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**4th Edition 2015,**  
A Practical Book for



professor  
**Mohammed Haroon**

# **BUILDING ESTIMATION**

For All Civil Engineers & Architects (Diploma, Degree & Masters)

**Sub-Structure | Super-Structure | Concrete & Reinforcement - Calculations**  
Format & Procedures for Project Work of Residential & Commercial Buildings

**A book for all Civil Engineers & Architects (Diploma, Degree, & Masters)**

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**A Practical book for**

**BUILDING ESTIMATIONS**

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**TO MY  
MOTHER & FATHER**



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## CONTENTS

### Introduction

### Page no.

<b>1. Definition of Quantity Surveying</b>	<b>01 - 01</b>
<b>2. List of Topics under Quantity Surveying</b>	<b>02 - 03</b>
<b>3. Process of Executing Work on Site</b>	<b>04 - 09</b>
<b>4. Types of Footings</b>	<b>10 - 19</b>
<b>5. Types of Columns</b>	<b>20 - 23</b>
<b>6. Types of Floors</b>	<b>24 - 24</b>
<b>7. Types of Loads</b>	<b>25 - 25</b>
<b>8. Honey Comb</b>	<b>25 - 26</b>
<b>9. Types of Beams</b>	<b>26 - 31</b>
<b>10. Types of Slabs</b>	<b>31 - 39</b>
<b>11. Types of Walls</b>	<b>40 - 46</b>
<b>12. Types of Stair Cases</b>	<b>46 - 47</b>
<b>13. Unit Conversion (one, two &amp; three dimension)</b>	<b>48 - 54</b>
<b>14. Rate Conversion</b>	<b>55 - 56</b>
<b>15. Length &amp; Area Calculations</b>	<b>57 - 59</b>
<b>16. Shuttering Area Calculations</b>	<b>60 - 60</b>
<b>17. Volume Calculations</b>	<b>61 - 61</b>
<b>18. Problems &amp; Solutions of Various types of Footings</b>	<b>62 - 69</b>
<b>19. Problems &amp; Solutions of Various types of Columns</b>	<b>70 - 79</b>
<b>20. Problem &amp; Solution of Roof Frame with Drop Beams</b>	<b>80 - 83</b>
<b>21. Problem &amp; Solution of Dome Slab</b>	<b>83 - 88</b>
<b>22. Problem &amp; Solution of Hardy Slab</b>	<b>89 - 90</b>
<b>23. Problem &amp; Solution of Waffle Slab</b>	<b>91 - 92</b>
<b>24. Problem &amp; Solution of Pitch Roof</b>	<b>93 - 94</b>
<b>25. Problem &amp; Solution of Semi-round Stair Case</b>	<b>95 - 98</b>
<b>26. Problem &amp; Solution of Lift Pit</b>	<b>99 - 101</b>
<b>27. Problem &amp; Solution of Ramp</b>	<b>102 - 104</b>
<b>28. Standard Data required for Quantity Surveying</b>	<b>104 - 106</b>

**C:M (cement:mortar) required for Brick work**  
**C:M (cement:mortar) required for Plastering**  
**Concrete Mix Design with different Grades of Concrete**  
**Standard Weight and Density of Cement, Sand, Aggregate, Water & Steel, etc.**

<b>29. Brick work Calculations &amp; Problems</b>	<b>107 – 111</b>
<b>30. Plastering Calculations &amp; Problems</b>	<b>112 – 117</b>
<b>31. Emulsion paint (or Water Bond Paint for wall) Calculations &amp; Problems</b>	<b>118 – 118</b>
<b>32. Wall Putty Calculation &amp; Problem</b>	<b>119 – 119</b>
<b>33. Flooring Calculation &amp; Problem</b>	<b>120 – 120</b>
<b>34. Over-Head Water Tank Calculation &amp; Problem</b>	<b>121 – 123</b>
<b>35. Pictures of advance method of Plastering with machine</b>	<b>124 – 124</b>
<b>36. Complete Format &amp; Method to prepare Estimate of Residential Villa Project with M.S office Excel Sheet and List of items to be calculated</b>	<b>125 – 127</b>
<b>37. Project Drawings (Architectural, Structural &amp; Reinforcement)</b>	<b>128 – 152</b>

## **SUB-STRUCTURE CALCULATIONS**

<b>38. Calculation for (a)Volume of Concrete (b) Shuttering Area (c)Bitumen Paint Area (d) Polythene Sheet Area (e) Termite Control Area</b>	<b>153 - 154</b>
<b>39. Calculation &amp; Solution for Footings</b>	<b>155 – 162</b>
<b>40. Calculation &amp; Solution for P.C.C under Footings</b>	<b>163 – 164</b>
<b>41. Calculation &amp; Solution for Neck Columns</b>	<b>165 – 174</b>
<b>42. Calculation &amp; Solution for Tie Beams &amp; Strap beams</b>	<b>175 – 178</b>
<b>43. Calculation &amp; Solution for P.C.C under Tie Beams</b>	<b>179 – 181</b>
<b>44. Calculation &amp; Solution for Plinth Beams</b>	<b>182 – 184</b>
<b>45. Calculation &amp; Solution for P.C.C under Plinth Beams</b>	<b>185 – 186</b>
<b>46. Calculation &amp; Solution for 20 cm thick Slab with steel mesh under floor tiles</b>	<b>187 – 189</b>
<b>47. Calculation &amp; Solution for Retaining Wall</b>	<b>190 – 193</b>
<b>48. Calculation &amp; Solution for Rectangular Sump</b>	<b>194 – 196</b>
<b>49. Calculation &amp; Solution for Circular Sump</b>	<b>197 – 200</b>
<b>50. Calculation &amp; Solution for Septic Tank</b>	<b>201 – 203</b>
<b>61. Calculation &amp; Solution for Earth Work Excavation &amp; Back fill with Pit-Wise Method</b>	<b>204 – 212</b>

<b>62. Abstract for the Quantities of Sub-Structure and its Solution</b>	<b>213 – 216</b>
<b>63. Bill of Quantities for Sub-Structure</b>	<b>217 – 217</b>

## **SUPER-STRUCTURE CALCULATIONS**

<b>64. Calculation for (a)Volume of Concrete (b) Shuttering Area</b>	<b>218 – 218</b>
<b>65. Calculation &amp; Solution for Floor Columns</b>	<b>219 – 228</b>
<b>66. Calculation &amp; Solution for Drop Beams</b>	<b>229 – 232</b>
<b>67. Calculation &amp; Solution for Roof Slab</b>	<b>233 – 239</b>
<b>68. Calculation &amp; Solution for Dog-Leg Stair Case</b>	<b>240 – 242</b>
<b>69. Calculation &amp; Solution for Brick work</b>	<b>243 – 247</b>
<b>70. Calculation &amp; Solution for cement : mortar required for Brick work</b>	<b>248 – 248</b>
<b>71. Calculation &amp; Solution for Plastering</b>	<b>249 – 280</b>
<b>72. Calculation &amp; Solution for cement : mortar required for Plastering</b>	<b>281 – 282</b>
<b>73. Calculation &amp; Solution for Paint (Emulsion &amp; Enamel paint)</b>	<b>283 – 285</b>
<b>74. Calculation &amp; Solution for Wall Putty</b>	<b>286 – 287</b>
<b>75. Calculation &amp; Solution for False Ceiling</b>	<b>288 – 292</b>
<b>76. Calculation &amp; Solution for Flooring, Wall Skirting &amp; Wall Tiles</b>	<b>293 – 312</b>
<b>77. Calculation &amp; Solution for cement : mortar required for Flooring</b>	<b>313 – 313</b>
<b>78. Calculation &amp; Solution for cement required for Wall Skirting &amp; Wall Tiles</b>	<b>314 – 314</b>
<b>79. Bill of Quantities for Doors &amp; Window</b>	<b>315 – 316</b>
<b>80. Calculation for the Fitting of Doors &amp; Windows</b>	<b>317 – 320</b>
<b>81. Bill of Quantities for Doors &amp; Windows Fittings</b>	<b>321 – 321</b>
<b>82. Window Grill &amp; Gate Calculations</b>	<b>322 – 322</b>
<b>81. Calculation &amp; Solution for Miscellaneous item (Loft, Kitchen Plat-form, Lintel, Sun-shade etc.</b>	<b>323 – 338</b>
<b>82. Abstract for the Quantities of Super-Structure (Concrete &amp; Shuttering)</b>	<b>339 – 339</b>
<b>83. Abstract for the Quantities of Super –Structure</b>	<b>340 – 341</b>
<b>84. Bill of Quantities for Super-Structure</b>	<b>342 – 343</b>
<b>85. Bill of Quantities for Residential Villa</b>	<b>344 – 345</b>

## **REINFORCEMENT CALCULATIONS**

<b>86. Reinforcement Calculations</b>	<b>346 – 346</b>
<b>87. Bar Bending Schedules (B.B.S)</b>	<b>347 – 357</b>
<b>88. Project Drawing for Reinforcement</b>	<b>358 – 375</b>

## **SUB-STRUCTURE REINFORCEMENT CALCULATIONS**

<b>89. Calculation &amp; Solution of Reinforcement for Footings</b>	<b>377 – 395</b>
<b>90. Calculation &amp; Solution of Reinforcement for Neck Column</b>	<b>396 – 421</b>
<b>91. Calculation &amp; Solution of Reinforcement for Tie Beams</b>	<b>422 – 431</b>
<b>92. Calculation &amp; Solution of Reinforcement for Plinth Beams</b>	<b>432 – 440</b>
<b>93. Calculation &amp; Solution of Reinforcement for Slab under Floor Tiles</b>	<b>441 – 450</b>
<b>94. Calculation &amp; Solution of Reinforcement for Retaining Wall</b>	<b>451 – 478</b>
<b>95. Calculation &amp; Solution of Reinforcement for Rectangular Sump</b>	<b>479 – 485</b>
<b>96. Calculation &amp; Solution of Reinforcement for Circular Sump</b>	<b>486 – 493</b>
<b>97. Calculation &amp; Solution of Reinforcement for Septic Tank</b>	<b>494 – 500</b>
<b>98. Abstract of Reinforcement for Sub-Structure</b>	<b>501 – 501</b>
<b>99. Bill of Quantities for Reinforcement of Sub-Structure</b>	<b>502 – 502</b>

## **SUPER-STRUCTURE REINFORCEMENT CALCULATIONS**

<b>100. Calculation &amp; Solution of Reinforcement for Columns</b>	<b>504 – 536</b>
<b>101. Calculation &amp; Solution of Reinforcement for Drop Beams</b>	<b>537 – 566</b>
<b>102. Calculation &amp; Solution of Reinforcement for Roof Slab</b>	<b>567 – 584</b>
<b>103. Calculation &amp; Solution of Reinforcement for Dog-Leg Stair Case</b>	<b>585 – 592</b>
<b>104. Calculation &amp; Solution of Reinforcement for Miscellaneous items</b>	<b>593 – 606</b>
<b>105. Abstract of Reinforcement for Super Structure</b>	<b>607 – 607</b>
<b>106. Bill of Quantities for Reinforcement of Super Structure</b>	<b>608 – 608</b>

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## **A Practical book for Quantity Surveying**

### **Definition:** Quantity Surveying

*If any building is to be constructed, then finding out the quantities of all materials and cost required to construct it, is called as Quantity Surveying.*

### **Topics under Quantity Surveying:**

1. Types of footings.
2. Types of columns.
3. Types of beams.
4. Types of slabs.
5. Types of walls.
6. Unit conversion → one/two/three → dimension conversion.
7. Length calculation.
8. Area calculation.
9. Volume calculation.
10. Module-I      → Sub-structure calculation [Item below ground level].
11. Module-II     → Super-structure calculation [Item above ground level].
12. Module-III    → Reinforcement calculation for R.C.C and Steel structure.
13. Module-IV    → Computer Application (MS Excel sheet and Auto-cad).
14. Module-V     → Project work.

### **(A). List of items to be calculated below Ground level [sub structure]**

1. P.C.C under footings
2. Footings
3. Neck columns
4. Tie beams and Strap beams
5. P.C.C under Tie beams
6. Plinth beams or Ground beams
7. P.C.C. under plinth beams
8. Grade Slab or Slab on Grade

- 
- 9. Retaining wall
  - 10. Retaining wall Base.
  - 11. Retaining wall P.C.C.
  - 12. Water calculation
  - 13. Rectangular Sump
  - 14. Circular Sump
  - 15. Septic tank
  - 16. Lift pit
  - 17. Earth work Excavation calculation
  - 18. Back- Fill calculation
  - 19. Abstract for the Quantities of Sub-structure.
  - 20. Bill of Quantities
  - 21. Concrete proportions and Ratios with Concrete mix-design

**List of items to be calculated for each item below Ground level**

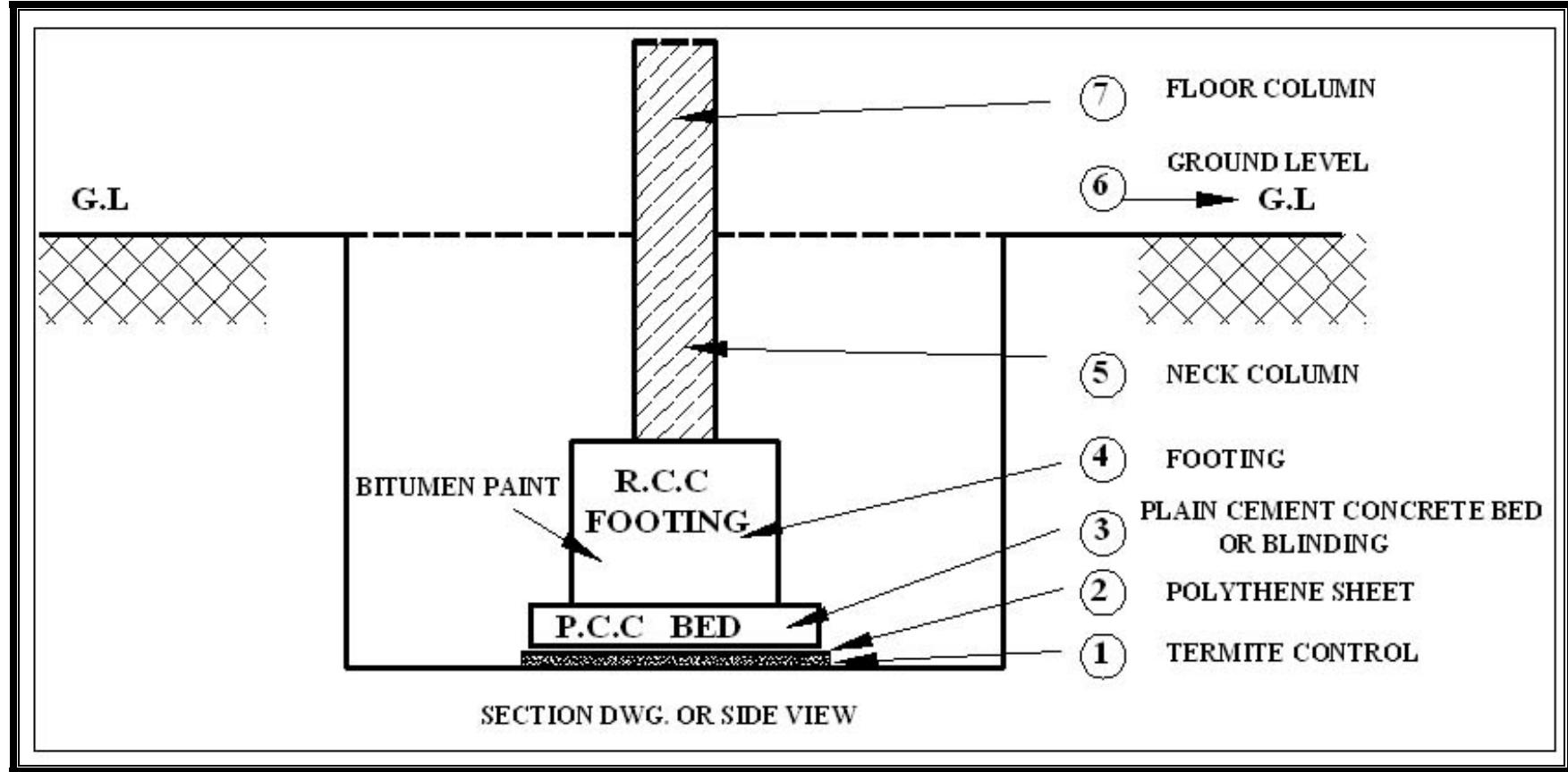
- 1. Volume of Concrete in m<sup>3</sup>
- 2. Area of Shuttering in m<sup>2</sup>
- 3. Area of Water-proof membrane with bitumen paint in m<sup>2</sup>
- 4. Area of Termite control in m<sup>2</sup>
- 5. Area of Polythene sheet or Vapour Barrier in m<sup>2</sup>
- 6. Reinforcement in Kgs or Tones

**(B). List of items to be calculated above Ground level [Super Structure]**

- 1. Floor columns
- 2. Floor beams
- 3. Floor slabs
- 4. Stair cases (Typical & Semi-Circular)
- 5. Ramp (inclined & Semi-Circular)
- 6. Parking platform
- 7. Brick work (No. of bricks required)

- 
- 8. Cement: Mortar required for brick work
  - 9. Wall putty calculation
  - 10. Paint calculations in Liters (Emulsion paint & Enamel paint)
  - 11. False-Ceiling Calculations in m<sup>2</sup>
  - 12. Flooring Calculations (Marble tiles, Vitrified tiles, Parking Tiles & Inter-lock Tiles)
  - 13. Wall Skirting Calculations
  - 14. Wall Tiles (Ceramic Tiles) calculations
  - 15. Wood calculations for doors & windows
  - 16. Doors & Windows Fittings (Tower bolt, Door handle etc)
  - 17. Windows grill, Glass, and Iron Gate calculations
  - 18. Over-Head Water tank Calculations
  - 19. Expansion Joint Details
  - 20. Weight of Concrete Calculations for Pre-cast Wall, Column, Slabs etc.
  - 21. Calculation for the miscellaneous item (Lintel, Loft (Chajjas), Window Sunshade & Kitchen Platforms.
  - 22. Abstract for the quantities of super structure
  - 23. Bill of Quantities for Super structure.

## PROCESS OF EXECUTING WORK ON SITE



1. Termite control (anti-fungus spray)
2. Polythene sheet ( thickness =2mm to 4mm)
3. Plain Cement concrete bed or Blinding (thickness of blinding = 10cm) P.C.C bed without Reinforcement.
4. R.C.C Footing (Reinforced cement concrete bed)
5. Neck column (From top of footing up to bottom of Ground beam)
6. Ground level
7. Floor column (Part of Column above Ground Level)
8. Bitumen Paint

---

### **Earth work excavation:**

This is the process of digging earth on site where the foundation is to be laid.



### **Termite Control:**

After excavation, compaction is done on the earth's surface and then it is treated with ***termite control (Anti fungus spray)***. Generally Earth is treated to control the attack of the insects to the structure and protecting the Sub-Structure item from future damage; Liquid spray is sprayed on the Surface of the Earth and is kept open to the atmosphere for 24 hours to kill all types of insects which is likely to come in future time.



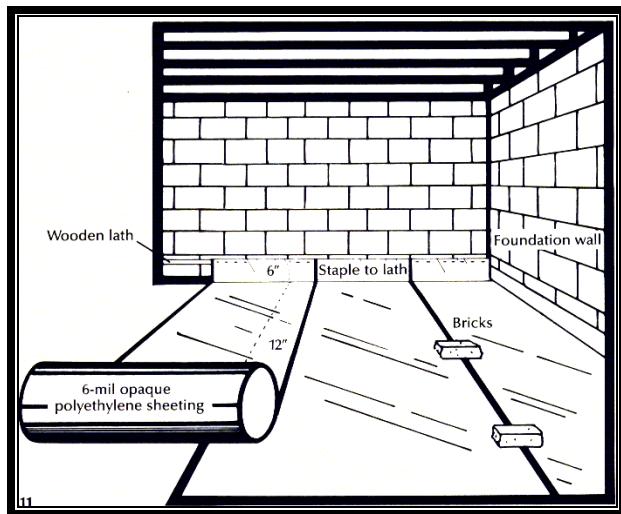


### **Polythene sheet:**

Polythene sheet is laid on the surface of ground after Termite Control Spray is spread. Generally they are 2mm to 6mm thick.

The purpose of laying sheet is to hold the water of concrete and not letting it to have seepage on ground.

Generally when plain Cement concrete is put on surface of the ground, the water from the concrete will come out and it will be absorbed by the earth, then concrete will lose its workability and strength.





### **Plain Cement Concrete bed: [P.C.C. Bed]**

This is also called as blinding. It is just a mixture of cement, sand and aggregate without reinforcement. Generally the Grade of concrete for P.C.C is used as M<sub>7.5</sub> with ratio or proportion of concrete as 1:4:8. Where 1 = one bag of cement; 4 = four bags of Sand; 8 = eight bags of Aggregate. And 40 liters of water / m<sup>3</sup>. The thickness of Blinding is 10cm or 100mm or 0.10m.



---

### **Reinforced cement concrete (R.C.C):**

This is a Concrete with cement, sand and aggregate with reinforcement. Generally the Grade of concrete is used as M<sub>15</sub> with ratio 1:2:4, Where 1 = one bag of cement; 2 = two bags of Sand; 4 = four bags of Aggregate. And 30 liters of water / m<sup>3</sup>

### **Neck column:**

The part of Column which comes between the top of footing to bottom of Ground beam is called as **Neck column**.

### **Bitumen paint:** It can be in liquid form or in Sheet form.

It's a black colour paint, painted to the structure wwhich is under ground before back filling of Soil. The purpose of using the **Bitumen paint** is to

- (i) Increase the life of the structure
- (ii) Give strength to it
- (iii) To acts as water-proofing agent
- (iv) And to safe the structure from Corrosion.



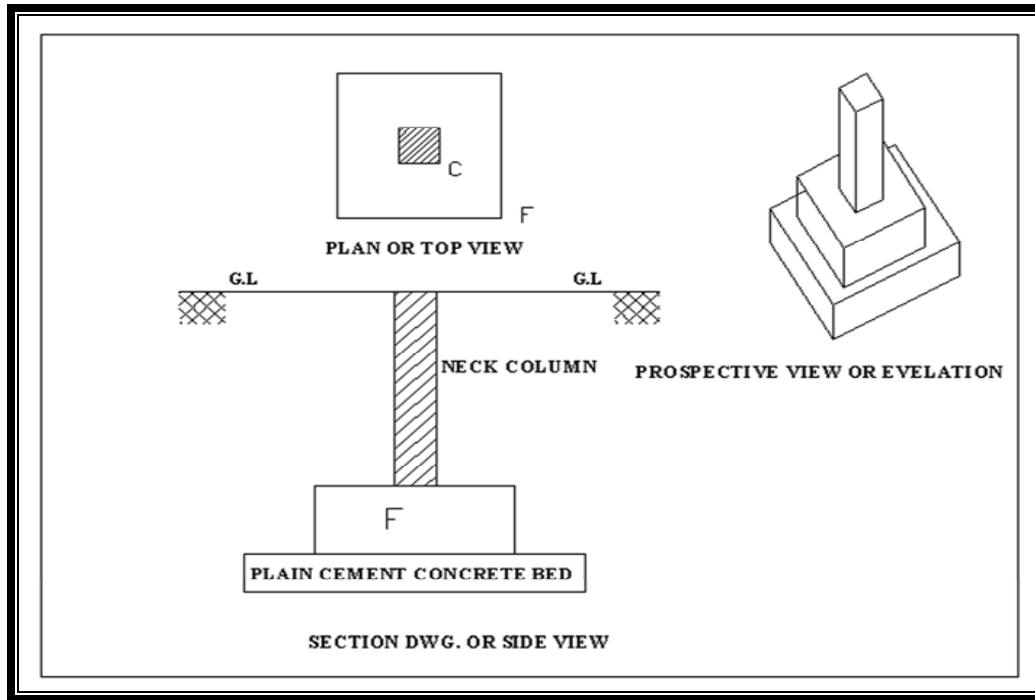


## Types of Footings

1. Plain Footing
2. Step Footing
3. Isolated/Strip/Tapered Footing
4. Plain Combined Footing
5. Isolated Combined Footing
6. Strap footing or Neighbor footing or Shoe Footing
7. Raft Footing
8. Pile Footing

## **1. Plain Footing:-**

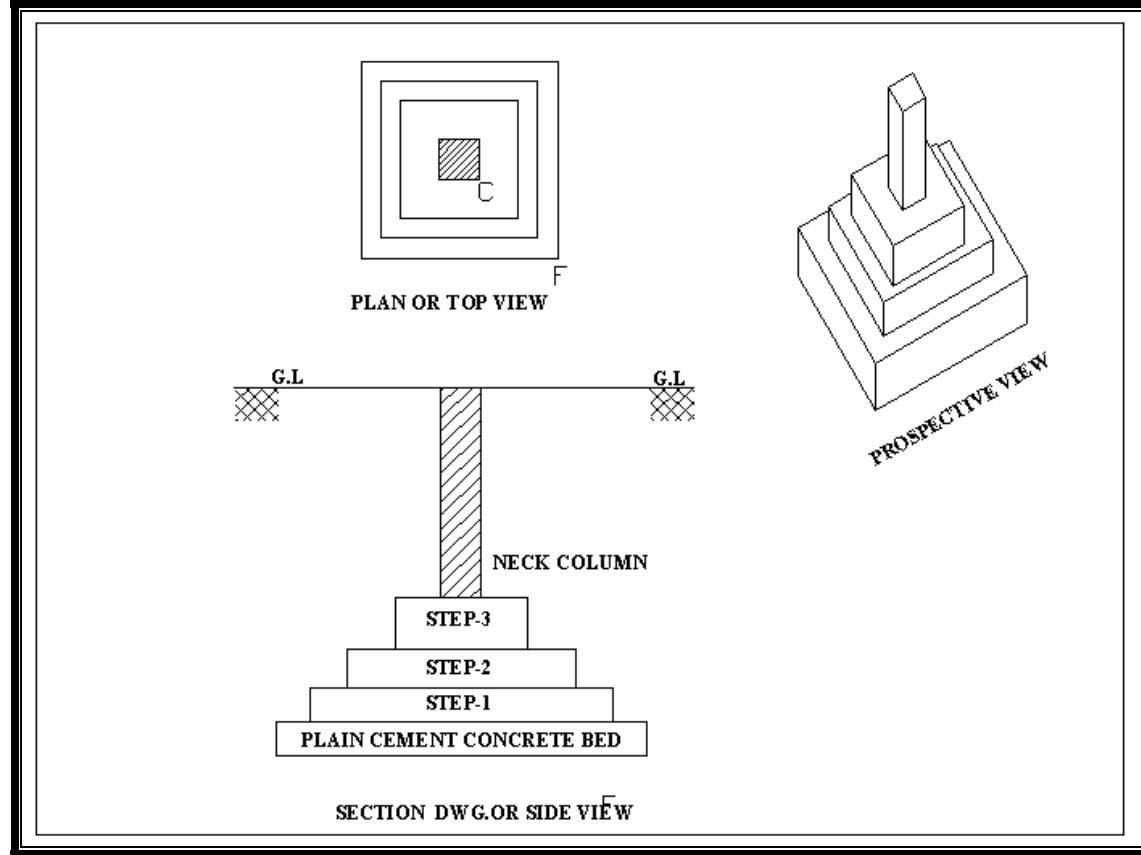
These footings are generally common in both India as well as Gulf countries. It is easy to construct and consume less time. It is constructed where the soil bearing capacity is normal (Good). SBC = 24kn / m<sup>3</sup>



C=Column; F=Footing

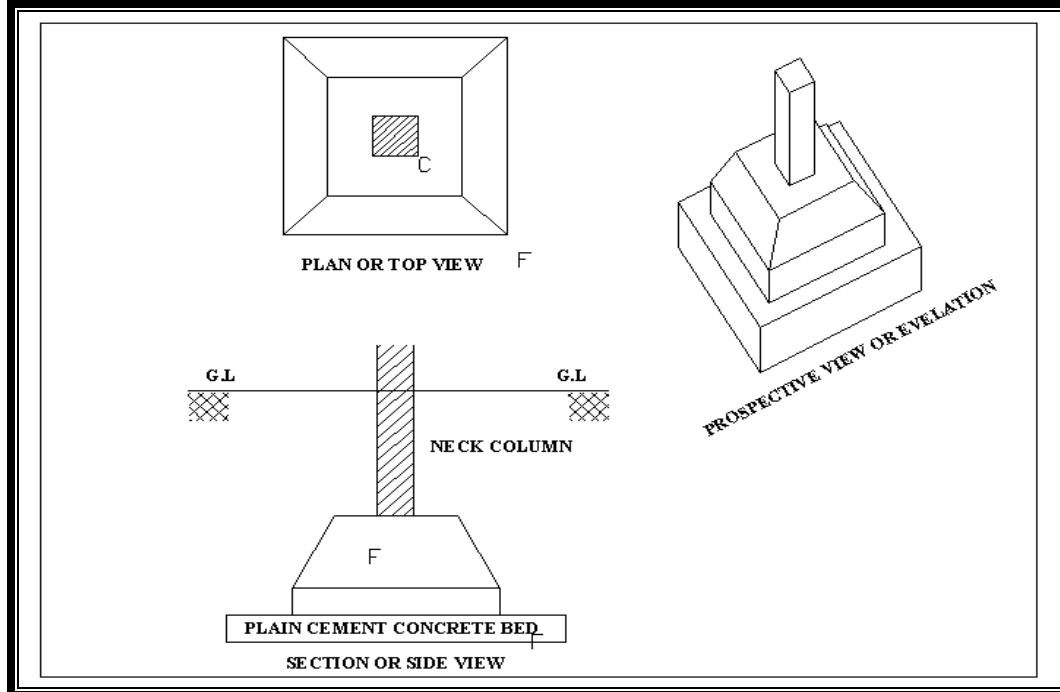
## **2. Step footing:-**

These types of footings were constructed in olden days, now they are out dated.



### 3. Isolated Footing:-

These types of footings are constructed for single column and they may be in square or rectangular shape.



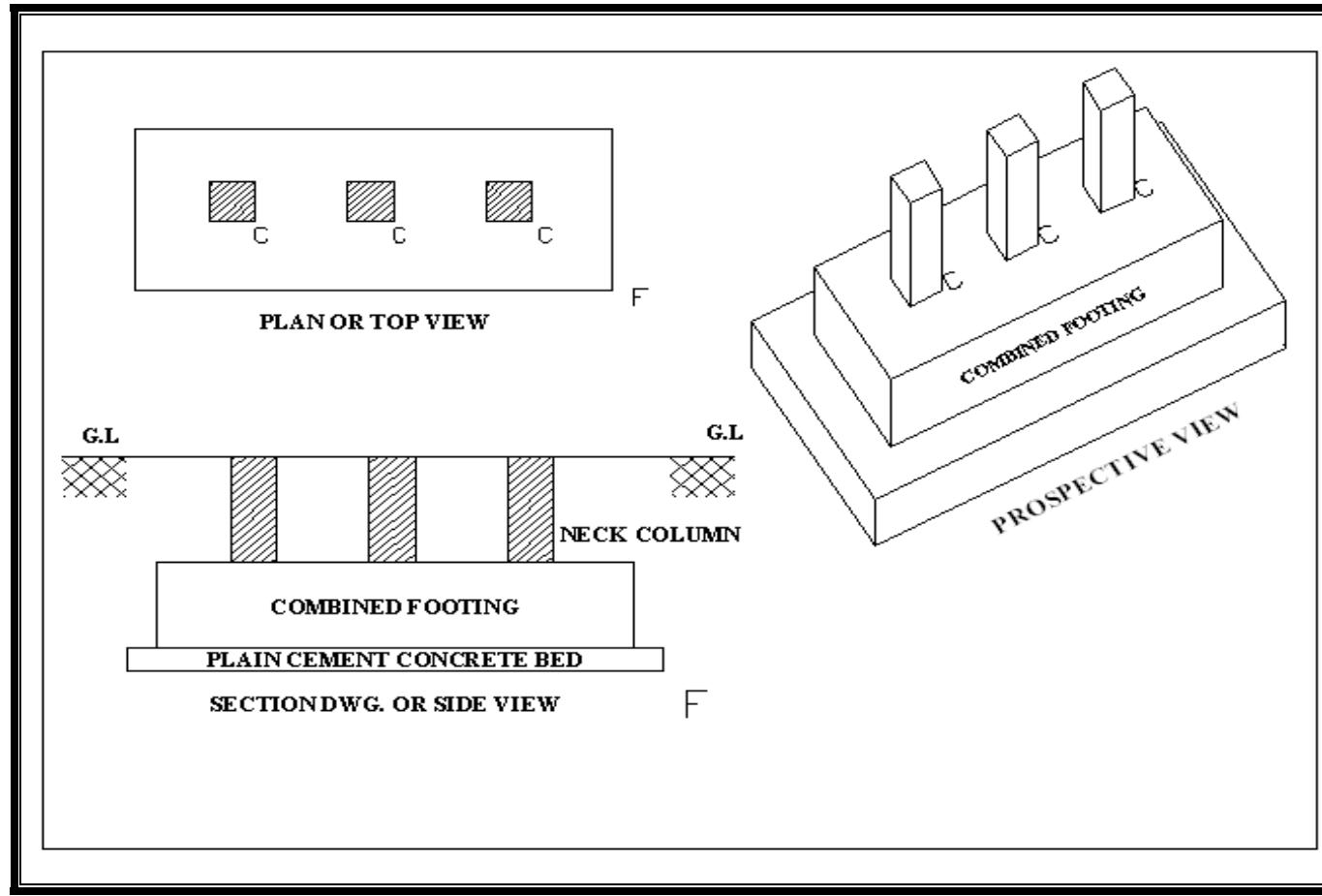
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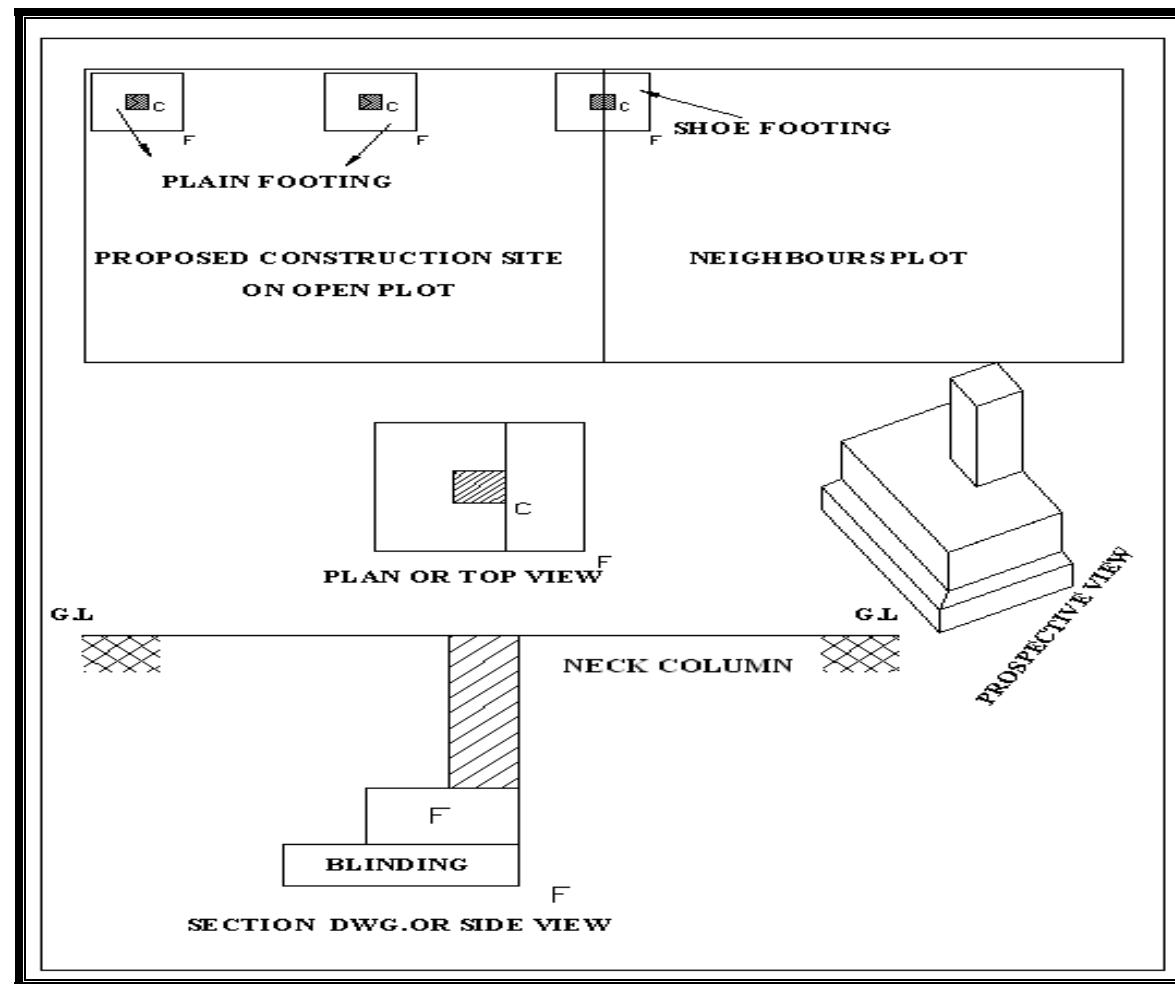
#### **4. Combined Footing:-**

A footing which has more than one column is called as combined footing. They are constructed for two or more column and they may be in rectangular or trapezoidal in shape. It is design in a place where the space is limited, where due to lack of space we cannot cast individual footings, therefore footings are combined in to one footing.



## **5. Strap or Neighbor or Shoe-footing:-**

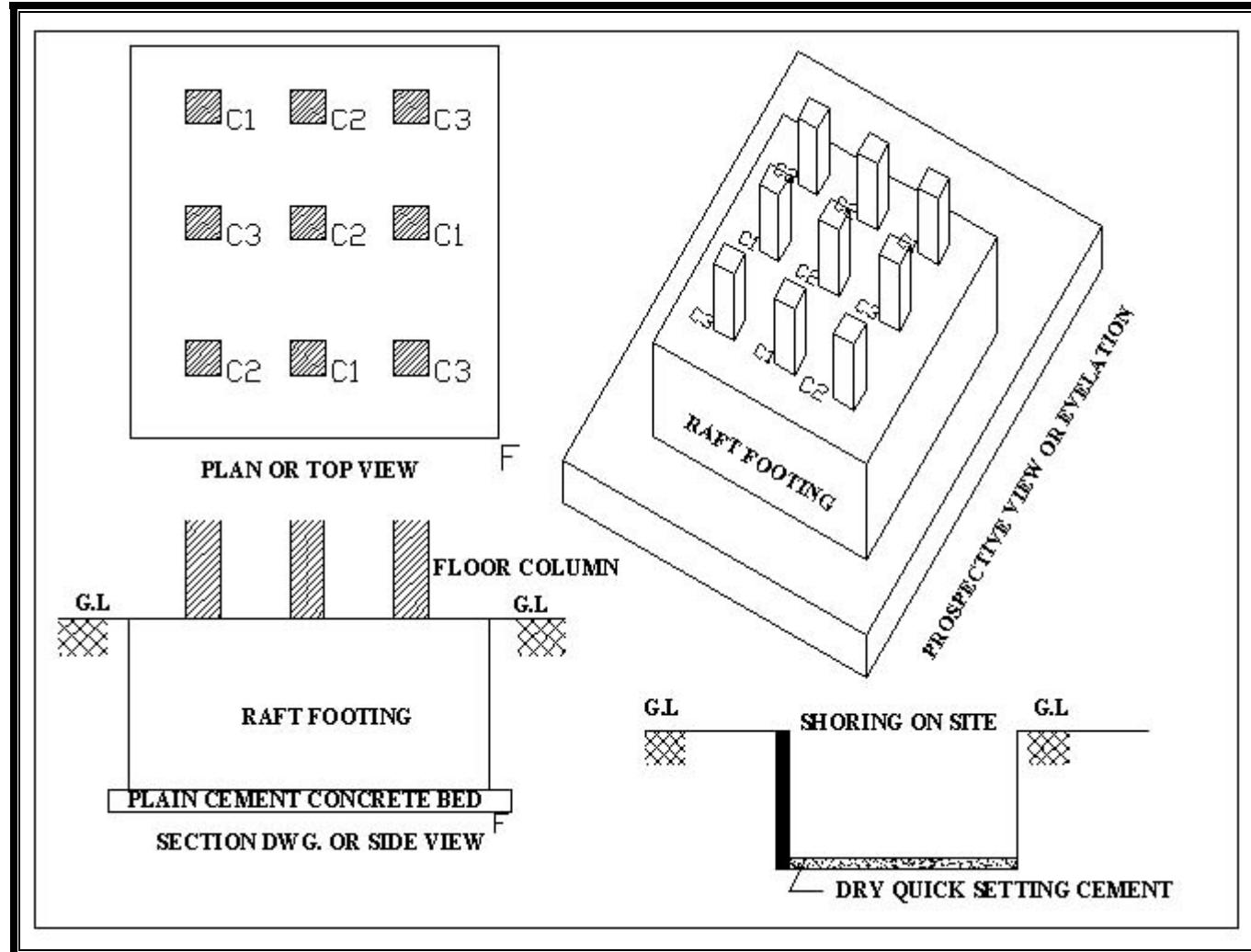
Shoe footing is the half footing cut-out from the original footing and which has shape of Shoe. It is provided on the corner of plot next to Neighbors' plot. Where there is no provision of setback area. They are constructed on property boundary.



**Note:** All the Shoe-fooings are constructed on the soil, where the soil bearing capacity (SBC) is normal. SBC = 24kn / m<sup>3</sup>

6. **Raft Footing:-** Its is one footing in on whole plot and it provided in a places like seashore area, coastal area or beach area where the water table is very high and the soil bearing capacity is weak. Such as five star hotels and High-rise buildings near the beaches.

When number of column in more than one row, provided with a combined footing, the footing is called as Mat or Raft Footing.



---

### **Process of executing Raft:**

There are two steps involved in executing the Raft Footing, Namely

- (i) De-watering and
- (ii) Shoring

#### **i) De-watering:**

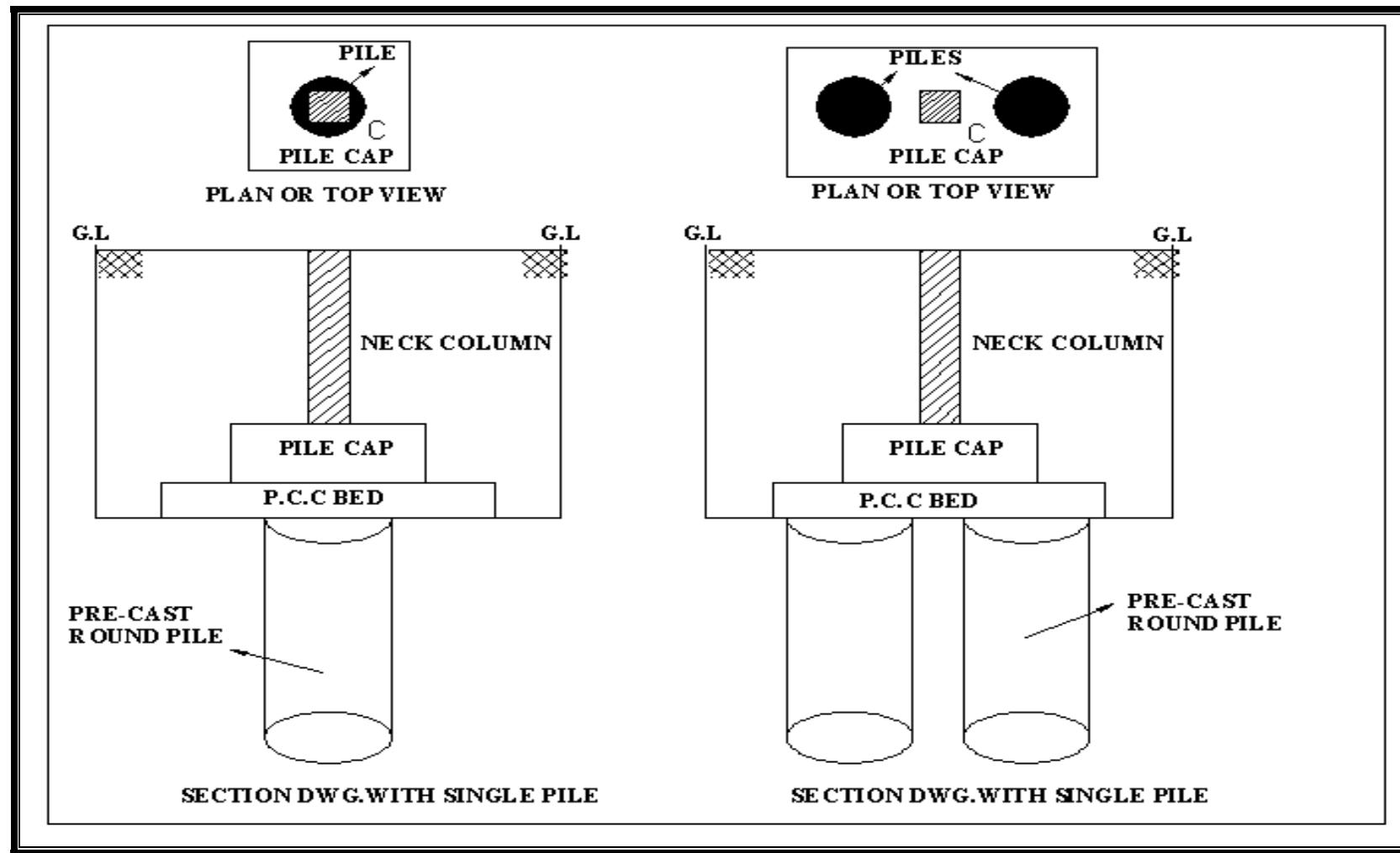
It is the process of taking off water from excavated area and discharging it to any other place.

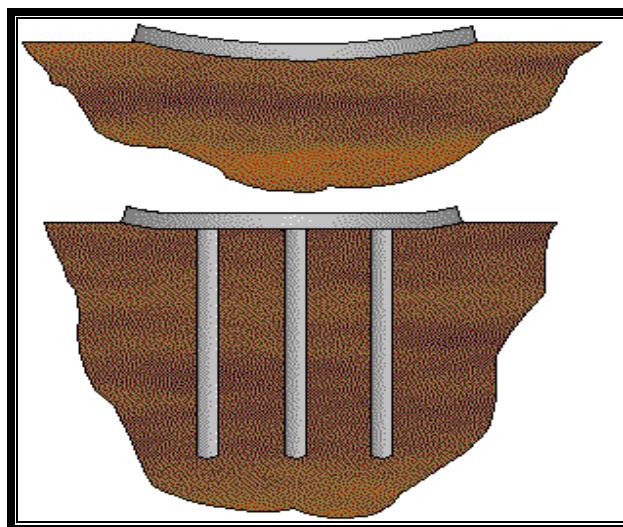
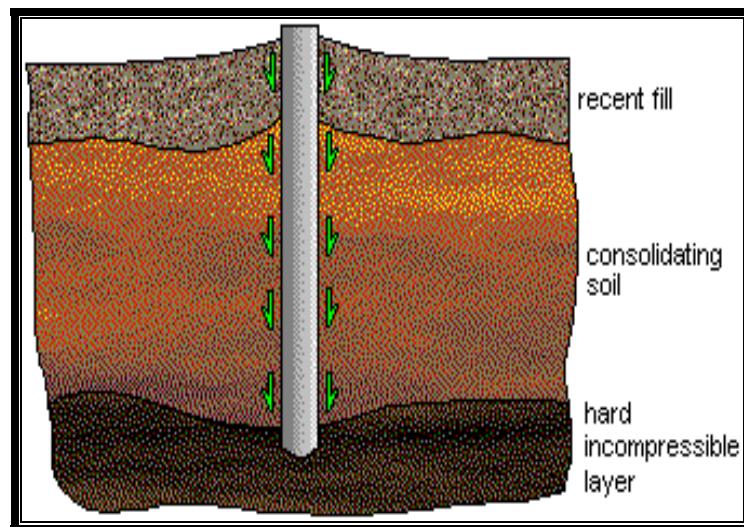
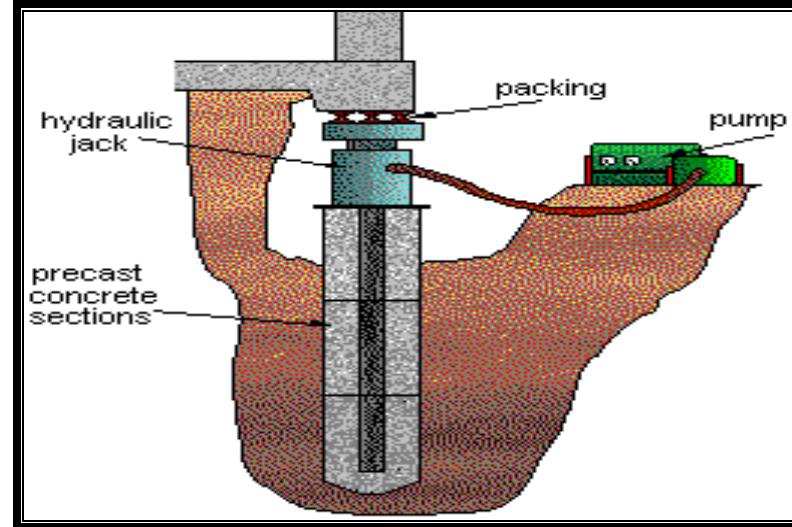
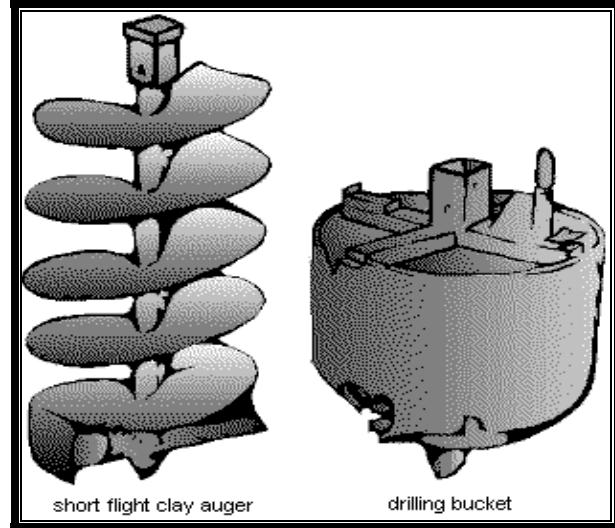
- ii) **Shoring:** It is nothing but Shuttering for the wall of excavated pit, to avoid the sliding of soil.

**Note:** Raft footing does not have Neck column, they start directly from the ground surface but reinforcement of neck column starts from Raft.

7. **Pile Footing:-** They are constructed where excessive settlement is to be eliminated and where the load is to be transferred through soft soil stratum, where the Soil bearing capacity is sufficient.

- Piles are nothing but round columns, they may be pre-cast or cast- in- situ [cast on site]
- These types of footings are provided when the Soil bearing capacity of soil is very weak and the Ground water table (level) is high,
- The main objective of providing piles under the footing is to prevent structure from settlement.
- If we don't provide pile under the footing, then the building will have settlement.
- Piles are hammered in to the ground till hard strata (in compressible) layer of earth is found.
- These types of footings are generally designed on sea shore areas.







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## **Types of Columns**

➤ **Square column or Rectangular column:**

They are generally used in construction of buildings, which are common in practice; these types of column are provided only if the shape of room is rectangular or square.

➤ **Circular column:**

They are special designed columns; they are generally used in piling and in the elevation of buildings.

➤ **“L” type column:**

They are generally used in the corners of the boundary wall.

➤ **“T” type column:**

They are used depending on design requirements and also in over bridges, etc.

➤ **“V” type column:**

Depending upon the structure, they are also constructed in buildings, if the shape of the room is trapezoidal.

➤ **Hexagon type column:**

They are generally modified columns to give a good look to the column, which is provided in open verandah and Halls.

➤ **Arch type column:**

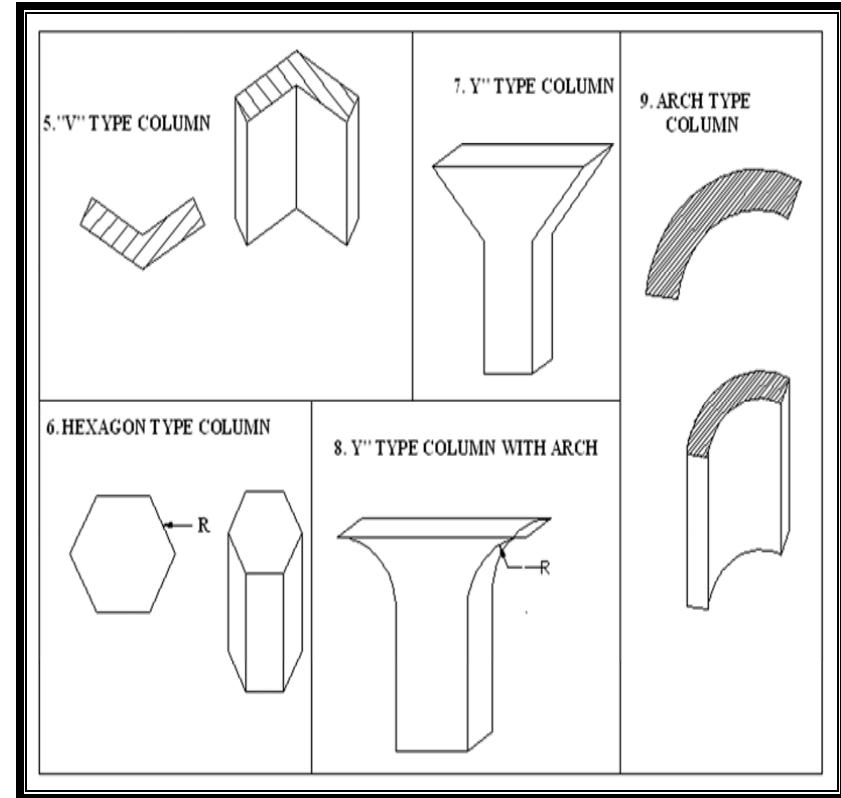
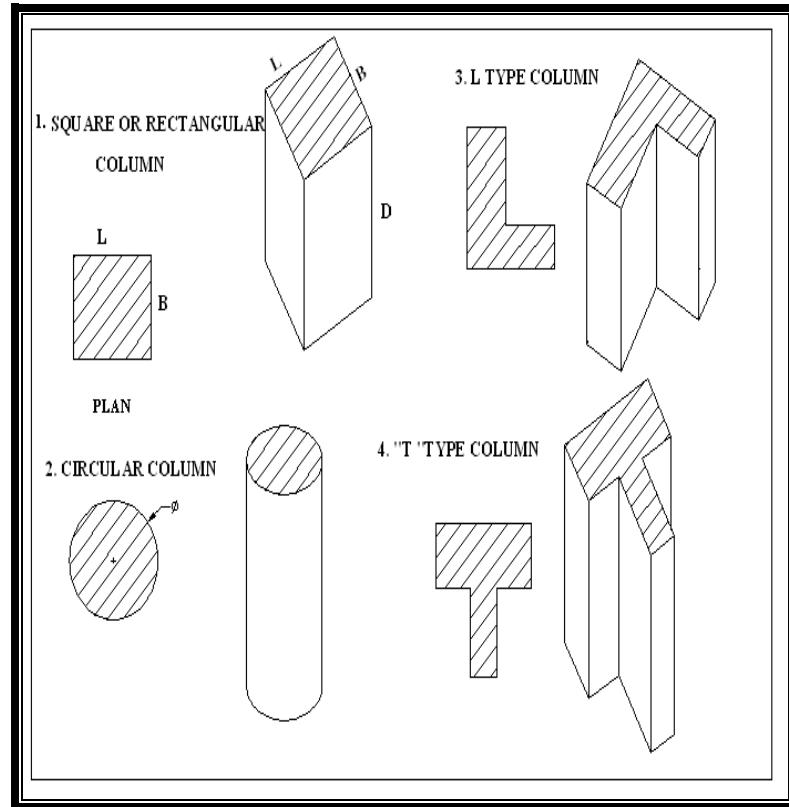
These types of columns are design if the room has arch shape.

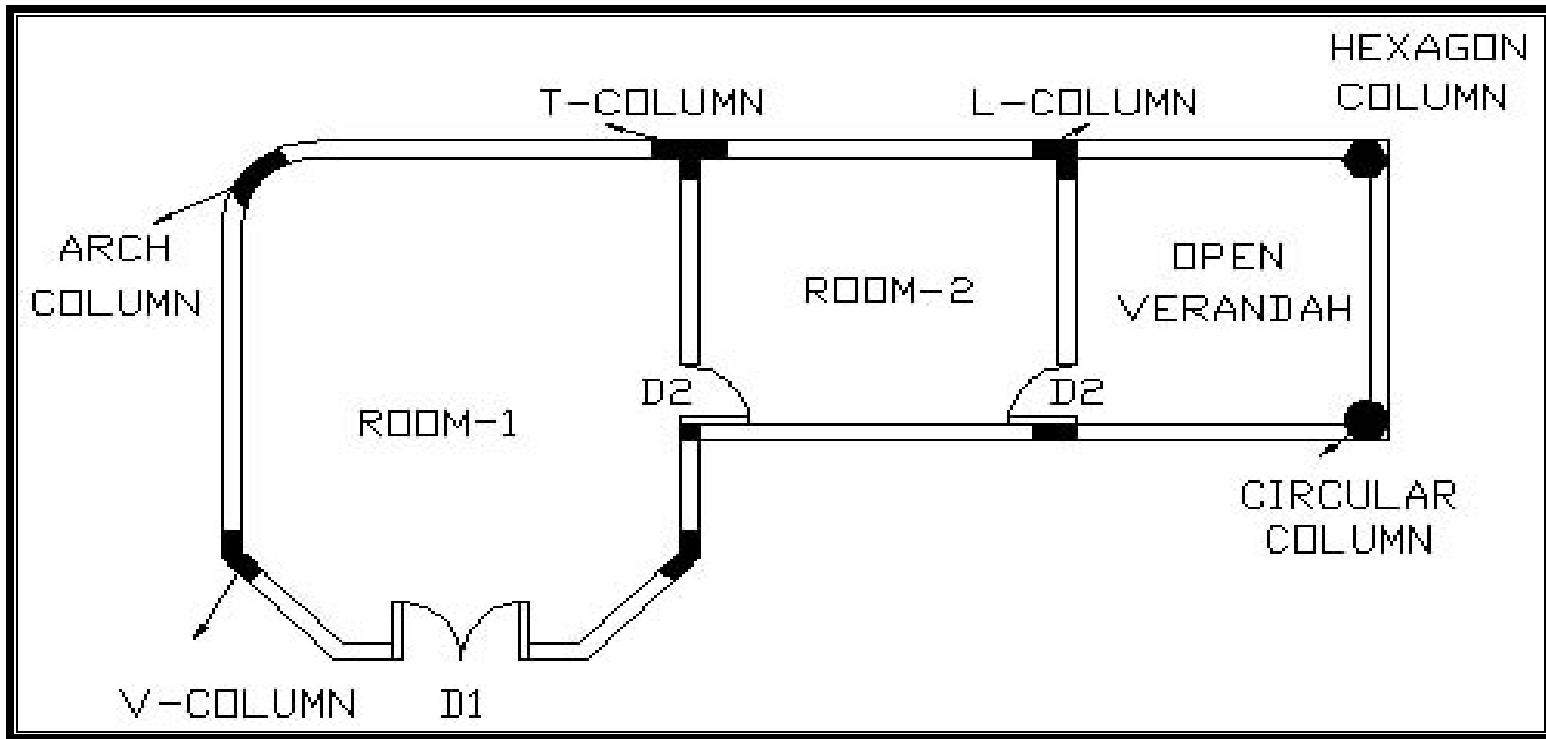
➤ **“Y” type column:**

These types of columns are generally used in the construction of bridges, fly-over's, etc.

➤ **"Y" type column with arch:**

It is similar to Y column, but to give a good look to the column, arch shape is provided.

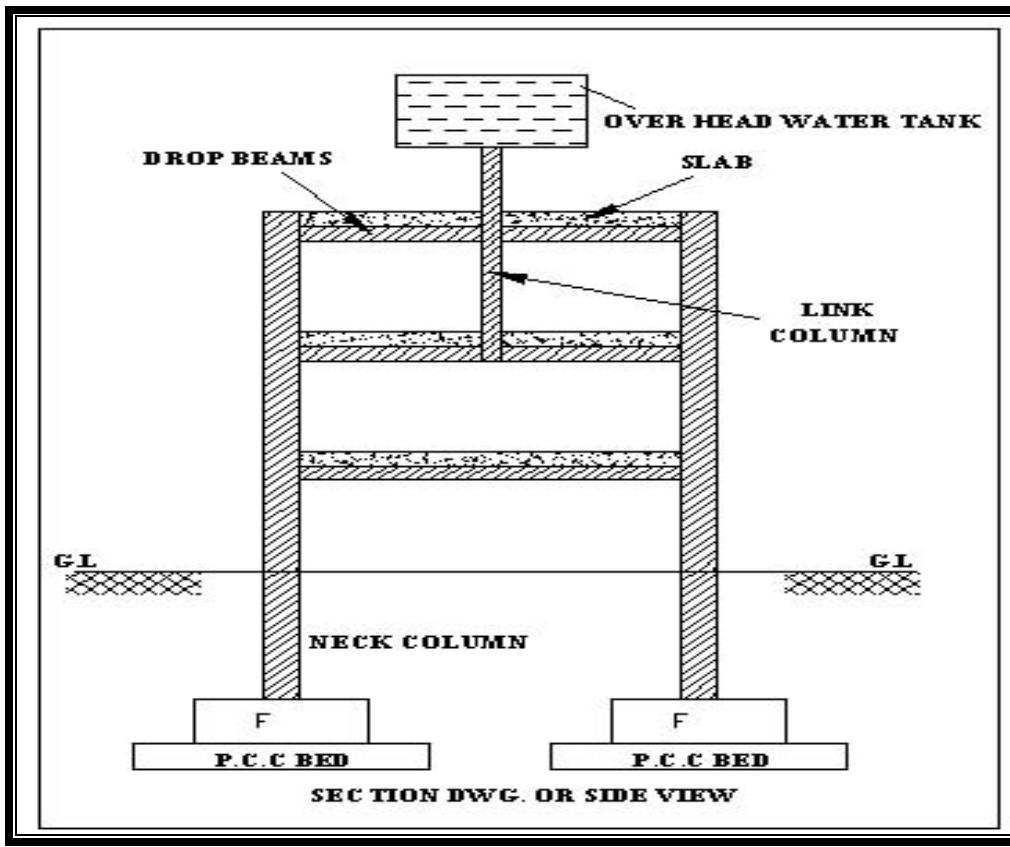




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### Types of Floors:

- Basement Floor
- Podium Floor
- Ground Floor
- Mezzanine Floor
- First Floor
- Typical Floor
- Helipad

---

### **Basement Floor:**

The floor which is constructed below ground level for store rooms or mechanical room or parking is called as Basement Floor.

### **Podium Floor:**

The floor which is constructed either below ground level or above ground level, especially for car parking is called as Podium floor.

### **Ground Floor:**

The floor which is constructed on ground level is called as Ground floor.

### **Mezzanine Floor:**

The floor which is constructed between Ground and First Floor is called as Mezzanine floor. This type of floor is constructed for Services of building, shops & offices, to provide facilities for the occupants who are living in High-rise buildings. For proper ventilation the ceiling height of floor is increase 1metre more than the normal ceiling height.

### **First Floor:**

The floor which is constructed above ground floor or above mezzanine floor is called as first floor.

### **Typical Floor:** Typical floor is nothing but repeated floor.

The plan which is design for Ground floor and want to have the same plan for other floors, then these floors are called as Typical floor-1 or typical floor-2, etc.

### **Helipad:**

The floor which is constructed above Roof Floor and which is used for Landing of Helicopter or Taking off of Helicopter is called as Helipad.

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## **Types of load**

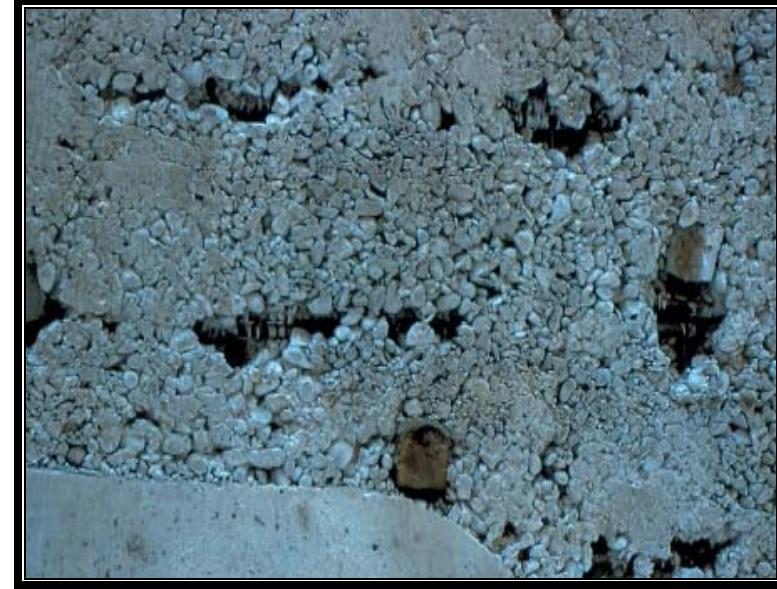
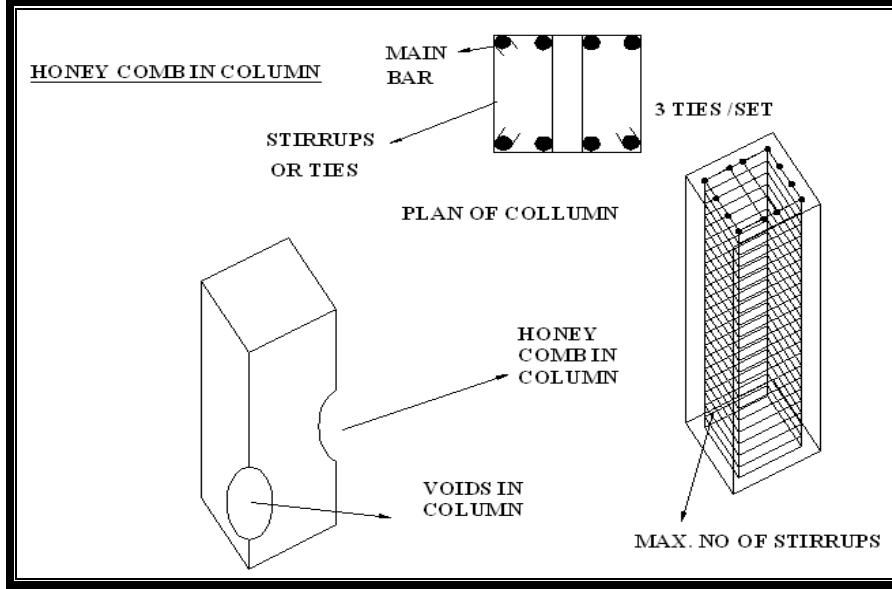
1. Point load
2. Uniformly Distributed Load [UDL]
3. Wind load
4. Concentric load
5. Rolling load or Moving load
6. Dead load
7. Live load
8. Self load
9. Seismic load
- 10. Eccentric load**

## **Honey comb**

Honey comb is nothing but voids or gaps in the concrete structure after removing the wooden or iron Shutter. Honey comb appears in concrete structure mainly due to heavy reinforcement inside structure. (For example more no. of stirrups in columns or beams etc.)

To prevent concrete from honey comb, Vibrator should run in concrete in proper manner during filling of concrete. The vibrator should run with specific time. The duration of running vibrator should not exceed more than 30 seconds; otherwise it will start separating water from concrete, which will let the concrete to lose its workability and strength.

In some cases even after running the vibrator honey comb will appear and in such cases add the admixture to cement: mortar and paste it in voids and concrete will regain its strength.

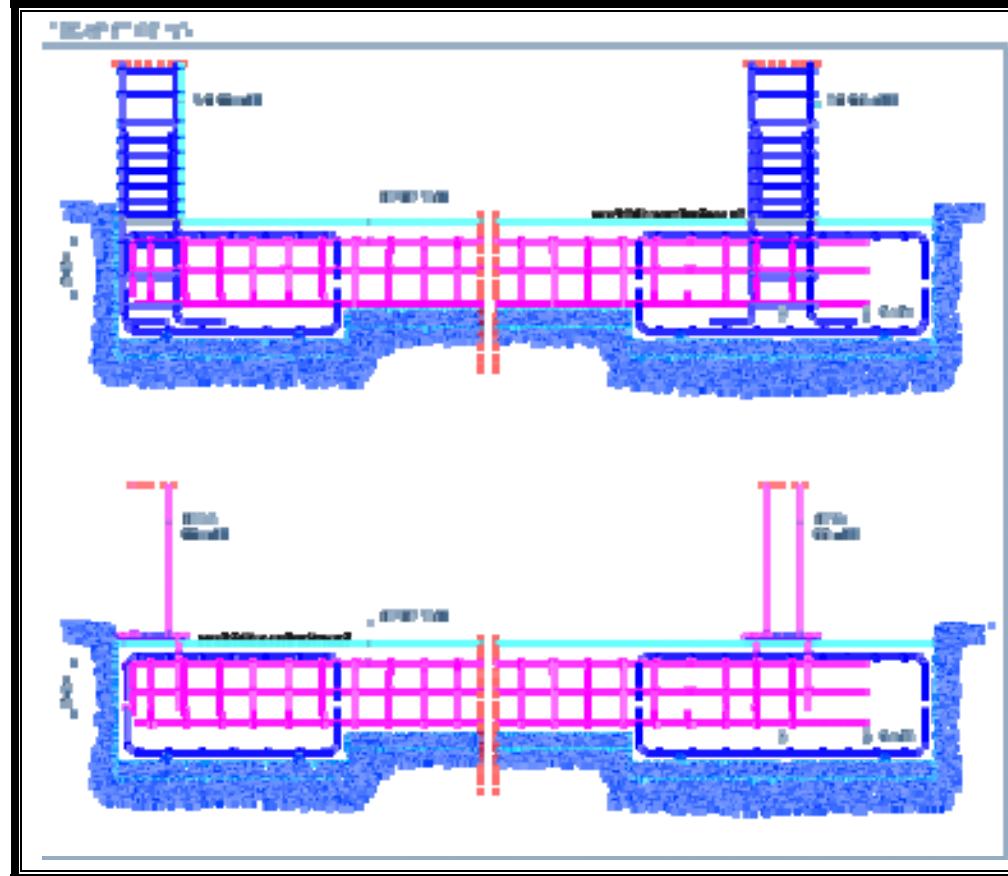


## Types of Beams

### 1. Tie beam:

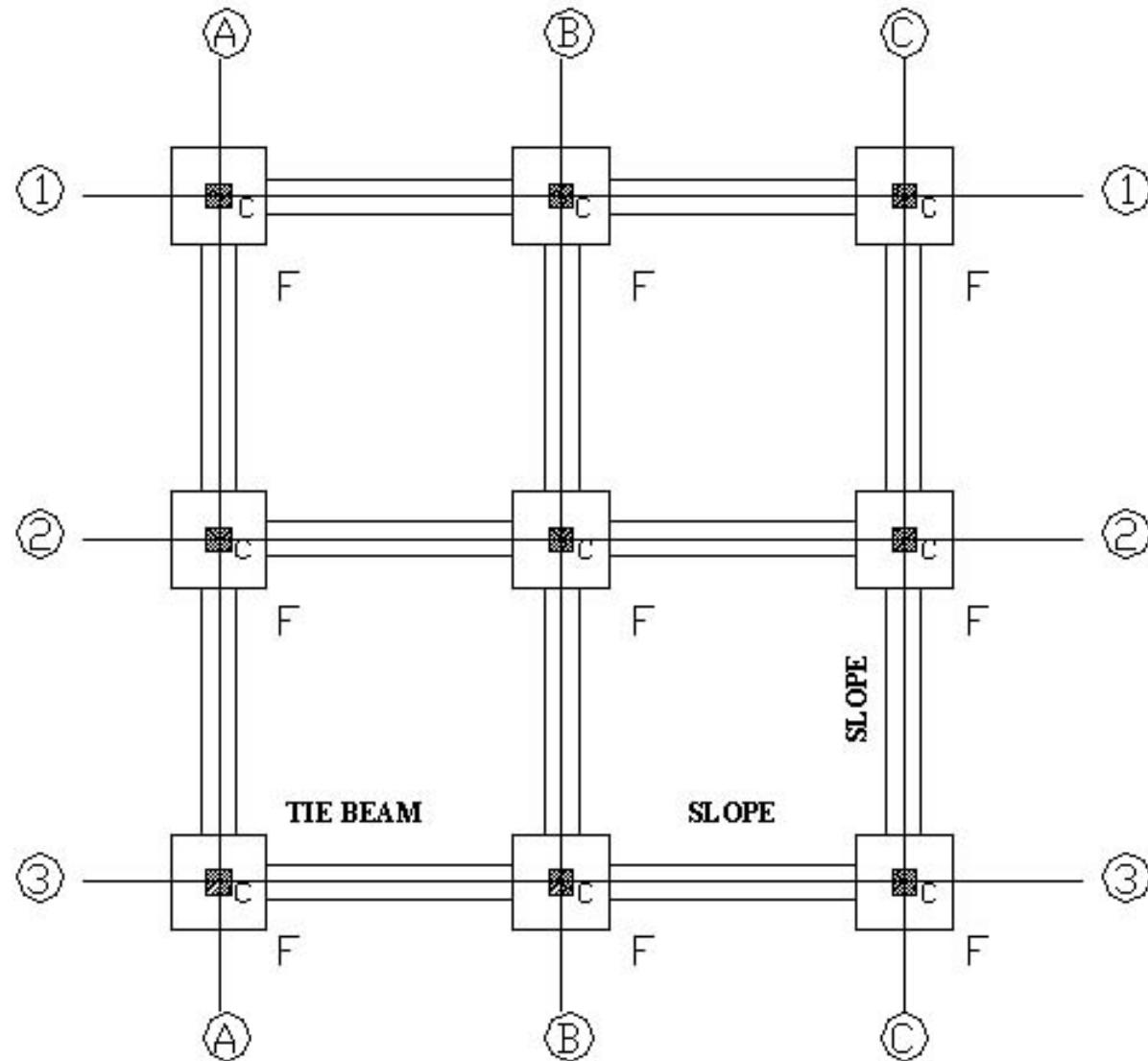
The beam which ties two footings from one face of footing to the other face of footing with linear (straight) length is called as Tie beam.





## 2. STRAP beam:

The beam which ties two footings from one face of footing to another face of footing with inclined length or with an angle is called as Strap beam.



**PLAN SHOWING TIE BEAMS WITH FOOTING**

### **3. Plinth beam or Ground beam:**

The beam which ties two columns from one face of column to another face of the Column is called as plinth beam. Plinth beams are casted above natural ground **level (N.G.L)** and below building ground level (**B.G.L**).

### **4. Drop beam & Inverted beam :**

Beams under the Slab are called as Drop beams and if they are inverted, then they are called as Inverted beams.

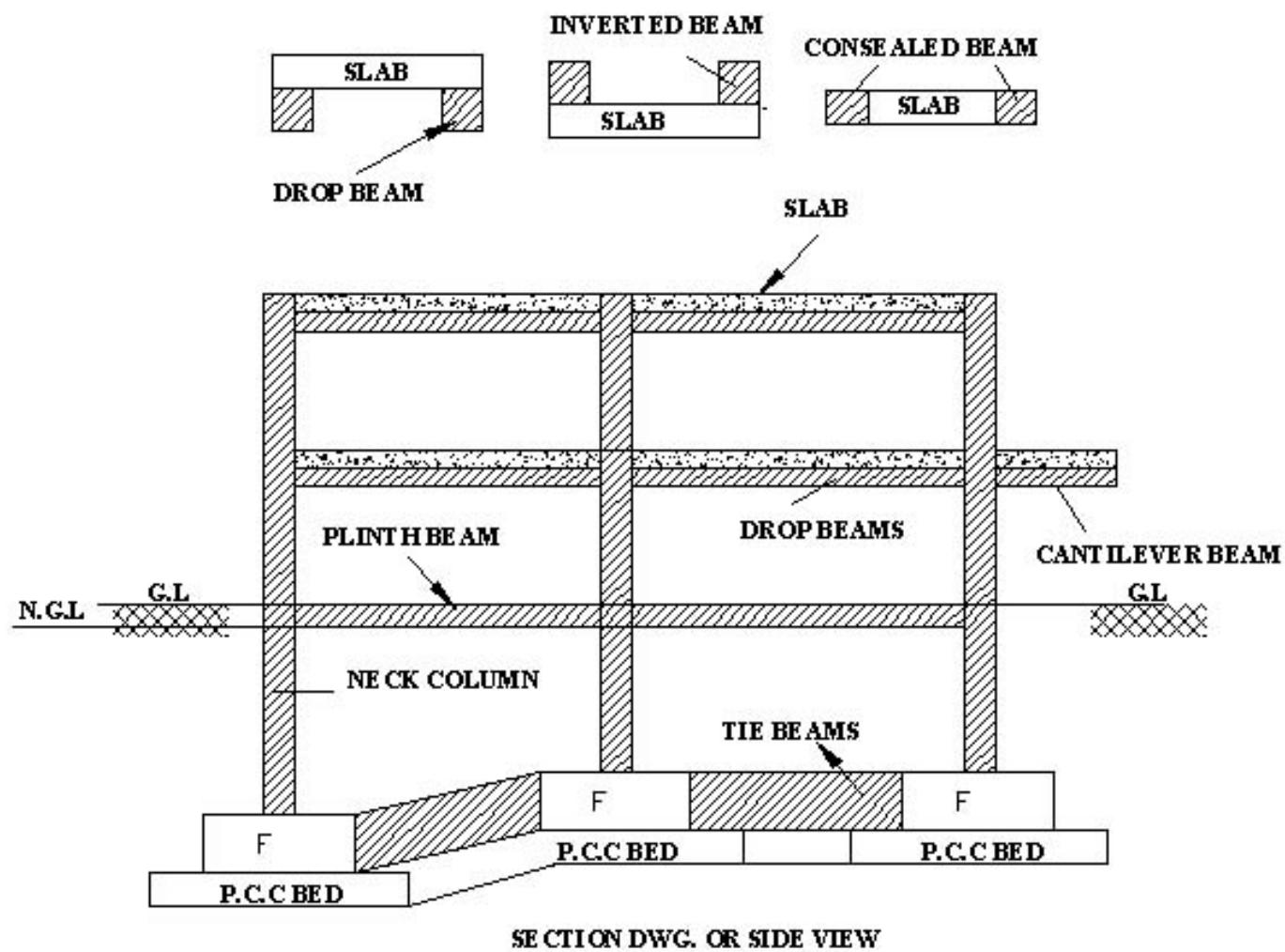
### **5. Concealed beam:**

The beam which supports the slab within the thickness of the slab is called as concealed beam.

### **6. Cantilever beam:**

The beam supported on one end and free on other end is called as Cantilever beam.







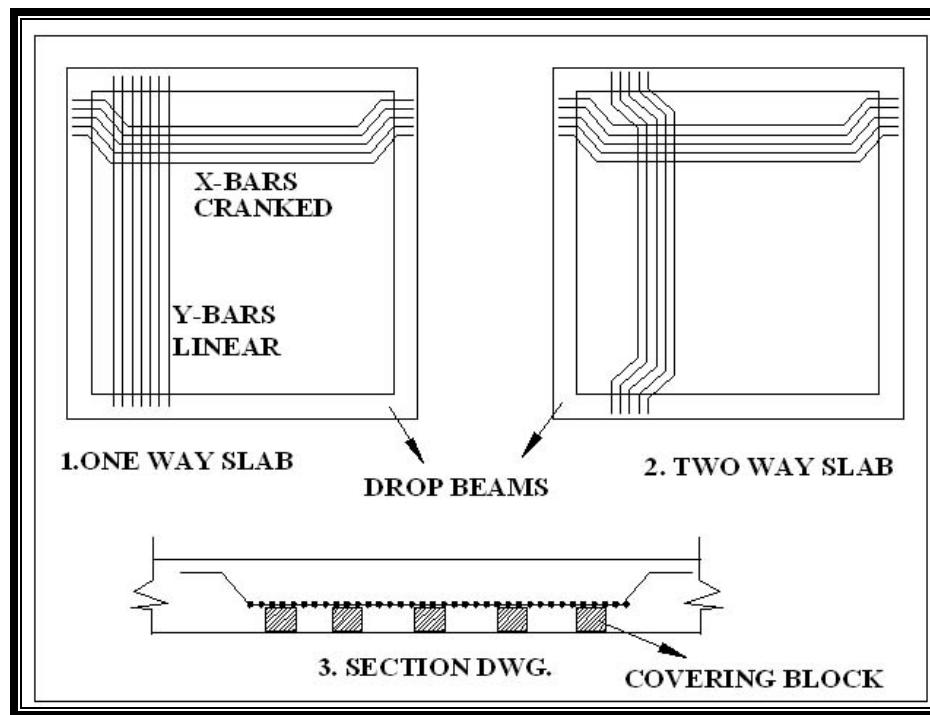
## **Types of Slab**

1. Conventional Slab
  - (i)one-way slab
  - (ii)Two ways slab
2. Hardy or Hordy slab
3. Waffle slab
4. Dome slab
5. Pitch roof
6. Projected slab or portico slab
7. Pre-stressed slab
8. Cable suspension slab
9. Slab with arches
10. Grade slab
11. Hollow-core ribbed slab
12. Sunken-slab or Depressed slab
- 13. Low roof / Loft or Chajja**

- 
1. **Flat slabs:** The slab which is supported on Columns head or Column caps without beams is called as Flat slab.

Conventional or Ordinary slabs are of two types,

- (i) **One way slab:** Main reinforcement for bending moment will be only in one direction, the other reinforcement will be distribution steel.
- (ii) **Two way slab:** Reinforcement for bending moment will be in two directions.



2. **Hordy or Hardy slab:**

Hardy slab or Hordy slab is a type of slab which is most commonly used in overseas, the process of execution is as follows:-

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**Step 1→** Form work is arranged and then shutters are fixed on the form work

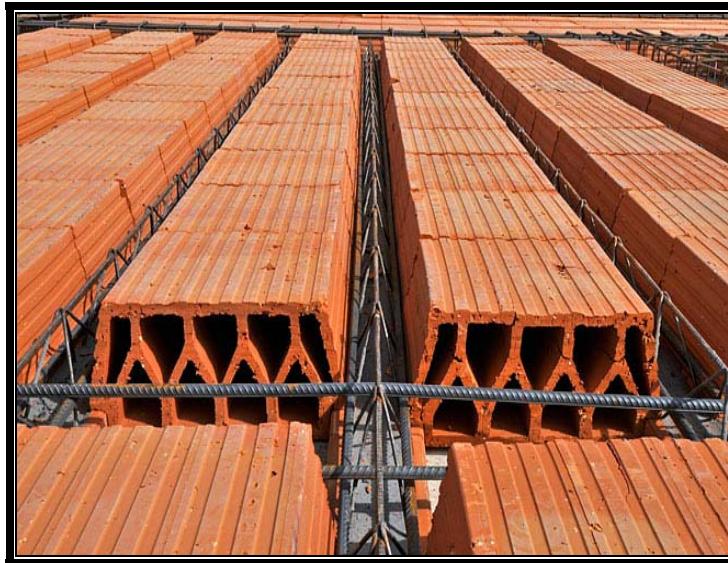
**Step 2 →** Hardy blocks are placed on the shutter with one brick gap on the entire shutter

**Step 3 →** The gaps between the blocks are called as rib. Reinforcement is provided in a form of beam within the gap such as rib.

**Step 4 →** After placing the rib, the Plane steel mesh is placed on the entire slab area resting on ribs.

**Step 5→** Now, pouring of concrete is done on whole slab.

**Note →** the thickness of slab = 27cm; the thickness of Hardy block = 20cm.



### 3. **Waffle slab:**

This is a type of slab where we find hollow hole in the slab when the form work is removed. This is generally constructed in the hotels, universities and restaurants, etc.



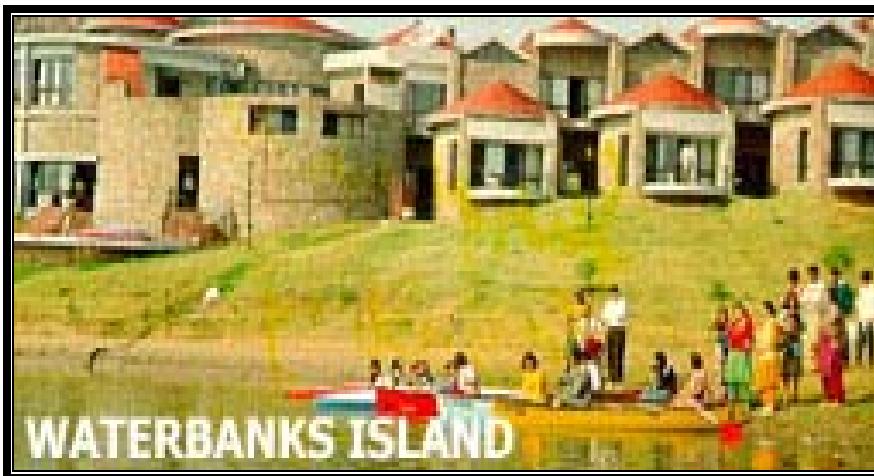
#### **4. Dome slab:**

These types of slabs are generally constructed in temples, mosques, palaces, etc.



##### **5. Pitch roof:**

Pitch roof is an inclined slab, generally constructed on resorts for a natural look.  
They are also constructed near gardens, re-creation centers, etc



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**6. Projected slab:**

The slab which has one side fixed and the other side is free is called as Projected slab. These types of slabs are generally constructed in hotels, universities functions, halls, etc. to use that area for dropping or picking up zone and for loading and unloading area.

**7. Pre-stress Concrete slab:**

Pre-stressing is artificially induced compressive stresses in a structure before it is loaded so that the tensile stresses which might be caused by the external dead and live load are automatically canceled and the cracks are eliminated. These are done by pre-tensioning and post tensioning. It is best suited for mass production of pre-cast members.



**8. Cable suspension slab:**

If the span of slab is very long, then we go for cable suspension slab which is supported on cable, such as Howrah Bridge and London Bridge, etc.

**9. Ground slab or Grade Slab:**

The slab which is casted on surface of earth is called as Ground slab. This type of slab is used in Basement Floor.



#### 10. **Slab with arches:**

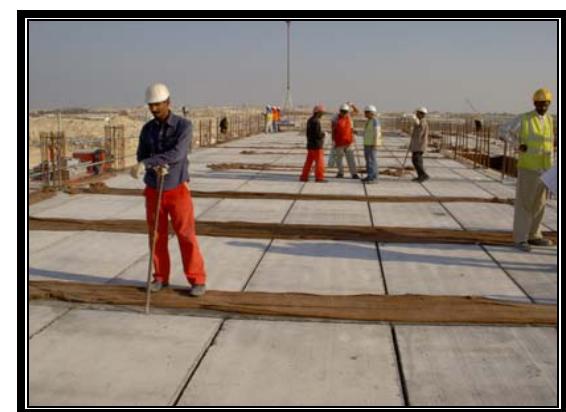
This is a type of slab which is generally adopted in construction of bridges.



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## **11. Hollow core ribbed slab:**

This is a type pre-cast slab used to reduce the weight of slab. This slab is directly placed on floor beam with the help of cranes and pasted with screed.



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**12. Sunken slab or Depressed slab:**

This kind of slab is provided only for toilets & kitchens, so that the drainage pipe can be laid in to it.



**13. Low Roof and Loft:** low roof is provided on lintel-level of doors and loft is provided in kitchens for storage of house material.



**Low roof**



**Loft**

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## **Types of walls**

1. Brick masonry wall
2. Course rubble stone masonry wall or C.R.S Wall
3. Random rubble stone masonry wall or R.R.S Wall.
4. Retaining wall
5. Shear wall
6. Curtain wall
7. Pre-cast wall
8. Parapet wall
9. Compound or boundary wall
10. Drop wall
11. Partition wall
12. Load bearing wall
13. Core wall

### **1. Brick masonry wall:**

The wall which is constructed with bricks is called as brick wall. The thickness of brick wall could be 10cm or 20cm.  
10cm wall is called as Single brick wall or partition wall.

20cm wall is called as Double brick wall or outer wall of house or boundary wall.

The density of Brick =  $2.42 \text{ kgs/cm}^3$

**With fine clay =  $1.92 \text{ kgs/cm}^3$**

**Note:** the length of the Brick wall in single stretch should not exceed more than 4m. If it exceeds a column must and should be constructed with bricks or R.C.C.

### **2. Course Rubble Stone masonry:**

The wall which is constructed with regular size of Granites is called as course rubble stone masonry.

### **3. Random Rubble Stone:**

The wall which is constructed with irregular size of granite is called as Random Rubble Stone masonry.



(i) Brick wall



(ii) C.R.S wall



(iii) R.R.S wall

4. **Retaining wall:** A wall designed to maintain unequal level of ground on its two faces is called as retaining wall. The wall which is constructed all around the plot below ground level to retain the soil and land sliding after the earth work excavation on site is called as retaining wall. Retaining wall can be made up of R.C.C or C.R.S





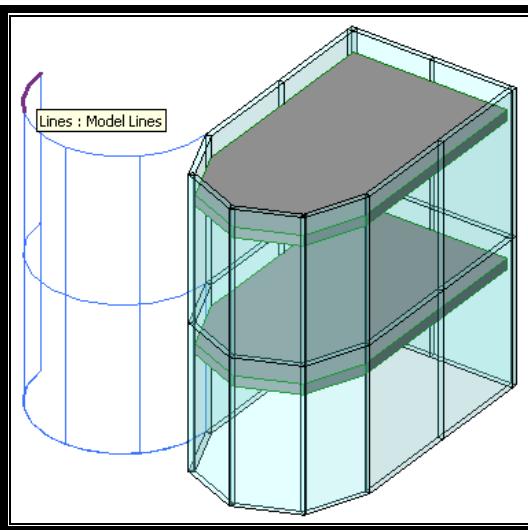
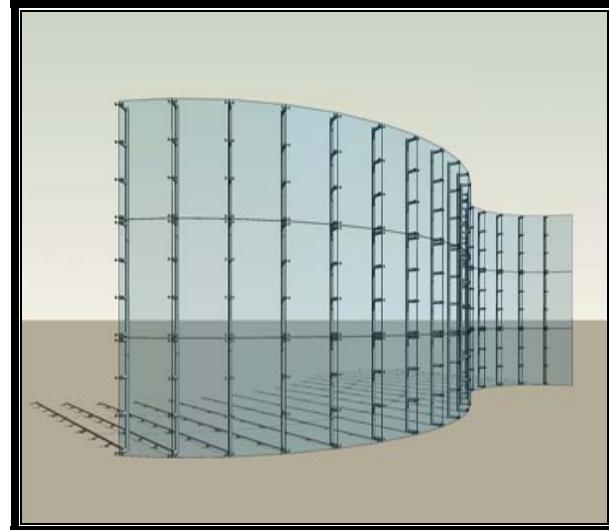
##### **5. Shear wall:**

The wall which is constructed around the water Sump, lift pit or stair case to retain the soil is called as Shear wall. It will share two pressures i.e, water pressure & soil pressure or water pressure & wind pressure.



##### **6. Curtain wall:**

The wall which is constructed with glass and aluminum or steel frame in a long hall to make individual cabins is called as Curtain wall.



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**7. Pre-cast wall:**

The readymade wall which is made up of R.C.C and which is directly installed on site is called as Pre-cast wall.



**8. Parapet wall:**

The wall is constructed on the top roof of the building to prevent the falling in anything from the roof. The height of wall = 3 ft.



**9. Boundary wall or compound wall:**

The wall which is constructed all around the house to show the limits of plot is called as Boundary wall.

**10. Drop wall or Non-Load bearing wall:**

It is a type of wall which is very thin of having thickness 1" to 2". Generally it is constructed with Reinforced mesh (kabutar jali) and cement : mortar plaster.



**11. Partition wall:**

The wall which divides one room to two rooms is called as Partition wall.

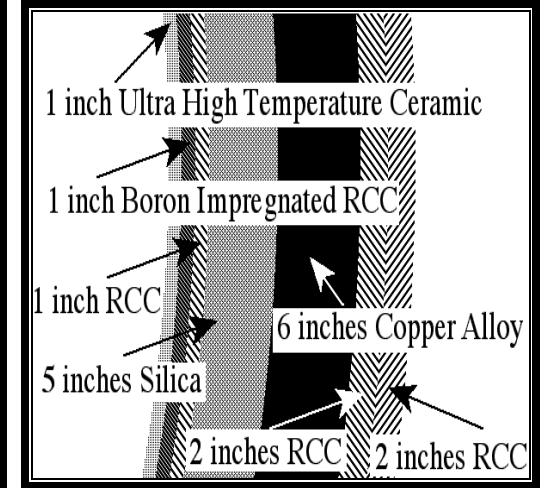
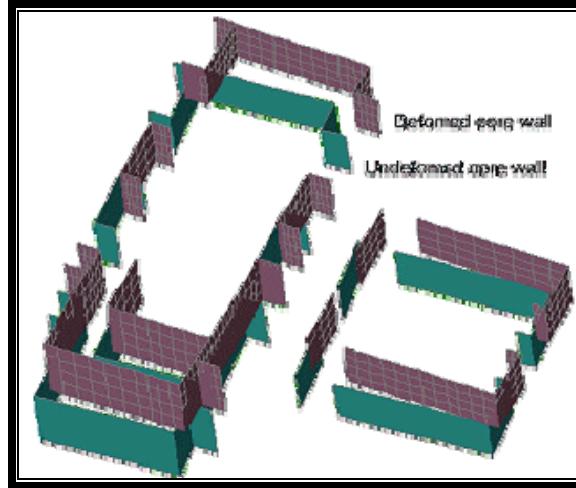
**12. Load bearing wall:**

The building structure which is resting on walls instead of columns, those walls which are bearing the weight of structure are called as Load bearing wall. The thickness of wall = 30 cm to 40cm.

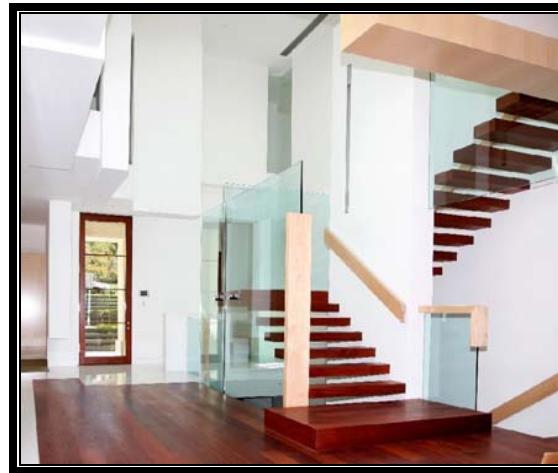
**13. Core wall:**

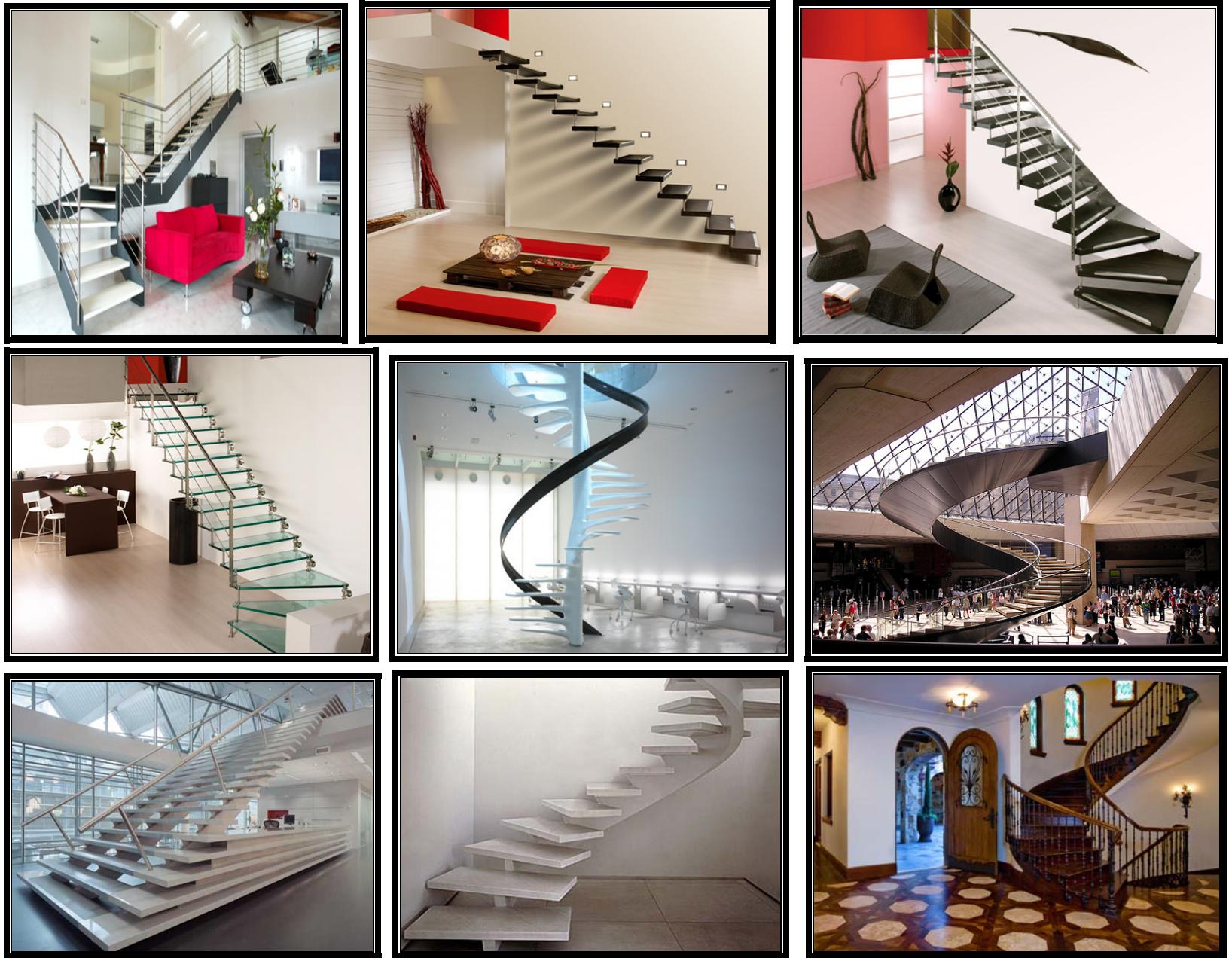
This wall is constructed from foundation and it is used as columns in buildings and which will rise up to the height of the building.





#### Types of Stair-case:





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## Unit Conversion

### **One dimensional calculation:**

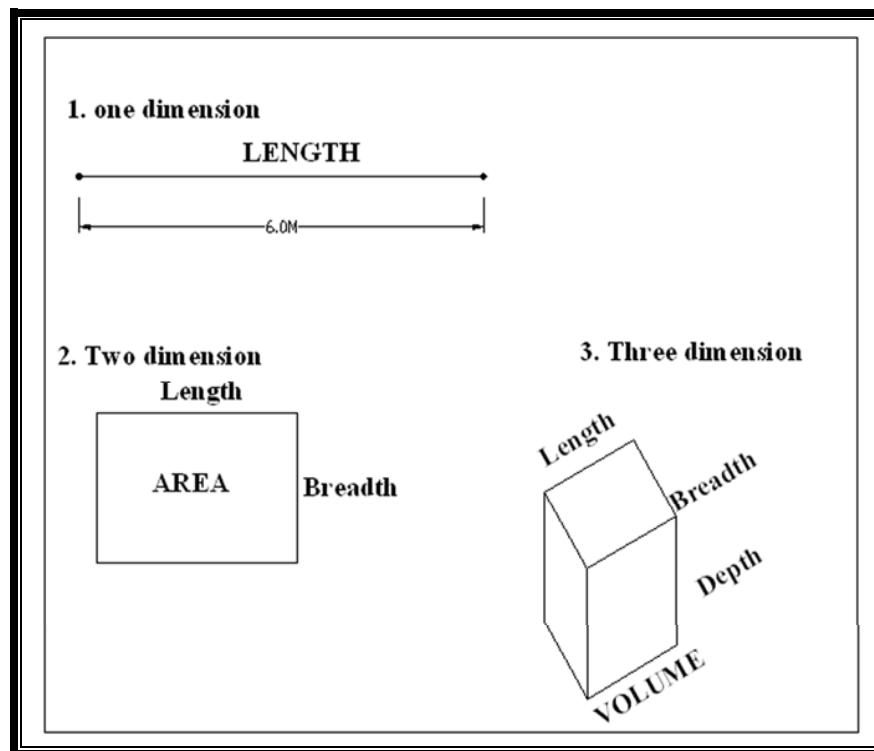
The distance between two points is called as length and the length calculation is called as one dimensional calculation.

### **Two-dimensional calculation:**

Two-dimensional calculation is carried out in two directions, i.e. “X” and “Y” axes, so it is also called as area calculation or two dimensional calculations.

### **Three-dimensional calculation:**

Three-dimensional calculation is carried out in three directions, i.e. “X”, “Y” & “Z” axes and it is called as volume calculation or three dimensional calculation.



## Types of unit conversion:

**M.K.S unit (Meter-Kilogram/Second):** Meters, Centimeters, millimeters. These units are called as Engineering units.

**F.P.S unit (Foot-Pound/Second):** Feet, inches & yards. These units are called as Architectural units.

S.no	Unit	Denoted by symbol	One dimension (Length)	Two Dimension (Area)	Three dimension (Volume)
1	Meter	M	M	$M \times M = M^2$ or SQM or Square meter	$M \times M \times M = M^3$ or CUM or Cubic meter
2	Centimeter	CM	CM	$CM \times CM = CM^2$ or SCM or Square centimeter	$CM \times CM \times CM = CM^3$ or CUCM or Cubic centimeter
3	Millimeter	MM	MM	$MM \times MM = MM^2$ or SMM or Square Millimeter	$MM \times MM \times MM = MM^3$ or CUMM or Cubic millimeter
4	Feet	FT	FT	$FT \times FT = FT^2$ or SFT or Square feet	$FT \times FT \times FT = FT^3$ or CFT or Cubic feet
5	Inch	INCH	INCH	$INCH \times INCH = INCH^2$ or SINCH or Square inch	$INCH \times INCH \times INCH = INCH^3$ or CINCH or Cubic inch
6	Yard	YD	YD	$YD \times YD = YD^2$ or SYD or Square yard	$YD \times YD \times YD = YD^3$ or CYD or Cubic yard

## Scales:

1 meter = 1000 mm  
 1 meter = 100 cm  
 1 cm = 10 mm  
 1 meter = 1.0936 yd  
 1 meter = 3.28 ft  
 1 meter = 39.37"  
 1 feet = 12"

1" = 2.54 cm  
 1" = 25.4 mm  
 1 yard = 36"  
 1 yard = 3 feet  
 1yd<sup>2</sup> = 9 square feet  
 1 acre = 4840 yd<sup>2</sup>  
 1 hectare = 2.47 acre

Problems on unit conversion with solutions			
S.no	One dimensional problem conversion (length conversion)	Two dimensional problem conversion (Area conversion)	Three dimensional problem conversion (Volume conversion)
1	$15\text{m} = ? \text{fts}$ Since $1\text{m} = 3.28 \text{ ft}$ Therefore $15 \times 3.28 = 49.212 \text{ ft}$	$15\text{m}^2 = ? \text{fts}^2$ Since $1\text{m} = 3.28 \text{ ft}$ Therefore $15 \times 3.28^2 = 161.458 \text{ ft}^2$	$15\text{m}^3 = ? \text{fts}^3$ Since $1\text{m} = 3.28 \text{ ft}$ Therefore $15 \times 3.28^3 = 529.72 \text{ ft}^3$
2	$22 \text{ m} = ? \text{ inches}$ Since $1\text{m} = 39.37''$ Therefore $22 \times 39.37'' = 866.141''$	$22 \text{ m}^2 = ? \text{ inches}^2$ Since $1\text{m} = 39.37''$ Therefore $22 \times 39.37''^2 = 34100.06''^2$	$22 \text{ m}^3 = ? \text{ inches}^3$ Since $1\text{m} = 39.37''$ Therefore $22 \times 39.37''^3 = 1342522.37''^3$
3	$2.5 \text{ m} = ? \text{ mm}$ Since $1\text{m} = 1000\text{mm}$ Therefore $2.5 \times 1000 = 2500 \text{ mm}$	$2.5 \text{ m}^2 = ? \text{ mm}^2$ Since $1\text{m} = 1000\text{mm}$ Therefore $2.5 \times 1000^2 = 2500000 \text{ mm}^2$	$2.5 \text{ m}^3 = ? \text{ mm}^3$ Since $1\text{m} = 1000\text{mm}$ Therefore $2.5 \times 1000^3 = 2500000000 \text{ mm}^3$
4	$2.0 \text{ m} = ? \text{ cm}$ Since $1\text{m} = 100 \text{ cm}$ Therefore $2.0 \times 100 = 200 \text{ cm}$	$2.0 \text{ m}^2 = ? \text{ cm}^2$ Since $1\text{m} = 100 \text{ cm}$ Therefore $2.0 \times 100^2 = 20000 \text{ cm}^2$	$2.0 \text{ m}^3 = ? \text{ cm}^3$ Since $1\text{m} = 100 \text{ cm}$ Therefore $2.0 \times 100^3 = 2000000 \text{ cm}^3$
5	$14\text{m} = ? \text{ yd}$ Since $1\text{m} = 1.093 \text{ yd}$ Therefore $14 \times 1.093 = 15.302 \text{ yd}$	$14\text{m}^2 = ? \text{ yd}^2$ Since $1\text{m} = 1.093 \text{ yd}$ Therefore $14 \times 1.093^2 = 16.74 \text{ yd}^2$	$14\text{m}^3 = ? \text{ yd}^3$ Since $1\text{m} = 1.093 \text{ yd}$ Therefore $14 \times 1.093^3 = 18.31 \text{ yd}^3$
6	$18\text{ft} = ? \text{ yd}$ Since $1 \text{ yd} = 3'$ Therefore $18 / 3 = 6.0 \text{ yd}$	$18\text{ft}^2 = ? \text{ yd}^2$ Since $1 \text{ yd} = 3'$ Therefore $18 / 3^2 = 2.0 \text{ yd}^2$	$18\text{ft}^3 = ? \text{ yd}^3$ Since $1 \text{ yd} = 3'$ Therefore $18 / 3^3 = 0.666 \text{ yd}^3$
7	$15\text{ft} = ? \text{ inches}$ Since $1 \text{ ft} = 12''$ Therefore $15 \times 12 = 180''$	$15\text{ft}^2 = ? \text{ inches}^2$ Since $1 \text{ ft} = 12''$ Therefore $15 \times 12^2 = 2160''^2$	$15\text{ft}^3 = ? \text{ inches}^3$ Since $1 \text{ ft} = 12''$ Therefore $15 \times 12^3 = 25920''^3$
8	$15\text{ft} = ? \text{ m}$ Since $1 \text{ m} = 3.28 \text{ ft}$ Therefore $15/3.28 = 4.57 \text{ m}$	$15\text{ft}^2 = ? \text{ m}^2$ Since $1 \text{ m} = 3.28 \text{ ft}$ Therefore $15/3.28^2 = 1.394 \text{ m}^2$	$15\text{ft}^3 = ? \text{ m}^3$ Since $1 \text{ m} = 3.28 \text{ ft}$ Therefore $15/3.28^3 = 0.425 \text{ m}^3$

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9	$15\text{ft} = ? \text{ cm}$ Since 1 ft = 12" Therefore $15 \times 12 = 180"$ Since 1" = 2.54cm Therefore $180 \times 2.54 = 457.20 \text{ cm}$	$15\text{ft}^2 = ? \text{ cm}^2$ Since 1 ft = 12" Therefore $15 \times 12^2 = 2160"$ <sup>2</sup> Since 1" = 2.54cm Therefore $2160 \times 2.54^2 = 13935.456 \text{ cm}^2$	$15\text{ft}^3 = ? \text{ cm}^3$ Since 1 ft = 12" Therefore $15 \times 12^3 = 25920"$ <sup>3</sup> Since 1" = 2.54cm Therefore $25920 \times 2.54^3 = 424752.69 \text{ cm}^3$
10	$1\text{ft} = ? \text{ mm}$ Since 1 ft = 12" Therefore $1 \times 12 = 12"$ Since 1" = 25.4mm Therefore $12 \times 25.4 = 304.8 \text{ mm}$	$1\text{ft}^2 = ? \text{ mm}^2$ Since 1 ft = 12" Therefore $1 \times 12^2 = 144"$ <sup>2</sup> Since 1" = 25.4mm Therefore $144 \times 25.4^2 = 92903.04 \text{ mm}^2$	$1\text{ft}^3 = ? \text{ mm}^3$ Since 1 ft = 12" Therefore $1 \times 12^3 = 1728"$ <sup>3</sup> Since 1" = 25.4mm Therefore $1728 \times 25.4^3 = 28316846.59 \text{ mm}^3$
11	$12 \text{ yd} = ? \text{ mm}$ Since 1 yd = 36" Therefore $12 \times 36 = 432"$ Since 1" = 25.4mm Therefore $432 \times 25.4 = 10972.8 \text{ mm}$	$12 \text{ yd}^2 = ? \text{ mm}^2$ Since 1 yd = 36" Therefore $12 \times 36^2 = 15552"$ <sup>2</sup> Since 1" = 25.4mm Therefore $15552 \times 25.4^2 = 10033528.32 \text{ mm}^2$	$12 \text{ yd}^3 = ? \text{ mm}^3$ Since 1 yd = 36" Therefore $12 \times 36^3 = 559872"$ <sup>3</sup> Since 1" = 25.4mm Therefore $559872 \times 25.4^3 = 9174658296 \text{ mm}^3$
12	$1.5 \text{ yd} = ? \text{ cm}$ Since 1 yd = 36" Therefore $1.5 \times 36 = 54"$ Since 1" = 2.54cm Therefore $54 \times 2.54 = 137.16 \text{ cm}$	$1.5 \text{ yd}^2 = ? \text{ cm}^2$ Since 1 yd = 36" Therefore $1.5 \times 36^2 = 1944"$ <sup>2</sup> Since 1" = 2.54cm Therefore $1944 \times 2.54^2 = 12541.91 \text{ cm}^2$	$1.5 \text{ yd}^3 = ? \text{ cm}^3$ Since 1 yd = 36" Therefore $1.5 \times 36^3 = 69984"$ <sup>3</sup> Since 1" = 2.54cm Therefore $69984 \times 2.54^3 = 1146832.287 \text{ cm}^3$
13	$15 \text{ yd} = ? \text{ m}$ Since 1 m = 1.093 yd Therefore $15 / 1.093 = 13.723 \text{ m}$	$15 \text{ yd}^2 = ? \text{ m}^2$ Since 1 m = 1.093 yd Therefore $15 / 1.093^2 = 12.555 \text{ m}^2$	$15 \text{ yd}^3 = ? \text{ m}^3$ Since 1 m = 1.093 yd Therefore $15 / 1.093^3 = 11.487 \text{ m}^3$
14	$25 \text{ yd} = ? \text{ ft}$ Since 1 yd = 3 ft Therefore $25 \times 3 = 75 \text{ ft}$	$25 \text{ yd}^2 = ? \text{ ft}^2$ Since 1 yd = 3 ft Therefore $25 \times 3^2 = 225 \text{ ft}^2$	$25 \text{ yd}^3 = ? \text{ ft}^3$ Since 1 yd = 3 ft Therefore $25 \times 3^3 = 675 \text{ ft}^3$
15	$18 \text{ yd} = ? \text{ inches}$ Since 1 yd = 36"	$18 \text{ yd}^2 = ? \text{ inches}^2$ Since 1 yd = 36"	$18 \text{ yd}^3 = ? \text{ inches}^3$ Since 1 yd = 36"

	Therefore $18 \times 36 = 648"$	Therefore $18 \times 36^2 = 23328"{}^2$	Therefore $18 \times 36^3 = 839808"{}^3$
16	9600 mm = ? inches Since 1 inch = 25.4mm Therefore $9600 / 25.4 = 377.952"$	9600 mm <sup>2</sup> = ? inches <sup>2</sup> Since 1 inch = 25.4mm Therefore $9600 / 25.4^2 = 14.88"{}^2$	9600 mm <sup>3</sup> = ? inches <sup>3</sup> Since 1 inch = 25.4mm Therefore $9600 / 25.4^3 = 0.585"{}^3$
17	5500 mm = ? ft Since 1 inch = 25.4mm Therefore $5500 / 25.4 = 216.535"$ Since 1ft = 12" Therefore $216.535/12 = 18.044$ ft	5500 mm <sup>2</sup> = ? ft <sup>2</sup> Since 1 inch = 25.4mm Therefore $5500 / 25.4^2 = 8.525"{}^2$ Since 1ft = 12" Therefore $8.525/12^2 = 0.059$ ft <sup>2</sup>	5500 mm <sup>3</sup> = ? ft <sup>3</sup> Since 1 inch = 25.4mm Therefore $5500 / 25.4^3 = 0.335"{}^3$ Since 1ft = 12" Therefore $0.335/12^3 = 0.000194$ ft <sup>3</sup>
18	800 mm = ? cm Since 1 cm = 10 mm Therefore $800 / 10 = 80$ cm	800 mm <sup>2</sup> = ? cm <sup>2</sup> Since 1 cm = 10 mm Therefore $800 / 10^2 = 8$ cm <sup>2</sup>	800 mm <sup>3</sup> = ? cm <sup>3</sup> Since 1 cm = 10 mm Therefore $800 / 10^3 = 0.8$ cm <sup>3</sup>
19	800 mm = ? m Since 1 m = 1000 mm Therefore $800 / 1000 = 0.8$ m	800 mm <sup>2</sup> = ? m <sup>2</sup> Since 1 m = 1000 mm Therefore $800 / 1000^2 = 0.0008$ m <sup>2</sup>	800 mm <sup>3</sup> = ? m <sup>3</sup> Since 1 m = 1000 mm Therefore $800 / 1000^3 = 0.0000008$ m <sup>3</sup>
20	9500 mm = ? yd Since 1 inch = 25.4 mm Therefore $9500 / 25.4 = 374.015"$ Since 1 yd = 36" Therefore $374.015/36 = 10.389$ yd	9500 mm <sup>2</sup> = ? yd <sup>2</sup> Since 1 inch = 25.4 mm Therefore $9500 / 25.4^2 = 14.725"{}^2$ Since 1 yd = 36" Therefore $14.725/36^2 = 0.011361$ yd <sup>2</sup>	9500 mm <sup>3</sup> = ? yd <sup>3</sup> Since 1 inch = 25.4 mm Therefore $9500 / 25.4^3 = 0.5797"{}^3$ Since 1 yd = 36" Therefore $0.5797/36^3 = 0.0000124$ yd <sup>3</sup>
21	850 cm = ? yd Since 1 inch = 2.54 cm Therefore $850 / 2.54 = 334.645"$ Since 1 yd = 36" Therefore $334.645/36 = 9.295$ yd	850 cm <sup>2</sup> = ? yd <sup>2</sup> Since 1 inch = 2.54 cm Therefore $850 / 2.54^2 = 131.75"{}^2$ Since 1 yd = 36" Therefore $131.75/36^2 = 0.1016$ yd <sup>2</sup>	850 cm <sup>3</sup> = ? yd <sup>3</sup> Since 1 inch = 2.54 cm Therefore $850 / 2.54^3 = 51.87"{}^3$ Since 1 yd = 36" Therefore $51.87/36^3 = 0.00111$ yd <sup>3</sup>
22	600 cm = ? ft Since 1 inch = 2.54 cm Therefore $600 / 2.54 = 236.22"$ Since 1 ft = 12"	600 cm <sup>2</sup> = ? ft <sup>2</sup> Since 1 inch = 2.54 cm Therefore $600 / 2.54^2 = 93.0"{}^2$ Since 1 ft = 12"	600 cm <sup>3</sup> = ? ft <sup>3</sup> Since 1 inch = 2.54 cm Therefore $600 / 2.54^3 = 36.614"{}^3$ Since 1 ft = 12"

	Therefore $236.22 / 12 = 19.685$ ft	Therefore $93.0 / 12^2 = 0.645$ ft <sup>2</sup>	Therefore $93.0 / 12^3 = 0.0538$ ft <sup>3</sup>
23	100 cm = ? inch Since 1 inch = 2.54 cm Therefore $100 / 2.54 = 39.37''$	100 cm <sup>2</sup> = ? inch <sup>2</sup> Since 1 inch = 2.54 cm Therefore $100 / 2.54^2 = 15.50''^2$	100 cm <sup>3</sup> = ? inch <sup>3</sup> Since 1 inch = 2.54 cm Therefore $100 / 2.54^3 = 6.10''^3$
24	3500 mm = ? m Since 1 m = 1000 mm Therefore $3500 / 1000 = 3.50$ m	3500 mm <sup>2</sup> = ? m <sup>2</sup> Since 1 m = 1000 mm Therefore $3500 / 1000^2 = 0.0035$ m <sup>2</sup>	3500 mm <sup>3</sup> = ? m <sup>3</sup> Since 1 m = 1000 mm Therefore $3500 / 1000^3 = 0.0000035$ m <sup>3</sup>
25	650 cm = ? mm Since 1 cm = 10 mm Therefore $650 \times 10 = 6500$ mm	650 cm <sup>2</sup> = ? mm <sup>2</sup> Since 1 cm = 10 mm Therefore $650 \times 10^2 = 65000$ mm	650 cm <sup>3</sup> = ? mm <sup>3</sup> Since 1 cm = 10 mm Therefore $650 \times 10^3 = 650000$ mm
26	300 inch = ? mm Since 1 inch = 25.4 mm Therefore $300 \times 25.4 = 7620$ mm	300 inch <sup>2</sup> = ? mm <sup>2</sup> Since 1 inch = 25.4 mm Therefore $300 \times 25.4^2 = 193548$ mm <sup>2</sup>	300 inch <sup>3</sup> = ? mm <sup>3</sup> Since 1 inch = 25.4 mm Therefore $300 \times 25.4^3 = 4916119.2$ mm <sup>3</sup>
27	28 inch = ? cm Since 1 inch = 2.54 cm Therefore $28 \times 2.54 = 71.12$ cm	28 inch <sup>2</sup> = ? cm <sup>2</sup> Since 1 inch = 2.54 cm Therefore $28 \times 2.54^2 = 180.644$ cm <sup>2</sup>	28 inch <sup>3</sup> = ? cm <sup>3</sup> Since 1 inch = 2.54 cm Therefore $28 \times 2.54^3 = 458.837$ cm <sup>3</sup>
28	915 inch = ? m Since 1 m = 39.37'' Therefore $915 / 39.37 = 23.241$ m	915 inch <sup>2</sup> = ? m <sup>2</sup> Since 1 m = 39.37'' Therefore $915 / 39.37^2 = 0.59$ m <sup>2</sup>	915 inch <sup>3</sup> = ? m <sup>3</sup> Since 1 m = 39.37'' Therefore $915 / 39.37^3 = 0.0149$ m <sup>3</sup>
29	665 inch = ? ft Since 1ft = 12'' Therefore $665 / 12 = 55.416$ ft	665 inch <sup>2</sup> = ? ft <sup>2</sup> Since 1ft = 12'' Therefore $665 / 12^2 = 4.618$ ft <sup>2</sup>	665 inch <sup>3</sup> = ? ft <sup>3</sup> Since 1ft = 12'' Therefore $665 / 12^3 = 0.384$ ft <sup>3</sup>
30	6512 inch = ? yd Since 1yd = 36'' Therefore $6512 / 36 = 180.888$ yd	6512 inch <sup>2</sup> = ? yd <sup>2</sup> Since 1yd = 36'' Therefore $6512 / 36^2 = 5.024$ yd <sup>2</sup>	6512 inch <sup>3</sup> = ? yd <sup>3</sup> Since 1yd = 36'' Therefore $6512 / 36^3 = 0.139$ yd <sup>3</sup>
31	6'6'' = ? ft Since 1 ft = 12'' $6 / 12 = 0.5$ ft Therefore $6' + 0.5' = 6.5$ ft	-	-
32	9'3'' = ? m Since 1 ft = 12''	-	-

	$3 / 12 = 0.25 \text{ ft}$ Therefore $9' + 0.25' = 9.25 \text{ ft}$ Since $1\text{m} = 3.28 \text{ ft}$ Therefore $9.25/3.28 = 2.82 \text{ m}$		
33	$8\frac{3}{4}'' = ? \text{ inch}$ Since $1 \text{ ft} = 12''$ $8 \times 12 = 96''$ $96'' + 3\frac{3}{4}'' = 96'' + 0.75'' = 96.75''$	-	-
34	$4'4'' = ? \text{ cm}$ Since $1 \text{ ft} = 12''$ Therefore $4 \times 12 = 48''$ $48'' + 4'' = 52''$ Since $1'' = 2.54 \text{ cm}$ Therefore $52 \times 2.54 = 132.08 \text{ cm}$	-	-
35	$12'4'' = ? \text{ mm}$ Since $1 \text{ ft} = 12''$ Therefore $12 \times 12 = 144''$ $144'' + 4'' = 148''$ Since $1'' = 25.4 \text{ mm}$ Therefore $148 \times 25.4 = 3759.2 \text{ mm}$	-	-
36	$18'12'' = ? \text{ yd}$ Since $1 \text{ ft} = 12''$ Therefore $12 / 12 = 1 \text{ ft}$ $18' + 1' = 19 \text{ ft}$ Since $1 \text{ yd} = 3 \text{ ft}$ Therefore $19/3 = 6.33 \text{ yd}$	-	-

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## **Rate Conversion**

**Problem-1 :** if Rate/ft = 12 rupees; what will be Rate/m = ?

**Solution:**

Method-1:

Since 1 m = 3.28 ft

$$= 12 \times 3.28$$

= 39.36 or approximately equal to 40 rupees / m

Method-2:

1ft = ? m

Since 1m = 3.28 ft

$$= 1/3.28$$

= 0.304 m

Since 1ft = 0.304 m

= 0.304 m = 12 rupees

$$= 1 \text{ m} = ?$$

$$= (1/0.304) \times 12$$

= 39.47 or approximately equal to 40 rupees / m

**Problem-2 :**

Rate/Sft = 25 rupees

Rate/m<sup>2</sup> = ?

**Solution :**

Method-1:

Since 1 m = 3.28 ft

$$= 25 \times 3.28^2$$

= 268.96 or approximately equal to 269.0 rupees / m<sup>2</sup>

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**Method-2:**

$$1\text{ft}^2 = ? \text{ m}^2$$

Since  $1\text{m} = 3.28 \text{ ft}$

$$= 1/3.28^2$$

$$= 0.0929 \text{ m}^2$$

Since  $1\text{ft}^2 = 0.0929 \text{ m}^2$

$$= 0.0929 \text{ m}^2 = 25 \text{ rupees}$$

$$= 1 \text{ m}^2 = ?$$

$$= (1/0.0929) \times 25$$

$$= 269.0 \text{ rupees / m}^2$$

**Problem-3 :**

Rate/Cft = 55 rupees

$$\text{Rate/m}^3 = ?$$

**Solution**

Method-1:

Since  $1 \text{ m} = 3.28 \text{ ft}$

$$= 55 \times 3.28^3$$

$$= 1940.81 \text{ or approximately equal to } 1941.0 \text{ rupees / m}^3$$

Method-2:

$$1\text{ft}^3 = ? \text{ m}^3$$

Since  $1\text{m} = 3.28 \text{ ft}$

$$= 1/3.28^3$$

$$= 0.02833 \text{ m}^3$$

Since  $1\text{ft}^3 = 0.02833 \text{ m}^3$

$$= 0.02833 \text{ m}^3 = 55 \text{ rupees}$$

$$= 1 \text{ m}^3 = ?$$

$$= (1/0.02833) \times 55$$

$$= 1941.40 \text{ rupees / m}^3$$

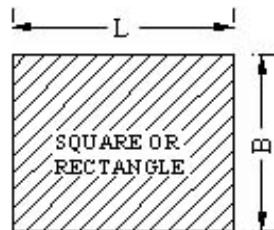
## Length and Area Calculations

Formulas:

### 1. Square or Rectangle

(i) Area =  $A = L \times B$

(ii) Peripheral Length =  $L = (L+B) \times 2$

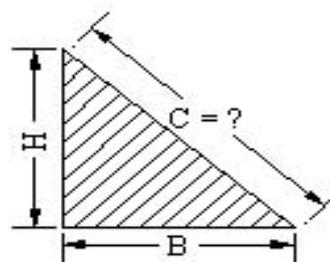


### 2. Pythagoras theorem

this theorem is used to find out any inclined length

$$c^2 = a^2 + b^2$$

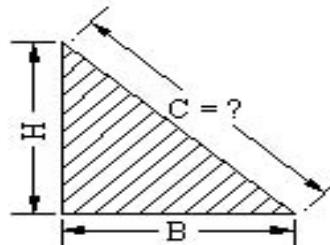
$$c = \sqrt{a^2 + b^2}$$



### 3. Tri-angle

(i) Area =  $A = 1/2 \times B \times H$

(ii) Peripheral Length =  $L = B + H + C$

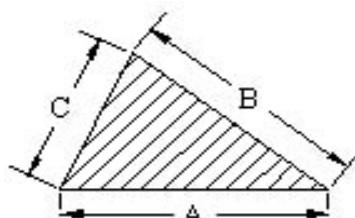


### 4. Irregular Tri-angle

(i) Area =  $A = \sqrt{s(s-a)(s-b)(s-c)}$

$$\text{where } s = (a + b + c)/2$$

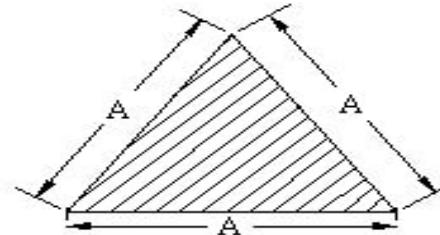
(ii) Peripheral Length =  $L = a + b + c$



### 5. Equilateral Tri-angle

(i) Area =  $A = (a^2/4) \times \sqrt{3}$

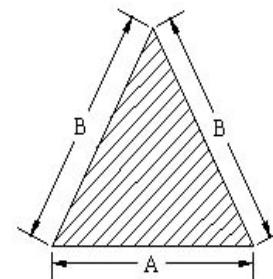
(ii) Peripheral Length =  $L = a + a + a = 3a$



### 6. Isosceles Tri-angle

(i) Area =  $A = (a/4) \times \sqrt{4b^2-a^2}$

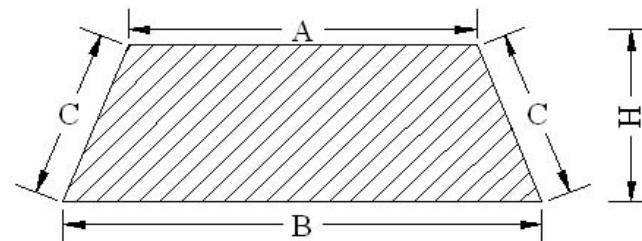
(ii) Peripheral Length =  $L = a + b + b = a + 2b$



### 7. Trapezoidal

(i) Area =  $A = 1/2 ( a+b ) \times h$

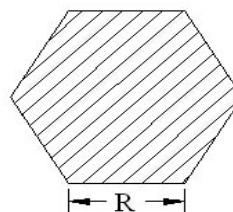
(ii) Peripheral Length =  $L = a + b + c + c$



### 8. Hexagon

(i) Area =  $A = (0.5 \times r \times 0.5 \times r \times \tan 60) \times 6$

(ii) Peripheral Length =  $L = 6r$



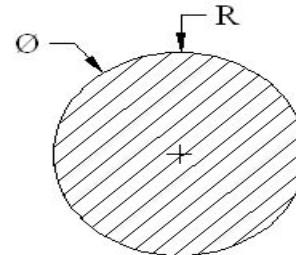
## 9. Circle

$$(i) \text{ Area } A = \pi/4 \times d^2$$

where  $d$  = diameter of circle ;  $\pi = 3.14$

$$(ii) \text{ Peripheral Length } L = 2 \times \pi \times r$$

where  $r$  = radius of circle



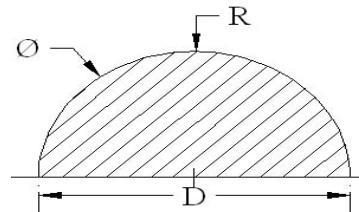
## 10. Semi-Circle

$$(i) \text{ Area } A = \pi/4 \times d^2 \times 0.50$$

where  $d$  = diameter of circle ;  $\pi = 3.14$

$$(ii) \text{ Peripheral Length } L = 2 \times \pi \times r \times 0.50$$

where  $r$  = radius of circle



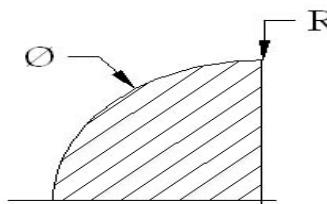
## 11. Quarter Circle

$$(i) \text{ Area } A = \pi/4 \times d^2 \times 0.25$$

where  $d$  = diameter of circle ;  $\pi = 3.14$

$$(ii) \text{ Peripheral Length } L = 2 \times \pi \times r \times 0.25$$

where  $r$  = radius of circle



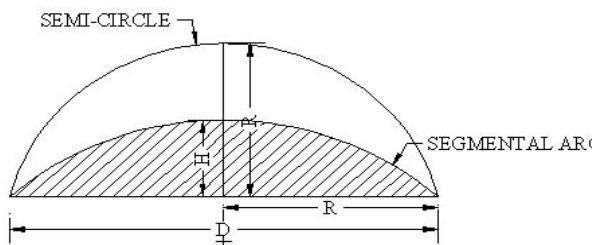
## 12. Segmental Arc

$$(i) \text{ Area } A = (2/3 \times D \times H) + (H^3/2D)$$

where  $d$  = diameter of circle  
 $H$  = height of arc

$$(ii) \text{ Arc Length } L = (8b - 2r)/3$$

where  $r$  = radius of circle  
 $b = \sqrt{r^2 + h^2}$



### Wooden or Iron Shuttering Area Calculations

Problem-1: find shuttering area for the given column

Solution: Shuttering area = Peripheral length x depth

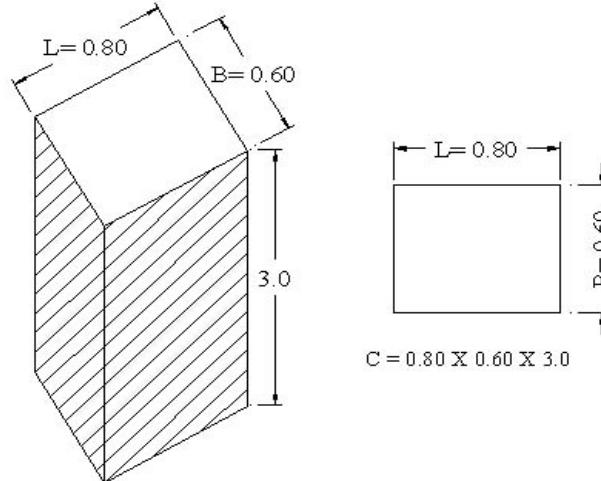
$$= 2.80 \times 3.0$$

$$= 8.4 \text{ m}^2$$

$$\text{peripheral length} = L = (L+B) \times 2$$

$$L = (0.80 + 0.60) \times 2$$

$$L = 2.80 \text{ m}$$



Problem-2: find shuttering area for the given column

Solution: Shuttering area = Peripheral length x depth

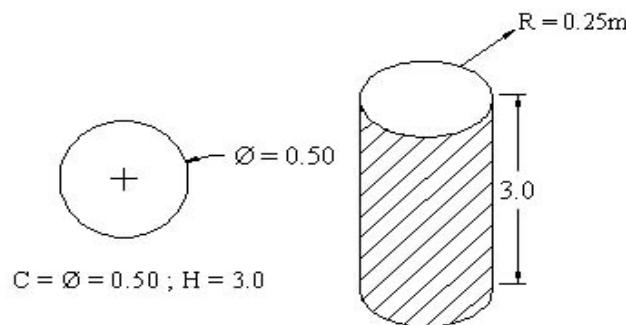
$$= 1.57 \times 3.0$$

$$= 4.71 \text{ m}^2$$

$$\text{peripheral length} = L = 2 \times \pi \times r$$

$$L = 2 \times \pi \times 0.25$$

$$L = 1.57 \text{ m}$$



## Volume of Concrete Calculations

Problem-1: find Volume of concrete for the given Rectangular column

Solution: volume of Concrete = Area x Depth

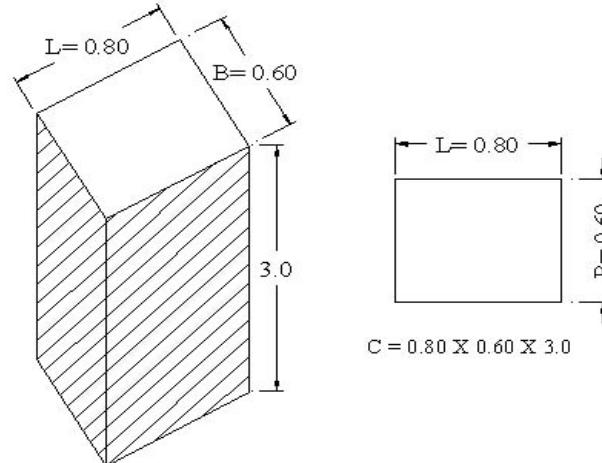
$$= 0.48 \times 3.0$$

$$= 1.44 \text{ m}^3$$

therefore area of column = L x B

$$A = 0.80 \times 0.60$$

$$A = 0.48 \text{ m}^2$$



Problem-2: find Volume of concrete for the given column

Solution: volume of Concrete = Area x Depth

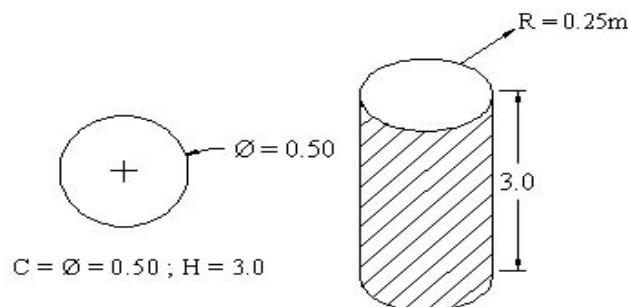
$$= 0.196 \times 3.0$$

$$= 0.588 \text{ m}^3$$

therefore area of column =  $\pi/4 \times d^2$

$$A = \pi/4 \times 0.5^2$$

$$A = 0.196 \text{ m}^2$$



### Problems on Footings

- Problem-1: For a given Plain-footing find  
 1. volume of concrete  
 2. Area of Shuttering  
 3. Area of Bitumen paint

Solution:

$$\begin{aligned} 1. \text{ Volume of Concrete} &= \text{Area} \times \text{Depth} \\ &= L \times B \times D \\ &= 0.80 \times 0.80 \times 0.50 \\ &= 0.32 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} 2. \text{ Shuttering Area} &= \text{Peripheral Length} \times \text{Depth} \\ &= (L + B) \times 2 \times D \\ &= (0.80 + 0.80) \times 2 \times 0.50 \\ &= 1.6 \text{ m}^2 \end{aligned}$$

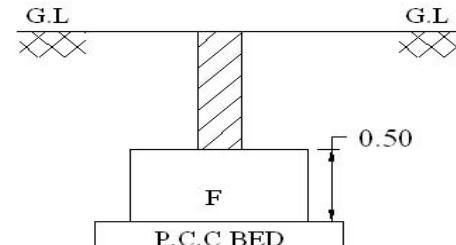
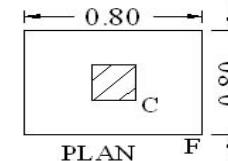
$$\begin{aligned} 3. \text{ Bitumen paint Area} &= \text{peripheral length} \times \text{Depth} + \text{top area} - \text{Column Area} \\ &= (L + B) \times 2 \times D + L \times B - l \times b \text{ (Column Dimension)} \\ &= (0.80 + 0.80) \times 2 \times 0.50 + 0.80 \times 0.80 - 0.35 \times 0.35 \\ &= 2.117 \text{ m}^2 \end{aligned}$$

- Problem-2: For a given Plain-Combined footing find  
 1. volume of concrete                       $F = 3.50\text{m} \times 1.20\text{m} \times 0.60\text{m}$   
 2. Area of Shuttering                       $C_1 = 0.40\text{m} \times 0.40\text{m}$   
 3. Area of Bitumen paint                 $C_2 = \emptyset = 0.50$  ;

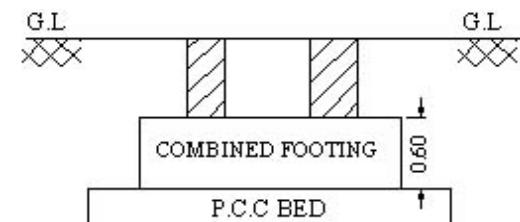
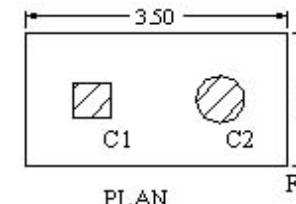
Solution:

$$\begin{aligned} 1. \text{ Volume of Concrete} &= \text{Area} \times \text{Depth} \\ &= L \times B \times D \\ &= 3.5 \times 1.20 \times 0.60 \\ &= 2.52 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} 2. \text{ Shuttering Area} &= \text{Peripheral Length} \times \text{Depth} \\ &= (L + B) \times 2 \times D \\ &= (3.5 + 1.2) \times 2 \times 0.60 \\ &= 5.64 \text{ m}^2 \end{aligned}$$



$$\begin{aligned} F &= 0.80\text{m} \times 0.80\text{m} \times 0.50\text{m} \\ C &= 0.35\text{m} \times 0.35\text{m} \end{aligned}$$



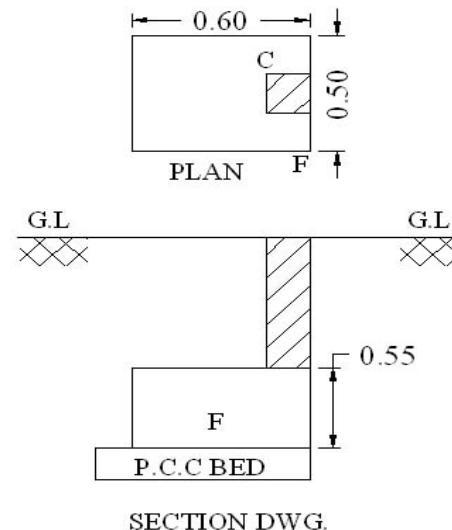
$$\begin{aligned}
 3. \text{ Bitumen paint Area} &= \text{peripheral length} \times \text{Depth} + \text{top area} - \text{Column Area} \\
 &= (L + B) \times 2 \times D + L \times B - l \times b \text{ (Column Dimensions)} \\
 &= (3.5 + 1.2) \times 2 \times 0.60 + 3.5 \times 1.2 - 0.40 \times 0.40 - \pi/4 \times 0.5^2 \\
 &= 9.483 \text{ m}^2
 \end{aligned}$$

- Problem-3: For a given Shoe-footing find
1. volume of concrete
  2. Area of Shuttering
  3. Area of Bitumen paint
- $F = 0.60m \times 0.50m \times 0.55m$
- $C = 0.25m \times 0.25m$

Solution:

$$\begin{aligned}
 1. \text{ Volume of Concrete} &= \text{Area} \times \text{Depth} \\
 &= L \times B \times D \\
 &= 0.6 \times 0.50 \times 0.55 \\
 &= 0.165 \text{ m}^3
 \end{aligned}$$

$$\begin{aligned}
 2. \text{ Shuttering Area} &= \text{Peripheral Length} \times \text{Depth} \\
 &= (L + B) \times 2 \times D \\
 &= (0.60 + 0.50) \times 2 \times 0.55 \\
 &= 1.21 \text{ m}^2
 \end{aligned}$$



$$\begin{aligned}
 3. \text{ Bitumen paint Area} &= \text{peripheral length} \times \text{Depth} + \text{top area} - \text{Column Area} \\
 &= (L + B) \times 2 \times D + L \times B - l \times b \text{ (Column Dimension)} \\
 &= (0.60 + 0.50) \times 2 \times 0.55 + 0.60 \times 0.50 - 0.25 \times 0.25 \\
 &= 1.447 \text{ m}^2
 \end{aligned}$$

Problem-4: For a given Raft-footing find  
 1. volume of concrete  
 2. Area of Shuttering  
 3. Area of Bitumen paint

$$F = 12.5 \text{m} \times 10.6 \text{m} \times 1.40 \text{m}$$

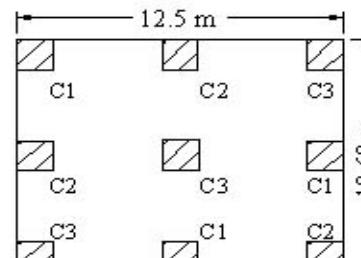
$$C_1 = 0.40 \text{m} \times 0.40 \text{m}$$

$$C_2 = 0.40 \text{m} \times 0.50 \text{m}$$

$$C_3 = 0.50 \text{m} \times 0.50 \text{m}$$

Solution:

$$\begin{aligned} 1. \text{ Volume of Concrete} &= \text{Area} \times \text{Depth} \\ &= L \times B \times D \\ &= 12.5 \times 10.6 \times 1.4 \\ &= 185.50 \text{ m}^3 \end{aligned}$$



PLAN

$$\begin{aligned} 2. \text{ Shuttering Area} &= \text{Peripheral Length} \times \text{Depth} \\ &= (L + B) \times 2 \times D \\ &= (12.5 + 10.6) \times 2 \times 1.40 \\ &= 64.68 \text{ m}^2 \end{aligned}$$

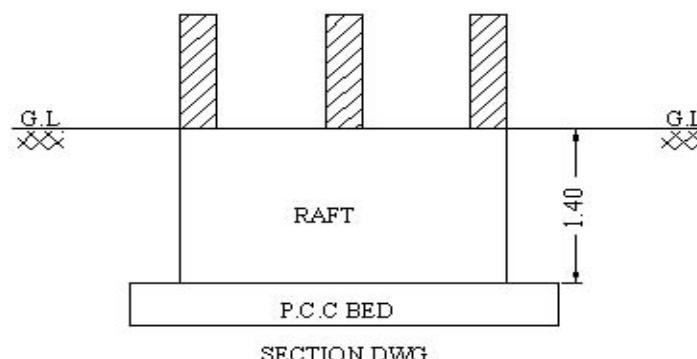
therefore column area =  $L \times B \times \text{no. of columns}$

$$C_1 = 0.40 \times 0.40 \times 3 = 0.48 \text{ m}^2$$

$$C_2 = 0.40 \times 0.50 \times 3 = 0.60 \text{ m}^2$$

$$C_3 = 0.50 \times 0.50 \times 3 = 0.75 \text{ m}^2$$

$$\text{Total Column area} = 0.48 + 0.60 + 0.75 = 1.83 \text{ m}^2$$



SECTION DWG.

$$\begin{aligned} 3. \text{ Bitumen paint Area} &= \text{peripheral length} \times \text{Depth} + \text{top area} - \text{Column Area} \\ &= (L + B) \times 2 \times D + L \times B - l \times b \text{ (Column Area)} \\ &= (12.5 + 10.6) \times 2 \times 1.40 + 12.5 \times 10.6 - 1.83 \\ &= 195.35 \text{ m}^2 \end{aligned}$$

Problem-5: For a given Step-footing find  
 1. volume of concrete  
 2. Area of Shuttering  
 3. Area of Bitumen paint

$$F = \text{step-1} : 0.80m \times 0.80m \times 0.25m$$

$$F = \text{step-2} : 0.70m \times 0.70m \times 0.25m$$

$$F = \text{step-3} : 0.60m \times 0.60m \times 0.25m$$

$$C = 0.30m \times 0.30m$$

Solution:

1. Volume of Concrete = Area x Depth

$$\therefore L \times B \times D$$

$$\text{step-1} \quad \therefore 0.80 \times 0.80 \times 0.25 \quad \therefore 0.16 m^3$$

$$\text{step-2} \quad \therefore 0.70 \times 0.70 \times 0.25 \quad \therefore 0.122 m^3$$

$$\text{step-3} \quad \therefore 0.60 \times 0.60 \times 0.25 \quad \underline{\therefore 0.09 m^3}$$

$$\text{Total Volume} \quad \underline{\therefore 0.372 m^3}$$

2. Shuttering Area = Peripheral Length x Depth

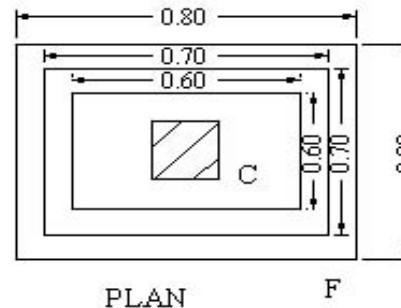
$$\therefore (L + B) \times 2 \times D$$

$$\text{step-1} \quad \therefore (0.80 + 0.80) \times 2 \times 0.25 \quad \therefore 0.80 m^2$$

$$\text{step-2} \quad \therefore (0.70 + 0.70) \times 2 \times 0.25 \quad \therefore 0.70 m^2$$

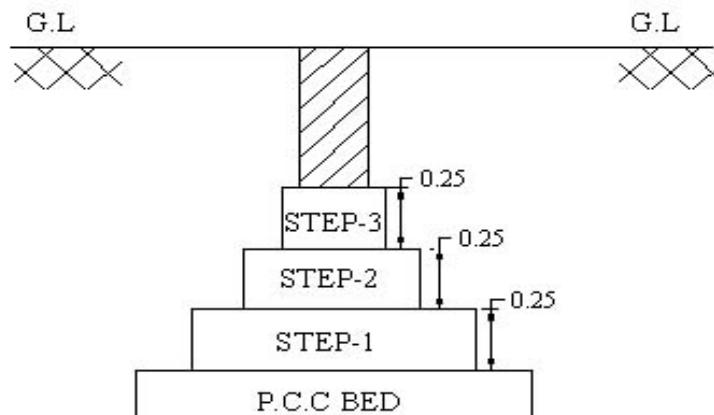
$$\text{step-3} \quad \therefore (0.60 + 0.60) \times 2 \times 0.25 \quad \therefore 0.60 m^2$$

$$\text{Total Area} \quad \underline{\therefore 2.10 m^2}$$



PLAN

F



SECTION DWG.

3. Bitumen paint Area = peripheral length x Depth + top area - top step area

$$\text{step-1} \quad \therefore (0.80 + 0.80) \times 2 \times 0.25 + 0.80 \times 0.80 - 0.7 \times 0.70 \quad \therefore 0.95 m^2$$

$$\text{step-2} \quad \therefore (0.70 + 0.70) \times 2 \times 0.25 + 0.70 \times 0.70 - 0.60 \times 0.60 \quad \therefore 0.83 m^2$$

$$\text{step-3} \quad \therefore (0.60 + 0.60) \times 2 \times 0.25 + 0.60 \times 0.60 - 0.30 \times 0.30 \quad \therefore 0.87 m^2$$

$$\text{Total Area} \quad \underline{\therefore 2.65 m^2}$$

- Problem-6: For a given Pile-under footing (pile-cap) find
1. volume of concrete
  2. Area of Shuttering
  3. Area of Bitumen paint

Pile Dimension :  
 $\emptyset = 0.50\text{m}$ ; height = 3.5m

Solution:

1. Volume of Concrete = Area x Depth

$$= \pi/4 \times d^2 \times D$$

$$= \pi/4 \times 0.5^2 \times 3.5$$

$$= 0.687 \text{ m}^3$$

2. Shuttering Area = Peripheral Length x Depth

$$= 2 \times \pi \times r \times D$$

$$= 2 \times \pi \times 0.25 \times 3.50$$

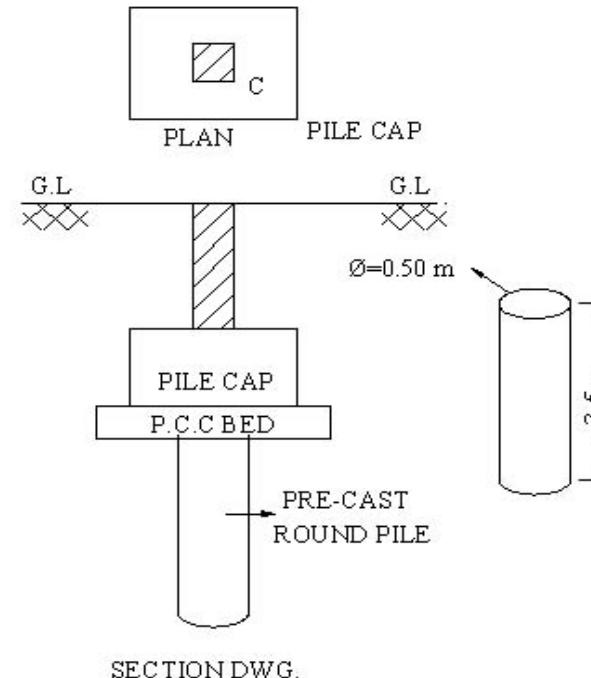
$$= 5.49 \text{ m}^2$$

3. Bitumen paint Area = peripheral length x Depth + bottom area

$$= 2 \times \pi \times r \times D + \pi/4 \times d^2$$

$$= 2 \times \pi \times 0.25 \times 3.50 + \pi/4 \times 0.5^2$$

$$= 5.68 \text{ m}^2$$



- Problem-7: For a given Isolated-footing find
1. volume of concrete
  2. Area of Shuttering
  3. Area of Bitumen paint

Solution:

$$C = 0.35 \times 0.35$$

$$1. \text{ Volume of Concrete} = \text{Area} \times \text{Depth}$$

$$\begin{aligned} \text{Part-1:} \quad &= L \times B \times D \\ &= 0.675 \times 0.675 \times 0.58 \\ &= 0.264 \text{ m}^3 \end{aligned}$$

$$\text{Therefore Average length "L" } = (L_1 + L_2)/2$$

$$\begin{aligned} &= (0.85 + 0.50)/2 \\ &= 0.675 \text{ m} \end{aligned}$$

$$\text{Therefore Average Breadth "B" } = (B_1 + B_2)/2$$

$$\begin{aligned} &= (0.85 + 0.50)/2 \\ &= 0.675 \text{ m} \end{aligned}$$

$$1. \text{ Volume of Concrete} = \text{Area} \times \text{Depth}$$

$$\begin{aligned} \text{Part-2:} \quad &= L \times B \times D \\ &= 0.85 \times 0.85 \times 0.33 \\ &= 0.238 \text{ m}^3 \end{aligned}$$

$$\text{Total volume of concrete for the footing} = \text{vol. of part-1} + \text{vol. of part-2}$$

$$\begin{aligned} &= 0.264 + 0.238 \\ &= 0.502 \text{ m}^3 \end{aligned}$$

$$2. \text{ Shuttering Area} = \text{Peripheral Length} \times \text{Depth}$$

$$\begin{aligned} \text{Part-1:} \quad &= (L + B) \times 2 \times D \\ &= (0.675 + 0.675) \times 2 \times 0.58 \\ &= 1.566 \text{ m}^2 \end{aligned}$$

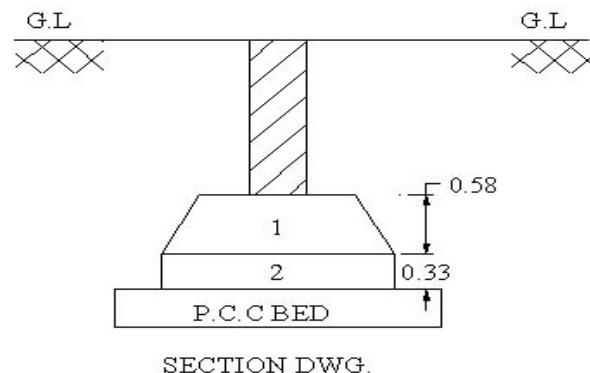
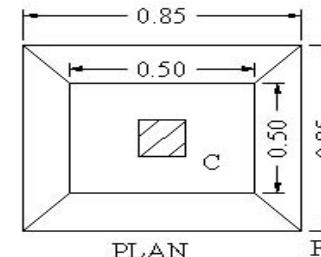
$$\begin{aligned} \text{Part-2:} \quad &= (L + B) \times 2 \times D \\ &= (0.85 + 0.85) \times 2 \times 0.33 \\ &= 1.122 \text{ m}^2 \end{aligned}$$

footing dimension:

Bottom dimension :  $L_1 = 0.85\text{m}; B_1 = 0.85\text{m}$

Top dimension :  $L_2 = 0.50\text{m}; B_2 = 0.50$

Depth of Footing = 0.91m



$$\begin{aligned}\text{Total shuttering area for the footing} &= \text{area. of part-1} + \text{area of part-2} \\ &= 1.566 + 1.122 \\ &= 2.688 \text{ m}^2\end{aligned}$$

3. Bitumen paint Area = peripheral length x Depth + top area - Column Area

Part-1:  $= (L + B) \times 2 \times D + L \times B - L \times B$  (Column area)

$$\begin{aligned}&= (0.675 + 0.675) \times 2 \times 0.58 + 0.50 \times 0.50 - 0.35 \times 0.35 \\ &= 1.693 \text{ m}^2\end{aligned}$$

Bitumen paint Area = peripheral length x Depth

Part-2:  $= (L + B) \times 2 \times D$

$$\begin{aligned}&= (0.85 + 0.85) \times 2 \times 0.33 \\ &= 1.122 \text{ m}^2\end{aligned}$$

Total Bitumen paint area for the footing = area. of part-1 + area of part-2

$$\begin{aligned}&= 1.693 + 1.122 \\ &= 2.815 \text{ m}^2\end{aligned}$$

Problem-8: For a given Combined Isolated-footing find

1. volume of concrete
2. Area of Shuttering
3. Area of Bitumen paint

footing dimension:

Bottom dimension :  $L_1 = 0.85\text{m}; B_1 = 0.85\text{m}$

Top dimension :  $L_2 = 0.50\text{m}; B_2 = 0.50$

Depth of Footing = 0.91m

$C_1 = 0.35 \times 0.35$

$C_2 = 0.40 \times 0.40$

Solution:

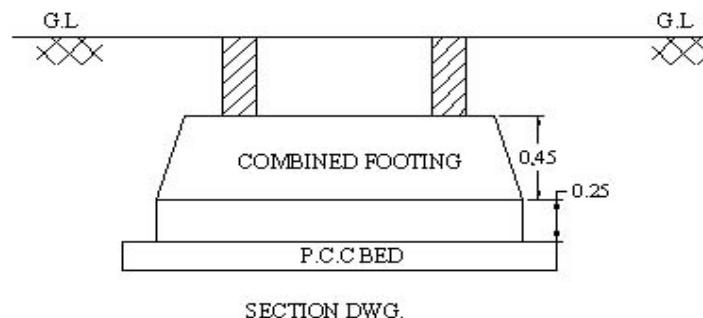
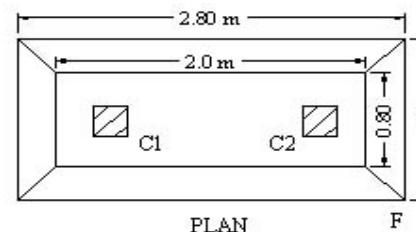
1. Volume of Concrete = Area x Depth

Part-1:  $= L \times B \times D$

$$\begin{aligned}&= 2.40 \times 1.0 \times 0.45 \\ &= 1.08 \text{ m}^3\end{aligned}$$

Therefore Average length "L" =  $(L_1 + L_2)/2$

$$\begin{aligned}&= (2.80 + 2.0)/2 \\ &= 2.40\text{m}\end{aligned}$$



$$\begin{aligned}\text{Therefore Average Breadth "B" } &= (B_1 + B_2)/2 \\ &= (1.20 + 0.80)/2 \\ &= 1.0\text{m}\end{aligned}$$

1. Volume of Concrete = Area x Depth

$$\begin{aligned}\text{Part-2: } &= L \times B \times D \\ &= 2.80 \times 1.20 \times 0.25 \\ &= 0.84 \text{ m}^3\end{aligned}$$

Total volume of concrete for the footing = vol. of part-1 + vol. of part-2

$$\begin{aligned}&= 1.08 + 0.84 \\ &= 1.92 \text{ m}^3\end{aligned}$$

2. Shuttering Area = Peripheral Length x Depth

$$\begin{aligned}\text{Part-1: } &= (L + B) \times 2 \times D \\ &= (2.40 + 1.0) \times 2 \times 0.45 \\ &= 3.06 \text{ m}^2\end{aligned}$$

$$\begin{aligned}\text{Part-2: } &= (L + B) \times 2 \times D \\ &= (2.80 + 1.20) \times 2 \times 0.25 \\ &= 2.0 \text{ m}^2\end{aligned}$$

Total shuttering area for the footing = area. of part-1 + area of part-2

$$\begin{aligned}&= 3.06 + 2.0 \\ &= 5.06 \text{ m}^2\end{aligned}$$

3. Bitumen paint Area = peripheral length x Depth + top area - Column Area

$$\begin{aligned}\text{Part-1: } &= (L + B) \times 2 \times D + L \times B - L \times B \text{ (Column area)} \\ &= (2.40 + 1.0) \times 2 \times 0.45 + 2.0 \times 0.80 - (0.35 \times 0.35 + 0.40 \times 0.40) \\ &= 4.3775 \text{ m}^2\end{aligned}$$

Bitumen paint Area = peripheral length x Depth

$$\begin{aligned}\text{Part-2: } &= (L + B) \times 2 \times D \\ &= (2.80 + 1.20) \times 2 \times 0.25 \\ &= 2.0 \text{ m}^2\end{aligned}$$

Total Bitumen paint area for the footing = area. of part-1 + area of part-2

$$\begin{aligned}&= 4.3775 + 2.0 \\ &= 6.3775 \text{ m}^2\end{aligned}$$

### Problems on Columns

Problem-1: For a given Square Column find

1. volume of concrete
2. Area of Shuttering
3. Area of Bitumen paint

Solution:

$$\begin{aligned} 1. \text{ Volume of Concrete} &= \text{Area} \times \text{Depth} \\ &= L \times B \times D \\ &= 0.45 \times 0.45 \times 3.0 \\ &= 0.607 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} 2. \text{ Area of Shuttering} &= \text{Peripheral Length} \times \text{Depth} \\ &= (L+B) \times 2 \times D \\ &= (0.45 + 0.45) \times 2 \times 3.0 \\ &= 5.40 \text{ m}^2 \end{aligned}$$

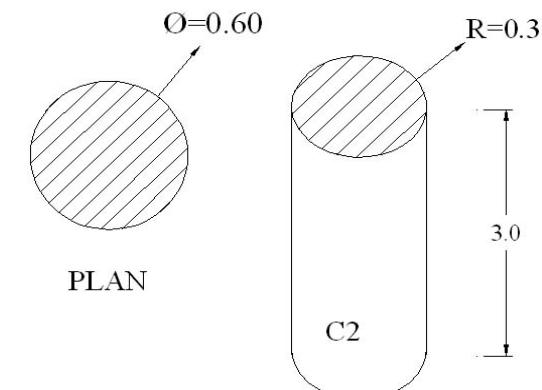
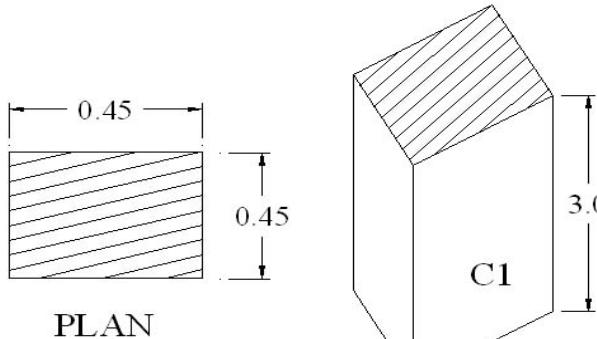
$$\begin{aligned} 3. \text{ Area of Bitumen paint} &= \text{Peripheral Length} \times \text{Depth} \\ &= (L+B) \times 2 \times D \\ &= (0.45 + 0.45) \times 2 \times 3.0 \\ &= 5.40 \text{ m}^2 \end{aligned}$$

Problem-2: For a given Circular Column find

1. volume of concrete
2. Area of Shuttering
3. Area of Bitumen paint

Solution:

$$\begin{aligned} 1. \text{ Volume of Concrete} &= \text{Area} \times \text{Depth} \\ &= \pi/4 \times d^2 \times D \\ &= \pi/4 \times 0.6^2 \times 3.0 \\ &= 0.848 \text{ m}^3 \end{aligned}$$



$$2. \text{ Area of Shuttering} = \text{Peripheral Length} \times \text{Depth}$$

$$.= 2 \times \pi \times r \times D$$

$$.= 2 \times \pi \times 0.30 \times 3.0$$

$$.= 5.654 \text{ m}^2$$

$$3. \text{ Area of Bitumen paint} = \text{Peripheral Length} \times \text{Depth}$$

$$.= 2 \times \pi \times r \times D$$

$$.= 2 \times \pi \times 0.30 \times 3.0$$

$$.= 5.654 \text{ m}^2$$

Problem-3: For a given L-type Column find

1. volume of concrete

2. Area of Shuttering

3. Area of Bitumen paint

Solution:

$$1. \text{ Volume of Concrete} = \text{Area} \times \text{Depth}$$

$$.= 0.18 \times 3.0$$

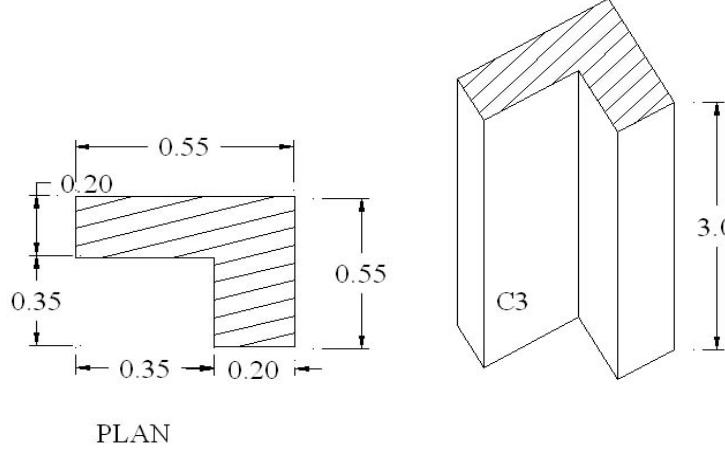
$$.= 0.54 \text{ m}^3$$

To find the area of column divide area in to two parts

$$\text{therefore area1} = 0.55 \times 0.20 = 0.11$$

$$\text{area2} = 0.20 \times 0.35 = 0.07$$

$$\text{total area} \quad \underline{\underline{0.18 \text{ m}^2}}$$



$$2. \text{ Shuttering Area} = \text{Peripheral length} \times \text{Depth}$$

$$.= 2.20 \times 3.0$$

$$.= 6.60 \text{ m}^2$$

$$\text{therefore Peripheral length} = 0.55 + 0.55 + 0.20 + 0.35 + 0.35 + 0.20$$

$$.= 2.20\text{m}$$

$$3. \text{ Area of Bitumen paint} = \text{Peripheral Length} \times \text{Depth}$$

$$.= 2.20 \times 3.0$$

$$.= 6.60 \text{ m}^2$$

2. Area of Shuttering = Peripheral Length x Depth

$$\begin{aligned} &= 2 \times \pi \times r \times D \\ &= 2 \times \pi \times 0.30 \times 3.0 \\ &= 5.654 \text{ m}^2 \end{aligned}$$

3. Area of Bitumen paint = Peripheral Length x Depth

$$\begin{aligned} &= 2 \times \pi \times r \times D \\ &= 2 \times \pi \times 0.30 \times 3.0 \\ &= 5.654 \text{ m}^2 \end{aligned}$$

Problem-4: For a given T-type Column find

1. volume of concrete
2. Area of Shuttering
3. Area of Bitumen paint

Solution:

1. Volume of Concrete = Area x Depth

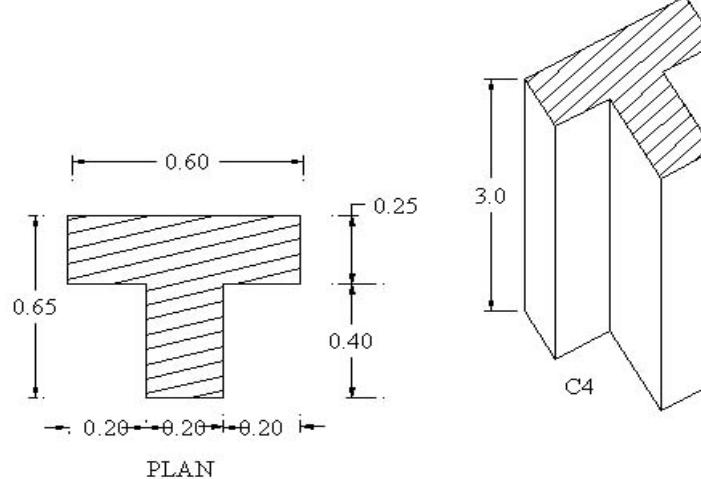
$$\begin{aligned} &= 0.23 \times 3.0 \\ &= 0.69 \text{ m}^3 \end{aligned}$$

To find the area of column divide area in to two parts

therefore area1 =  $0.60 \times 0.25 = 0.15$

area2 =  $0.20 \times 0.40 = 0.08$

total area  $0.23 \text{ m}^2$



2. Shuttering Area = Peripheral length x Depth

$$\begin{aligned} &= 2.50 \times 3.0 \\ &= 7.50 \text{ m}^2 \end{aligned}$$

therefore Peripheral length =  $0.60 + 0.25 + 0.20 + 0.40 + 0.20 + 0.40 + 0.20 + 0.25$

$$= 2.50\text{m}$$

3. Area of Bitumen paint = Peripheral Length x Depth

$$\begin{aligned} &= 2.50 \times 3.0 \\ &= 7.50 \text{ m}^2 \end{aligned}$$

- Problem-5: For a given arc-type Column find
1. volume of concrete
  2. Area of Shuttering
  3. Area of Bitumen paint

Solution:

first find the arc length and to find this, use  
segmental arc length formula

$$\text{arc length} = (8B - 2r)/3$$

$$\text{where } B = \sqrt{H^2 + r^2}$$

therefore with centre line method

$$\text{Height of arc } H = 0.50\text{m}$$

$$\text{Radius of arc } r = 0.60\text{m}$$

$$B = \sqrt{0.50^2 + 0.60^2}$$

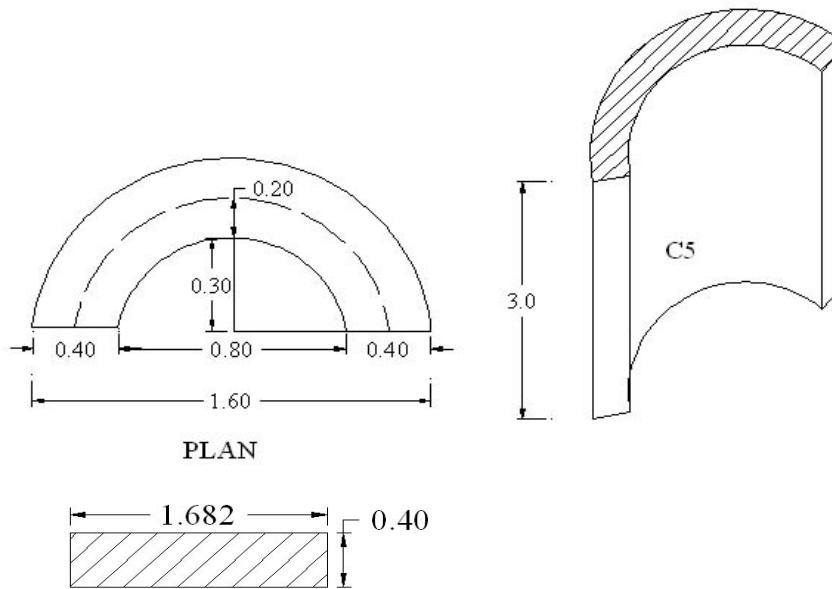
$$B = 0.781$$

$$\text{arc length} = (8B - 2r)/3$$

$$= (8 \times 0.781 - 2 \times 0.60) /3$$

$$= 1.682\text{m}$$

therefore Length of column = 1.682m ; Breadth of column = 0.40m and Depth of column = 3.0m



1. Volume of Concrete = Area x Depth

$$= L \times B \times D$$

$$= 1.682 \times 0.40 \times 3.0$$

$$= 2.018 \text{ m}^3$$

2. Shuttering Area = Peripheral length x Depth

$$= (L + B) \times 2 \times D$$

$$= (1.682 + 0.40) \times 2 \times 3.0$$

$$= 12.492 \text{ m}^2$$

3. Area of Bitumen paint = Peripheral Length x Depth

$$= (L + B) \times 2 \times D$$

$$= (1.682 + 0.40) \times 2 \times 3.0$$

$$= 12.492 \text{ m}^2$$

- Problem-6: For a given 'V'-type Column find
1. volume of concrete
  2. Area of Shuttering
  3. Area of Bitumen paint

Solution:

$$\begin{aligned} \text{1. Volume of Concrete} &= \text{Area} \times \text{Depth} \\ &= 0.285 \times 3.0 \\ &= 0.855 \text{ m}^3 \end{aligned}$$

To find the area of column divide area in to two parts

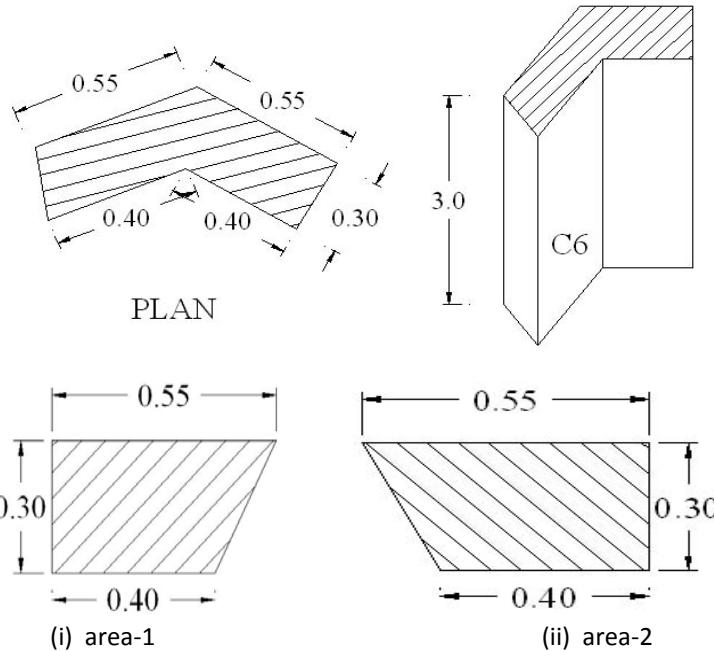
$$\begin{aligned} \text{therefore } \text{area}_1 &= L \times B = 0.475 \times 0.30 = 0.1425 \\ \text{area}_2 &= L \times B = 0.475 \times 0.30 = 0.1425 \\ \text{total area} &= \underline{\underline{0.285 \text{ m}^2}} \\ L_1 &= 0.55; L_2 = 0.40 \text{ and } B = 0.30 \end{aligned}$$

$$\begin{aligned} \text{average } L &= (L_1 + L_2)/2 \\ L &= (0.55 + 0.40) / 2 \\ L &= 0.475 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{2. Shuttering Area} &= \text{Peripheral length} \times \text{Depth} \\ &= 2.50 \times 3.0 \\ &= 7.50 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{therefore Peripheral length} &= 0.55 + 0.55 + 0.30 + 0.40 + 0.40 + 0.30 \\ &= 2.50 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{3. Area of Bitumen paint} &= \text{Peripheral Length} \times \text{Depth} \\ &= 2.50 \times 3.0 \\ &= 7.50 \text{ m}^2 \end{aligned}$$



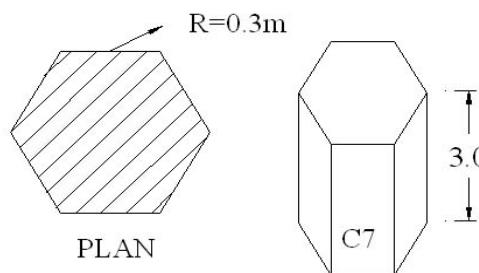
- Problem-7: For a given Hexagon-type Column find
1. volume of concrete
  2. Area of Shuttering
  3. Area of Bitumen paint

Solution:

1. Volume of Concrete = Area x Depth

$$= 0.233 \times 3.0$$

$$= 0.699 \text{ m}^3$$



Formula to find out area of Hexagon =  $(0.50 \times r \times 0.50 \times r \times \tan 60) \times 6$

$$= (0.50 \times 0.30 \times 0.50 \times 0.30 \times 1.732) \times 6$$

$$= 0.233 \text{ m}^2$$

2. Shuttering Area = Peripheral length x Depth

$$= 6 \times r \times D$$

$$= 6 \times 0.30 \times 3.0$$

$$= 5.40 \text{ m}^2$$

therefore Peripheral length =  $6r$

3. Area of Bitumen paint = Peripheral Length x Depth

$$= 6 \times r \times D$$

$$= 6 \times 0.30 \times 3.0$$

$$= 5.40 \text{ m}^2$$

- Problem-8: For a given 'Y'-type Column find
1. volume of concrete
  2. Area of Shuttering
  3. Area of paint

Solution:

1. Volume of Concrete = front area of Column x thickness of Column  

$$= 0.96 \times 0.30$$
  

$$= 0.288 \text{ m}^3$$

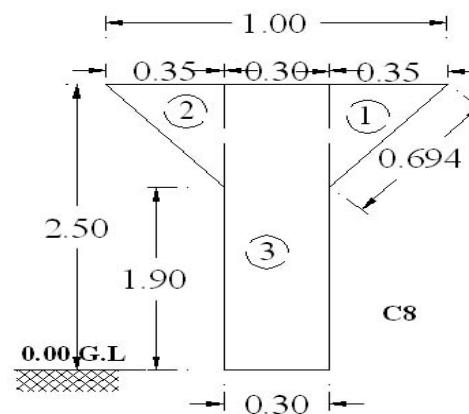
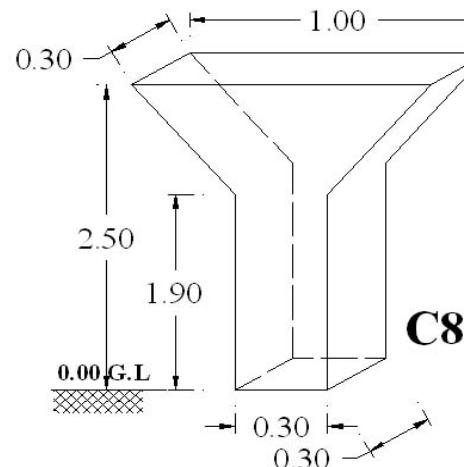
To find out front area of Column, divide front area of column in to three parts

Area of part-1 (triangle shape)       $= \frac{1}{2} \times b \times h$   
 $= 0.50 \times 0.35 \times 0.60$   
 $= 0.105 \text{ m}^2$

Area of part-2 (triangle shape)       $= \frac{1}{2} \times b \times h$   
 $= 0.50 \times 0.35 \times 0.60$   
 $= 0.105 \text{ m}^2$

Area of part-3 (rectangle shape)       $= L \times B$   
 $= 0.30 \times 2.50$   
 $= 0.75 \text{ m}^2$

Total Front area of Column       $= 0.105 + 0.105 + 0.75$   
 $= 0.96 \text{ m}^2$

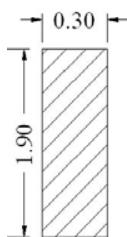


2. Shuttering Area      = front area of column + back area of column + side area of column + side area of column  
 $= 0.96 + 0.96 + 0.778 + 0.778$   
 $= 3.476 \text{ m}^2$

therefore side area can be find out by dividing the side area in to two parts :

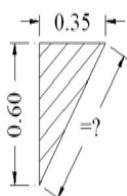
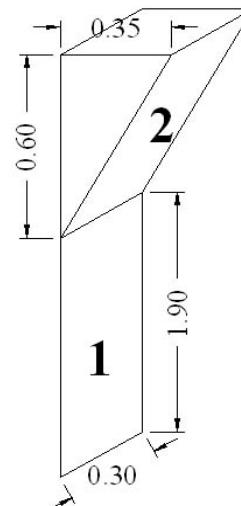
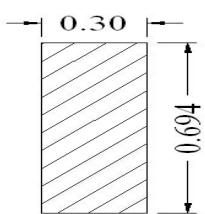
part-1:

$$\begin{aligned}\text{side area for part-1} &= L \times B \\ &= 0.30 \times 1.90 \\ &= 0.57 \text{ m}^2\end{aligned}$$



part-2:

$$\begin{aligned}\text{side area for part-2} &= L \times B \\ &= 0.30 \times 0.694 \\ &= 0.208 \text{ m}^2\end{aligned}$$



according to Pythagoras theorem:

$$\begin{aligned}\text{inclined length } c &= \sqrt{a^2 + b^2} \\ &= \sqrt{(0.35^2 + 0.60^2)} \\ &= 0.694 \text{ m}\end{aligned}$$

Hence total side area =  $A_1 + A_2$

$$\begin{aligned}&= 0.57 + 0.208 \\ &= 0.778 \text{ m}^2\end{aligned}$$

$$\begin{aligned}3. \text{ Area of paint} &= \text{Area of Shuttering} \\ &= 3.476 \text{ m}^2\end{aligned}$$

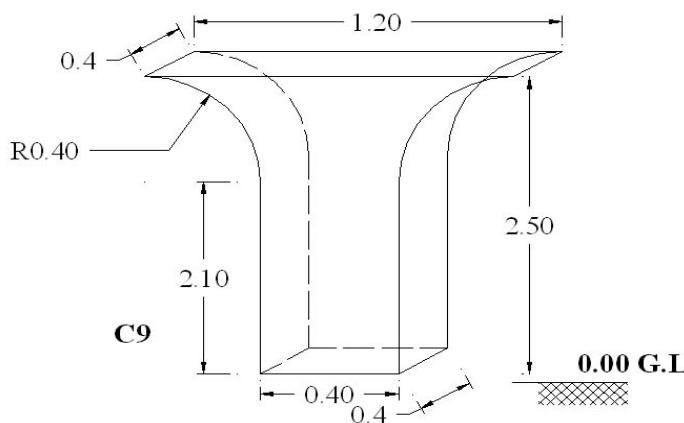
- Problem-9: For a given 'Y'-type Column with arch find
1. volume of concrete
  2. Area of Shuttering
  3. Area of paint

Solution:

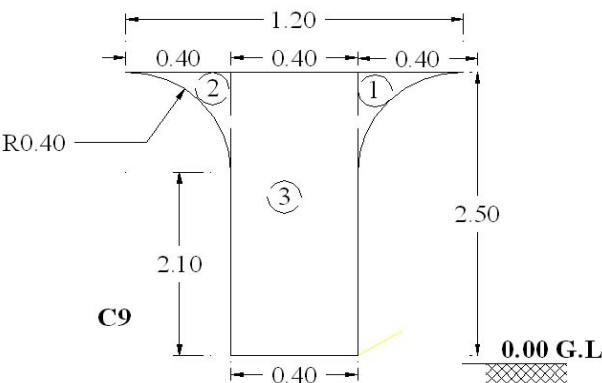
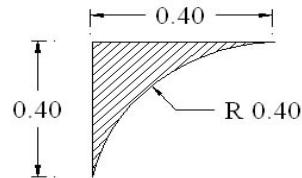
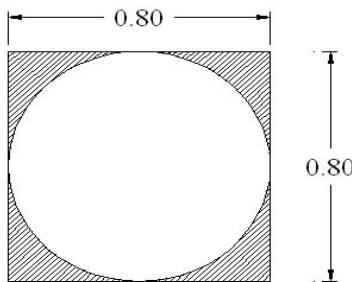
1. Volume of Concrete = Front Area x thickness of Column  

$$= 1.069 \times 0.40$$
  

$$= 0.4276 \text{ m}^3$$



To find out front area of Column, divide front area of column in to three parts



1. area of Square =  $L \times B = 0.80 \times 0.80$   
 $= 0.64 \text{ m}^2$

2. area of Circle =  $\pi/4 \times d^2$   
 $= \pi/4 \times 0.8^2$   
 $= 0.502 \text{ m}^2$

Deduction of circle area from square area

$$= 0.64 - 0.502$$

Area for four panels

$$= 0.138 \text{ m}^2$$

Area of each panel

$$= 0.138/4$$

$$= 0.0345 \text{ m}^2$$

Front area of column:

$$1. \text{ Part-1} = 0.0345 \text{ m}^2$$

$$2. \text{ Part-2} = 0.0345 \text{ m}^2$$

$$3. \text{ Part-3} = L \times B = 0.40 \times 2.50 = 1.0 \text{ m}^2$$

$$\text{total area} = 0.0345 + 0.0345 + 1.0 = 1.069 \text{ m}^2$$

2. Shuttering Area = front area of column + back area of column + side area of column + side area of column

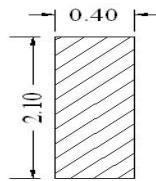
$$= 1.069 + 1.069 + 1.091 + 1.091$$

$$= 4.32 \text{ m}^2$$

therefore side area can be find out by dividing the side area in to two parts :

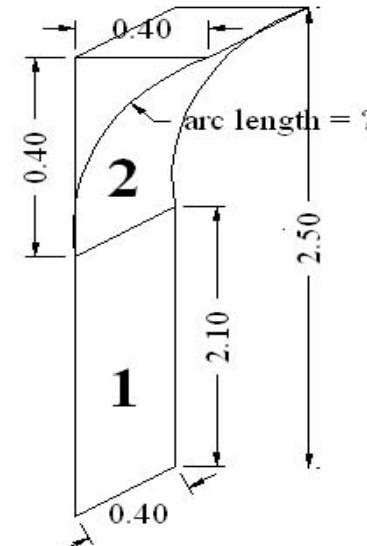
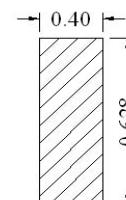
part-1:

$$\begin{aligned} \text{side area for part-1} &= L \times B \\ &= 0.40 \times 2.10 \\ &= 0.84 \text{ m}^2 \end{aligned}$$



part-2:

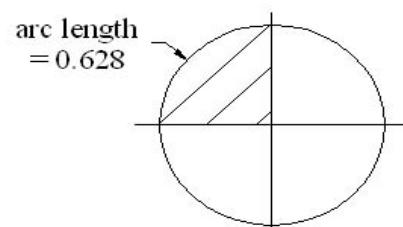
$$\begin{aligned} \text{side area for part-2} &= L \times B \\ &= 0.40 \times 0.628 \\ &= 0.251 \text{ m}^2 \end{aligned}$$



Formula to find out arc length for quarter circle :

$$\text{arc length} = 2 \times \pi \times r \times 1/4$$

$$\begin{aligned} &= 2 \times \pi \times 0.40 \times 0.25 \\ &= 0.628 \text{ m} \end{aligned}$$



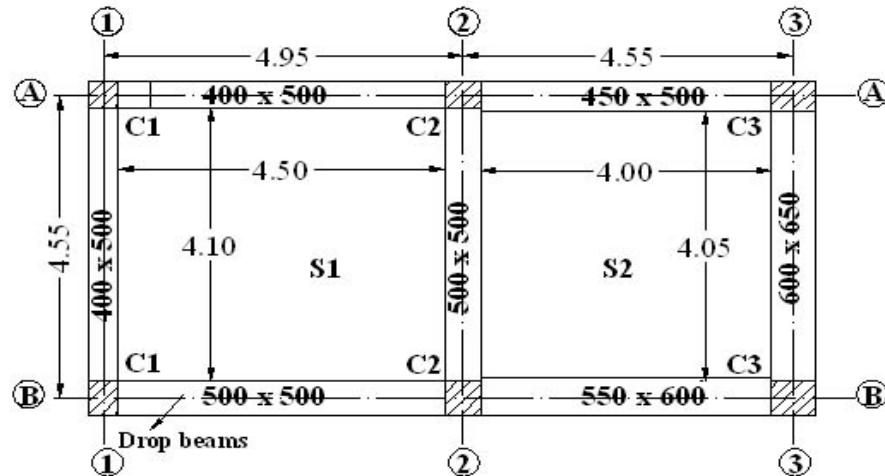
Hence total side area =  $A_1 + A_2$

$$\begin{aligned} &= 0.84 + 0.251 \\ &= 1.091 \text{ m}^2 \end{aligned}$$

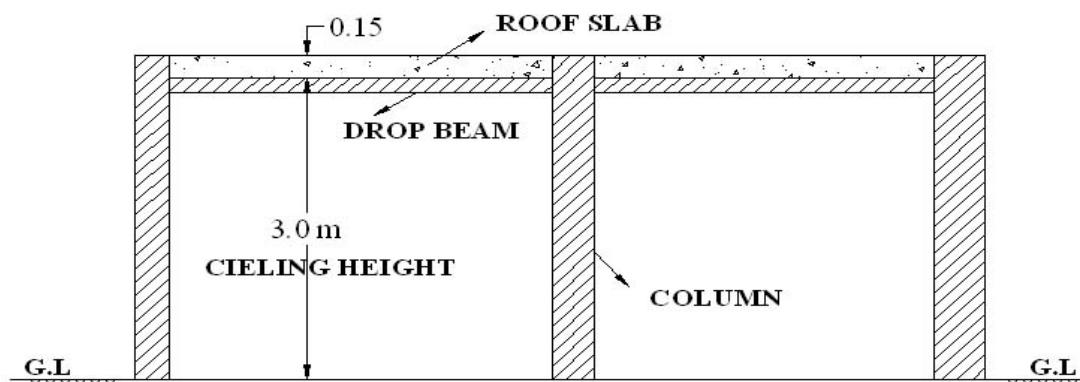
$$\begin{aligned} 3. \text{ Area of paint} &= \text{Area of Shuttering} \\ &= 4.322 \text{ m}^2 \end{aligned}$$

- Problem-10: For a given Roof frame find volume of concrete & area of shuttering for
1. Columns
  2. Drop Beams
  3. Roof Slabs

$$C1 = 0.40 \times 0.40; C2 = 0.50 \times 0.45; C3 = 0.45 \times 0.60$$



**PLAN SHOWING ROOF FRAME DETAILS**



**SECTION DWG.**

(i) Solution for Columns:

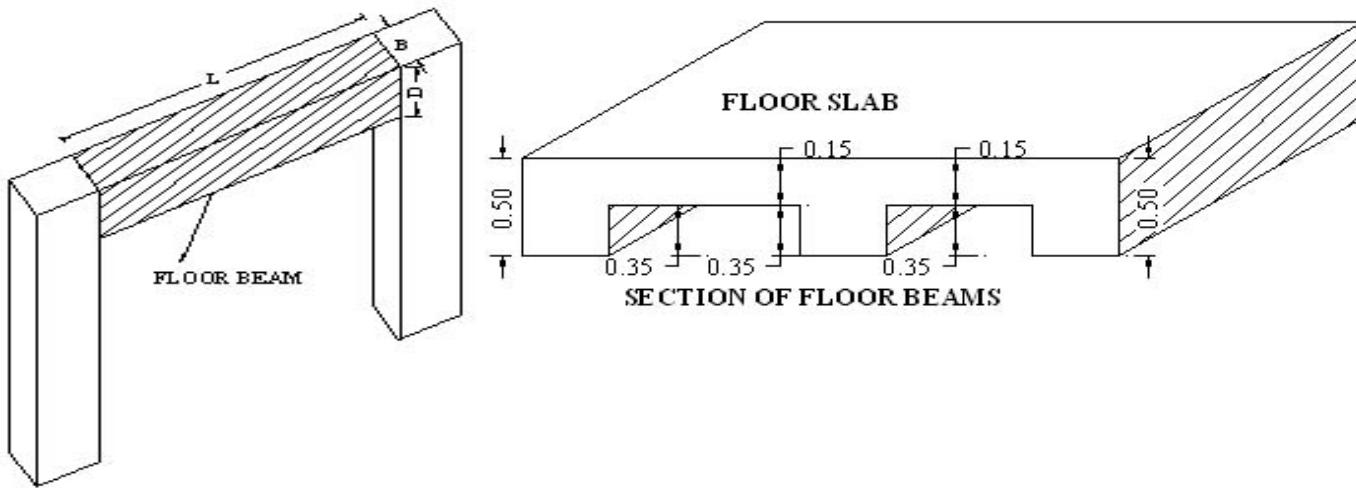
$$\begin{aligned}
 1. \text{ Volume of Concrete} &= \text{Area} \times \text{Depth} \times \text{no. of Columns} \\
 &= L \times B \times D \times \text{no.s} \\
 \text{Column-1} &= 0.40 \times 0.40 \times 3.15 \times 2 = 1.008 \text{ m}^3 \\
 \text{Column-2} &= 0.50 \times 0.45 \times 3.15 \times 2 = 1.417 \text{ m}^3 \\
 \text{Column-3} &= 0.45 \times 0.60 \times 3.15 \times 2 = 1.701 \text{ m}^3 \\
 \text{Total volume of concrete required for Floor columns} &= 4.126 \text{ m}^3
 \end{aligned}$$

$$\begin{aligned}
 2. \text{ Shuttering Area} &= \text{Peripheral length} \times \text{Depth} \times \text{no. of Columns} \\
 &= (L + B) \times 2 \times D \times \text{no.s} \\
 \text{Column-1} &= (0.40 + 0.40) \times 2 \times 3.0 \times 2 = 9.60 \text{ m}^2 \\
 \text{Column-2} &= (0.50 + 0.45) \times 2 \times 3.0 \times 2 = 11.40 \text{ m}^2 \\
 \text{Column-3} &= (0.45 + 0.60) \times 2 \times 3.0 \times 2 = 12.60 \text{ m}^2 \\
 \text{Total shuttering area required for Floor Columns} &= 33.60 \text{ m}^2
 \end{aligned}$$

Note : while calculating shuttering area for Columns, Height of column should be taken up to Ceiling Height, excluding Slab thickness.

(ii) Solution for Drop Beams:

$$\begin{aligned}
 1. \text{ Volume of Concrete for Drop beam} &= \text{Area} \times \text{Length} \times \text{no. of beams} \\
 &= L \times B \times D \\
 \text{a. Drop beam on axis-A between axis-1 and axis-2} &= 4.50 \times 0.40 \times 0.50 = 0.90 \text{ m}^3 \\
 \text{b. Drop beam on axis-A between axis-2 and axis-3} &= 4.00 \times 0.45 \times 0.50 = 0.90 \text{ m}^3 \\
 \text{c. Drop beam on axis-B between axis-1 and axis-2} &= 4.50 \times 0.50 \times 0.50 = 1.125 \text{ m}^3 \\
 \text{d. Drop beam on axis-B between axis-2 and axis-3} &= 4.00 \times 0.55 \times 0.60 = 1.32 \text{ m}^3 \\
 \text{e. Drop beam on axis-1 between axis-A and axis-B} &= 4.10 \times 0.40 \times 0.50 = 0.82 \text{ m}^3 \\
 \text{f. Drop beam on axis-2 between axis-A and axis-B} &= 4.10 \times 0.50 \times 0.50 = 1.025 \text{ m}^3 \\
 \text{g. Drop beam on axis-3 between axis-A and axis-B} &= 4.05 \times 0.60 \times 0.65 = 1.579 \text{ m}^3 \\
 \text{Total volume of Concrete for Drop beams} &= 7.669 \text{ m}^3
 \end{aligned}$$



2. Shuttering Area for Drop beams = Front area + back area + bottom area  

$$= L \times D + L \times D + L \times B$$

Note:

- (i) for finding out shuttering area for Drop beam, for internal beams, slab thickness is to be deducted from both side of beams, i.e. external and internal face.

Calculations:

- a. Drop beam on axis-A between axis-1 and axis-2  $= 4.50 \times 0.50 + 4.50 \times 0.35 + 4.5 \times 0.40 = 5.625 \text{ m}^2$   
 Note: for external Drop beams Slab thickness has to be deducted from depth of beam from internal face of beams
- b. Drop beam on axis-A between axis-2 and axis-3  $= 4.0 \times 0.50 + 4.0 \times 0.35 + 4.0 \times 0.45 = 5.20 \text{ m}^2$
- c. Drop beam on axis-B between axis-1 and axis-2  $= 4.50 \times 0.5 + 4.50 \times 0.35 + 4.50 \times 0.50 = 6.075 \text{ m}^2$
- d. Drop beam on axis-B between axis-2 and axis-3  $= 4.00 \times 0.60 + 4.0 \times 0.45 + 4.0 \times 0.55 = 6.40 \text{ m}^2$
- e. Drop beam on axis-1 between axis-A and axis-B  $= 4.10 \times 0.50 + 4.10 \times 0.35 + 4.10 \times 0.40 = 5.125 \text{ m}^2$
- f. Drop beam on axis-2 between axis-A and axis-B  $= 4.10 \times 0.35 + 4.10 \times 0.35 + 4.10 \times 0.50 = 4.92 \text{ m}^2$   
 Note: for internal Drop beams Slab thickness has to be deducted from depth of beam from both side of beams
- g. Drop beam on axis-3 between axis-A and axis-B  $= 4.05 \times 0.65 + 4.05 \times 0.50 + 4.05 \times 0.60 = 7.0875 \text{ m}^2$   
 Total Shuttering area for Drop beams  $= 40.432 \text{ m}^2$

(ii) Solution for Roof Slab:

$$1. \text{ Volume of Concrete} = \text{Area} \times \text{Depth}$$

$$\therefore = L \times B \times D$$

Slab-1 (S1)	$= 4.50 \times 4.10 \times 0.15 = 2.76 \text{ m}^3$
Slab-2 (S2)	$= 4.0 \times 4.05 \times 0.15 = 2.43 \text{ m}^3$
Total Volume	<u><math>= 5.19 \text{ m}^3</math></u>

$$2. \text{ Shuttering Area} = \text{Bottom area of Slab}$$

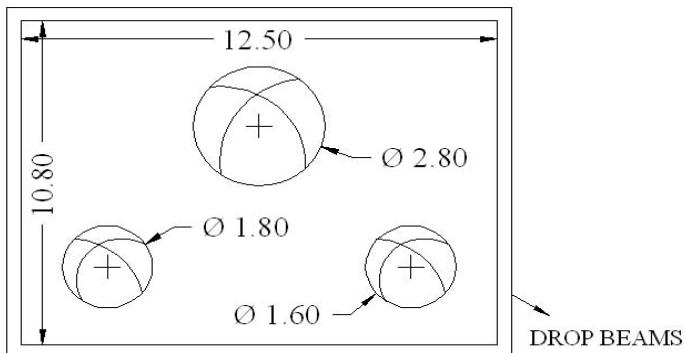
$$\therefore = L \times B$$

Slab-1 (S1)	$= 4.50 \times 4.10 = 18.45 \text{ m}^2$
Slab-2 (S2)	$= 4.00 \times 4.05 = 16.20 \text{ m}^2$

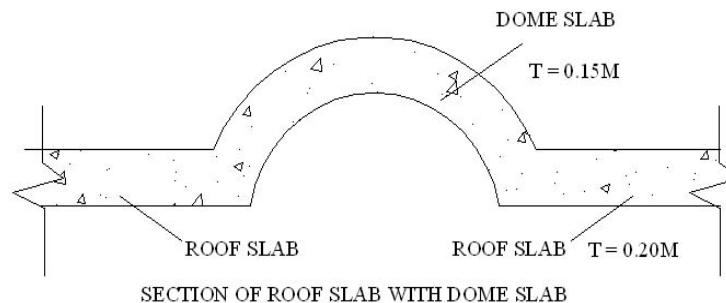
### **DOME SLAB CALCULATION**

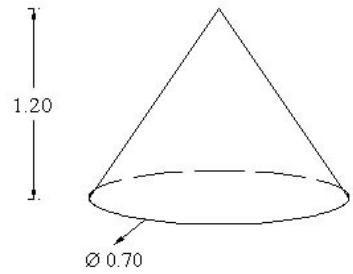
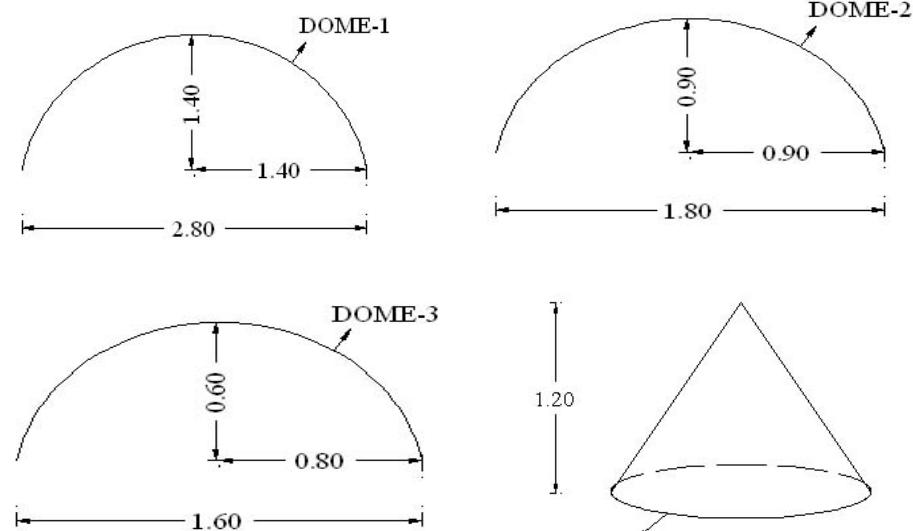
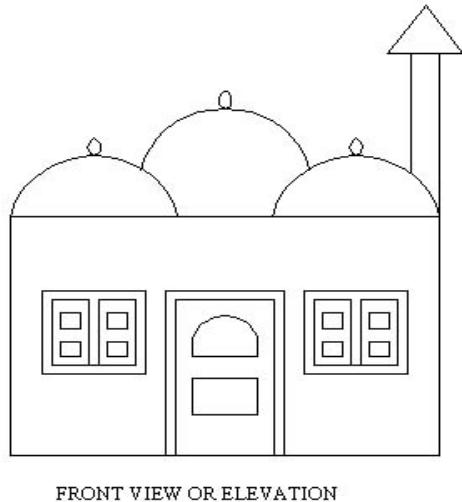
Problem-11: For a given Roof frame find volume of concrete & area of shuttering for

1. Roof Slab
2. Dome Slabs



PLAN SHOWING DETAILS OF ROOF SLAB WITH DOME SLAB





(A) Solution for Roof Slab :

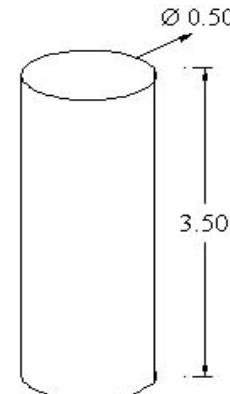
$$\begin{aligned} \text{1. Volume of Concrete} &= \text{Area} \times \text{Depth} \times \text{no. of Slabs} \\ &= L \times B \times D \times \text{no.s} \\ &= 12.50 \times 10.80 \times 0.20 \times 1 = 27.0 \text{ m}^3 \end{aligned}$$

Deduction of Dome area

$$\begin{aligned} \text{(i) Dome-1} &= \text{Area} \times \text{Depth} \\ &= \pi / 4 \times d^2 \times D \\ &= \pi / 4 \times 2.80^2 \times 0.20 \\ &= 1.231 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{(ii) Dome-2} &= \text{Area} \times \text{Depth} \\ &= \pi / 4 \times d^2 \times D \\ &= \pi / 4 \times 1.80^2 \times 0.20 \\ &= 0.508 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{(iii) Dome-3} &= \text{Area} \times \text{Depth} \\ &= \pi / 4 \times d^2 \times D \\ &= \pi / 4 \times 1.60^2 \times 0.20 \\ &= 0.402 \text{ m}^3 \end{aligned}$$



Cylinder details

$$\begin{aligned} \text{Total volume of concrete required} &= 27.0 - 1.231 - 0.508 - 0.402 \\ &= 24.859 \text{ m}^3 \end{aligned}$$

$$\begin{aligned}
 2. \text{ Shuttering area} &= (\text{Bottom area of floor slab} + \text{peripheral length of Dome-1} \times \text{Depth} + \text{peripheral length of Dome-2} \times \\
 &\quad \text{Depth} + \text{peripheral length of Dome-3} \times \text{Depth}) \\
 &= L \times B + 2 \times \pi \times r_1 \times D + 2 \times \pi \times r_2 \times D + 2 \times \pi \times r_3 \times D \\
 &= 12.50 \times 10.80 + 2 \times \pi \times 1.40 \times 0.20 + 2 \times \pi \times 0.90 \times 0.20 + 2 \times \pi \times 0.80 \times 0.20 \\
 &= 138.89 \text{ m}^2
 \end{aligned}$$

Deduction of Dome area

(i) Dome-1 = Bottom Area of Dome-1

$$\begin{aligned}
 &= \pi /4 \times d^2 \\
 &= \pi /4 \times 2.80^2 \\
 &= 6.157 \text{ m}^2
 \end{aligned}$$

(ii) Dome-2 = Bottom Area of Dome-2

$$\begin{aligned}
 &= \pi /4 \times d^2 \\
 &= \pi /4 \times 1.80^2 \\
 &= 2.544 \text{ m}^2
 \end{aligned}$$

(iii) Dome-3 = Bottom Area of Dome-3

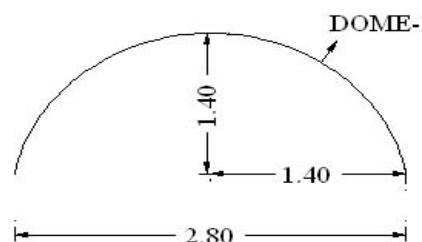
$$\begin{aligned}
 &= \pi /4 \times d^2 \\
 &= \pi /4 \times 1.60^2 \\
 &= 2.01 \text{ m}^2
 \end{aligned}$$

Total shuttering area required =  $138.89 - 6.157 - 2.544 - 2.01$

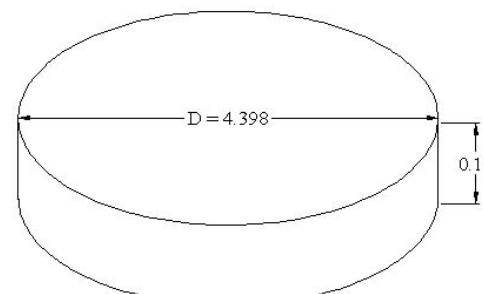
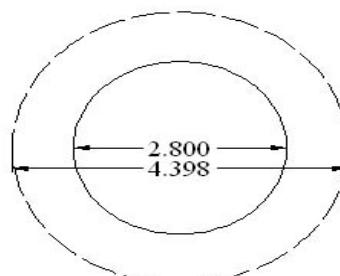
$$= 128.176 \text{ m}^2$$

#### (B) Solution for Dome Slabs :

##### Dome-1:



$$\begin{aligned}
 \text{semi-circle length} &= 2 \pi r \times 1/2 \\
 &= 2 \times \pi \times 1.40 \times 0.5 \\
 &= 4.398 \text{ m}
 \end{aligned}$$



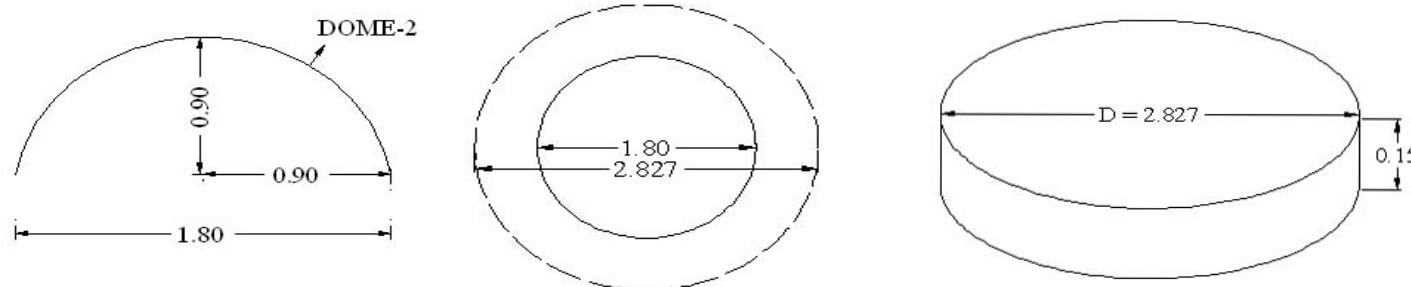
1. Volume of Concrete = Area x Depth

$$\begin{aligned}
 &= \pi /4 \times d^2 \times D \\
 &= \pi /4 \times 4.398^2 \times 0.15 \\
 &= 2.278 \text{ m}^3
 \end{aligned}$$

2. Shuttering area = bottom area of dome

$$\begin{aligned}
 &= \pi /4 \times d^2 \\
 &= \pi /4 \times 4.398^2 \\
 &= 15.191 \text{ m}^2
 \end{aligned}$$

Dome-2:



$$\begin{aligned}\text{semi-circle length} &= 2 \pi r \times 1/2 \\ &= 2 \times \pi \times 0.90 \times 0.5 \\ &= 2.827 \text{ m}\end{aligned}$$

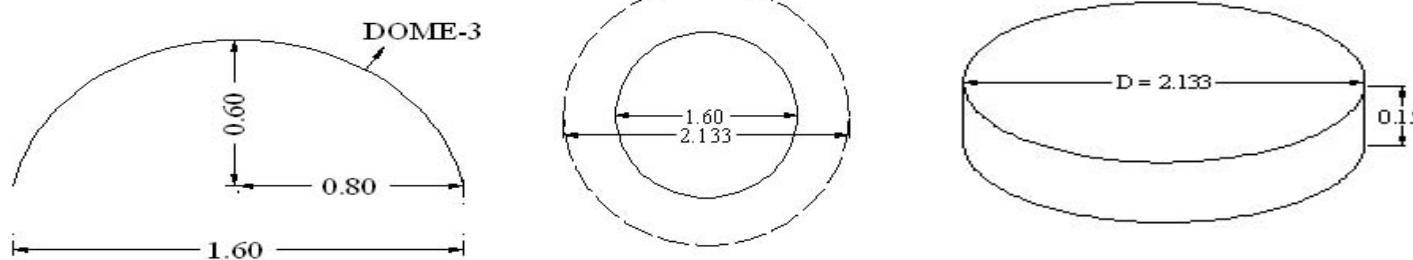
1. Volume of Concrete = Area x Depth

$$\begin{aligned}&= \pi /4 \times d^2 \times D \\ &= \pi /4 \times 2.827^2 \times 0.15 \\ &= 0.941 \text{ m}^3\end{aligned}$$

2. Shuttering area = bottom area of dome

$$\begin{aligned}&= \pi /4 \times d^2 \\ &= \pi /4 \times 2.827^2 \\ &= 6.276 \text{ m}^2\end{aligned}$$

Dome-3:



$$\begin{aligned}\text{Segmental arc length} &= (8B - 2R)/3 \\ \text{therefore } D &= 1.60 \text{ m} ; R = 0.80 \text{ m} ; H = 0.60 \text{ m}\end{aligned}$$

$$B = \sqrt{R^2 + H^2}$$

$$B = \sqrt{0.80^2 + 0.60^2}$$

$$B = 1.0$$

$$\begin{aligned}\text{Arc length 'L'} &= (8 \times 1.0 - 2 \times 0.80)/3 \\ &= 2.133 \text{ m}\end{aligned}$$

$$\begin{aligned}
 1. \text{ Volume of Concrete} &= \text{Area} \times \text{Depth} \\
 &= \pi /4 \times d^2 \times D \\
 &= \pi /4 \times 2.133^2 \times 0.15 \\
 &= 0.535 \text{ m}^3
 \end{aligned}$$

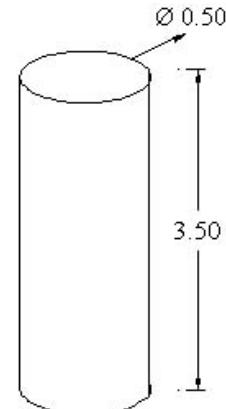
$$\begin{aligned}
 2. \text{ Shuttering area} &= \text{bottom area of dome} \\
 &= \pi /4 \times d^2 \\
 &= \pi /4 \times 2.133^2 \\
 &= 3.573 \text{ m}^2
 \end{aligned}$$

(B) Solution for Minaret :

#### Cylinder:

$$\begin{aligned}
 1. \text{ Volume of Concrete} &= \text{Area} \times \text{Depth} \\
 &= \pi /4 \times d^2 \times D \\
 &= \pi /4 \times 0.50^2 \times 3.50 \\
 &= 0.687 \text{ m}^3
 \end{aligned}$$

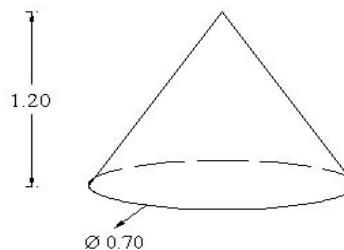
$$\begin{aligned}
 2. \text{ Shuttering Area} &= \text{Peripheral length} \times \text{depth} \\
 &= 2 \times \pi \times r \times D \\
 &= 2 \times \pi \times 0.25 \times 3.5 \\
 &= 5.497 \text{ m}^2
 \end{aligned}$$



#### Cone:

$$\begin{aligned}
 1. \text{ Volume of Concrete} &= \text{Area} \times \text{Depth} \times 1/3 \\
 &= \pi /4 \times d^2 \times D \times 1/3 \\
 &= \pi /4 \times 0.70^2 \times 1.20 \times 1/3 \\
 &= 0.153 \text{ m}^3
 \end{aligned}$$

$$\begin{aligned}
 2. \text{ Shuttering Area} &= \text{Peripheral length} \times \text{depth} \times 1/3 \\
 &= 2 \times \pi \times r \times D \times 1/3 \\
 &= 2 \times \pi \times 0.35 \times 1.20 \times 1/3 \\
 &= 0.879 \text{ m}^2
 \end{aligned}$$

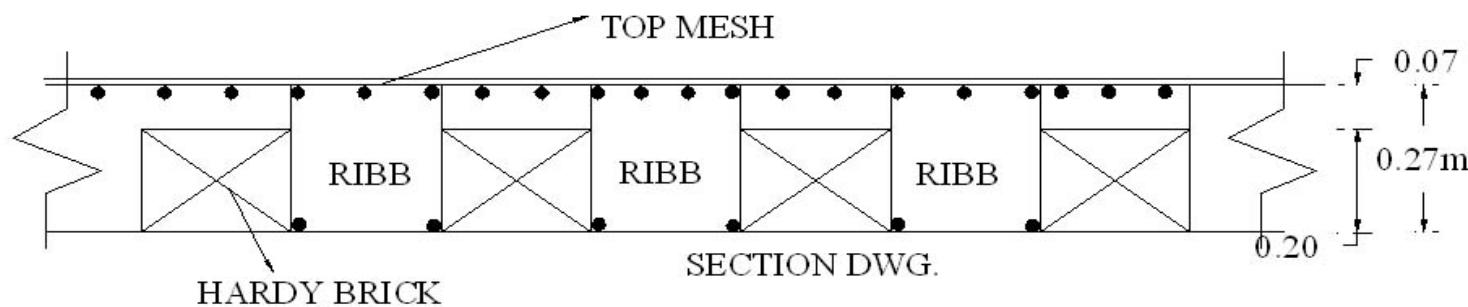
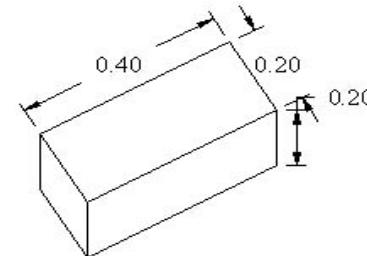
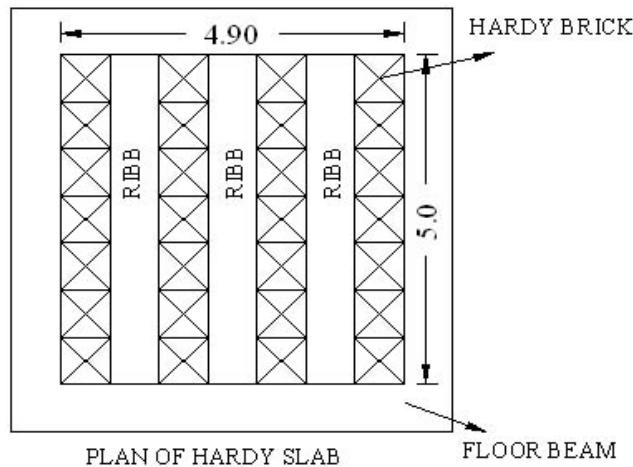




### HARDY SLAB CALCULATION

Problem-12: For a given drawing of Hardy Slab find

1. Volume of Concrete
2. Area of Shuttering



(A) Solution for Hardy Slab :

1. Volume of Concrete = Area x Depth  
.= L x B x D  
.=  $4.90 \times 5.0 \times 0.27 = 6.615 \text{ m}^3$

Deduction for the Hardy Bricks:

Volume of Hardy Brick = L x B x D x no. of Bricks  
.=  $0.40 \times 0.20 \times 0.20 \times 28$   
.=  $0.448 \text{ m}^3$

Total Volume of Concrete required =  $6.615 - 0.448$   
.=  $6.167 \text{ m}^3$

2. Shuttering Area = Bottom area of Slab  
.= L x B  
.=  $4.90 \times 5.0$   
.=  $24.50 \text{ m}^2$

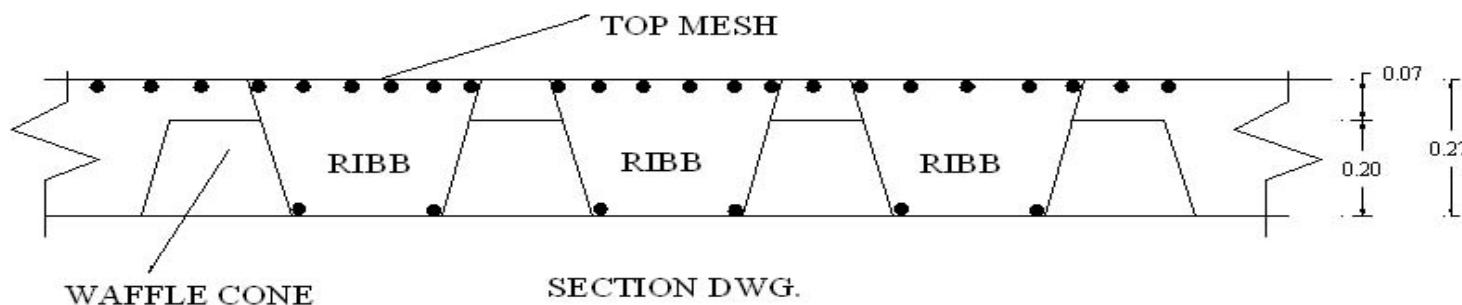
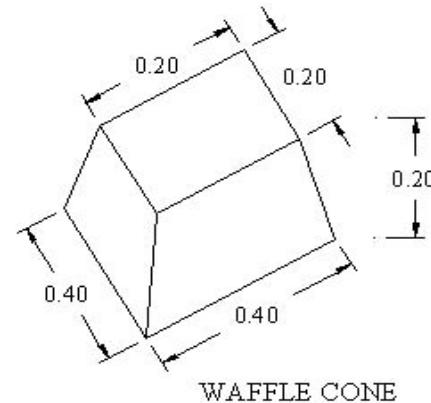
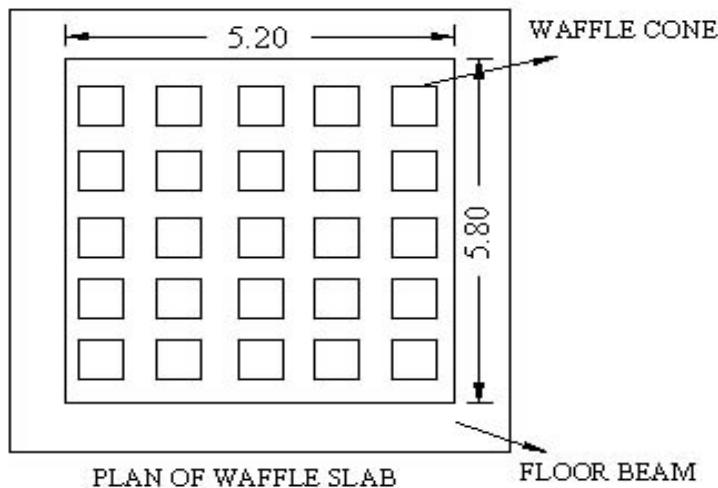


PICTURE SHOWING DETAILS OF HARDY SLAB & HARDY BRICKS PLACED ON SHUTTERING

### WAFFLE SLAB CALCULATION

Problem-13: For a given drawing of Waffle Slab find

1. Volume of Concrete
2. Area of Shuttering



(A) Solution for Waffle Slab :

$$\begin{aligned} \text{1. Volume of Concrete} &= \text{Area} \times \text{Depth} \\ &= L \times B \times D \\ &= 5.20 \times 5.80 \times 0.27 = 8.143 \text{ m}^3 \end{aligned}$$

Deduction for the Waffle Cone:

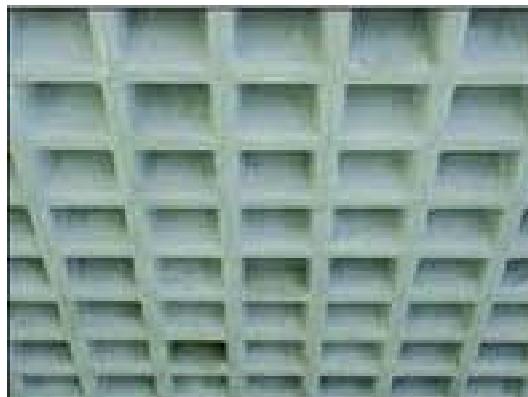
$$\begin{aligned} \text{Volume of Waffle Cone} &= L \times B \times D \times \text{no. of Cones} \\ &= 0.30 \times 0.30 \times 0.20 \times 25 \\ &= 0.45 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Total Volume of Concrete required} &= 8.1432 - 0.45 \\ &= 7.6932 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} L1 &= 0.20; B1 = 0.20 \\ L2 &= 0.40; B2 = 0.40 \\ \text{Average Length} &= (L1 + L2)/2 \\ &= (0.20 + 0.40)/2 \\ &= 0.30\text{m} \end{aligned}$$

$$\begin{aligned} \text{Average Breadth} &= (B1 + B2)/2 \\ &= (0.20 + 0.40)/2 \\ &= 0.30\text{m} \end{aligned}$$

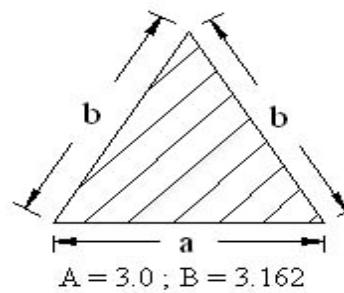
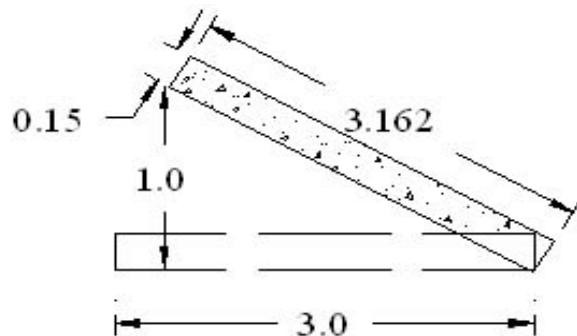
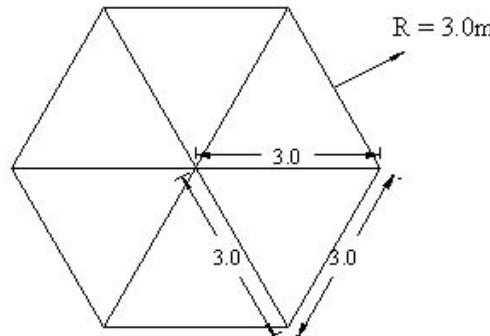
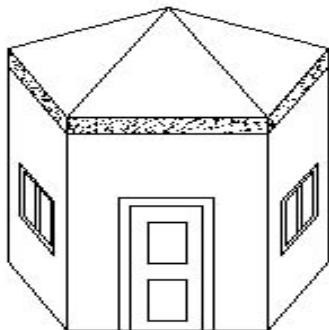
$$\begin{aligned} \text{2. Shuttering Area} &= \text{Bottom area of Slab} \\ &= L \times B \\ &= 5.20 \times 5.80 \\ &= 30.16 \text{ m}^2 \end{aligned}$$



### PITCH ROOF CALCULATION

Problem-14: For a given drawing of Pitch Roof find

1. Volume of Concrete
2. Area of Shuttering



$$c = \sqrt{3.0^2 + 1.0^2}$$

$$c = 3.162 \text{ m} \quad (\text{inclined length})$$

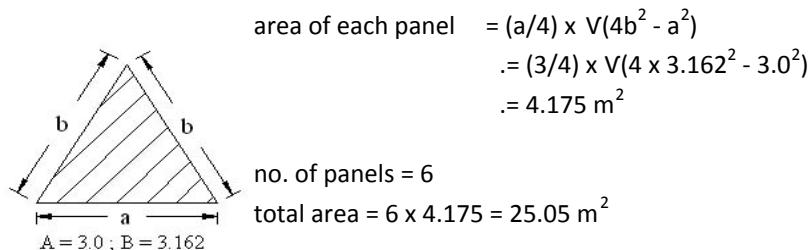
(A) Solution for Pitch Roof :

$$\begin{aligned}
 1. \text{ Volume of Concrete for each panel} &= \text{Area} \times \text{thickness of slab} \\
 &= (a/4) \times V(4b^2 - a^2) \times t \\
 &= (3/4) \times V(4 \times 3.162^2 - 3.0^2) \times 0.15 \\
 &= 4.175 \times 0.15 \\
 &= 0.626 \text{ m}^3
 \end{aligned}$$

no. of panels = 6

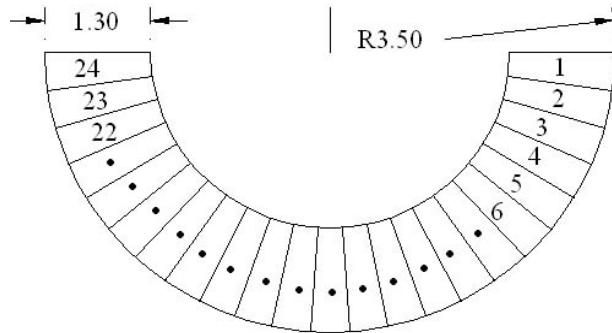
$$\text{total Volume of Concrete required} = 0.626 \times 6 = 3.756 \text{ m}^3$$

$$\begin{aligned}
 2. \text{ Shuttering Area} &= \text{Peripheral length} \times \text{thickness of slab} + \text{Bottom area of Slab} \\
 &= 6R \times t + \text{slab area} \\
 &= 6 \times 3.0 \times 0.15 + 25.05 \\
 &= 27.75 \text{ m}^2
 \end{aligned}$$



### SEMI-ROUND STAIR-CASE CALCULATION

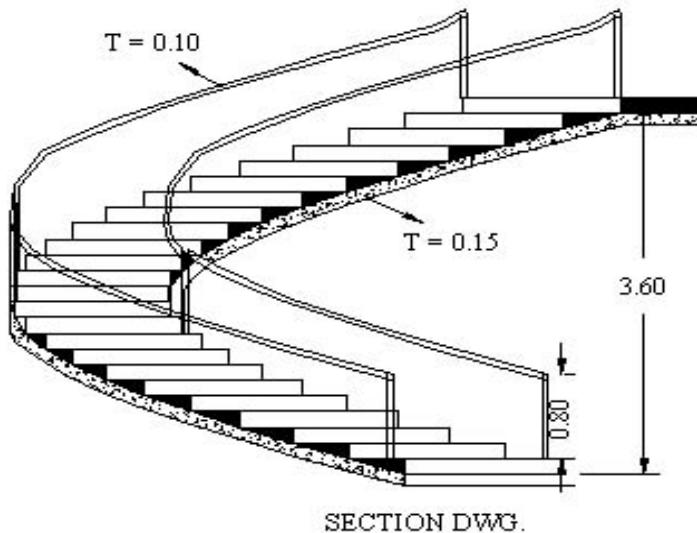
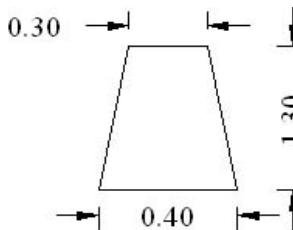
Problem-15: For a given drawing of Semi-round Stair-case find  
 1. Volume of Concrete  
 2. Area of Shuttering



PLAN OF HALF-ROUND STAIR CASE

Height of riser = 0.15m

Tread =



SECTION DWG.

Radius of waist Slab = 3.50m

Height of Ceiling = Height of Riser x No. of Riser

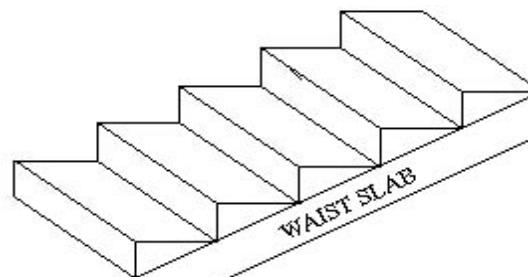
$$= 0.15 \times 24$$

$$= 3.60\text{m}$$

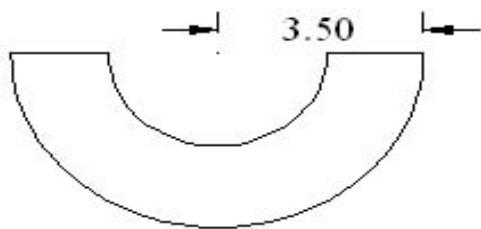
Waist Slab thickness = 0.15m

Width of Waist Slab = 1.30m

No. of Step = 24

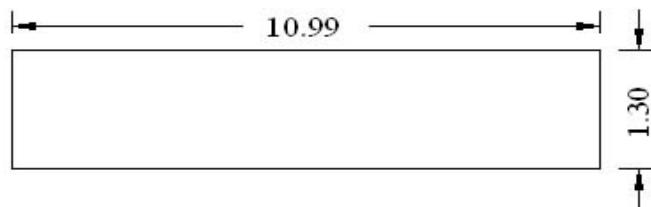


(A) Solution for stair case :

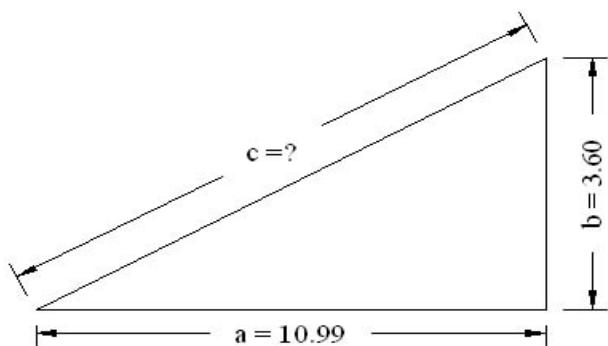


To find out semi-circle length the formula =  $2 \times \pi \times r \times 0.50$   
therefore radius of waist slab 'r' = 3.50m

$$\begin{aligned} &= 2 \times \pi \times 3.5 \times 0.50 \\ &= 10.99\text{m (linear length)} \end{aligned}$$



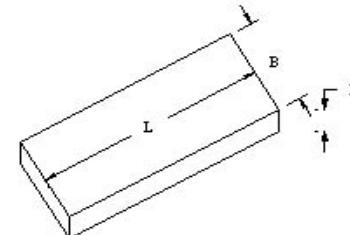
$$\begin{aligned} \text{Inclined length} &= \sqrt{(10.99^2 + 3.60^2)} \\ C &= 11.56\text{m} \end{aligned}$$



### **1. Waist Slab:**

(a) Volume of Concrete for waist slab

$$\begin{aligned}
 &= \text{Area} \times \text{thickness} \\
 &= L \times B \times D \\
 &= 11.56 \times 1.30 \times 0.15 \\
 &= 2.254 \text{ m}^3
 \end{aligned}$$



(b) Shuttering Area for waist slab

$$\begin{aligned}
 &= L \times D \times 2 + B \times D + L \times B \\
 &= 11.56 \times 0.15 \times 2 + 1.30 \times 0.15 + 11.56 \times 1.30 \\
 &= 18.691 \text{ m}^2
 \end{aligned}$$

### **2. Steps:**

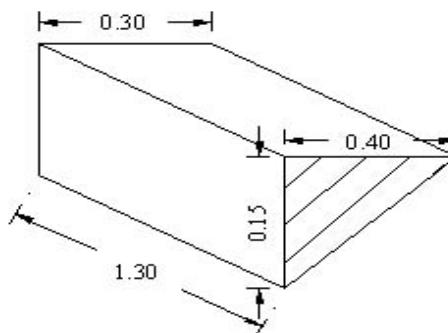
length of step = 1.30m

width of tread = 0.30m on one side and 0.40m on other side

Average width of riser =  $(0.30 + 0.40)/2$

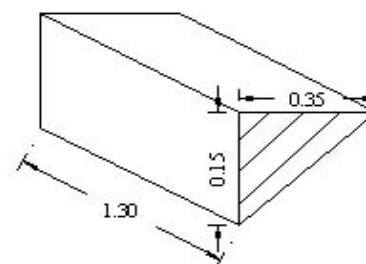
$$B = 0.35\text{m}$$

Height of Riser = 0.15m



(a) Volume of Concrete for Step

$$\begin{aligned}
 &= \text{Area} \times \text{length of step} \times \text{no. of steps} \\
 &= 1/2 \times b \times h \times L \times \text{no. of steps} \\
 &= 0.50 \times 0.35 \times 0.15 \times 1.3 \times 24 \\
 &= 0.819 \text{ m}^3
 \end{aligned}$$



(b) Shuttering area for Step

$$\begin{aligned}
 &= (1/2 \times B \times H \times 2 + L \times D) \times \text{no.s} \\
 &= (0.50 \times 0.35 \times 0.15 \times 2 + 1.30 \times 0.15) \times 24 \\
 &= 5.94 \text{ m}^2
 \end{aligned}$$

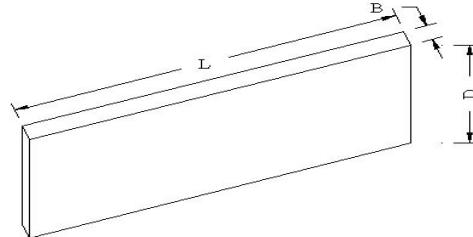
### 3. Hand-Rail :

therefore  $L = 11.56\text{m}$

$B = 0.10\text{m}$

$D = 0.80\text{m}$

no.s = 2



(a) Volume of Concrete for Hand-Rail       $= \text{area} \times \text{depth} \times \text{no. of Hand rails}$

$$= L \times B \times D \times \text{no.s}$$

$$= 11.56 \times 0.10 \times 0.80 \times 2$$

$$= 1.849 \text{ m}^3$$

(b) Shuttering area for Hand-Rail       $= (L+B) \times 2 \times D \times \text{no.s}$

$$= (11.56 + 0.10) \times 2 \times 0.80 \times 2$$

$$= 37.312 \text{ m}^2$$

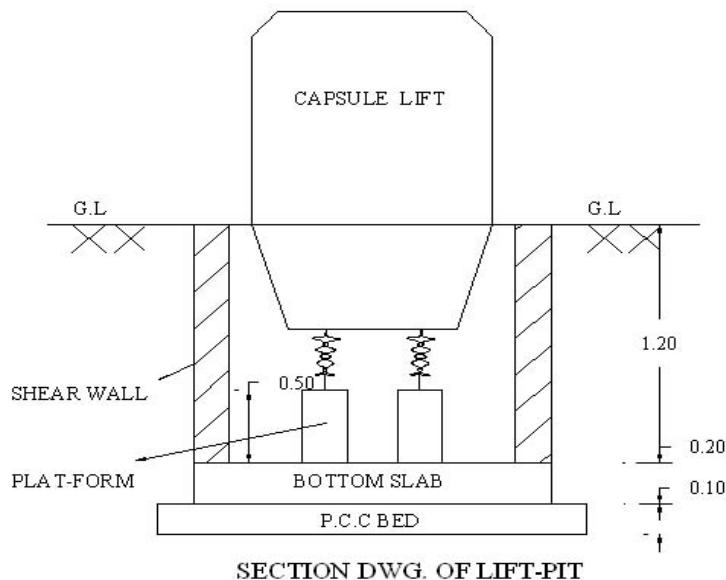
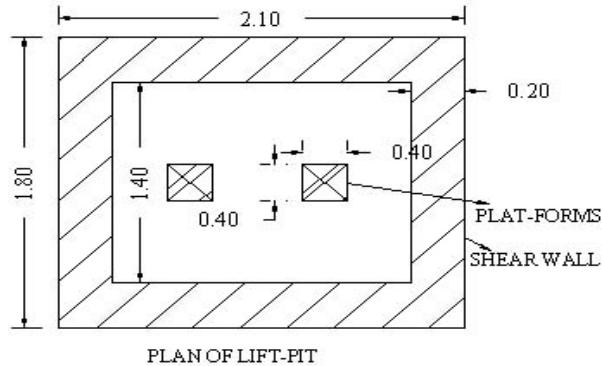
(i) Total Concrete for stair case       $= 2.254 + 0.819 + 1.849$   
 $= 4.922 \text{ m}^3$

(ii) Total Shuttering area for stair-case       $= 18.691 + 5.94 + 37.312$   
 $= 61.943 \text{ m}^2$

### LIFT-PIT CALCULATION

Problem-15: For a given drawing of Lift-Pit find

1. Volume of Concrete
2. Area of Shuttering



(A) Solution for Lift-Pit :

**1. Plain Cement Concrete Bed :**

$$L = 2.30m ; B = 2.0m ; T = 0.10m$$

(a) Volume of Concrete for p.c.c bed

$$\begin{aligned} &= \text{area} \times \text{thickness of p.c.c bed} \\ &= L \times B \times D \\ &= 2.30 \times 2.0 \times 0.10 \\ &= 0.46 \text{ m}^3 \end{aligned}$$

(b) Shuttering area for p.c.c bed

$$\begin{aligned} &= (L+B) \times 2 \times D \\ &= (2.30 + 2.0) \times 2 \times 0.10 \\ &= 0.86 \text{ m}^2 \end{aligned}$$

**2. Bottom slab :**

$$L = 2.10m ; B = 1.80m ; T = 0.20m$$

(a) Volume of Concrete for Bottom slab

$$\begin{aligned} &= \text{area} \times \text{thickness of bottom slab} \\ &= L \times B \times D \\ &= 2.10 \times 1.80 \times 0.20 \\ &= 0.756 \text{ m}^3 \end{aligned}$$

(b) Shuttering area for Bottom slab

$$\begin{aligned} &= (L+B) \times 2 \times D \\ &= (2.10 + 1.80) \times 2 \times 0.20 \\ &= 1.56 \text{ m}^2 \end{aligned}$$

**3. Shear wall along Horizontal plane :**

$$L = 2.10m ; B = 0.20m ; H = 1.20 m$$

(a) Volume of Concrete for Shear wall

$$\begin{aligned} &= \text{area} \times \text{depth} \times \text{no. of walls} \\ &= L \times B \times D \times \text{no.s} \\ &= 2.10 \times 0.20 \times 1.20 \times 2 \\ &= 1.008 \text{ m}^3 \end{aligned}$$

(b) Shuttering area for Shear wall                    $.= L \times D \times 2 \times \text{no.s}$   
 $.= 2.10 \times 1.20 \times 2 \times 2$   
 $.= 10.08 \text{ m}^2$

#### **4. Shear wall along vertical plane :**

$$L = 1.40\text{m} ; B = 0.20\text{m} ; H = 1.20 \text{ m}$$

(a) Volume of Concrete for Shear wall                    $.= \text{area} \times \text{depth} \times \text{no. of walls}$   
 $.= L \times B \times D \times \text{no.s}$   
 $.= 1.40 \times 0.20 \times 1.20 \times 2$   
 $.= 0.672 \text{ m}^3$

(b) Shuttering area for Shear wall                    $.= L \times D \times 2 \times \text{no.s}$   
 $.= 1.40 \times 1.20 \times 2 \times 2$   
 $.= 6.72 \text{ m}^2$

#### **5. Plat-forms :**

$$L = 0.40\text{m} ; B = 0.40\text{m} ; H = 0.50 \text{ m}$$

(a) Volume of Concrete for Plat-form                    $.= \text{area} \times \text{depth} \times \text{no. of plat-forms}$   
 $.= L \times B \times D \times \text{no.s}$   
 $.= 0.40 \times 0.40 \times 0.50 \times 2$   
 $.= 0.16 \text{ m}^3$

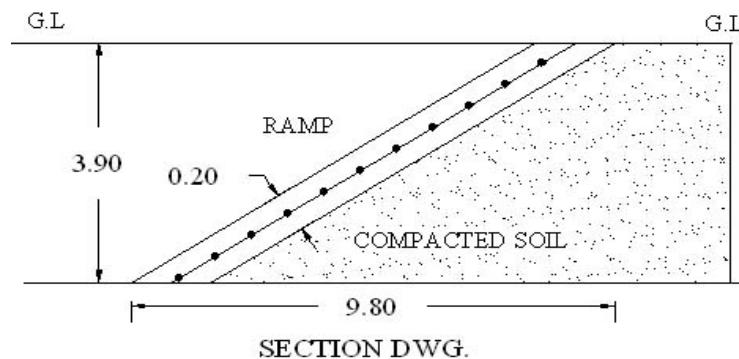
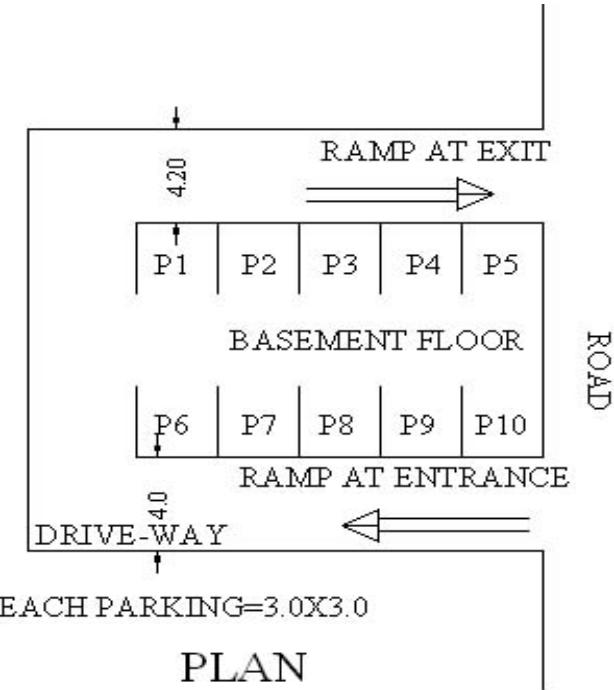
(b) Shuttering area for Plat-form                    $.= (L + B) \times 2 \times D \times \text{no.s}$   
 $.= (0.40 + 0.40) \times 2 \times 0.50 \times 2$   
 $.= 1.60 \text{ m}^2$

(i) Total Volume of Concrete for Lift-Pit                    $.= 0.46 + 0.756 + 1.008 + 0.672 + 0.16 = 3.056 \text{ m}^3$   
(ii) Total Shuttering area for Lift-Pit                    $.= 0.86 + 1.56 + 10.08 + 6.72 + 1.60 = 20.82 \text{ m}^2$

### RAMP CALCULATION

Problem-15: For a given drawing of Ramp find

1. Volume of Concrete
2. Area of Shuttering



(A) Solution for Ramp :

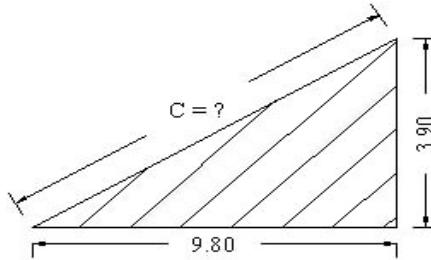
1. Ramp at entrance:

$$L = 10.547 \text{ m} ; B = 4.0 \text{ m} ; T = 0.20 \text{ m}$$

$$c = \sqrt{a^2 + b^2}$$

$$c = \sqrt{(9.80^2 + 3.90^2)}$$

$$c = 10.547 \text{ m}$$



(a) Volume of Concrete for Ramp

$$= \text{area} \times \text{thickness of Ramp}$$

$$= L \times B \times D$$

$$= 10.547 \times 4.0 \times 0.20$$

$$= 8.437 \text{ m}^3$$

(b) Shuttering area for p.c.c bed

$$= (L+B) \times 2 \times D$$

$$= (10.547 + 4.0) \times 2 \times 0.20$$

$$= 5.81 \text{ m}^2$$

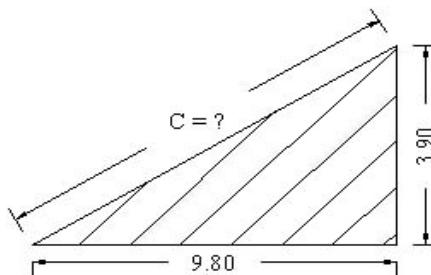
2. Ramp at exit:

$$L = 10.547 \text{ m} ; B = 4.20 \text{ m} ; T = 0.20 \text{ m}$$

$$c = \sqrt{a^2 + b^2}$$

$$c = \sqrt{(9.80^2 + 3.90^2)}$$

$$c = 10.547 \text{ m}$$



(a) Volume of Concrete for Ramp

$$\begin{aligned}
 &= \text{area} \times \text{thickness of Ramp} \\
 &= L \times B \times D \\
 &= 10.547 \times 4.20 \times 0.20 \\
 &= 8.859 \text{ m}^3
 \end{aligned}$$

(b) Shuttering area for p.c.c bed

$$\begin{aligned}
 &= (L+B) \times 2 \times D \\
 &= (10.547 + 4.20) \times 2 \times 0.20 \\
 &= 5.89 \text{ m}^2
 \end{aligned}$$

- (i) Total Concrete for both Ramps =  $8.437 + 8.859 = 17.296 \text{ m}^3$
- (ii) Total Shuttering area for both Ramps =  $5.81 + 5.89 = 11.70 \text{ m}^2$

#### STANDARD DATA IN METRIC SYSTEM

1 Cement : Mortar Required for Brick work/ $\text{m}^3$

2 Cement : Mortar Required for Plastering/ $\text{m}^3$

3 Concrete-Mix Design with different proportion & ratios/ $\text{m}^3$

(a)

Cement : Mortar required for Brick Work (for $1\text{m}^3$ of Brick work)					
S.no	Proportion or ratio	Sand in in $\text{m}^3$	Cement in Kgs	Cement in Bags	Cement in $\text{m}^3$
1	. 1:3	0.20	96.00	1.920	0.066
2	. 1:4	0.20	72.00	1.440	0.050
3	. 1:5	0.20	57.60	1.152	0.040
4	. 1:6	0.20	48.00	0.960	0.033
5	. 1:7	0.20	41.14	0.822	0.028
6	. 1:8	0.20	36.00	0.720	0.025

**Cement in  $\text{m}^3$ :**

$$\begin{aligned}
 1440 \text{ kgs} &= 1\text{m}^3 \\
 96.0 \text{ kgs} &= ? \text{m}^3 \\
 96.0 / 1440 & \\
 &= 0.066 \text{ m}^3
 \end{aligned}$$

For  $1\text{m}^3$  of C:M      Sand =  $0.20 \text{ m}^3$  Constant for all proportion

For  $1\text{m}^3$  of C:M      Cement in kgs =  $(0.20 \times 1440) / \text{last digit of ratio or proportion}$

$$\begin{aligned}
 &= 0.20 \times 1440 / 3 \\
 &= 96.0 \text{ kgs}
 \end{aligned}$$

therefore each bag of cement = 50kgs

Cement in Bags

$$\begin{aligned}
 &= 96.0 / 50 \\
 &= 1.92 \text{ bags}
 \end{aligned}$$

**Standard Weight & Density**

- 1 Weight of Cement in kgs/m<sup>3</sup> .= 1440 kgs
- 2 Weight of each Cement Bag .= 50 kgs
- 3 No. of Cement bags /m<sup>3</sup> .= 1440/50  
.= 28.80 or approximately equal to 29 bags
- 4 Weight of Sand /m<sup>3</sup> .= 1600kgs to 1750 kgs. Sand weight varies depending on condition i.e. Dry or Moisturizing
- 5 Weight of Aggregate /m<sup>3</sup> .= 2400 kgs
- 6 Weight of Water / m<sup>3</sup> .= 1000 kgs
- 7 Weight of Water /litre .= 1 kg
- 8 Density of Concrete /m<sup>3</sup> .= 2400 kgs
- 9 Density of Steel /m<sup>3</sup> .= 7850 kgs
- 10 Density of Brick .= 1.92 grms/cm<sup>3</sup> (Normal clay) or 2.42 grms/cm<sup>3</sup> (Fine Clay)
- 11 Weight of Concrete /m<sup>3</sup> .= 2500 kgs to 2800 kgs (R.C.C)
- 12 M<sub>15</sub> = 1:2:4

Where M<sub>15</sub> = Grade of Concrete

1 ton = 1000 kgs

M= Mix-Design

1 quintal = 100 kgs

15 = Compressive Strength of Concrete

1 kg = 1000 grms

1 = 1 bag of Cement

2 = 2 bags of Sand

4 = 4 bags of Aggregate

(b)

Cement : Mortar required for Plastering (for 1m <sup>3</sup> of C:M for Plastering)					
S.no	Proportion or ratio	Sand in	Cement	Cement	Cement
		in m <sup>3</sup>	in Kgs	in Bags	in m <sup>3</sup>
1	. 1:3	1.25	600.00	12.0	0.417
2	. 1:4	1.25	450.00	9.0	0.313
3	. 1:5	1.25	360.00	7.2	0.250
4	. 1:6	1.25	300.00	6.0	0.208
5	. 1:7	1.25	257.14	5.143	0.179
6	. 1:8	1.25	225.00	4.5	0.156

Cement in m<sup>3</sup> :

1440 kgs = 1m<sup>3</sup>

600.0 kgs = ? m<sup>3</sup>

600.0/1440

.= 0.4166 m<sup>3</sup>

For 1m<sup>3</sup> of C:M Sand = 1.25 m<sup>3</sup> Constant for all proportion

For 1m<sup>3</sup> of C:M Cement in kgs = (1.25 x 1440)/last digit of ratio or proportion

$$.= 1.25 \times 1440/3$$

$$.= 600.0 \text{ kgs}$$

therefore each bag of cement = 50kgs

Cement in Bags .= 600/50 .= 12 bags

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Phone no. : +91 40 66710031; +91 9550259317; website: [www.quantitysurveyindia.com](http://www.quantitysurveyindia.com)

**General Practice :**

Plastering is done in two coats i.e. 1<sup>st</sup> coat & 2<sup>nd</sup> coat

1<sup>st</sup> coat is called as Rough Coat with Cement : Mortar ratio 1:6

2<sup>nd</sup> Coat is called as Finish Coat with Cement : Mortar ratio 1:3

Total thickness of Plaster should be consider as 20mm or 2cm or 0.02 m

thickness for 1<sup>st</sup> coat of plaster . = 12mm

thickness for 2<sup>nd</sup> coat of plaster . = 8mm

total thickness .= 20mm

(c)

Cement, Sand & Aggregate required for different Grades of Concrete /m <sup>3</sup>							
S.no	Grade of Concrete	Ratio of Concrete	Sand in m <sup>3</sup>	Aggregate in m <sup>3</sup>	Cement in Kgs	Cement in Bags	Cement in m <sup>3</sup>
1	M <sub>7.5</sub>	. 1:4:8	0.46	0.92	165.6	3.312	0.115
2	M <sub>10</sub>	. 1:3:6	0.46	0.92	220.8	4.416	0.153
3	M <sub>15</sub>	. 1:2:4	0.46	0.92	331.2	6.624	0.230
4	M <sub>20</sub>	. 1:1.5:3	0.46	0.92	441.6	8.832	0.307
5	M <sub>25</sub>	. 1:1:2	0.46	0.92	662.4	13.248	0.460
6	M <sub>30</sub>	.1:0.75:1.5	0.46	0.92	883.2	17.664	0.613
7	M <sub>35</sub>	. 1:0.5:1	0.46	0.92	1324.8	26.496	0.920
8	M <sub>40</sub>	.1:0.25:0.5	0.46	0.92	2649.6	52.992	1.840

For 1m<sup>3</sup> of Concrete Sand = 0.46 m<sup>3</sup> Constant for all proportion

For 1m<sup>3</sup> of Concrete Aggregate = 0.92 m<sup>3</sup> Constant for all proportion

For 1m<sup>3</sup> of Concrete Cement in kgs = (0.92 x 1440)/last digit of ratio or proportion

$$.= 0.92 \times 1440/8$$

$$.= 165.60 \text{ kgs}$$

Each bag of cement = 50kgs

Therefore Cement in Bags .= 165.60/50  
.= 3.312 bags

Cement in m<sup>3</sup> :

$$1440 \text{ kgs} = 1\text{m}^3$$

$$165.60 \text{ kgs} = ? \text{m}^3$$

$$165.60/1440$$

$$.= 0.115 \text{ m}^3$$

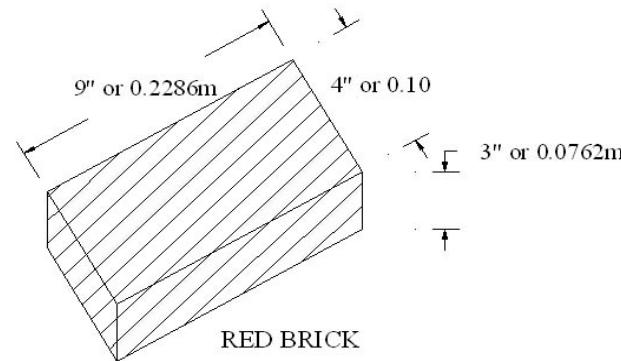
### Brick Work Calculations & problems

#### A. Indian Red Brick

$$\begin{aligned}\text{Size of Brick} &= 9'' \times 4'' \times 3'' \\ &= 0.2286m \times 0.10m \times 0.0762m\end{aligned}$$

$$\text{Volume of each Brick} = 0.001741 \text{ m}^3$$

$$\begin{aligned}\text{no. of bricks / m}^3 &= \frac{\text{total Volume of brick work}}{\text{Volume of each Brick}} \\ &= 1/0.001741 \\ &= 574.38 \text{ or approximately equal to 575 bricks}\end{aligned}$$

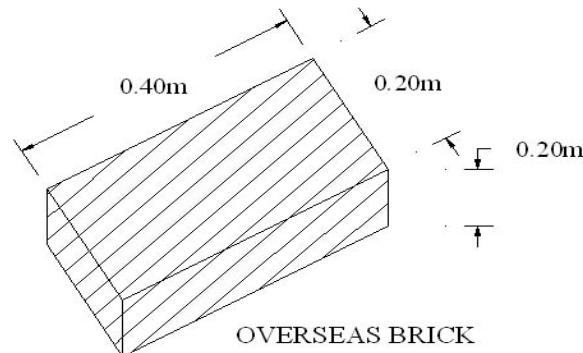


#### B. Overseas Bricks

$$\text{Size of each Brick} = 0.40m \times 0.20m \times 0.20m$$

$$\text{Volume of each Brick} = 0.016 \text{ m}^3$$

$$\begin{aligned}\text{no. of bricks / m}^3 &= \frac{\text{total Volume of brick work}}{\text{Volume of each Brick}} \\ &= 1/0.016 \\ &= 62.50 \text{ or approximately equal to 63 bricks}\end{aligned}$$



#### Problem-1:

For an area of  $160 \text{ m}^2$  with wall thickness 10 cm find

- (i) No. of bricks
- (ii) C:M required for Brick work with ratio 1:6

#### Solution

$$1. \text{ volume of brick work} = \text{Area} \times \text{thickness}$$

$$\begin{aligned}&= 160 \times 0.10 \\ &= 16 \text{ m}^3\end{aligned}$$

$$\begin{aligned} \text{2. No. of bricks} &= \frac{\text{Total volume of brick work}}{\text{Volume of each brick}} \\ &= \frac{16}{0.001741} \\ &= 9190.12 \text{ or approximately equal to 9191 bricks} \end{aligned}$$

3. C:M required for Brick work:

$$\begin{aligned} \text{(i) Sand} &= 1m^3 = 0.20 m^3 \\ 16 m^3 &= ? m^3 \\ &= 16 \times 0.20 \\ &= 3.20 m^3 \end{aligned}$$

$$\begin{aligned} \text{(ii) Cement} &= 1m^3 = (0.20 \times 1440)/6 \\ 1 m^3 &= 48 \text{ kgs} \\ 16 m^3 &= ? m^3 \\ &= 16 \times 48 \\ &= 768 \text{ kgs} \end{aligned}$$

$$\begin{aligned} \text{no. of Cement bags} &= 768 / 50 \\ &= 15.36 \text{ or approximately equal to 16 bags} \end{aligned}$$

### Problem-2:

For an area of  $1800 \text{ ft}^2$  with wall thickness 20 cm find

- (i) No. of bricks
- (ii) C:M required for Brick work with ratio 1:5

### Solution

$$\begin{aligned} \text{1. volume of brick work} &= \text{Area} \times \text{thickness} \\ &= 167.311 \times 0.20 \\ &= 33.462 m^3 \end{aligned}$$

$$\begin{aligned} 1800 \text{ ft}^2 &= ? m^2 \\ \text{therefore } 1m &= 3.28 \text{ ft} \\ &= 1800/3.28^2 \\ &= 167.311 m^2 \end{aligned}$$

$$\begin{aligned} \text{2. No. of bricks} &= \frac{\text{Total volume of brick work}}{\text{Volume of each brick}} \\ &= \frac{33.462}{0.001741} \\ &= 19219.98 \text{ or approximately equal to 19220 bricks} \end{aligned}$$

3. C:M required for Brick work:

$$\begin{aligned} \text{(i) Sand} &= 1\text{m}^3 = 0.20\text{ m}^3 \\ &33.462\text{ m}^3 = ?\text{ m}^3 \\ &.= 33.462 \times 0.20 \\ &.= 6.692\text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{(ii) Cement} &= 1\text{m}^3 = (0.20 \times 1440)/5 \\ &1\text{ m}^3 = 57.6\text{ kgs} \\ &33.462\text{ m}^3 = ?\text{ m}^3 \\ &.= 33.462 \times 57.60 \\ &.= 1927.41\text{ kgs} \end{aligned}$$

$$\begin{aligned} \text{no. of Cement bags} &= 1927.41 / 50 \\ &.= 38.548 \text{ or approximately equal to } 39 \text{ bags} \end{aligned}$$

### Problem-3:

For a given plan find

- (i) No. of bricks
  - (ii) C:M required for Brick work with ratio 1:5
- $$D = 1.0 \times 2.10$$
- Height of Ceiling = 3.0 m

### Solution

$$\text{Length of wall} = 'L' = 5.40 \times 2 + 4.0 \times 2 = 18.80\text{m}$$

$$L = 18.80\text{ m}$$

$$B = 0.20\text{ m}$$

$$D = 3.0\text{ m}$$

$$1 \quad \text{volume of brick work} = \text{Area} \times \text{thickness}$$

$$\begin{aligned} &.= 18.80 \times 0.20 \times 3.0 \\ &.= 11.28\text{ m}^3 \end{aligned}$$

$$\text{Deduction of Door} = L \times B \times D = 1.0 \times 2.10 \times 0.20 = -0.42\text{ m}^3$$

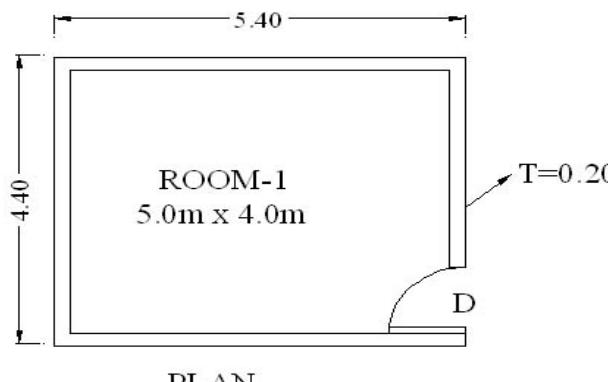
$$\text{Deduction of Door Lintel} = L \times B \times D = 1.20 \times 0.10 \times 0.20 = -0.024\text{ m}^3$$

Note:

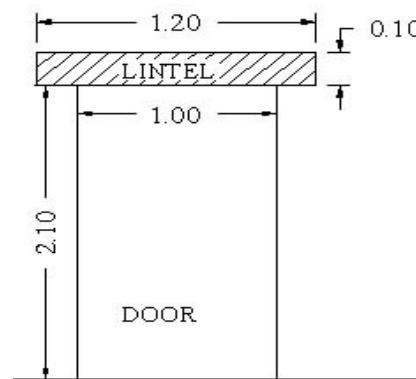
$$\text{Breadth of Lintel} = \text{thickness of wall} = 0.20\text{ m}$$

for Lintel Dimension 10cm bearing should be added on each side of length of Door and Height of lintel = 0.10m

$$\text{Total Volume of brick work after deductions} = 11.28 - 0.42 - 0.024 = 10.836\text{ m}^3$$



PLAN



2 No. of bricks =  $\frac{\text{Total volume of brick work}}{\text{Volume of each brick}}$

$$= \frac{10.836}{0.001741}$$

$$= 6224.009 \text{ or approximately equal to 6225 bricks}$$

3 C:M required for Brick work:

(i) Sand =  $1\text{m}^3 = 0.20\text{ m}^3$   
 $10.836\text{ m}^3 = ?\text{ m}^3$   
 $= 10.836 \times 0.20$   
 $= 2.167\text{ m}^3$

(ii) Cement =  $1\text{m}^3 = (0.20 \times 1440)/5$   
 $1\text{ m}^3 = 57.6\text{ kgs}$   
 $10.836\text{ m}^3 = ?\text{ m}^3$   
 $= 10.836 \times 57.60$   
 $= 624.153\text{ kgs}$

no. of Cement bags =  $624.153/ 50$   
 $= 12.48 \text{ or approximately equal to 13 bags}$

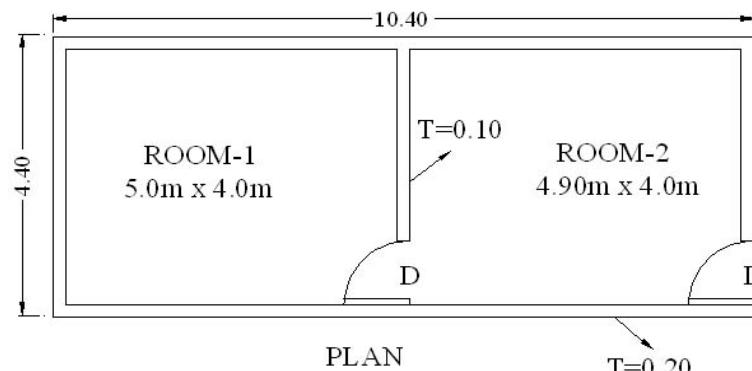
#### Problem-4:

For a given plan find

- (i) No. of bricks
- (ii) C:M required for Brick work with ratio 1:6  
 $D = 1.0 \times 2.10$   
 Height of Ceiling = 3.0 m

Solution :

- (i) for External wall or 20cm wall  
 $\text{Length of wall} = 'L' = 10.40 \times 2 + 4.0 \times 2 = 28.80\text{m}$   
 $L = 28.80\text{ m}$        $B = 0.20\text{ m}$        $D = 3.0\text{ m}$



volume of brick work for 20cm wall =  $\text{Area} \times \text{thickness}$   
 $= L \times B \times D$   
 $= 28.80 \times 0.20 \times 3.0$   
 $= 17.28\text{ m}^3$

(ii) for internal wall or 10cm wall

Length of wall = ' L ' = 4.0m

$$L = 4.0 \text{ m} \quad B = 0.10 \text{ m} \quad D = 3.0 \text{ m}$$

volume of brick work for 10cm wall = Area x thickness

$$\begin{aligned} &= L \times B \times D \\ &= 4.0 \times 0.10 \times 3.0 \\ &= 1.20 \text{ m}^3 \end{aligned}$$

(iii) Total Volume of Brick work =  $17.28 + 1.20 = 18.48 \text{ m}^3$

Deduction of Door =  $L \times B \times D \times \text{no.s} = 1.0 \times 2.10 \times 0.20 \times 1 = -0.42 \text{ m}^3$

Deduction of Door =  $L \times B \times D \times \text{no.s} = 1.0 \times 2.10 \times 0.10 \times 1 = -0.21 \text{ m}^3$

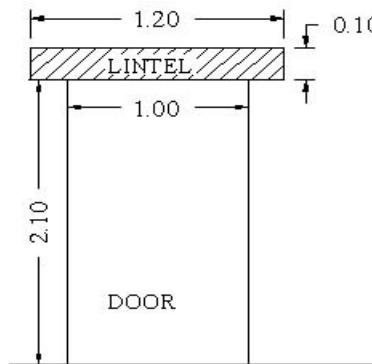
Deduction of Door Lintel =  $L \times B \times D \times \text{no.s} = 1.20 \times 0.10 \times 0.20 \times 1 = -0.024 \text{ m}^3$

Deduction of Door Lintel =  $L \times B \times D \times \text{no.s} = 1.20 \times 0.10 \times 0.10 \times 1 = -0.012 \text{ m}^3$

Note:

Breadth of Lintel = thickness of wall = 0.20 m

for Lintel Dimension 10cm bearing should be added on each side of length of Door and Height of lintel = 0.10m



Total Volume of brick work after deductions =  $18.48 - 0.42 - 0.21 - 0.024 - 0.012 = 17.814 \text{ m}^3$

(iv) No. of bricks = total volume of brick work

Volume of each brick

$$= 17.814 / 0.001741$$

= 10232.05 or approximately equal to 10233 bricks

(v) C:M required for Brick work:

(i) Sand =  $1 \text{ m}^3 = 0.20 \text{ m}^3$

$$17.814 \text{ m}^3 = ? \text{ m}^3$$

$$= 17.814 \times 0.20$$

$$= 3.562 \text{ m}^3$$

(ii) Cement =  $1 \text{ m}^3 = (0.20 \times 1440) / 6$

$$1 \text{ m}^3 = 48 \text{ kgs}$$

$$17.814 \text{ m}^3 = ? \text{ m}^3$$

$$= 17.814 \times 48$$

$$= 855.072 \text{ kgs}$$

no. of Cement bags =  $855.072 / 50$

= 17.101 or approximately equal to 18 bags

## Plastering Calculations & problems

### Problem-1:

For an area of 120 m<sup>2</sup> find C:M required for plastering

- (i) 1st coat with c:m ratio 1:6
- (ii) 2nd coat with c:m ration 1:3

### Solution

(i) 1st coat of plaster: thickness of plaster = 12mm or 0.012m C:M = 1:6

volume of C:M for Plastering = Area of plaster x thickness of plaster

$$\begin{aligned} &= 120 \times 0.012 \\ &= 1.44 \text{ m}^3 \end{aligned}$$

Cement : Mortar required for plastering:

#### a. Sand :

$$\begin{aligned} 1\text{m}^3 &= 1.25 \text{ m}^3 \\ 1.44 \text{ m}^3 &= ? \text{ m}^3 \\ &= 1.44 \times 1.25 \\ &= 1.80 \text{ m}^3 \end{aligned}$$

#### b. Cement :

$$\begin{aligned} 1\text{m}^3 &= (1.25 \times 1440)/6 \\ 1\text{m}^3 &= 300 \text{ kgs} \\ 1.44 \text{ m}^3 &= ? \text{ Kgs} \\ &= 1.44 \times 300 \\ &= 432.0 \text{ kgs} \\ \text{no. of cement bags} &= 432/50 = 8.64 \text{ or } 9 \text{ bags} \end{aligned}$$

(ii) 2nd coat of plaster: thickness of plaster = 8mm or 0.008m C:M = 1:3

volume of C:M for Plastering = Area of plaster x thickness of plaster

$$\begin{aligned} &= 120 \times 0.008 \\ &= 0.96 \text{ m}^3 \end{aligned}$$

Cement : Mortar required for plastering:

#### a. Sand :

$$\begin{aligned} 1\text{m}^3 &= 1.25 \text{ m}^3 \\ 0.96 \text{ m}^3 &= ? \text{ m}^3 \\ &= 0.96 \times 1.25 \\ &= 1.20 \text{ m}^3 \end{aligned}$$

#### b. Cement :

$$\begin{aligned} 1\text{m}^3 &= (1.25 \times 1440)/3 \\ 1\text{m}^3 &= 600 \text{ kgs} \\ 0.96 \text{ m}^3 &= ? \text{ Kgs} \\ &= 0.96 \times 600 \\ &= 576.0 \text{ kgs} \\ \text{no. of cement bags} &= 576/50 = 11.52 \text{ or } 12 \text{ bags} \end{aligned}$$

total Sand required = 1.80 + 1.20 = 3.0 m<sup>3</sup>

Total Cement required = 9 + 12 = 21 bags

**Problem-2:**

For an area of 2400 Sft find C:M required for plastering

- (i) 1st coat with c:m ratio 1:5
- (ii) 2nd coat with c:m ration 1:3

**Solution**

(i) 1st coat of plaster: thickness of plaster = 12mm or 0.012m      C:M = 1:5

$$\text{volume of C:M for Plastering} = \text{Area of plaster} \times \text{thickness of plaster}$$

$$= 223.08 \times 0.012$$

$$= 2.676 \text{ m}^3$$

$$\left| \begin{array}{l} 2400 \text{ ft}^2 = ? \text{ m}^2 \\ 1\text{m} = 3.28\text{ft} \\ = 2400/3.28^2 \\ = 223.08 \text{ m}^2 \end{array} \right.$$

Cement : Mortar required for plastering:

a. Sand :

$$1\text{m}^3 = 1.25 \text{ m}^3$$

$$2.676 \text{ m}^3 = ? \text{ m}^3$$

$$= 2.676 \times 1.25$$

$$= 3.345 \text{ m}^3$$

b. Cement :

$$1\text{m}^3 = (1.25 \times 1440)/5$$

$$1\text{m}^3 = 360 \text{ kgs}$$

$$2.676 \text{ m}^3 = ? \text{ Kgs}$$

$$= 2.676 \times 360$$

$$= 963.36 \text{ kgs}$$

$$\text{no. of cement bags} = 963.36/50 = 19.267 \text{ or } 20 \text{ bags}$$

(ii) 2nd coat of plaster: thickness of plaster = 8mm or 0.008m      C:M = 1:3

$$\text{volume of C:M for Plastering} = \text{Area of plaster} \times \text{thickness of plaster}$$

$$= 223.08 \times 0.008$$

$$= 1.784 \text{ m}^3$$

Cement : Mortar required for plastering:

a. Sand :

$$1\text{m}^3 = 1.25 \text{ m}^3$$

$$1.784 \text{ m}^3 = ? \text{ m}^3$$

$$= 1.784 \times 1.25$$

$$= 2.23 \text{ m}^3$$

b. Cement :

$$1\text{m}^3 = (1.25 \times 1440)/3$$

$$1\text{m}^3 = 600 \text{ kgs}$$

$$1.784 \text{ m}^3 = ? \text{ Kgs}$$

$$= 1.784 \times 600$$

$$= 1070.40 \text{ kgs}$$

$$\text{no. of cement bags} = 1070.40/50 = 21.40 \text{ or } 22 \text{ bags}$$

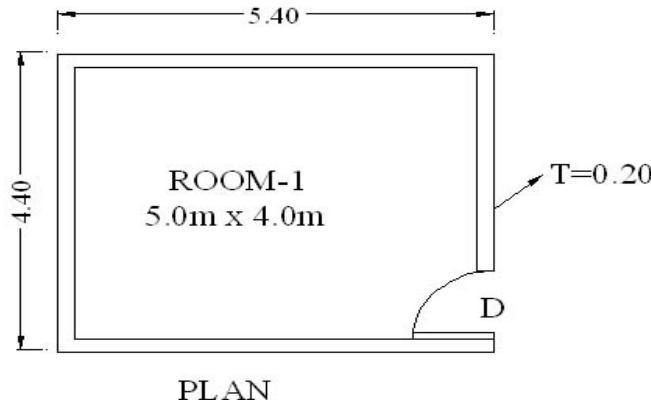
$$\text{total Sand required} = 3.345 + 2.23 = 5.575 \text{ m}^3$$

$$\text{Total Cement required} = 20 + 22 = 42 \text{ bags}$$

**Problem-3:**

For a given plan find

- a Area of plastering excluding ceiling area
- b C:M required for plastering
  - (i) 1st coat with c:m ratio 1:5
  - (ii) 2nd coat with c:m ration 1:3
  - (iii) Ceiling height = 3.0m
  - (iv) Slab thickness = 0.15 m
  - (v) Door ' D ' = 1.0 x 2.10



**Solution**

a. Area of plastering:

$$(i) \text{ Internal Plaster area} = \text{Peripheral Length} \times \text{Depth}$$

$$= (L + B) \times 2 \times D$$

$$= (5.0 + 4.0) \times 2 \times 3.0$$

$$= 54.0 \text{ m}^2$$

Deduction of door area =  $L \times D = 1.0 \times 2.10 = -2.10$   
 total internal plaster area =  $54.0 - 2.10 = 51.90 \text{ m}^2$

(ii) External Plaster area = Peripheral Length x Depth

$$= (L + B) \times 2 \times D$$

$$= (5.4 + 4.4) \times 2 \times 3.15$$

$$= 61.74 \text{ m}^2$$

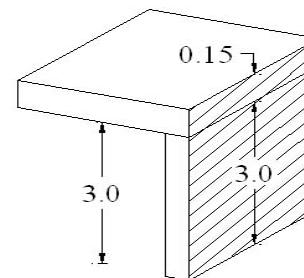
Deduction of door area =  $L \times D = 1.0 \times 2.10 = -2.10$   
 total external plaster area =  $61.74 - 2.10 = 59.64 \text{ m}^2$

Note: while finding external plaster area, Slab thickness has to be added with Ceiling height

(iii) Total Plaster area =  $51.90 + 59.64 = 111.54 \text{ m}^2$

b. C:M required for plastering:

(i) 1st coat of plaster: thickness of plaster = 12mm or 0.012m      C:M = 1:5  
 volume of C:M for Plastering = Area of plaster x thickness of plaster  
 $= 111.54 \times 0.012$   
 $= 1.338 \text{ m}^3$



Cement : Mortar required for plastering:

a. Sand :

$$\begin{aligned}1m^3 &= 1.25 m^3 \\1.338 m^3 &= ? m^3 \\&= 1.338 \times 1.25 \\&= 1.672 m^3\end{aligned}$$

b. Cement :

$$\begin{aligned}1m^3 &= (1.25 \times 1440)/5 \\1m^3 &= 360 \text{ kgs} \\1.338 m^3 &= ? \text{ Kgs} \\&= 1.338 \times 360 \\&= 481.68 \text{ kgs} \\ \text{no. of cement bags} &= 481.68/50 = 9.633 \text{ or } 10 \text{ bags}\end{aligned}$$

- (ii) 2nd coat of plaster: thickness of plaster = 8mm or 0.008m C:M = 1:3  
volume of C:M for Plastering = Area of plaster x thickness of plaster  
 $= 111.54 \times 0.008$   
 $= 0.892 m^3$

Cement : Mortar required for plastering:

a. Sand :

$$\begin{aligned}1m^3 &= 1.25 m^3 \\0.892 m^3 &= ? m^3 \\&= 0.892 \times 1.25 \\&= 1.115 m^3\end{aligned}$$

b. Cement :

$$\begin{aligned}1m^3 &= (1.25 \times 1440)/3 \\1m^3 &= 600 \text{ kgs} \\0.892 m^3 &= ? \text{ Kgs} \\&= 0.892 \times 600 \\&= 535.20 \text{ kgs} \\ \text{no. of cement bags} &= 535.20/50 = 10.704 \text{ or } 11 \text{ bags}\end{aligned}$$

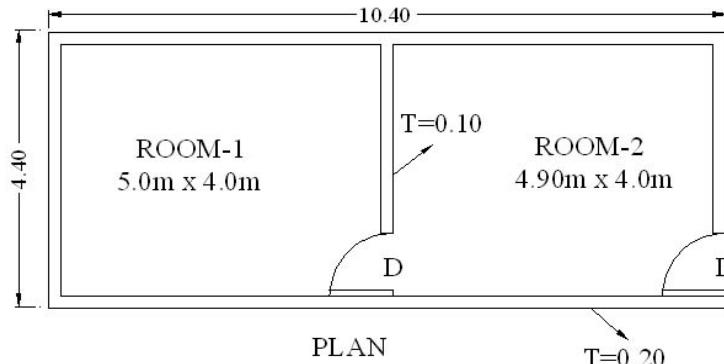
total Sand required =  $1.672 + 1.115 = 2.787 m^3$

Total Cement required =  $10 + 11 = 21$  bags

**Problem-4:**

For a given plan find

- a Area of plastering excluding ceiling area
- b C:M required for plastering
- (i) 1st coat with c:m ratio 1:5
- (ii) 2nd coat with c:m ration 1:3
- (iii) Ceiling height = 3.0m
- (iv) Slab thickness = 0.15 m
- (v) Door ' D ' =  $1.0 \times 2.10$



**Solution**

a. Area of plastering:

$$(i) \text{ Internal Plaster area} = \text{Peripheral Length} \times \text{Depth}$$

$$\text{Room-1} \quad . = (L + B) \times 2 \times D$$

$$. = (5.0 + 4.0) \times 2 \times 3.0$$

$$. = 54.0 \text{ m}^2$$

$$\text{Room-2} \quad . = (L + B) \times 2 \times D$$

$$. = (4.90 + 4.0) \times 2 \times 3.0$$

$$. = 53.40 \text{ m}^2$$

$$(ii) \text{ External Plaster area} = \text{Peripheral Length} \times \text{Depth}$$

$$. = (L + B) \times 2 \times D$$

$$. = (10.4 + 4.4) \times 2 \times 3.15$$

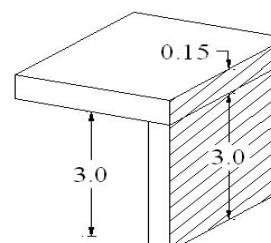
$$. = 93.24 \text{ m}^2$$

$$(iii) \text{ Deduction of door area} = L \times D \times \text{no.s} = 1.0 \times 2.10 \times 4 = -8.40 \text{ m}^2$$

Door area has to be deducted from both side i.e. front side & back side

$$\text{total plaster area} = 54.0 + 53.40 + 93.24 - 8.40 = 192.24 \text{ m}^2$$

Note: while finding external plaster area, Slab thickness has to be added with Ceiling height



- b. C:M required for plastering:
- (i) 1st coat of plaster: thickness of plaster = 12mm or 0.012m C:M = 1:5  
volume of C:M for Plastering = Area of plaster x thickness of plaster  
.=  $192.24 \times 0.012$   
.=  $2.306 \text{ m}^3$

Cement : Mortar required for plastering:

a. Sand :

$$\begin{aligned} 1\text{m}^3 &= 1.25 \text{ m}^3 \\ 2.306 \text{ m}^3 &= ? \text{ m}^3 \\ .&= 2.306 \times 1.25 \\ .&= 2.88 \text{ m}^3 \end{aligned}$$

b. Cement :

$$\begin{aligned} 1\text{m}^3 &= (1.25 \times 1440)/5 \\ 1\text{m}^3 &= 360 \text{ kgs} \\ 2.306 \text{ m}^3 &= ? \text{ Kgs} \\ .&= 2.306 \times 360 \\ .&= 830.16 \text{ kgs} \\ \text{no. of cement bags} &= 830.16/50 = 16.60 \text{ or } 17 \text{ bags} \end{aligned}$$

- (ii) 2nd coat of plaster: thickness of plaster = 8mm or 0.008m C:M = 1:3  
volume of C:M for Plastering = Area of plaster x thickness of plaster  
.=  $192.24 \times 0.008$   
.=  $1.537 \text{ m}^3$

Cement : Mortar required for plastering:

a. Sand :

$$\begin{aligned} 1\text{m}^3 &= 1.25 \text{ m}^3 \\ 1.537 \text{ m}^3 &= ? \text{ m}^3 \\ .&= 1.537 \times 1.25 \\ .&= 1.921 \text{ m}^3 \end{aligned}$$

b. Cement :

$$\begin{aligned} 1\text{m}^3 &= (1.25 \times 1440)/3 \\ 1\text{m}^3 &= 600 \text{ kgs} \\ 1.537 \text{ m}^3 &= ? \text{ Kgs} \\ .&= 1.537 \times 600 \\ .&= 922.20 \text{ kgs} \\ \text{no. of cement bags} &= 922.20/50 = 18.44 \text{ or } 19 \text{ bags} \end{aligned}$$

$$\text{total Sand required} = 2.88 + 1.921 = 4.801 \text{ m}^3$$

$$\text{Total Cement required} = 17 + 19 = 36 \text{ bags}$$

### Emulsion Paint or Water Bond-Paint for walls ( Calculations & problems)

#### Problem-1:

For a given plan find

- a Area of Paint
- b Emulsion Paint required in litres
- (i) Ceiling height = 3.0m
- (ii) Slab thickness = 0.15 m
- (iii) Door ' D ' = 1.0 x 2.10

#### Solution

a. Area of Emulsion Paint :

$$\begin{aligned} \text{(i) Internal Paint area} &= \text{Peripheral Length} \times \text{Depth} \\ &= (L + B) \times 2 \times D \\ &= (5.0 + 4.0) \times 2 \times 3.0 \\ &= 54.0 \text{ m}^2 \end{aligned}$$

Deduction of door area =  $L \times D = 1.0 \times 2.10 = -2.10$

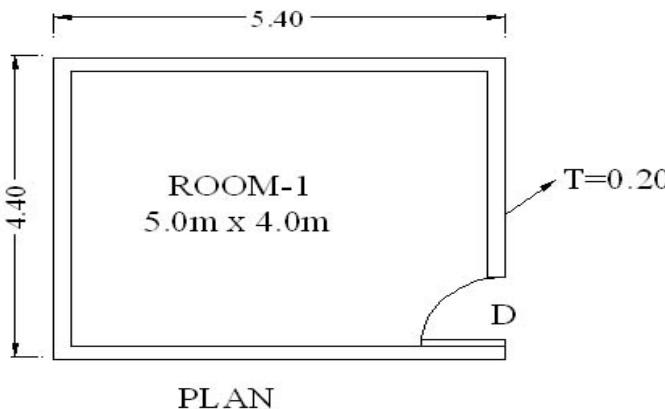
total internal paint area =  $54.0 - 2.10 = 51.90 \text{ m}^2$

$$\begin{aligned} \text{(ii) External Paint area} &= \text{Peripheral Length} \times \text{Depth} \\ &= (L + B) \times 2 \times D \\ &= (5.4 + 4.4) \times 2 \times 3.15 \\ &= 61.74 \text{ m}^2 \end{aligned}$$

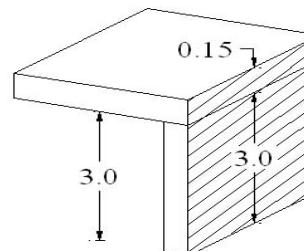
Deduction of door area =  $L \times D = 1.0 \times 2.10 = -2.10$

total external paint area =  $61.74 - 2.10 = 59.64 \text{ m}^2$

$$\text{(iii) Total Paint area} = 51.90 + 59.64 = 111.54 \text{ m}^2$$



Note: while finding external paint area, Slab thickness has to be added with Ceiling height



#### Standards for Double Coat of Emulsion Paint:

- (a) 1 Litre of paint will cover  $4.2 \text{ m}^2$  area or
- (b) 1 litre of paint will cover 45 Sft area

$$\begin{aligned} \text{(iv) Emulsion paint required in litres:} \quad 4.2 \text{ m}^2 &= 1 \text{ Litre} \\ 111.54 \text{ m}^2 &= ? \text{ Litre} \\ &= 111.54 / 4.2 \\ &= 26.557 \text{ or approximately equal to 27 Litres} \end{aligned}$$

## Wall Putty- Calculations & problems

### Problem-1:

For a given plan find no. of bags required for wall-putty  
( only for internal area of walls)

- (i) Ceiling height = 3.0m
- (ii) Slab thickness = 0.15 m
- (iii) Door ' D ' = 1.0 x 2.10

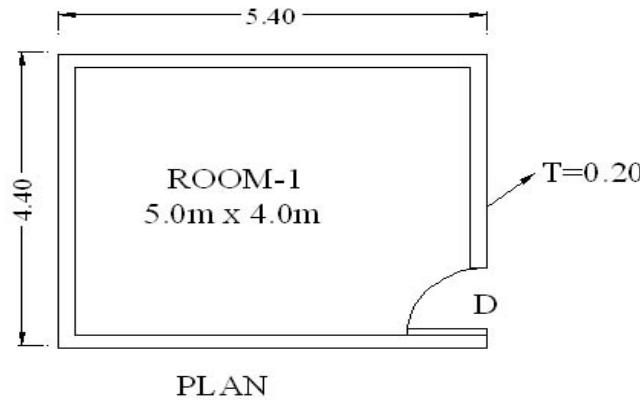
### Solution

- a. Area of Wall-putty :  
(i) Internal area = Peripheral Length x Depth

$$\begin{aligned} &= (L + B) \times 2 \times D \\ &= (5.0 + 4.0) \times 2 \times 3.0 \\ &= 54.0 \text{ m}^2 \end{aligned}$$

Deduction of door area =  $L \times D = 1.0 \times 2.10 = -2.10$

total internal area =  $54.0 - 2.10 = 51.90 \text{ m}^2$



### Standards for Wall-Putty :

Thickness of Wall-putty layer = 3mm or 0.003m

Weight of Wall-putty/m<sup>3</sup> = 849.0 kgs

Volume of Wall-putty = Area x thickness

$$\begin{aligned} &= 51.90 \times .003 \\ &= 0.155 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} 1 \text{ m}^3 &= 849.0 \text{ kgs} \\ 0.155 \text{ m}^3 &= ? \text{ Kgs} \\ &= 0.155 \times 849 \\ &= 131.595 \text{ kgs} \end{aligned}$$

Available bag of Wall-putty = 5 kgs, 10 kg, 20 kg & 40 kg

$$\begin{aligned} \text{no. of bags required} &= 131.595/40 \\ &= 3.289 \text{ or approximately equal to 4 bags of 40 kgs} \end{aligned}$$

## Flooring- Calculations & problem

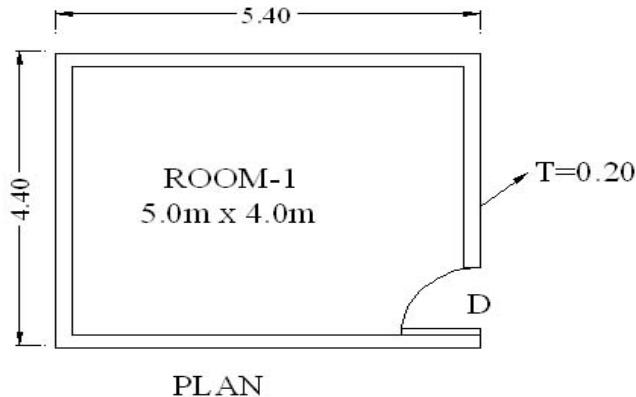
### Problem-1:

For a given plan find no. of Tiles required for Flooring  
if the size of each Floor Tile = 12" x 12"

#### Solution

a. Area of Flooring :  
(i) Floor area = L x B  
.=  $5.0 \times 4.0$   
.=  $20.0 \text{ m}^2$

(ii) Size of each Floor tile = 12" x 12"  
.=  $144\text{"}^2$



$$\begin{aligned}144\text{"}^2 &= ? \text{ M}^2 \\ \text{therefore } 1 \text{ m} &= 39.37\text{"} \\ &= 144\text{"}^2 / 39.37^2 \\ &= 0.0929 \text{ m}^2\end{aligned}$$

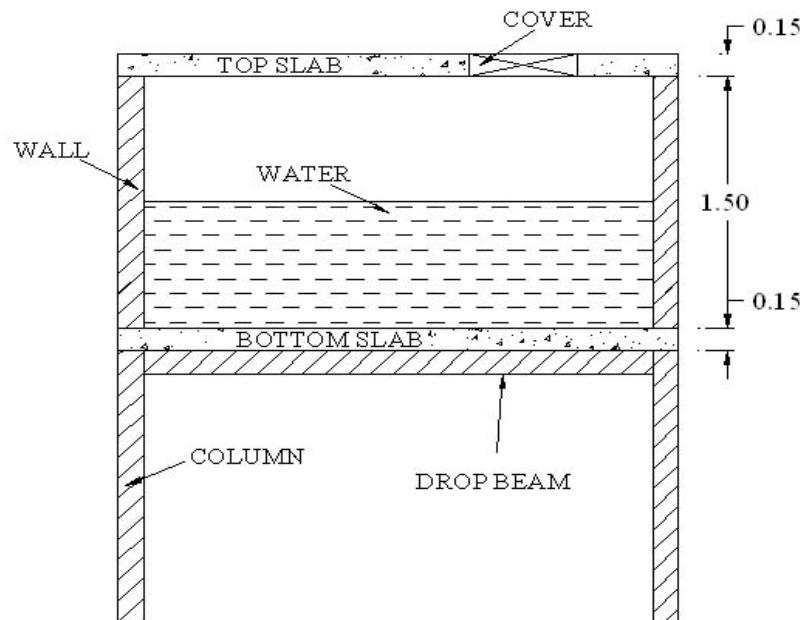
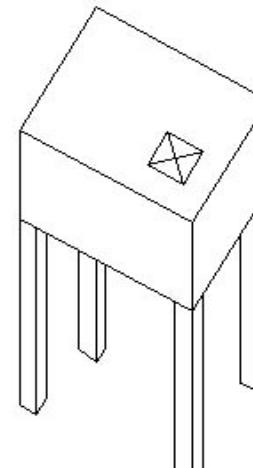
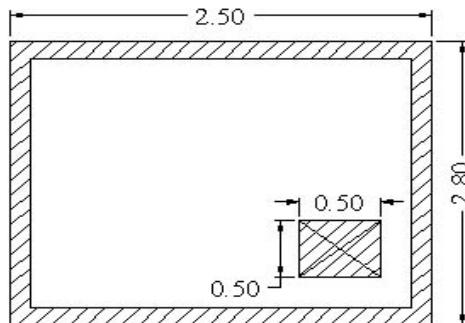
(iii) no. of floor tiles required = Total floor area / area of each tile  
.=  $20.0 / 0.0929$   
.= 215.28 or approximately equal to 216 Tiles

## Over-Head Water Tank Calculation & Problem

### Problem-1:

For a given problem find

- a volume of concrete
- b shuttering area
- c volume of water in litres.



thickness of wall = 0.20m

Solution:

(i) Bottom Slab :

- 1 Volume of Concrete =  $L \times B \times D$   
.=  $2.50 \times 2.80 \times 0.15$   
.=  $1.05 \text{ m}^3$
- 2 Shuttering area =  $(L+B) \times 2 \times D + L \times B$   
.=  $(2.50 + 2.80) \times 2 \times 0.15 + 2.50 \times 2.80$   
.=  $8.59 \text{ m}^2$

(ii) Top Slab :

- 1 Volume of Concrete =  $L \times B \times D$   
.=  $2.50 \times 2.80 \times 0.15$   
.=  $1.05 \text{ m}^3$
- 2 Shuttering area =  $(L+B) \times 2 \times D + l \times b(\text{internal dimension}) + (L+B) \times 2 \times D (\text{cover dimension})$   
.=  $(2.50 + 2.80) \times 2 \times 0.15 + 2.10 \times 2.40 + (0.50 + 0.50) \times 2 \times 0.15$   
.=  $6.93 \text{ m}^2$

(iii) wall along horizontal axis:

- 1 Volume of Concrete =  $L \times B \times D \times \text{no.s}$   
.=  $2.50 \times 0.20 \times 1.50 \times 2$   
.=  $1.50 \text{ m}^3$
- 2 Shuttering area =  $L \times D \times 2 \times \text{no.s}$   
.=  $2.50 \times 1.50 \times 2 \times 2$   
.=  $15.0 \text{ m}^2$

(iii) wall along vertical axis:

- 1 Volume of Concrete =  $L \times B \times D \times \text{no.s}$   
.=  $2.40 \times 0.20 \times 1.50 \times 2$   
.=  $1.44 \text{ m}^3$

2 Shuttering area = L x D x 2 x no.s  
.=  $2.40 \times 1.50 \times 2 \times 2$   
.=  $14.40 \text{ m}^2$

- (iv) Total Volume of Concrete =  $1.05 + 1.05 + 1.50 + 1.44 = 5.04 \text{ m}^3$   
(v) Total Shuttering area =  $8.59 + 6.93 + 15.0 + 14.40 = 44.92 \text{ m}^2$

**Water calculations :**

Internal volume of sump = L x B x D  
.=  $2.10 \times 2.40 \times 1.50$   
.=  $7.56 \text{ m}^3$

According to Standards :  $1 \text{ m}^3 = 1000 \text{ Litres}$  and  $1 \text{ ft}^3 = 28.34 \text{ litres}$

$1\text{m}^3 = 1000 \text{ litres}$   
 $7.56 \text{ m}^3 = ? \text{ Litres}$   
.=  $7.56 \times 1000$   
.= 7560 litres

each water tanker (truck) has capacity of 5000 litres  
therefore no. of water tanker required =  $7560/5000$   
.= 1.512 or approximately equal to 2 tankers

## Plastering with Machine



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