.63m^3$

2 : steel reinforcement :

A : main reinforcement (cross−sectional) $\phi16$ on span of 10 m

$$l_1 = 3.6 - 2*0.075 + 32db = 3.45 + 32*0.016 = 3.962m$$

$$No. = \frac{10}{0.2} + 1 = 51\ bars$$

$$L_1 = 51*l_1*2 = 51*3.962*2 = 404.124m$$

$$w_1 = \frac{L_1 D_1^2}{162} = \frac{404.124*16^2}{162} = 638.62kg$$

B : secondary reinforcement (longitudinal) $\phi12$

$$spacing = 3.6 - 2*0.075 = 3.45m$$

$$No. = \frac{3.45}{0.25} + 1 = 15\ bars$$

$$l_2 = 10m,\ L_2 = 10*15*2 = 300m$$

$$w_2 = \frac{L_2 D_2^2}{162} = \frac{300*12^2}{162} = 266.67kg$$

C: dowel reinforcement $\phi 12$ with span of 10 m

$$No. = \frac{10}{0.2} + 1 = 51 bars$$

$$l_3 = H + 56db - cover = 0.35 + 56 * 0.012 - 0.075 = 0.947m$$

$$L_3 = 0.947 * 51 * 2 * 2 = 193.188m$$

$$w_3 = \frac{L_3 D_2^2}{162} = \frac{193.188 * 12^2}{162} = 171.72kg$$

Wall reinforcement:

Main direction: $\phi 12$

No. = 51 bars

$l_4 = 2.05 + 0.3 - 0.04 + 32db = 2.694m$

$L_4 = 2.694 * 51 * 2 * 2 = 549.576m$

$$w_4 = \frac{L_4 D_2^2}{162} = \frac{549.576 * 12^2}{162} = 488.512kg$$

Longitudinal direction: $\phi 12$

$$spacing = 2.05m, \; No. = \frac{2.05}{0.25} + 1 = 10 bars$$

$$l_5 = 10m, \; L_5 = 10 * 10 * 2 * 2 = 400m$$

$$w_5 = \frac{L_5 D_2^2}{162} = \frac{400 * 12^2}{162} = 355.56kg$$

Slab reinforcement:

$\phi 16$

$$spacing = 10m, \; No. = \frac{10}{0.15} + 1 = 68 bars$$

$$l_6 = 3.6 - 2 * 0.04 + 32db = 3.904m$$

$$L_6 = 3.904 * 68 * 2 = 530.944m$$

$$w_6 = \frac{L_6 D_1^2}{162} = \frac{530.944 * 16^2}{162} = 839.02kg$$

$\phi 12$

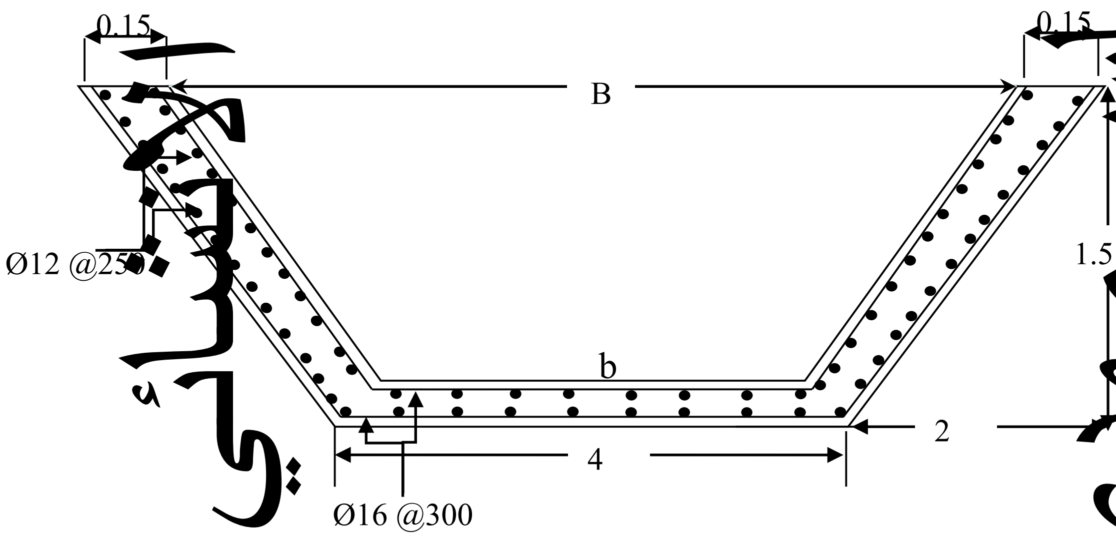
$$spacing = 3m,\ No. = \frac{3}{0.25} + 1 = 13 bars$$

$$l_7 = 10m,\ L_7 = 10 * 13 * 2 = 260m$$

$$w_7 = \frac{L_7 D_2^2}{162} = \frac{260 * 12^2}{162} = 231.11kg$$

w_T of $\phi 12$ = 1513.57kg, w_T of $\phi 16$ = 1477.64kg, W_T = 2991.21kg

Example: Estimate the material quantities (cement, sand, gravel, and steel reinforcement) required for constructing 100 m concrete canal of the following typical cross section, concrete mix of 1:2:4 and thickness of 15 cm.



Solution:

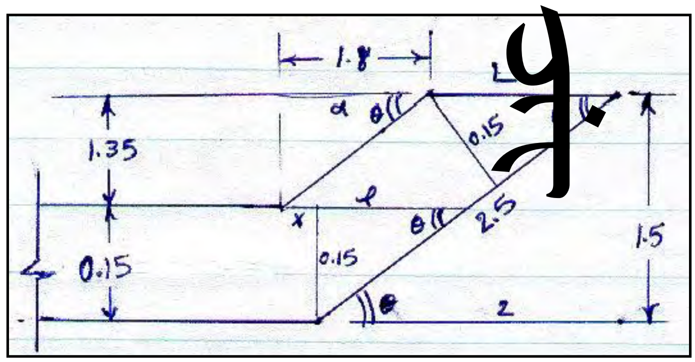
$$\sin\theta = \frac{1.5}{2.5} = \frac{0.15}{L} \Rightarrow L = 0.25m$$

$$\tan\theta = \frac{0.15}{l} = \frac{1.5}{2} \Rightarrow l = 0.2m$$

$$x = L - l = 0.05m$$

$$\tan\theta = \frac{1.5}{2} = \frac{1.35}{a} \Rightarrow a = 1.8m$$

$$b = 4 - 2x = 3.9m$$



$B = 8 - 2 * L = 7.5m$

$$Vol. = \left[\left(\frac{4+8}{2} \right) * 1.5 - \left(\frac{3.9+7.5}{2} \right) * 1.35 \right] * 100 = 130.5m^3$$

$Cement = 39.15ton, Sand = 65.25m^3, Gravel = 130.5m^3$

Steel reinforcement:

The calculation can be simplified through considering that the canal as concrete plate with thickness of 15 cm and width equal to the average of two circumstances; the inner and outer circumstances with concrete cover of 5 cm.

outer circumstances $= 4 + 2 * \sqrt{1.5^2 + 2^2} = 9m$

inner circumstances $= 3.9 + 2 * \sqrt{1.35^2 + 1.8^2} = 8.4m$

width $= \frac{9+8.4}{2} = 8.7m$

Main reinforcement $\phi 16$

$$space = 100m, No. = \frac{100}{0.3} + 1 = 335$$

$$l_1 = 8.7 - 2 * 0.05 + 32db + 2 * 4db = 9.24m,\ L_1 = 9.24 * 335 * 2 = 6190.8m$$

$$w_1 = \frac{L_1 D_1^2}{162} = \frac{6190.8 * 16^2}{162} = 9782.99kg$$

Secondary reinforcement $\phi 12$

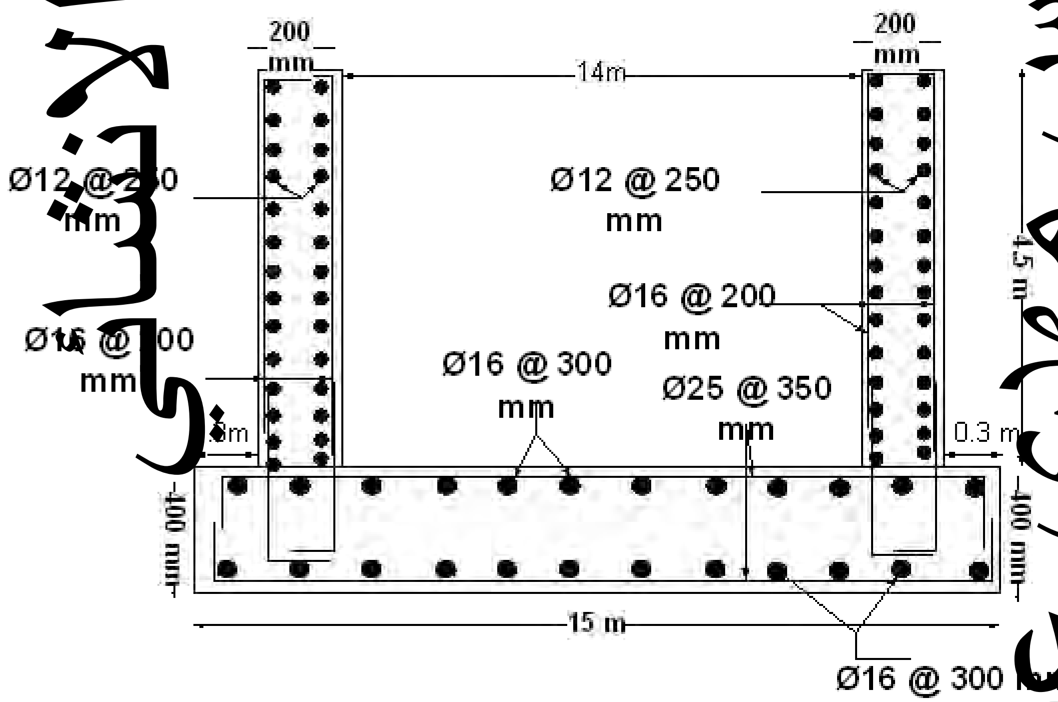
$$space = 8.7 - 2 * 0.05 = 8.6m,\ No.of\ oerlaps = \frac{100}{12} = 8.3 = 8,\ No. = \frac{8.6}{0.25} + 1 = 36bars$$

$$l_2 = 100 + 8 * 0.3 = 102.4m,\ L_2 = 102.4 * 36 * 2 = 7372.8m$$

$$w_2 = \frac{L_2 D_2^2}{162} = \frac{7372.8 * 12^2}{162} = 6553.6kg$$

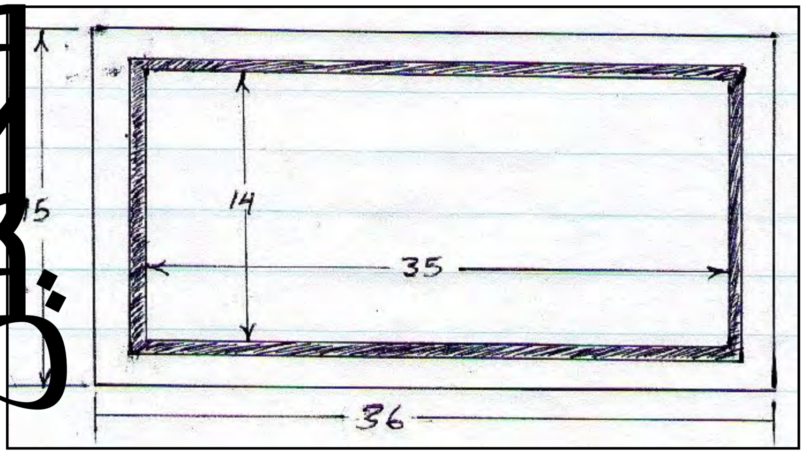
$$w_t = 1633659kg$$

The figure below represent an open water tank from the above, the net interior dimention are 14 X 35 m. the reinforcement for the four side is the same. Estimate the material quantities (cement, sand, gravel, and steel reinforcement) required for constructing this water tank if concrete mix is of 1:2:4.



Solution:

Vol.=15*36*0.4+{(14.4*35.4)-(14*35)}*4.5=304.92m^3
Cement=91.476ton, Sand=152.46m^3, Gravel=304.92m^3



Steel reinforcement:

Basement:

A: Main reinforcement:

$$space = 36 - 2*0.075 = 35.85m,\ No.of\ overlaps = \frac{15}{12} = 1.25 = 1$$

$$l_1 = 15 - 2*0.075 + 32db + 1*0.3 = 15.95m,\ No. = \frac{35.85}{0.35} + 1 = 104bars$$

$$L_1 = 15.95*104*2 = 3317.6m,\ w_1 = \frac{L_1 D_1^2}{162} = \frac{3317.6*25^2}{162} = 12799.38kg$$

B: Secondary reinforcement:

$$space = 15 - 2*0.075 = 14.85m,\ No.of\ overlaps = \frac{36}{12} = 3$$

$$l_2 = 36 - 2*0.075 + 32db + 3*0.3 = 37.262m,\ No. = \frac{14.85}{0.3} + 1 = 51bars$$

$$L_2 = 37.262*51*2 = 3800.724m,\ w_2 = \frac{L_2 D_2^2}{162} = \frac{3800.724*16^2}{162} = 6006.08kg$$

Dowels:

$$space = 35 * 2 + 14.4 * 2 = 98.8m,\ No. = \frac{98.8}{0.2} + 1 = 495.0...bars$$

$$l_3 = 56db + H - cover = 56 * 0.016 + 0.4 - 0.075 = 1.221m$$

$$L_3 = 1.221 * 495 * 2 = 1208.79m,\ w_3 = \frac{L_3 D_2^2}{162} = \frac{1208.79 * 16^2}{162} = 1910.19kg$$

Wall reinforcement:

Main reinforcement:

$$\boldsymbol{No. = 495bars,\ l_4 = 4.5 - 0.04 + 16db = 4.716m}$$

$$\boldsymbol{L_4 = 4.716 * 495 * 2 = 4668.84m,\ w_4 = \frac{L_4 D_2^2}{162} = \frac{4668.84 * 16^2}{162} = 7377.92kg}$$

Secondary reinforcement: consider all walls as one unit of length is 98.8 m

$$\boldsymbol{space = 4.5 - 0.04 = 4.46m,\ No.of\ overlaps = \frac{98.8}{12} = 8.2 = 8}$$

$$\boldsymbol{l_5 = 98.8 - 8 * 0.04 + 4 * 32db + 8 * 0.3 = 102.416m,\ No. = \frac{4.46}{0.25} + 1 = 19bars}$$

$$\boldsymbol{L_5 = 102.416 * 19 * 2 = 3891.808m,\ w_5 = \frac{L_5 D_3^2}{162} = \frac{3891.808 * 12^2}{162} = 3459.38kg}$$

w_t *of* $\phi 12$*=3459.38kg,* w_t *of* $\phi 16$*=15294.19kg,* w_t *of* $\phi 25$*=12799.38kg*

$W_T = 31552.95kg$