A Practical Book for Quantity Surveying

Procedure of Concrete, Shuttering, Reinforcement and Finish work calculations

For Civil Engineers

(in FPS system)

Author
Mohammed Haroon
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A Practical book for Quantity Surveying

By
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FIRST EDITION 2021 - 2022

DEDICATED TO MY

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<td>4</td>
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<td>459-460</td>
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<td>4</td>
<td>Paint</td>
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<td>5</td>
<td>P.O.P Ceiling Border</td>
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**FINAL BILL OF QUANTITIES FOR G+1 BUILDING PROJECT**  478-480
UNIT CONVERSION

(i). One dimension calculation = length calculation
(ii). Two dimension calculation = area calculation
(iii). Three dimension calculation = volume calculation

Types of units :-
1. M.K.S Units (Metre-Kilogram/Sec) : Metres, Centimetres & Millimetres (Scales used).
   These units are practically called as Engineering Unit.

2. F.P.S Units (Foot-Pound/Sec) : Feets, Inches and Yards (scales used).
   These units are practically called as Architectural Unit.

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<th>Two-Dimension</th>
<th>Three-Dimension</th>
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<td></td>
<td>Length</td>
<td>Area</td>
<td>Volume</td>
</tr>
<tr>
<td>1</td>
<td>Metre</td>
<td>M</td>
<td>m x m = m² / square metre</td>
<td>m x m x m = m³ / cum</td>
</tr>
<tr>
<td>2</td>
<td>Centimeter</td>
<td>CM</td>
<td>cm x cm = cm² / sq. centimetre</td>
<td>cm x cm x cm = cm³ / cuctm</td>
</tr>
<tr>
<td>3</td>
<td>Millimeter</td>
<td>MM</td>
<td>mm x mm = mm²/sq. milimetre</td>
<td>mm x mm x mm = mm³/cumm</td>
</tr>
<tr>
<td>4</td>
<td>Feet</td>
<td>FT</td>
<td>Ft x Ft = Ft² / square feet</td>
<td>Ft x Ft x Ft = Ft³/cft</td>
</tr>
<tr>
<td>5</td>
<td>Inch</td>
<td>INCH</td>
<td>inch x inch = inch² / square inch</td>
<td>inch x inchx inch = inch³/cuinch</td>
</tr>
<tr>
<td>6</td>
<td>Yard</td>
<td>YD</td>
<td>Yd x Yd = Yd² / square yard</td>
<td>Yd x Yd x Yd = Yd³/cuyd</td>
</tr>
</tbody>
</table>

Scales :-
1 metre = 1000mm  
1 metre = 100cm  
1 cm = 10mm  
1 metre = 1.0936 yd  
1 metre = 3.28 Ft  
1 yd = 36"  
1 yd = 3'  
1 yd² = 9 Ft²  
1 Acre = 4840 yd²  
1 Hectare = 2.47 Acre
<table>
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<th>S.no</th>
<th>One-Dimension</th>
<th>Two-Dimension</th>
<th>Three-Dimension</th>
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<td>Length</td>
<td>Area</td>
<td>Volume</td>
</tr>
<tr>
<td>1</td>
<td>6m = ? Mm</td>
<td>6m² = ? Mm²</td>
<td>6m³ = ? Mm³</td>
</tr>
<tr>
<td></td>
<td>Since 1m = 1000mm</td>
<td>Since 1m = 1000mm</td>
<td>Since 1m = 1000mm</td>
</tr>
<tr>
<td></td>
<td>6 x 1000 = 6000mm</td>
<td>6 x 1000² = 6000000mm²</td>
<td>6 x 1000³ = 6000000000mm³</td>
</tr>
<tr>
<td>2</td>
<td>25m = ? Cm</td>
<td>25m² = ? Cm²</td>
<td>25m³ = ? Cm³</td>
</tr>
<tr>
<td></td>
<td>Since 1m = 100cm</td>
<td>Since 1m = 100cm</td>
<td>Since 1m = 100cm</td>
</tr>
<tr>
<td></td>
<td>25 x 100 = 2500cm</td>
<td>25 x 100² = 2500000cm²</td>
<td>25 x 100³ = 250000000cm³</td>
</tr>
<tr>
<td>3</td>
<td>60m = ? Yd</td>
<td>60m² = ? Yd²</td>
<td>60m³ = ? Yd³</td>
</tr>
<tr>
<td></td>
<td>Since 1m = 1.0936yd</td>
<td>Since 1m = 1.0936yd</td>
<td>Since 1m = 1.0936yd</td>
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<tr>
<td></td>
<td>60 x 1.0936 = 65.616yd</td>
<td>60 x 1.0936² = 71.757yd²</td>
<td>60 x 1.0936³ = 78.474yd³</td>
</tr>
<tr>
<td>4</td>
<td>0.20m = ? Ft</td>
<td>0.20m² = ? Ft²</td>
<td>0.20m³ = ? Ft³</td>
</tr>
<tr>
<td></td>
<td>Since 1m = 3.28Ft</td>
<td>Since 1m = 3.28Ft</td>
<td>Since 1m = 3.28Ft</td>
</tr>
<tr>
<td></td>
<td>0.20 x 3.28 = 0.656Ft</td>
<td>0.20 x 3.28² = 2.151Ft²</td>
<td>0.20 x 3.28³ = 7.057Ft³</td>
</tr>
<tr>
<td>5</td>
<td>55m = ? Inch</td>
<td>55m² = ? Inch²</td>
<td>55m³ = ? Inch³</td>
</tr>
<tr>
<td></td>
<td>Since 1m = 39.37&quot;</td>
<td>Since 1m = 39.37&quot;</td>
<td>Since 1m = 39.37&quot;</td>
</tr>
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### Quantity Surveying Book

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One-Dimension Two-Dimension Three-Dimension

AL-Madina College of Chartered Quantity Survey, Mehdipatnam, Hyderabad, INDIA.
website: www.quantitysurveyindia.com ; Ph. no. +91 40 23512686 ; +91 9550259317
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<td>10 x 12 = 120&quot;</td>
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<td>120&quot; + 0.75&quot; = 120.75&quot;</td>
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<td>120.75&quot; = ? M</td>
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<td>Since 1m = 39.37&quot;</td>
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<td>120.75/39.37 = 3.067m</td>
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LENGTH AND AREA CALCULATION FORMULAS

Formulas:

1. **Square or Rectangle**

(i) Area = A = L x B

(ii) Peripheral Length = L = (L+B) x 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 = \( \frac{1}{2} \times B \times H \)

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

4. **Irregular Tri-angle**

(i) Area = A = \( \sqrt{s(s-a)(s-b)(s-c)} \)
   where \( s = \frac{(a + b + c)}{2} \)

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

5. **Equilateral Tri-angle**

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

(ii) Peripheral Length = L = a + a + a = 3a
6. Isosceles Tri-angle

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

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

7. Trapezoidal

(i) Area = \( A = \frac{1}{2} (a + b) \times h \)

(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) Area = \( A = \frac{\pi}{4} \times d^2 \)

\[ \text{where } d \text{ = diameter of circle; } \pi = 3.14 \]

(ii) Peripheral Length = \( L = 2 \times \pi \times r \)

\[ \text{where } r \text{ = radius of circle} \]

10. Semi-Circle

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

\[ \text{where } d \text{ = diameter of circle; } \pi = 3.14 \]

(ii) Peripheral Length = \( L = 2 \times \pi \times r \times 0.50 \)

\[ \text{where } r \text{ = radius of circle} \]
11. Quarter Circle

(i) Area = \( A = \frac{\pi}{4} \times d^2 \times 0.25 \)
where \( d \) = diameter of circle ; \( \pi = 3.14 \)

(ii) Peripheral Length = \( L = 2 \times \pi \times r \times 0.25 \)
where \( r \) = radius of circle

12. Segmental Arc

(i) Area = \( A = \left( \frac{2}{3} \times D \times H \right) + \left( \frac{H^3}{2D} \right) \)
where \( d \) = diameter of circle
\( H \) = height of arc

(ii) Arc Length = \( L = \frac{8b - 2r}{3} \)
where \('r' = radius of circle \)
\( b' = V\left(r^2 + h^2\right) \)

---

### PLOT AREA CALCULATION

**Problem-1:**
find area of plot = ?

**Solution:** the area of plot can be find out by using
trapezoidal area formula i.e
area = \( \frac{1}{2} \times [ a + b ] \times h \)
area = \( 0.5 \times [30 + 40] \times 18 \)
area = 630.0 Ft\(^2\)

Method - ii :
Area of plot can be found out by using thumb rule i.e. dividing area in to parts
A1 = Area-1 = 0.5 x 5 x 18 = 45.0 \text{ Ft}^2
A2 = Area-2 = 30 x 18 = 540.0 \text{ Ft}^2
A3 = Area-3 = 0.5 x 5 x 18 = 45.0 \text{ Ft}^2

\text{total area of plot} = 630.0 \text{ Ft}^2

**Problem-2:**
find area of plot = ?

A1 = Area-1 = 40 x 39 = 1560.0 \text{ Ft}^2
A2 = Area-2 = 0.5 x 8 x 9 = 36.0 \text{ Ft}^2
A3 = Area-3 = 20 x 5 = 100.0 \text{ Ft}^2

\text{total area of plot} = 1696.0 \text{ Ft}^2

**Solution:**
Area of plot can be found out by using thumb rule i.e. dividing area in to parts.

A1 = Area-1 = 40 x 39 = 1560.0 \text{ Ft}^2
A2 = Area-2 = 0.5 x 8 x 9 = 36.0 \text{ Ft}^2
A3 = Area-3 = 20 x 5 = 100.0 \text{ Ft}^2

\text{total area of plot} = 1696.0 \text{ Ft}^2
Problem-3:
find area of plot = ?

Solution: Area of plot can be found out by using thumb rule i.e. dividing area in to parts
A1 = Area-1 = 0.5 \times 35 \times 42 = 735.0 \text{ Ft}^2
A2 = Area-2 = \sqrt{S(S-A)(S-B)(S-C)}
where \( S = (a + b + c)/2 \)
\( C = \sqrt{a^2 + b^2} \)
\( C = \sqrt{35^2 + 42^2} \)
\( C = 54.671 \)
\( S = (86.75 + 81.75 + 54.671)/2 \)
\( S = 111.585 \)
A2 = Area-2 = \sqrt{111.585(111.585-86.75)(111.585-81.75)(111.585-54.671)}
A2 = Area-2 = 2169.239 Ft$^2$
Total area of plot = A1 + A2 = 2904.239 Ft$^2$

Problem-4:
find area of plot = ?

Solution: Area of plot can be found out by using thumb rule i.e. dividing area in to parts
Area-1 = A1 = area of semi-circle = \( \pi/4 \times d^2 \times 0.50 = \pi/4 \times 25^2 \times 0.50 = 245.436 \text{ Ft}^2 \)
Area-2 = A2 = area of rectangle = \( L \times B = 40 \times 25 = 1000 \text{ Ft}^2 \)
Area-3 = A3 = area of segmental arc = \( (2/3 \times D \times H) + (H^3 / 2D) \)
\[ = (2/3 \times 25 \times 11) + (11^3 / 2 \times 25) \]
\[ = 183.333 + 26.62 \]
\[ = 209.953 \text{ Ft}^2 \]

Total area of plot = A1 + A2 + A3 = 1455.389 \text{ Ft}^2

**Problem-5:**
find area of Slab = ?

Area-1 = A1 = area of rectangle = \( L \times B = 40 \times 12 = 480.0 \text{ Ft}^2 \)
Area-2 = A2 = area of triangle = \( 0.5 \times L \times B = 0.5 \times 8 \times 6 = 24.0 \text{ Ft}^2 \)
Area-3 = A3 = area of rectangle = \( L \times B = 34 \times 18 = 612.0 \text{ Ft}^2 \)
Area-4 = A4 = area of triangle = \( 0.5 \times L \times B = 0.5 \times 9 \times 10 = 45.0 \text{ Ft}^2 \)
Area-5 = A5 = area of rectangle = \( L \times B = 24 \times 19 = 456.0 \text{ Ft}^2 \)
Area-6 = A6 = area of semi-circle = \( \pi/4 \times d^2 \times 0.50 = \pi/4 \times 24^2 \times 0.50 = 226.194 \text{ Ft}^2 \)

Total area of Slab = A1 + A2 + A3 + A4 + A5 + A6
\[ = 1843.194 \text{ Ft}^2 \]
Problem-6:
From the given figure find no. of car-parking space
If size of plot = 46' x 200' and
size of each car park space = 16' x 10'
Size of Drive-way = 14' x 200'
Solution :-
1. Plot area = 46' x 200' = 9200 \text{ Ft}^2

2. Drive-way area = 14' x 200' = 2800.0 \text{ Ft}^2

3. Car-parking space = Plot area - Drive-way area
   \[= 9200 - 2800\]
   \[= 6400 \text{ Ft}^2\]

4. Area of each Car-park space = 16' x 10' = 160\text{Ft}^2

5. No. of Car-park space to be provided = Car-park space / area of each Car-park space
   \[= 6400 / 160\]
   \[= 40 \text{ Car-park space can be provided}\]

**CENTERING AND SHUTTERING AREA CALCULATION**

**Problem-1:** find area of Centering and Shuttering for footing = ?
If size of footing = 5' x 4' x 3'
Solution:
Note:
Area will be counted for wooden shuttering and as well as for laying footing steel mesh.

Centering and Shuttering area = Side area + Bottom area
= Peripheral Length x Depth + Bottom area
= (L + B) x 2 x D + L x B
= (5 + 4) x 2 x 3 + 5 x 4
= 74.0 Ft²

Problem-2: find area of Centering and Shuttering for Neck Column = ?
If size of neck column = 1' x 1' x 2' and size of footing = 5' x 4' x 3'

Solution:
Note:
Area will be counted for wooden shuttering and as well as for laying neck column steel.
Depth of Neck column shall be considered up to footing mesh, as steel bars of neck column rests on footing mesh.
Centering and Shuttering area = Side area
= Peripheral Length x Depth
= (L + B) x 2 x D
= (1 + 1) x 2 x 5
= 20.0 Ft²
**Problem-3:**
Find area of Centering and Shuttering for Plinth beam = ?
If size of Plinth beam = 12' x 0.75' x 1'

**Solution:**
Note:
area will be counted for wooden shuttering and as well as for laying Plinth beam steel.
Centering and Shuttering area = Side area + Bottom area
= L x D x 2 + L x B
= 12 x 1 x 2 + 12 x 0.75
= 33.0 Ft²

**Problem-4:**
Find area of Centering and Shuttering for Floor Column = ?
If size of Floor Column = 1' x 1' x 10'

**Solution:**
Note: area will be counted for wooden shuttering and as well as for tying Floor Column steel. Height of Floor column shall be considered up to Ceiling height.
Centering and Shuttering area = Surface area of column
= Peripheral Length x Depth
= ( L + B ) x 2 x D
= ( 1 + 1 ) x 2 x 10
= 40.0 Ft²
Problem-5:
Find area of Centering and Shuttering for Floor Beam = ?
If size of Floor beam = 12' x 0.75' x 1'

Solution:
Centering and Shuttering area = Side area + Bottom area
.= L x D x 2 + L x B
.= 12 x 1 x 2 + 12 x 0.75
.= 33.0 Ft²

Problem-6:
Find area of Centering and Shuttering for the given Floor Slab = ?
If size of Floor Slab = 10' x 12' x 0.5'

Solution:
Centering and Shuttering area = Side area + Bottom area
.= Peripheral Length x Depth + Bottom area
.= ( L + B ) x 2 x D + L x B
.= ( 10 + 12 ) x 2 x 0.5 + 10 x 12
.= 142.0 Ft²
Problem-7:
Find area of Centering and Shuttering for the given Floor Slab = ?

If size of Floor Slab = 17' x 53' x 0.5'; size of stair case = 7' x 17'
size of Duct-1 = 11' x 2.5'; size of Duct-2 = 2.5' x 8'

Solution:
Centering and Shuttering area = Side area + Bottom area
= Peripheral Length x Depth + Bottom area
= 147.0 x 0.5 + 744.5
= 818.0 Ft²

(1). Peripheral length of slab = 17 + 53 + 17 + 1 x 2 + 53 + 2.5 x 2 = 147.0 Ft.
Thickness of slab = 6" = 0.5'

Bottom area of Slab = 17 x 53 + 1 x 10 (projected slab area) = 911.0 Ft²

Deduction of openings:
Duct-1 = 11.0 x 2.5 = -27.50 Ft²
Duct-2 = 2.5 x 8.0 = -20.0 Ft²
Staircase area = 7 x 17 = -119.0 Ft²

Total bottom area of slab after deduction = 744.50 Ft²
Problem-8:
Find area of Centering and Shuttering for Floor Slab = ?
if thickness of slab = 6" = 0.5'

Solution:
Centering and Shuttering area = Side area + Bottom area
peripheral length x depth + bottom area
= 182.152 x 0.5 + 1843.194
= 1934.27 Ft²

(I). Peripheral length of slab = 40 + 49 + 2 x π x 12 x 0.50 + 10 + 13.453 + 10 + 10 + 12
= 182.152 Ft

Thickness of slab = 6" = 0.5'
**Using Pythagoras theorem to find inclined length**

\[ c = \sqrt{a^2 + b^2} \]
\[ c = \sqrt{10^2 + 9^2} = 13.453 \text{ Ft} \]
\[ c = \sqrt{6^2 + 8^2} = 10.0 \text{ Ft} \]

Bottom Area of Slab can be found out by using thumb rule i.e. dividing area in to parts

Area-1 = A1 = area of rectangle = \( L \times B = 40 \times 12 = 480.0 \text{ Ft}^2 \)

Area-2 = A2 = area of triangle = \( 0.5 \times L \times B = 0.5 \times 8 \times 6 = 24.0 \text{ Ft}^2 \)

Area-3 = A3 = area of rectangle = \( L \times B = 34 \times 18 = 612.0 \text{ Ft}^2 \)

Area-4 = A4 = area of triangle = \( 0.5 \times L \times B = 0.5 \times 9 \times 10 = 45.0 \text{ Ft}^2 \)

Area-5 = A5 = area of rectangle = \( L \times B = 24 \times 19 = 456.0 \text{ Ft}^2 \)

Area-6 = A6 = area of semi-circle = \( \pi/4 \times d^2 \times 0.50 = \pi/4 \times 24^2 \times 0.50 = 226.194 \text{ Ft}^2 \)

Total Bottom area of Slab = A1 + A2 + A3 + A4 + A5 + A6 = 1843.194 \text{ Ft}^2

**Problem-9:**

Find Area of Centering and Shuttering for Floor Column, Floor Beam and Floor Slab = ?

if size of column = 12" x 9"

Height of Ceiling = 10' and Slab thickness = 6" = 0.5'

Size of beam along horizontal axis = 12' x 9" x 1'

Size of beam along vertical axis = 12' x 9" x 1'
**Solution:**

Size of slab = therefore beam lengths =

\[ L = 13.5' - 9" - 9" = 12' \]
\[ B = 14' - 1' - 1' = 12' \]
\[ D = 6" = 0.5' \]

1. **Floor Column:**
   Centering and Shuttering area = Peripheral length \times Depth \times no. of Columns
   
   \[ = (L + B) \times 2 \times D \times \text{no.s} \]
   
   \[ = (1 + 0.75) \times 2 \times 10 \times 4 \]
   
   \[ = 140.0 \text{ Ft}^2 \]

   Note: while doing shuttering calculation for floor column, height of floor column shall be considered up to ceiling height only. (i.e., given ceiling height = 10')

2. **Floor Beam along horizontal axis:**
   Centering and Shuttering area = (Side area of beam + bottom area of beam)\times no. of beams
   
   \[ L = 13.5' - 9" - 9" \]
   
   \[ = (L \times D \times 2 + L \times B) \times \text{no. of beams} \]
   
   \[ = (12 \times 1 \times 2 + 12 \times 0.75) \times 2 \]
   
   \[ = 66.0 \text{ Ft}^2 \]

3. **Floor Beam along vertical axis:**
   Centering and Shuttering area = (Side area of beam + bottom area of beam)\times no. of beams
   
   \[ L = 14' - 1' - 1' \]
   
   \[ = (L \times D \times 2 + L \times B) \times \text{no. of beams} \]
   
   \[ = (12 \times 1 \times 2 + 12 \times 0.75) \times 2 \]
   
   \[ = 66.0 \text{ Ft}^2 \]

4. **Floor Slab:**
   Centering and Shuttering area = Side area of Slab + Bottom area of Slab
   
   \[ = \text{Peripheral length \times Depth + Bottom area of Slab} \]
   
   \[ = (L + B) \times 2 \times D + L \times B \]
   
   \[ = (13.5 + 14) \times 2 \times 0.5 + 13.5 \times 14 \]
   
   \[ = 216.50 \text{ Ft}^2 \]
Problem-10 :
Find Area of Centering and Shuttering for Floor Column, Floor Beam and Floor Slab = ?

If size of column = 12" x 9"
Height of Ceiling = 10' and Slab thickness = 6" = 0.5'
Breadth of beam = 9" ; Depth of Beam = 12"

Solution:

1. Floor Column:
Centering and Shuttering area = Peripheral length x Depth x no. of Columns
.= ( L + B ) x 2 x D x no. s
.= ( 1 + 0.75 ) x 2 x 10 x 6
.= 210.0 Ft²

Note: while doing shuttering calculation for floor column, height of floor column shall be considered up to ceiling height only. ( i.e., given ceiling height = 10' )

2. Floor Beam along horizontal axis :
Centering and Shuttering area = (Side area of beam + bottom area of beam)x no. of beams
L= 11' + 11.5'
L= 22.5'
.= ( L x D x 2 + L x B ) x no. of beams
.= ( 22.5 x 1 x 2 + 22.5 x 0.75 ) x 2 = 123.75 Ft²
3. Floor Beam along vertical axis:
Centering and Shuttering area = (Side area of beam + bottom area of beam) \times \text{no. of beams}
L= 14' - 1' - 1' \ldots (L \times D \times 2 + L \times B) \times \text{no. of beams}
L= 12' \ldots (12 \times 1 \times 2 + 12 \times 0.75) \times 3 = 99.0 \text{ Ft}^2

4. Floor Slab:
Centering and Shuttering area = \text{Side area of Slab} + \text{Bottom area of Slab}
\ldots \text{Peripheral length} \times \text{Depth} + \text{Bottom area of Slab}
\ldots (L + B) \times 2 \times D + L \times B
\ldots (24.75 + 14.0) \times 2 \times 0.5 + 24.75 \times 14.0
\ldots 385.25 \text{ Ft}^2

**Problem-11:**
Find Area of Centering and Shuttering for Stair-case = ?
Solution:

1. Waist Slab: S1 & S2
Centering and Shuttering area = (Side area of Slab + Bottom area of Slab) x no. of slabs
By Pythagoras theorem
\[ c = \sqrt{a^2 + b^2} \]
\[ c = \sqrt{(11.18 \times 0.5 \times 2 + 11.18 \times 3.5) \times 2} \]
\[ c = \sqrt{10^2 + 5^2} \]
\[ C = 11.18 \text{ Ft. (Inclined length)} \]

2. Steps:
Centering and Shuttering area = (Side area of Step + Front area of Step) x no. of Steps
\[ = (0.5 \times B \times H \times 2 + L \times D) \times \text{no. of Steps} \]
\[ = (0.5 \times 1 \times 0.5 \times 2 + 3.5 \times 0.5) \times 20 \]
\[ = 45.0 \text{ Ft}^2 \]

3. Landings: L1 & L2
Centering and Shuttering area = (three Side area of Landing + Bottom area of Landing) x no. of Landings
\[ = (B \times D \times 2 + L \times D + L \times B) \times \text{no. of Landings} \]
\[ = (4 \times 0.5 \times 2 + 7 \times 0.5 + 7 \times 4) \times 2 \]
\[ = 71.0 \text{ Ft}^2 \]
Definition: Capacity of anything is called as Volume, the unit is \( \text{Ft}^3 \) or \( \text{m}^3 \).

Volume = Area \times Depth

**Problem-1:** Find Volume of Concrete for a given figure

**Solution:**

\[
\text{Volume} = \text{Area} \times \text{Depth} = L \times B \times D = 6' \times 5' \times 10' = 300 \text{ Ft}^3
\]

**Problem-2:** Find Volume of Concrete for a given figure

**Solution:**

Dividing top area in to two parts to find Area

Area-1 = 1.5' \times 0.75' = 1.125 \text{ Ft}^2

Area-2 = 0.75' \times 0.75' = 0.5625 \text{ Ft}^2

Total Area = 1.6875 \text{ Ft}^2

Volume = \text{Area} \times \text{Depth} = 1.6875 \times 10' = 16.875 \text{ Ft}^3

**Problem-3:** Find Volume of Concrete for a given figure

**Solution:**

Dividing c/s area in to two parts to find Area

Area-1 = 3' \times 0.5' = 1.5 \text{ Ft}^2

Area-2 = 2' \times 0.5' = 1.0 \text{ Ft}^2

Total Area = 2.50 \text{ Ft}^2

Volume = \text{C/S Area} \times \text{Length} = 2.50 \times 10' = 25.0 \text{ Ft}^3

**Problem-4** :- Find Volume of Concrete for a given figure

**Solution :-**
Dividing c/s area in to three parts to find Area
Area-1 = 3' x 0.5' = 1.5 Ft²
Area-2 = 2.5' x 0.5' = 1.25 Ft²
Area-3 = 2.5' x 0.5' = 1.25 Ft²
Total Area = 4.0 Ft²

Volume = C/S Area x Length
.= 4.0 x 9'
.= 36.0 Ft³

**Problem-5** :- Find Volume of Concrete for a given figure

**Solution :-**

Arc Length = 2 x π x r x 0.5
Inner Arc Length = 2 x π x 0.5 x 0.5 = 1.57 Ft
Outer Arc Length = 2 x π x 1.0 x 0.5 = 3.141 Ft
Average Arc Length = (1.57 + 3.141)/2 = 2.355 Ft
Therefore, Length = 6' ; Breadth = 2.355' ; Depth = 0.5'

Volume = L x B x D = 6' x 2.355' x 0.5' = 7.065 Ft³

**Problem-6** :- Find Volume of Concrete for a given figure

**Solution :-**

Area of Equilateral Triangle = (a²/4) x √3
Volume = Area x Depth
.= (a²/4) x √3 x D
.= (1²/4) x √3 x 12
.= 5.196 Ft³
Problem-7 :- Find Volume of Concrete for a given figure

Solution :-
Area of Equilateral Triangle = \( \frac{a^2}{4} \times \sqrt{3} \)
Volume = \( \frac{(\text{Area} \times \text{Depth})}{3} \)
\[ = \frac{(\frac{a^2}{4} \times \sqrt{3} \times D)}{3} \]
\[ = \frac{(0.75^2/4) \times \sqrt{3} \times 16}{3} \]
\[ = 1.299 \text{ Ft}^3 \]

Problem-8 :- Find Volume of Concrete for a given figure

Solution :-
Area of Hexagon = \( \frac{0.5 \times R \times 0.5 \times R \times \tan 60}{6} \)
Volume = \( \text{Area} \times \text{Depth} \)
\[ = (0.5 \times 0.5' \times 0.5 \times 0.5' \times \tan 60) \times 6 \times D \]
\[ = (0.5 \times 0.5' \times 0.5 \times 0.5' \times \tan 60) \times 6 \times 8' \]
\[ = 5.196 \text{ Ft}^3 \]
**Problem-9** :: Find Volume of Concrete for a given figure

**Solution** ::

Area of Circle = $(\pi/4) \times d^2$

$d_1 = 2'$

$d_2 = 4'$

Average dia = $(d_1 + d_2) / 2 = (2+4)/2 = 3'$

Volume = Area x Depth

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

$= (\pi/4) \times 3^2 \times 6$

$= 42.411$ $\text{Ft}^3$

or

Volume = $(\pi \times r^2 \times h)$

$= (\pi \times 1.5^2 \times 6)$

$= 42.411$ $\text{Ft}^3$

**Problem-10** :: Find Volume of Concrete for a given figure

**Solution** ::

Area of Circle = $(\pi/4) \times d^2$

Volume = $(\text{Area} \times \text{Depth}) / 3$ OR $\text{Volume} = (\pi \times r^2 \times h) / 3$

$= (\pi/4) \times d^2 \times D / 3$

$= ((\pi/4) \times 4^2 \times 8) / 3$

$= 33.51$ $\text{Ft}^3$

**Problem-11** :: Find Volume of Concrete for a given figure

**Solution** ::

Length of R.C.C wall = $(L + B) \times 2$

External length = $(12' + 10') \times 2 = 44$ $\text{Ft}$

Internal length = $(11'+9') \times 2 = 40$ $\text{Ft}$

Average length = $(44 + 40) / 2 = 42$ $\text{Ft}$

Volume = $L \times B \times D$

$= 42' \times 0.5' \times 8'$

$= 168$ $\text{Ft}^3$
**Problem-12** :- Find Volume of Concrete for a given figure

**Solution :-**

- Length of Circle = \(2 \times \pi \times r\)
- Length of R.C.C wall = \(2 \times \pi \times r\)
- Internal length = \(2 \times \pi \times 5 = 31.415\text{Ft}\)
- External length = \(2 \times \pi \times 5.5 = 34.557\text{Ft}\)
- Average length = \(\frac{(31.415 + 34.557)}{2} = 32.986\text{Ft}\)

Volume = \(L \times B \times D\)

\[= 32.986' \times 0.5' \times 7'\]

\[= 115.451 \text{ Ft}^3\]

**Problem-13** :- Find Volume of Concrete for a given figure

**Solution :-**

Volume = \(\frac{c/s \text{ area} \times \text{length of step} \times \text{No. of steps}}{120} = 0.5 \times B \times H \times L \times \text{No. of steps} \)

\[= 0.5 \times 1' \times 0.5' \times 3.5' \times 4\]

\[= 3.50\text{Ft}^3\]

**Problem-14** :- Find Volume of Concrete for a given figure
Solution :-
Dividing c/s area in to three parts to find Volume
Volume of Step = L x B x D
Volume of step-1 = 3.5' x 1' x 0.5' = 1.75 Ft^3
Volume of step-2 = 3.5' x 2' x 0.5' = 3.50 Ft^3
Volume of step-3 = 3.5' x 3' x 0.5' = 5.25 Ft^3
Total Volume = 10.50 Ft^3

Problem-15 :: Find Volume of Concrete for a given figure

Public Stair-case

Solution :-
Volume of Step = Top area x Depth x 0.5
\[ = \frac{\pi}{4} \cdot d^2 \cdot D \cdot 0.5 \]
Volume of Step-1 = \( \frac{\pi}{4} \cdot 3^2 \cdot 0.5 \cdot 0.5 = 1.767 \text{ Ft}^3 \)
Volume of Step-2 = \( \frac{\pi}{4} \cdot 5^2 \cdot 0.5 \cdot 0.5 = 4.908 \text{ Ft}^3 \)
Volume of Step-3 = \( \frac{\pi}{4} \cdot 7^2 \cdot 0.5 \cdot 0.5 = 9.621 \text{ Ft}^3 \)
Volume of Step-4 = \( \frac{\pi}{4} \cdot 9^2 \cdot 0.5 \cdot 0.5 = 15.904 \text{ Ft}^3 \)
Total volume = 32.20 Ft^3

Problem-16 :: Find Volume of Concrete for a given figure

STAIRCASE IN STADIUM
Solution :-

Half-round stair-case

Arc Length of Step = \(2 \times \pi \times r \times 0.5\)

1. Arc Length of Step-1 = \(2 \times \pi \times 19.5' \times 0.5 = 61.261\) Ft
   
   For Step-1 External radius = 20'
   
   For Step-1 Internal radius = 19'
   
   Average radius for Step-1 = \((19' + 20')/2 = 19.5'\)

2. Arc Length of Step-2 = \(2 \times \pi \times 19' \times 0.5 = 59.69\) Ft
   
   For Step-2 External radius = 20'
   
   For Step-2 Internal radius = 18'
   
   Average radius for Step-2 = \((18' + 20')/2 = 19'\)

3. Arc Length of Step-3 = \(2 \times \pi \times 18.5' \times 0.5 = 58.119\) Ft
   
   For Step-3 External radius = 20'
   
   For Step-3 Internal radius = 17'
   
   Average radius for Step-3 = \((17' + 20')/2 = 18.5'\)

Volume = \(L \times B \times D\)

Step-1 = \(61.261' \times 1' \times 0.5' = 30.630\) \(\text{Ft}^3\)

Step-2 = \(59.690' \times 2' \times 0.5' = 59.69\) \(\text{Ft}^3\)

Step-3 = \(58.119' \times 3' \times 0.5' = 87.178\) \(\text{Ft}^3\)

Total Volume = \(177.498\) \(\text{Ft}^3\)

Problem-17 :- Find Volume of Concrete for a given figure
Solution:-

According to pythagorean theorem \( c = \sqrt{a^2 + b^2} \)

\[ = \sqrt{1^2 + 2.5^2} \]

\[ = 2.692 \text{Ft} \]

Length = 1.5' x 2 + 2.692 x 2 + 16' = 24.384Ft

Breadth = 14'

Thickness = 0.5'

Volume = L x B x D

1. Volume of Concrete for Bridge panel = 24.384' x 14' x 0.5' = 170.688 Ft\(^3\)

2. Volume of Concrete for 'Y' Column = Front Area of y-column x thickness of y-Column

\[ = 53' \times 3' = 159 \text{ Ft}^3 \]

According to thumb rule dividing front area in to three parts

1. Area-1 = 0.5 x B x H = 0.5 x 2.75' x 4' = 5.5 Ft\(^2\)
2. Area-2 = L x B = 3.5' x 12' = 42 Ft\(^2\)
3. Area-3 = 0.5 x B x H = 0.5 x 2.75' x 4' = 5.5 Ft\(^2\)
4. Total Area = 53.0Ft\(^2\)
Problem-18 :- Find Volume of Concrete for a given figure

Solution :- Dividing footing in to two parts

Part-1:-
L1 = 5' ; L2 = 3.5'
B1 = 5' ; B2 = 3.5'
D = 1.5'

Average length = (5'+3.5')/2 = 4.25'
Average Breadth = (5'+3.5')/2 = 4.25'

Part-2 :-
L = 5' ; B = 5'; D = 1.5'

1. Volume of Concrete for part-1 = L x B x D = 4.25 x 4.25 x 1.5 = 27.093 Ft$^3$
2. Volume of Concrete for part-2 = L x B x D = 5' x 5' x 1.5' = 37.5 Ft$^3$
Total Volume = 64.593 Ft$^3$
Problem-19 :-
Find Volume of Concrete for a Slab in a given figure
if thickness of Slab = 6"

Solution :-
Volume of Concrete required for slab = Area of slab x thickness of slab

\[ = 1843.194 \times 0.5' \]

\[ = 921.597 \text{ Ft}^3 \]
Area of Slab can be found out by using thumb rule i.e. dividing area in to parts

Area-1 = A1 = area of rectangle = L x B = 40 x 12 = 480.0 Ft²
Area-2 = A2 = area of triangle = 0.5 x L x B = 0.5 x 8 x 6 = 24.0 Ft²
Area-3 = A3 = area of rectangle = L x B = 34 x 18 = 612.0 Ft²
Area-4 = A4 = area of triangle = 0.5 x L x B = 0.5 x 9 x 10 = 45.0 Ft²
Area-5 = A5 = area of rectangle = L x B = 24 x 19 = 456.0 Ft²
Area-6 = A6 = area of semi-circle = π/4 x d² x 0.50 = π/4 x 24² x 0.50 = 226.194 Ft²

Total area of Slab = A1 + A2 + A3 + A4 + A5 + A6 = 1843.194 Ft²

Problem-20 :- Find Volume of Concrete from the given Arch type column

Solution:-

Segmental Arc formula :-

(i) Area = A = (2/3 x D x H) + (H³/2D)
where d = diameter of circle
H = height of arc

(ii) Arc Length = L = (8b - 2r)/3
where r = radius of circle
b = V (r² + h²)
Given: \( D = 2.75'\); \( R = 1.375'\); \( H = 1.0'\)

Segmental arc length = \( \frac{8B-2R}{3} \)
where \( 'B' = \sqrt{r^2 + h^2} \)
\[ \Rightarrow \sqrt{(1.375^2 + 1^2)} \]
\[ \Rightarrow 1.70 \]

Avg. \( 'D' \) = \( \frac{3+2.5}{2} = 2.75' \)
\( R = 1.375' \)

Segmental arc length = \( \frac{8 \times 1.7 - 2 \times 1.375}{3} \)
\[ \Rightarrow 3.616' \]

Volume of Concrete required for Arch Type column = \( L \times B \times D \)
Where \( L = 3.616'\); \( B = 0.5'\); \( D = 10' \)
Volume = \( 3.616' \times 0.50' \times 10' = 18.08 \text{ Ft}^3 \)

**Problem-21:** Find Volume of Concrete from the given Figure

**Solution:**

**Top Area:**
Area-1 = \( L \times B = 14' \times 9' = 126.0 \text{ Ft}^2 \)

Area-2 = \( L \times B = 11' \times 3' = 33.0 \text{ Ft}^2 \)

Area-3 = \( 0.5 \times B \times H = 0.5 \times 3' \times 3' = 4.50 \text{ Ft}^2 \)

Total Area = \( 163.50 \text{ Ft}^2 \)
Thickness = \( 6'' = 0.50' \)

Volume = Top area \times Depth
\[ = 163.50 \times 0.50 \]
\[ = 81.75 \text{ Ft}^3 \]
**Problem-22** :- Find Volume of Concrete from the given Figure

![Diagram of the concrete volume calculation](image)

**Solution :-**
Dividing Top Area in to parts :-

Area-1 = L x B = 20.5' x 12.75' = 261.375 Ft$^2$

Area-2 = L x B = 16.5' x 4' = 66.0 Ft$^2$

Area-3 = (π/4) x d$^2$ x 0.25
= (π/4) x 8$^2$ x 0.25 = 12.566 Ft$^2$

Total Area = 339.941 Ft$^2$

Thickness = 6" = 0.50'

Volume = Top area x Depth
= 339.941 x 0.50
= 169.97 Ft$^3$
Problem-1:-
Find capacity of Rectangular Sump (water tank below ground level)
if size of Sump = 14' x 12' x 6' and no. of water tanker required
to fill the sump if, each water tanker has capacity to carry 5000 litres.

Solution:-
1. Capacity of water tank:-
Standard Specification : 1.0Ft$^3$ = 28.34 Litres

Volume of Rectangular Sump $= L \times B \times D$
$= 14' \times 12' \times 6'$
$= 1008$ Ft$^3$

for 1.0 Ft$^3$ = 28.34 Litres
1008 Ft$^3$ = ? Litres
$= 1008 \times 28.34$

Total capacity $= 28,566.72$ Litres

2. No. of water tank required to fill the Sump:-

no. of water tanker required $= \frac{\text{capacity of water in Sump}}{\text{capacity of each water tanker}}$
$= \frac{28566.72}{5000}$
$= 5.71$ or approximately equal to 6 water tanker required.

Problem-2:-
Find (i). capacity of Circular Sump (water tank below ground level)
if Dia of Sump = 12' and Depth of Sump = 6'
(ii). no. of water tanker required to fill the sump if,
each water tanker has capacity to carry 5000 litres.

Solution:-
1. Capacity of water tank:-
Standard Specification : 1.0Ft$^3$ = 28.34 Litres

Volume of Circular Sump $= \text{Top area} \times \text{Depth}$
$= (\pi/4) \times d^2 \times D$
$= (\pi/4) \times 12^2 \times 6$
$= 678.584$ Ft$^3$
for $1.0 \text{ ft}^3 = 28.34 \text{ Litres}$

$678.584 \text{ ft}^3 = \text{? Litres}$

$. = 678.584 \times 28.34$

Total capacity $= 19,231.07 \text{ Litres}$

2. No. of water tanker required to fill the Sump:-

No. of water tanker required $= \frac{\text{capacity of water in Sump}}{\text{capacity of each water tanker}}$

$. = \frac{19,231.07}{5000}$

$. = 3.846 \text{ or approximately equal to 4 water tanker required}$

**Problem-3:-**

For a building of G+5 (Ground Floor + 5 Floor) with built-up area 30,000 $\text{ft}^2$,

Design required Size of Rectangular Sump or Circular Sump, so that the water stored in sump should be sufficient for the occupant who lives in building.

**Solution:-**

1. Total Built-up area $= 30,000 \text{ ft}^2$

2. No. of Floors $= 6$

3. Area of each Floor $= \frac{\text{Total built-up area for G+5 floor}}{\text{no. of floors}}$

$. = \frac{30,000}{6}$

$. = 5000 \text{ ft}^2$

4. Area of each flat $= 1000 \text{ ft}^2$

2BHK = Two bed room, Hall and kitchen, is generally built-up on an area of $100 \text{yd}^2 = 900 \text{ft}^2$

with an additional area $= 100 \text{ ft}^2$ common area

Total area of 2BHK $= 900 + 100 = 1000 \text{ ft}^2$

common area includes, Stair-case area + Lift area + Corridor area
4. No. of Flats on each Floor = Area of each floor / area of each Flat
   .= 5000 / 1000
   .= 5 Flats on each Floor

5. Total Flats in building = No. of Floors x No. of Flats on each Floor
   .= 5 x 5
   .= 25 Flats in building

Note:-
Ground Floor will be used for Car-parking and Occupant will start living from 1st Floor

6. No. of Occupant live in each Flat = 8 (common practice)
   (Father, Mother, four children and their grand Father and grand Mother)

7. Total no. of Occupants live in building = no. of Occupant x no. of Flats
   .= 8 x 25
   .= 200 people

8. Usage of water by each Human being / day = 100 litres
   other utensils (kitchen, laundry room, etc) = 50 liters
   Total = 150 litres

9. Water required for the building = usage of water by each Human being / day x no. of Occupants
   .= 150 x 200
   .= 30,000 Litres

10. Capacity of water for 1.0 Ft³ = 28.34 litres

   28.34 litres = 1.0 Ft³
   30,000 litres = ? Ft³
   .= (30,000 / 28.34) x 1
   .= 1058.57 Ft³
Case-I :- If Rectangular Sump to be designed then required dimension of Sump,

Required Size of Rectangular Sump = 14' x 13 ' x 6'

Volume \( = L \times B \times D \)
\( = 14' \times 13' \times 6' = 1092 \text{ Ft}^3 \)

there should be some surplus water

Case-II :- If Circular Sump to be designed then required dimension of Sump,

Required Size of Circular Sump: Dia = 15' : Depth = 6'

Volume \( = \left(\frac{\pi}{4}\right) \times d^2 \times D \)
\( = \left(\frac{\pi}{4}\right) \times 15^2 \times 6 \)
\( = 1060.28 \text{ Ft}^3 \)

there should be some surplus water
Most commonly used brick in India, is Indian red brick
size of each Indian red brick = 9" x 4" x 3"
size of each over-seas brick = 0.40m x 0.20m x 0.20m

<table>
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<tr>
<th>S.no.</th>
<th>Ratio or Dry proportion</th>
<th>Sand in m³</th>
<th>Cement in kgs</th>
<th>Cement in bags</th>
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</table>
For 1.0 m$^3$ of Brick work quantity of sand and cement:-

(i). Sand = 1.0 m$^3$ = 0.20 m$^3$ Constant

(ii). Cement = 1.0 m$^3$ = (0.20 x 1440) / last digit of ratio

C:M required for 1.0 m$^3$ of brick work with ratio 1:6

(i). Sand = for 1.0 m$^3$ = 0.20 m$^3$ constant

(ii) Cement in kgs = for 1.0 m$^3$ = (0.20 x 1440) / 6

= 48.0 kgs

(a). each bag of cement = 50.0 kgs

No. of bags required = 48.0 / 50.0

= 0.96 bag

(b). cement in m$^3$ :-

weight of cement/m$^3$ = 1440kgs

1440 kgs = 1.0 m$^3$

48 kgs = ? m$^3$

48 / 1440 = 0.333 m$^3$
Note:-
Volume of Cement : Mortar shall be deducted from Volume of Brick work because there will be lot of wastage while executing brick work.
if you still want to deduct the volume of C:M from volume of brick work then, the quantity of c:m shall be deducted as 20 % of brick work.

Brick work calculation can be done by means of Volume of wall or Area of wall.

**Problem-1 (with volume) :-**
For an area 1200 Ft$^2$ of brick work find no. of bricks and cement : mortar required with ratio 1 : 6 , if size of brick = 9" x 4" x 3" ; wall thickness = 4" ; Height of Ceiling = 10'

**Solution :-**
(i). Volume of Brick work = Area of wall x thickness of wall
$.= 1200 \times 0.333$
$.= 399.6$ Ft$^3$

(ii). Volume of each Brick = L x B x D
$.= 9\times 4\times 3$
$.= 0.0625$ Ft$^3$

(iii). No. of Bricks required = Volume of brick work required / Volume of each brick
$.= 399.6 / 0.0625$
$.= 6393.6$ bricks
$.= or approximately equal to 6394$ bricks

(iv). C:M required for brick work with ratio 1:6
Volume of brick work = 399.6 Ft$^3$
$.= 11.324$ m$^3$

(a). Sand = for 1.0m$^3$ = 0.20 m$^3$
$.= 11.324 \times 0.20$
$.= 2.264$ m$^3$
(b). Cement = For 1.0m$^3$ = (0.20 x 1440) / last digit of ratio
   .= (0.20 x 1440) / 6
   .= 48.0 kgs

for 1.0m$^3$ = 48.0 kgs
11.324 m$^3$ = ?
 .= 11.324 x 48
 .= 543.552 kgs

each bag of cement = 50.0 kgs
No. of bags = 543.552 / 50.0
 .= 10.87 bags
or approximately equal to 11 bags

Problem-2 (with Area):-
For an area 2000 Ft$^2$ of brick work find no. of bricks and cement : mortar required
with ratio 1:5 , if size of brick = 9" x 4" x 3"
; wall thickness = 4"
; Height of Ceiling = 10'

Solution: -
(i). Area of Brick work = 2000 Ft$^2$
    $27''^2$ = ? Ft$^2$
since 1' = 12"
(ii). Area of each brick = 9" x 3" $= 0.1875$ Ft$^2$
     $= 27''^2$
     $= 0.1875$ Ft$^2$

(iii). No. of bricks required = Area of brick work / Area of each brick
     .= 2000 / 0.1875
     .= 10666.66 bricks
     .= or approximately equal to 10667 bricks

(iv). C:M required for brick work with ratio 1:5
Volume of brick work = Area of brick work x wall thickness
     .= 2000 x 0.333
     .= 666 Ft$^3$
     .= 18.873 m$^3$

(a). Sand = for 1.0m$^3$ = 0.20 m$^3$
     18.873 m$^3$ = ?
     .= 18.873 x 0.20
     .= 3.774 m$^3$
(b). Cement = For 1.0 m$^3$ = (0.20 x 1440) / last digit of ratio
    = (0.20 x 1440) / 5
    = 57.6 kgs

for 1.0 m$^3$ = 57.6 kgs each bag of cement = 50.0 kgs

18.873 m$^3$ = ?

No. of bags = 1087.084 / 50.0
    = 21.741 bags

= or approximately equal to 22 bags

Problem - 3 :-

Find (i) No. of bricks required to construct this room
(ii). C:M required for brick work with ratio 1:6,
    if size of brick is 9" x 4" x 3" and Height of Ceiling is 10'
    size of door = 3' 6" x 7'
    size of column = 1' x 1'
    thickness of wall = 8"

Solution:-

Length of four walls after deduction of length of column = 14' x 2 + 16' x 2 = 60 Ft.

(I). Volume of Brick work = L x B x D 8" = ? Ft
    = 60 x 0.666 x 10' since 1' = 12"
    = 399.6 Ft$^3$

(ii). Deductions of openings:-

(a). Door Deduction :-

Vol. of Door = L x B x D
    = 3.5' x 0.666' x 7' = 16.317 Ft$^3$

(b). Lintel Deduction :-

Length of Lintel = 3.5' + 0.333' + 0.333'
    = 4.166 Ft

Note:-
Provide 4" bearings on each side of
Doors and Windows for each lintel.
Height of lintel = 4" = 0.333 Ft
Vol. of Lintel = L x B x D
= 4.166 x 0.666' x 0.333'
= 0.923 Ft

(iv). Vol. of each Brick = L x B x D
= 9" x 4" x 3"
= 108"³
= 108/ 12³
= 0.0625 Ft³

(v). No. of Bricks required = Volume of Brick work / Volume of each Brick
= 382.36 / 0.0625
= 6117.76 bricks
= approximately equal to 6118 bricks

(vi). C:M required for Brick work with ratio 1:6
(a). Sand = 1.0 M³ = 0.20 M³
= 10.835 m³ = ?
= 10835 x 0.20
= 2.167 m³

Sand in terms of weight :-
weight of sand / m³ = 1.75 tons
1.0m³ = 1.75 tons
2.167m³ = ?
1.75 x 2.167 = 3.792 tons (Sand in terms of weight)

(b). Cement required for brick work :-
1.0m³ = (0.20 x 1440) / last digit of ratio
= (0.20 x 1440) / 6
= 48.0 kgs
Problem - 4 :-

Find (i) No. of bricks required to construct these rooms
(ii). C:M required for brick work with ratio 1:6,
if size of brick is 9" x 4" x 3" and Height of Ceiling is 10'
size of door = 3' 6" x 7'
size of column = 1' x 1' and depth of drop beam is 1'
External wall thickness = 8"
internal wall thickness = 4"

Solution:-

Length of four external walls = 26' x 2 + 12' x 2 = 76 Ft.
Deduction for length of column (horizontally) = 1' x 6 = 6'
Deduction for length of column (vertically) = 1' x 4 = 4'

Total length of external wall = 76' - 6' - 4' = 66 Ft

(i). Volume of external wall :-
external wall thickness = 8"
.= L x B x D
.= 66 x 0.666 x 9'
.= 395.604 Ft³

Height of Ceiling = 10'
Depth of Drop beam = 1'
Total height of wall = 10' -1' = 9 Ft

(ii). Deduction of openings :-
(a). Volume of Doors = L x B x D x No.s
.= 3.5' x 0.666' x 7' x 2
.= 32.634 ft³
(b). Volume of Lintels = L x B x D x Nos.
L = 3'6" + 8" = 4.1666 ft
add 4" bearing on each side of door

(iii) Total volume of Brick work for external wall = \(395.604 - 32.634 - 0.924 = 362.046 \text{ ft}^3\)

(iv). Volume of internal wall = L x B x D
Length of internal wall = 12' - 1' - 1' = 10'
wall thickness = 4" = 0.333 ft

(v). Total Volume of Brick work = 362.046 + 29.97 = 392.016 \text{ ft}^3

(vi). Vol. of each Brick = L x B x D
since 1' = 12"

(vii). No. of Bricks required = Volume of Brick work / Volume of each Brick

(viii). C:M required for Brick work with ratio 1:6
(a). Sand = 1.0 M^3 = 0.20 M^3
\[11.109 \text{ m}^3 = ? \]
\[= 11.109 \times 0.20\]
\[= 2.221 \text{ m}^3\]

\[1.75 \times 2.221 = 3.886 \text{ tons}\]
(b). Cement required for brick work :-

\[ 1.0\text{m}^3 = \frac{(0.20 \times 1440)}{\text{last digit of ratio}} \]
\[ = \frac{(0.20 \times 1440)}{6} \]
\[ = 48.0 \text{ kgs} \]

\[ 11.109\text{m}^3 = ? \]
\[ = 11.109 \times 48 \]
\[ = 533.232 \text{ kgs} \]

Each bag of cement = 50kgs

no. of bags required = \( \frac{533.232}{50} \)
\[ = 10.664 \text{ bags} \]
\[ = \text{approximately equal to 11 bags} \]
Plastering is done in two coats
(i). 1st coat or rough coat with thickness of plaster = 12mm
(ii). 2nd coat of plaster with thickness of plaster = 8mm
Total thickness of plaster = 20mm

<table>
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<tr>
<th>S.no.</th>
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C:M required for 1.0m$^3$ of Plastering
(i). Sand = for 1.0m$^3$ = 1.25m$^3$ constant
(ii). Cement in kgs = for 1.0m$^3$ = (1.25 x 1440) / last digit of ratio

C:M required for 1.0m$^3$ of Plastering with ratio 1:6
(i). Sand = for 1.0m$^3$ = 1.25m$^3$ constant
(ii). Cement in kgs = for 1.0m$^3$ = (1.25 x 1440) / 6
  = 300 kgs

Each bag of cement = 50kgs
No. of cement bags = 300/50 = 6 bags

weight of cement/m$^3$ = 1440kgs
  1440kgs = 1.0m$^3$
  300kgs = ? m$^3$
  = 300/1440 = 0.208m$^3$

Problem-1 :-
For an Area of 1600 Ft$^2$ for plastering find C:M required with ratio 1:6 and 1:3

Solution:-
Area of plaster = 1600 Ft$^2$
  = 148.72 m$^2$

(i). Cement : Mortar required for 1st coat of Plaster with ratio 1:6 :-
note: thickness of plaster for 1st coat = 12mm = 0.012m
Volume of Plaster = Area of Plaster x Thickness of Plaster
  = 148.72 x 0.012
  = 1.784m$^3$

(a). Sand = for 1.0m$^3$ = 1.25m$^3$
  1.784m$^3$ = ?
  = 1.784 x 1.25
  = 2.23 m$^3$
(b). Cement in kgs = for $1.0m^3 = (1.25 \times 1440) / 6 = 300kgs$
   for $1.0m^3 = 300kgs$
   $1.784m^3 = ?$
   $ = 1.784 \times 300$
   $ = 535.2$ kgs

(ii). Cement : Mortar required for 2nd coat of Plaster with ratio 1:3 :-
   note: thickness of plaster for 2nd coat = 8mm = 0.008m
   Volume of Plaster = Area of Plaster x Thickness of Plaster
   $ = 148.72 \times 0.008$
   $ = 1.189m^3$

(a). Sand = for $1.0m^3 = 1.25m^3$
   $1.189m^3 = ?$
   $ = 1.189 \times 1.25$
   $ = 1.486$ m$^3$

(b). Cement in kgs = for $1.0m^3 = (1.25 \times 1440) / 3$
   $ = 600kgs$
   for $1.0m^3 = 600kgs$
   $1.189m^3 = ?$
   $ = 1.189 \times 600 = 713.4$ kgs

Problem - 2 :-

Find (i). Internal and External plaster area
   (ii). C:M required with ratio 1:6 and 1:3
   if height of Ceiling = 10'
   Slab thickness = 6''
   size of door = 3'6'' x 7'
   wall thickness = 9''
   Depth of Drop beam = 1'

Solution :-

(i). Internal Plaster area :-
   (a). Ceiling Plaster area :- $L \times B = 14 \times 16 = 224$ Ft$^2$
   (b). Wall Plaster area :- $L \times D = 60 \times 10 = 600$ Ft$^2$
   Length of four walls = $(14 + 16) \times 2 = 60$Ft
   Height of Ceiling = 10'
(c). Deduction of Door = L x D = 3.5' x 7' = -24.5 Ft²

Total internal plaster area = 224 + 600 - 24.5 = 799.5 Ft²

(ii). External Plaster area :-

(a). Length of four walls = (15.50 + 17.50) x 2 = 66.0 Ft

L = 14' + 0.75 + 0.75 = 15.50 Ft
B = 16' + 0.75 + 0.75 = 17.50 Ft
9" = ? Ft
since 1' = 12"
8/12 = 0.75Ft

External Plaster area = L x D = 66' x 10.5' = 693.0 Ft²

Height of Ceiling = 10'

Slab thickness = 6" = 0.5'
Total Height of external wall including slab thickness = 10.5'

(b). Internal plaster area for Door = L x B = 17.5 x 0.75 = 13.125 Ft²

Size of Door = 3'6" x 7'

Length of Door = 3.5' + 7' + 7' = 17.5 Ft
thickness of wall = 9" = 0.75 Ft

(c). Deduction of Door from external wall = L x D = 3.5' x 7' = - 24.5 Ft²

(d). Total external Plaster area = 693.0 + 13.125 - 24.5 = 681.625Ft²

(iv). Total Plaster area = internal + external
= 799.5 + 681.625
= 1481.125 Ft²
(v). Cement : Mortar required for 1st coat of Plaster with ratio 1:6 :-
Volume of Plaster = Area of Plaster x Thickness of Plaster
= \( 137.671 \times 0.012 \)
= \( 1.652 \, m^3 \)

Note: thickness of plaster for 1st coat = 12mm = 0.012m

(a). Sand = for 1.0m\(^3\) = 1.25m\(^3\)
\[
\begin{align*}
1.642 \, m^3 &= ? \\
&= 1.652 \times 1.25 \\
&= 2.065 \, m^3
\end{align*}
\]

(b). Cement in kgs = for 1.0m\(^3\) = \( \frac{1.25 \times 1440}{6} \) / 6
= 300kgs

for 1.0m\(^3\) = 300kgs
1.652 m\(^3\) = ?
\[
\begin{align*}
&= 1.652 \times 300 \\
&= 495.6 \, kgs
\end{align*}
\]

(vi). Cement : Mortar required for 2nd coat of Plaster with ratio 1:3 :-
Volume of Plaster = Area of Plaster x Thickness of Plaster
= \( 137.671 \times 0.008 \)
= \( 1.101 \, m^3 \)

Note: thickness of plaster for 2nd coat = 8mm = 0.008m

(a). Sand = for 1.0m\(^3\) = 1.25m\(^3\)
\[
\begin{align*}
1.101 \, m^3 &= ? \\
&= 1.101 \times 1.25 \\
&= 1.376 \, m^3
\end{align*}
\]

(b). Cement in kgs = for 1.0m\(^3\) = \( \frac{1.25 \times 1440}{3} \) / 3
= 600kgs

for 1.0m\(^3\) = 600kgs
1.101m\(^3\) = ?
\[
\begin{align*}
&= 1.101 \times 600 \\
&= 660.6 \, kgs
\end{align*}
\]
Problem-3 :-
Find (i). Internal and External plaster area (ii). C:M required with ratio 1:6 and 1:3
if height of Ceiling = 10'  Slab thickness = 6" ; size of door = 3'6" x 7'
External wall thickness = 9" ; internal wall thickness = 6" ; Depth of Drop beam = 1'

Solution :-
(i). Internal Plaster area :-
\[
\begin{align*}
\text{(a). Ceiling Plaster area :-} \\
1. \text{Room-1} &= L \times B = 13 \times 10.666 = 138.658 \text{ Ft}^2 \\
2. \text{Room-2} &= L \times B = 11.333 \times 10.666 = 120.877 \text{ Ft}^2 \\
\text{Total Ceiling Plaster area} &= 138.658 + 120.877 = 259.535 \text{ Ft}^2
\end{align*}
\]

\[
\begin{align*}
\text{(b). Wall Plaster area :-} \\
1. \text{Room-1} &= L \times D = 47.332 \times 10 = 473.32 \text{ Ft}^2 \\
\text{Length of four walls} &= (13 + 10.666) \times 2 = 47.332 \text{ Ft} \\
\text{Height of Ceiling} &= 10'
\end{align*}
\]
2. Room-2 = $L \times D = 43.998 \times 10 = 439.98\text{ Ft}^2$
Length of four walls = $(11.333 + 10.666) \times 2 = 43.998\text{ Ft}$
Height of Ceiling = 10'
(c). Deduction of Door = $L \times D \times \text{No.s} = 3.5' \times 7' \times 2 = -49.0\text{ Ft}^2$

**Total internal plaster area = Ceiling plaster area + Wall plaster area**
\[= 259.535 + 473.32 + 439.98 - 49 = 1123.835\text{ Ft}^2\]

(ii). External Plaster area :-
(a). Length of four external walls = $(26.333 + 12.166) \times 2 = 76.998\text{ Ft}$
since 1' = 12''
\[6/12 = 0.5\text{ Ft}\]
External Plaster area = $L \times D = 76.998' \times 10.5' = 808.479\text{ Ft}^2$
Height of Ceiling = 10'
Slab thickness = 6'' = 0.5'
Total Height of external wall including slab thickness = 10' + 0.5' = 10.5'

(b). Internal plaster area for Door = $L \times B \times \text{No.s} = 17.5 \times 0.75 \times 2 = 26.25\text{ Ft}^2$
Size of Door = 3'6'' x 7'
Length of Door = 3.5' + 7' + 7' = 17.5\text{ Ft}
thickness of wall = 9'' = 0.75\text{ Ft}

(c). Deduction of Door from external wall = $L \times D \times \text{No.s} = 3.5' \times 7' \times 2 = -49.0\text{ Ft}^2$

(d). **Total external Plaster area = 808.479 + 26.25 - 49.0 = 785.729\text{ Ft}^2**

(iv). **Total Plaster area = internal + external**
\[= 1123.835 + 785.729\]
\[= 1909.564\text{ Ft}^2\]

\[1909.564\text{ Ft}^2 = ?\text{ M}^2\]
since 1m = 3.28\text{ Ft}
\[= 1909.564 / 3.28^2\]
\[= 177.495\text{ m}^2\]

(v). Cement : Mortar required for 1st coat of Plaster with ratio 1:6 :
Volume of Plaster = Area of Plaster x Thickness of Plaster
\[= 177.495 \times 0.012\]
\[= 2.129\text{ m}^3\]

note: thickness of plaster for 1st coat = 12mm = 0.012m
(a). Sand = for 1.0m³ = 1.25m³
   2.129 m³ = ?
   .= 2.129 x 1.25
   .= 2.661 m³

(b). Cement in kgs = for 1.0m³ = ( 1.25 x 1440 ) / 6
   .= 300kgs

   for 1.0m³ = 300kgs
   2.129 m³ = ?
   .= 2.129 x 300
   .= 638.7 kgs

(vi). Cement : Mortar required for 2nd coat of Plaster with ratio 1:3 :-
Volume of Plaster = Area of Plaster x Thickness of Plaster
   .= 177.495 x 0.008
   .= 1.419 m³

note: thickness of plaster for 2nd coat = 8mm = 0.008m

(a). Sand = for 1.0m³ = 1.25m³
   1.419 m³ = ?
   .= 1.419 x 1.25
   .= 1.773 m³

(b). Cement in kgs = for 1.0m³ = ( 1.25 x 1440 ) / 3
   .= 600kgs

   for 1.0m³ = 600kgs
   1.419 m³ = ?
   .= 1.419 x 600
   .= 851.4 kgs
Problem-4 :-

From the given plan find (i). Internal and External Plastering Area and (ii). C:M required with ratio 1:6 and 1:3
if height of Ceiling = 10'
Slab thickness = 6''
size of door = 3' x 7'
wall thickness = 9''
 Depth of Drop beam = 1'

Solution :-

(i). Internal Plaster area :-

(a). Ceiling Plaster area :-
1. Room-1 = L x B = 12' x 13' = 156 Ft$^2$
since 1' = 12''
   9/12 = 0.75Ft

2. Room-2 :-
   Part-1 = L x B = 11' x 13' = 143Ft$^2$
   Part-2 = ($\pi$/4) x d$^2$ x 0.5 = ($\pi$/4) x ($8''$+$12''$) x 3' = 30.0Ft$^2$

3. Room-3 :-
   Part-1 = L x B = 12' x 10' = 120Ft$^2$
   Part-2 = 0.5 x (a+b) x h = 0.5 x (8'+12') x 3' = 30.0Ft$^2$
Total Ceiling Plaster area = 156 + 143 + 66.366 + 120 + 30 = 515.366 Ft$^2$
(b). Wall Plaster area :-

1. Room-1 = L x D = 50' x 10' = 500 Ft²
   Length of four walls = (12 + 13) x 2 = 50.0Ft
   Height of Ceiling = 10'

2. Room-2 = L x D = 55.42 x 10 = 554.2 Ft²
   Peripheral Length of walls = (11' + 2 x π x 6.5' x 0.5 + 11' + 13) = 55.42Ft
   Height of Ceiling = 10'

3. Room-3 = L x D = 47.21' x 10' = 472.1Ft²
   Peripheral Length of walls = (12' + 10' + 3.605 + 8' + 3.605' + 10') = 47.21Ft
   Height of Ceiling = 10'

According to pythagorean theorem inclined length = \( V(a^2 + b^2) \)
= \( V(2.75^2 + 3.75^2) \)
= 4.65Ft

Total wall plaster area = 500 + 554.2 + 472.1 = 1526.3 Ft²

(c). Deduction of Door = L x D x No.s = 3' x 7' x 4 = -84.0 Ft²

Total internal plaster area = Ceiling plaster area + Wall plaster area - Door area
= 515.366 + 1526.3 - 84 = 1957.666 Ft²

(ii). External Plaster area :-

(a). Length of external walls =
= (99'' + 12' + 9'' + 11' + 2 x π x r x 0.5 + 11' + 10' + 4.65' + 8' + 4.65' + 10' + 9'' + 13' + 9'')
= (0.75' + 12' + 0.75' + 11' + 2 x π x 7.25' x 0.5 + 11' + 10' + 4.65' + 8' + 4.65' + 10' + 0.75' + 13' + 0.75') = 110.076 Ft

According to pythagorean theorem inclined length = \( V(a^2 + b^2) \)
= \( V(2.75^2 + 3.75^2) \)
= 4.65Ft

External Plaster area = L x D = 110.076' x 10.5' = 1155.798 Ft²
Height of Ceiling = 10'
Slab thickness = 6'' = 0.5'
Total Height of external wall including slab thickness = 10' + 0.5' = 10.5'
(b). Internal plaster area for Door = L x B x No.s = 17 x 0.75 x 3 = 38.25 Ft$^2$

Size of Door = 3' x 7'

Length of Door = 3' + 7' + 7' = 17 Ft

thickness of wall = 9'' = 0.75 Ft

(c). Deduction of Door from external wall = L x D x No.s = 3' x 7' x 2 = - 42.0 Ft$^2$

(d). Total external Plaster area = 1155.798 + 38.25 - 42.0 = 1152.048Ft$^2$

(iv). Total Plaster area = internal + external

= 1957.666 + 1152.048

= 3109.714 Ft$^2$

3109.714 Ft$^2$ = ? M$^2$

since 1m = 3.28Ft

= 3109.714 / 3.28$^2$

= 289.049 m$^2$

(v). Cement : Mortar required for 1st coat of Plaster with ratio 1:6 :-

Volume of Plaster = Area of Plaster x Thickness of Plaster

= 289.049 x 0.012

= 3.468 m$^3$

note: thickness of plaster for 1st coat = 12mm = 0.012m

(a). Sand = for 1.0m$^3$ = 1.25m$^3$

3.468 m$^3$ = ?

= 3.468 x 1.25

= 4.335 m$^3$

(b). Cement in kgs = for 1.0m$^3$ = ( 1.25 x 1440 ) / 6

= 300kgs

for 1.0m$^3$ = 300kgs

3.468 m$^3$ = ?

= 3.468 x 300

= 1040.4 kgs
(vi). Cement : Mortar required for 2nd coat of Plaster with ratio 1:3 :-

Volume of Plaster = Area of Plaster x Thickness of Plaster

\[ = 289.049 \times 0.008 \]

\[ = 2.312 \, \text{m}^3 \]

note: thickness of plaster for 2nd coat = 8mm = 0.008m

(a). Sand = for 1.0m$^3$ = 1.25m$^3$

\[ 2.312 \, \text{m}^3 = ? \]

\[ = 2.312 \times 1.25 \]

\[ = 2.89 \, \text{m}^3 \]

(b). Cement in kgs = for 1.0m$^3$ = (1.25 x 1440) / 3

\[ = 600\text{kgs} \]

for 1.0m$^3$ = 600kgs

\[ 2.312 \, \text{m}^3 = ? \]

\[ = 2.312 \times 600 \]

\[ = 1387.2 \, \text{kgs} \]
Various types of Flooring: -
1. Marble Flooring
2. Vetrified Tiles Flooring
3. Inter-lock Tiles Flooring etc.

Problem-1: -
For a Room of size 40' x 30' with Floor Area of 1200 $\text{Ft}^2$ find,
(i). no. of floor tiles required for flooring and Skirting,
if size of each floor tile = 12" x 12" and Height of Skirting = 4"
(ii). Cement : Mortar required for laying Floor tiles with ratio 1:10
(iii). Cement required for sticking Skirting to walls

Solution: -
(i). Floor Tiles required for Flooring and Skirting:

1. Total Floor area = 1200 $\text{Ft}^2$
2. Area of each tile = 12" x 12"
   = 1' x 1'
   = 1.0$\text{Ft}^2$
3. Required no. of Floor tiles = Total floor area / area of each tile
   = 1200 / 1.0
   = 1200 tiles

4. Skirting calculation will be done in running feet:
(a). Peripheral Length of Room = (L + B) x 2
   = (40' + 30') x 2
   = 140 $\text{Ft}$
(b). Height of Skirting = 4" = 0.333$\text{Ft}$
(c). Area of Skirting = L x D = 140.0 x 0.333 = 46.62 $\text{Ft}^2$
(d). No. of tiles required for Skirting = Area of Skirting / Area of each tile
   Given area of each tile = 1' x 1' = 1.0$\text{Ft}^2$
   = 46.62 / 1.0
   = 46.62 or approximately equal to 47 tiles
(ii). Cement : Mortar required for laying Floor tiles with ratio 1:10 :-

Area of Flooring = 1200Ft²
thickness of C : M layer = 2" = 0.166Ft

Volume of C : M required for laying floor tiles = Area of Flooring x thickness of C : M layer
\[ = 1200 \times 0.166 \]
\[ = 199.20 \text{ Ft}^3 \]

Since 1.0m = 3.28Ft
\[ = 199.20 / 3.28^3 \]
\[ = 5.645 \text{m}^3 \]

Standards :-
(a). Quantity of Sand required : for 1.0m³ of C:M = 1.25m³ Constant value
(b). Quantity of Cement required : for 1.0m³ of C:M = (1.25 x 1440) / last digit of c:m ratio

(1). Quantity of Sand required : for 1.0m³ = 1.25m³
\[ 5.645 \text{m}^3 = ? \]
\[ = 5.645 \times 1.25 \]
\[ = 7.056 \text{m}^3 \]

(2). Quantity of Cement required : for 1.0m³ = (1.25 x 1440) / 10
\[ = 180.0 \text{kgs} \]
\[ 5.645 \text{m}^3 = ? \]
\[ = 5.645 \times 180.0 \]
\[ = 1016.10 \text{kgs} \]
each bag of cement = 50 kgs
no. of cement bags required = 1016.10 / 50 = 20.322 or approximately equal to 21 bags
(iii). Cement required for sticking Skirting to walls :-

Area of Skirting = 46.62 Ft$^2$

Thickness of Cement layer = 4mm = 0.0131 Ft

\[
\text{4mm} = \frac{4}{25.4} \text{"} = 0.1574\text{"
}\]

\[
\text{since 1'} = 12"
\]

\[
\text{= 0.1574}/12
\]

\[
\text{= 0.0131 Ft}
\]

Volume of Cement required = Area of Skirting x thickness of cement layer

\[
\text{= 46.62 x 0.0131}
\]

\[
\text{= 0.610 Ft}^3
\]

\[
\text{= 0.0172m}^3
\]

Standard weight of cement/m$^3$ = 1440kgs

\[
1.0m^3 = 1440kgs
\]

\[
0.0172m^3 = ? \text{Kgs}
\]

\[
\text{= 0.0172 x 1440}
\]

\[
\text{= 24.768kgs}
\]

each bag of cement = 50 kgs

no. of cement bags required = 24.764 / 50 = 0.495 or approximately equal to 1 bags

Problem-2 :-

From the given plan of two rooms find,

(i). No. of Floor tiles required for Flooring & Skirting, if size of each tile = 18" x 30" and Height of Skirting = 6" (ii). Cement : Mortar required for laying Floor tiles with ratio 1:8 (iii). Cement required for sticking Skirting to walls.
Solution :-

(i). Floor Tiles required for Flooring and Skirting :-

Floor Area:-
1. Room-1  = L x B
   = 13' x 10'8"
   = 11'4" x 10'8"
   = 138.658 Ft$^2$
2. Room-2 = L x B
   = 11'4" x 10'666'
   = 120.877 Ft$^2$

Total Floor area = 138.658 + 120.877 = 259.535 Ft$^2$

2. Area of each tile = 18" x 30"
   = 1.5' x 2.5'
   = 3.75Ft$^2$

3. Required no. of Floor tiles = Total floor area / area of each tile
   = 259.535 / 3.75
   = 69.20 tiles or approximately equal to 70 tiles

4. Skirting calculation will be done in running feet:
   (a). Peripheral Length of Room-1  = (L + B) x 2
       = (13' + 10'8'') x 2
       = (13' + 10.666') x 2
       = 47.332 Ft

   (b). Peripheral Length of Room-2  = (L + B) x 2
       = (11'4" + 10'8'') x 2
       = (11.333' + 10.666') x 2
       = 43.998 Ft

   (c). Total length of Skirting = 47.332 + 43.998 = 91.33 Ft

   (d). Height of Skirting = 6" = 0.50Ft

   (e). Area of Skirting = L x D = 91.33 x 0.50 = 45.665 Ft$^2$

   (d). No. of tiles required for Skirting = Area of Skirting / Area of each tile
   Given area of each tile = 1.5' x 2.5' = 3.75Ft$^2$
   = 45.665 / 3.75
   = 12.177 or approximately equal to 13 tiles
(ii). Cement : Mortar required for laying Floor tiles with ratio 1:8 :-

Area of Flooring = 259.535Ft$^2$  
thickness of C : M layer = 2" = 0.166Ft

Volume of C : M required for laying floor tiles = Area of Flooring x thickness of C : M layer  
\[= 259.535 \times 0.1666\]  
\[= 43.238 \text{ Ft}^3\]  
43.238 Ft$^3$ = ? M$^3$  
Since 1.0m = 3.28Ft  
\[= 43.238 / 3.28^3\]  
\[= 1.225 \text{ m}^3\]

Standards :-  
(a). Quantity of Sand required : for 1.0m$^3$ of C:M = 1.25m$^3$ Constant value  
(b). Quantity of Cement required : for 1.0m$^3$ of C:M=(1.25 x 1440) / last digit of c:m ratio

(1). Quantity of Sand required : for 1.0m$^3$ = 1.25m$^3$  
\[1.225\text{m}^3 = ?\]  
\[= 1.225 \times 1.25\]  
\[= 1.531\text{m}^3\]

(2). Quantity of Cement required : for 1.0m$^3$ = (1.25 x 1440) / 8  
\[= 225.0\text{kgs}\]  
\[1.225\text{m}^3 = ?\]  
\[= 1.225 \times 225.0\]  
\[= 275.625\text{kgs}\]  
each bag of cement = 50 kgs  
no. of cement bags required = 275.625 / 50 = 5.51 or approximately equal to 6 bags
(iii). Cement required for sticking Skirting to walls :-

Area of Skirting = 45.665 Ft²

Thickness of Cement layer = 4mm = 0.0131 Ft

Volume of Cement required = Area of Skirting x thickness of cement layer

= 45.665 x 0.0131

= 0.598 Ft³

= 0.0169 m³

Standard weight of cement/m³ = 1440kgs

1.0m³ = 1440kgs

0.0169m³ = ? Kgs

= 0.0169 x 1440

= 24.336kgs

Each bag of cement = 50 kgs

No. of cement bags required = 24.336 / 50 = 0.486 or approximately equal to 1 bags

Problem-3:-

From the given figure, find

(i). No. of inter-lock tiles to be layed in Parking Area with Inter-lock tile specification that, an area of 12.0Ft² will cover 30 no. of tiles.

(ii). C:M required for laying Inter-lock tiles in parking area with ratio 1 : 10

Solution :-

(i). Required no. of Inter-lock tiles:-

Area of Parking = L x B = 30' x 32'6"

= 30' x 32.5'

= 975.0Ft²
Given specification for Inter-lock tiles = 30 tiles will cover 12.0Ft² area

\[12.0 \text{ Ft}^2 = 30 \text{ tiles}\]
\[975.0 \text{ Ft}^2 = ? \text{ Tiles}\]

\[= (975.0 / 12.0) \times 30\]
\[= 2437.5 \text{ tiles or approximately equal to 2438 tiles}\]

(ii). C:M required for laying Inter-lock tiles in parking area with ratio 1 : 10:-

Area of Inter-lock tiles = 975.0Ft²
thickness of C : M layer = 2" = 0.166Ft

Volume of C : M required for laying floor tiles = Area of Inter-lock tiles x thickness of C : M layer

\[= 975.0 \times 0.166\]
\[= 162.435 \text{ Ft}^3\]

\[162.435 \text{ Ft}^3 = ? \text{ M}^3\]

Since 1.0m = 3.28Ft

\[= 162.435 / 3.28^3\]
\[= 4.603 \text{m}^3\]

Standards :-
(a). Quantity of Sand required : for 1.0m³ of C:M = 1.25m³ Constant value
(b). Quantity of Cement required : for 1.0m³ of C:M=(1.25 x 1440) / last digit of c:m ratio

(1). Quantity of Sand required : for 1.0m³ = 1.25m³

\[4.603\text{m}^3 = ?\]

\[= 4.603 \times 1.25\]
\[= 5.753 \text{m}^3\]

(2). Quantity of Cement required : for 1.0m³ = (1.25 x 1440) / 10

\[= 180.0\text{kgs}\]

\[4.603\text{m}^3 = ?\]

\[= 4.603 \times 180.0\]
\[= 828.54 \text{kgs}\]

each bag of cement = 50 kgs
	no. of cement bags required = 828.54 / 50 = 16.57 or approximately equal to 17 bags
Ceramic Tile or Vitrified Tiles for walls :-

Problem-1 :-
From the given plan of Toilet, Find
(i). Required no. of wall tiles, if size of each wall tile = 9" x 12"
wall tiles shall be provided up to Ceiling height
Height of Ceiling = 10'
Size of Door = 2'6" x 7'
Size of Ventilator = 3' x 2'
(ii). Cement required for sticking wall tiles

Solution:-
(i). Required no. of wall tiles :-
1. Wall Tile area = L x D = 30' x 10' = 300.0Ft²
   Where,
   L = Peripheral length of four wall
   D = Ht. of Ceiling = 10' given
   L = (L + B) x 2
   L = (7' + 8') x 2 = 30 Ft

2. Deduction of openings i.e., Door area & Ventilator area
   Door area = L x D = 2'6" x 7' = 17.5 Ft²
   Ventilator area = L x D = 3' x 2' = 6.0 Ft²
   Total area = 23.50 Ft²
3. Wall Tile area after deductions = 300.0 - 23.50 = 276.50 $\text{Ft}^2$

Since 1' = 12"

4. Area of each wall tile = $L \times D = 9'' \times 12'' = 108''^2 = 0.75 \text{Ft}^2$

$= 108 / 12^2$

$= 0.75 \text{Ft}^2$

5. No. of Wall Tiles required = Total wall tile area / area of each wall tile

$= 276.50 / 0.75$

$= 368.666$ or approximately equal to 369 wall tiles

(ii). Cement required for sticking wall tiles :-

Area of Wall tiles = 276.50 $\text{Ft}^2$

Thickness of Cement layer = 4mm = 0.0131 $\text{Ft}$

Volume of Cement required = Area of wall tiles x thickness of Cement layer

$= 276.50 \times 0.0131$

$= 3.622 \text{Ft}^3$

$= 0.102 \text{m}^3$

4mm = ? $\text{Ft}$

Since 1" = 25.4mm

$= 4/25.4$

$= 0.1574''$

Since 1' = 12"

$= 0.1574 / 12$

$= 0.0131 \text{Ft}$

Standard weight of Cement / $\text{m}^3 = 1440\text{kgs}$

for 1.0m$^3 = 1440 \text{kgs}$

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

$= 0.102 \times 1440$

$= 146.88 \text{kgs}$

each bag of cement = 50.0 kgs

No. of Cement bags required = 146.88 / 50

$= 2.93$ or approximately equal to 3 bags of cement
Problem-2 :-
From the given plan of Toilet, Find
(i). Required no. of wall tiles, if size of each wall tile = 24" x 12"
   wall tiles shall be provided up to Door Sill level
   Height of Ceiling = 10'
   Size of Door = 2'6" x 7'
   Size of Ventilator = 3' x 2'
(ii). Cement required for sticking wall tiles

Solution:-
(i). Required no. of wall tiles :-
   Sill level = Door height = 7'
   1. Wall Tile area = L x D = 32.5' x 7' = 227.5 Ft$^2$
   Where,
   L = Peripheral length of four wall
   D = Height up to Door Sill level = 7'
   L = (L + B) x 2
   L = (7'6" + 8'9") x 2 = 32.50 Ft

   2. Deduction of openings i.e., Door area & Ventilator area
   Door area = L x D = 2'6" x 7' = 17.5 Ft$^2$
   Ventilator area = L x D = 3' x 2' = 6.0 Ft$^2$
   Total area = 23.50 Ft$^2$

   3. Wall Tile area after deductions = 227.50 - 23.50 = 204.0 Ft$^2$
   288\(n^2\) = ? Ft
   Since 1' = 12"
   = 288 / 12$^2$
   = 2.0 Ft

   4. Area of each wall tile = L x D = 24" x 12" = 288\(n^2\) = 2.0 Ft$^2$
5. No. of Wall Tiles required = Total wall tile area / area of each wall tile
   . = 204.0 / 2.0
   . = 102 wall tiles required

(ii). Cement required for sticking wall tiles :-

Area of Wall tiles = 204.0 $\text{Ft}^2$
Thickness of Cement layer = 4mm = 0.0131 $\text{Ft}$

Volume of Cement required = Area of wall tiles $\times$ thickness of Cement layer
   . = 204.0 $\times$ 0.0131
   . = 2.672 $\text{Ft}^3$
   . = 0.0757 $\text{m}^3$

4mm = ? $\text{Ft}$
Since 1" = 25.4mm
   . = 4/25.4
   . = 0.1574"
0.1574" = ? $\text{Ft}$
Since 1" = 12"
   . = 0.1574 / 12
   . = 0.0131 $\text{Ft}$

Standard weight of Cement / $\text{m}^3$ = 1440kgs

for 1.0$\text{m}^3$ = 1440 kgs
0.0757 $\text{m}^3$ = ? Kgs
   . = 0.0757 $\times$ 1440
   . = 109.008 kgs

each bag of cement = 50.0 kgs
No. of Cement bags required = 109.008 / 50
   . = 2.18 or approximately equal to 3 bags of cement
Problem-3 :-
From the given plan of Kitchen, Find
(i). Required no. of wall tiles, if size of each wall tile = 18" x 12"
wall tiles shall be provided up to height 2'9" above kitchen platform.
Height of Ceiling = 10'
Size of Door = 3' x 7'
Size of Window = 3' x 3'
(ii). Cement required for sticking wall tiles

Solution:-
(i). Required no. of wall tiles :-

1. Wall Tile area = L x D = 22' x 2.75' = 60.50 Ft\(^2\)
   Where,
   L = length of two diagonal wall
   D = Height of wall tiles to be provided above kitchen platform i.e., 2'9" given
   L = 12' + 10' = 22'
   D = 2'9"

2. Deduction of openings i.e., Window area
   Window area = L x D = 3' x 3' = 9.0 Ft\(^2\)

3. Wall Tile area after deductions = 60.50 - 9.0 = 51.50 Ft\(^2\)

4. Area of each wall tile = L x D = 18" x 12" = 216"\(^2\) = 1.50 Ft\(^2\)

\[
\begin{align*}
4\text{mm} &= \text{? Ft} & 216\text{"}^2 &= \text{? Ft} & 0.674\text{ Ft}^3 &= \text{? M}^3 \\
\text{Since } 1\text{"} &= 25.4\text{mm} & \text{Since } 1\text{'} &= 12\text{"} & \text{Since } 1\text{m} &= 3.28\text{Ft} \\
\cdot &= 4/25.4 & \cdot &= 216 / 12^2 & \cdot &= 0.674 / 3.28^3 \\
\cdot &= 0.1574\" & \cdot &= 1.50 \text{ Ft} & \cdot &= 0.0191 \text{ m}^3 \\
0.1574\" &= \text{? Ft} & \text{Since } 1\text{'} &= 12\text{"} & \\
\cdot &= 0.1574 / 12 & \cdot &= 0.0131 \text{ Ft} \\
\end{align*}
\]
5. No. of Wall Tiles required = Total wall tile area / area of each wall tile
   = 51.50 / 1.50
   = 34.333 or approximately equal to 35 wall tiles required.

(ii). Cement required for sticking wall tiles:

Area of Wall tiles = 51.50 Ft$^2$
Thickness of Cement layer = 4mm = 0.0131 Ft
Volume of Cement required = Area of wall tiles x thickness of Cement layer
   = 51.50 x 0.0131
   = 0.674 Ft$^3$
   = 0.0191 m$^3$

Standard weight of Cement / m$^3$ = 1440kgs

   for 1.0m$^3$ = 1440 kgs
   0.0191 m$^3$ = ? Kgs
   = 0.0191 x 1440
   = 27.504 kgs

   each bag of cement = 50.0 kgs

No. of Cement bags required = 27.504 / 50
   = 0.55 or approximately equal to 1 bags of cement
False Ceiling:
The Ceiling provided under the True Ceiling is Called as False Ceiling. It is generally provided to have more interior look with eliminated florescent lights and also to hide Drop beams and HVAC Ducting (Heat, ventilation and air conditioning). False Ceiling is done by means of material gypsum board and pop board (plaster of Paris). Generally gypsum board is bit expensive then pop board.

The calculation of False Ceiling is done in terms of Area Calculation Ceiling border Calculation is done in Running Feet Extra money has to pay if Ceiling has offset design.
**Problem-1 :-**
Find Cost amount of False-Ceiling for a Room of size 15' x 18' with plain design along with the Ceiling border, by means of Gypsum board and Provide 20 no. of round Ceiling light. If,
1. Rate/SFt for Ceiling = 60.0 rupees, along with material and installation.
2. Rate/running feet for Ceiling border = 35.0 rupees along with material and installation.
3. Rate/each round ceiling light = 650.0 rupees

**Solution :-**
Size of room = 15' x 18'
Area of False Ceiling = 15' x 18' = 270Ft$^2$
Length of Ceiling border = Peripheral length "L" = (L+B) x 2 = (15'+18') x 2 = 66Ft

1. Cost amount for Ceiling = Area of Ceiling x Rate/Ft$^2$ for Ceiling
   = 270 x 60
   = 16,200.0 rupees

2. Cost amount for Ceiling border = length of Ceiling border x Rate/running feet
   = 66 x 35
   = 2310 rupees

3. Cost of Ceiling lights = Rate/each light x no. of lights
   = 650 x 20
   = 13,000 rupees

4. Total Cost = 16,200 + 2,310 + 13,000 = 31,510.0 rupees

**Problem-2 :-**
Find Cost amount of False-Ceiling for a Room of size 20' x 30' with 1Ft off-set plain design along with the Ceiling border, by means of Gypsum board and Provide 30 no. of round Ceiling light. If,
1. Rate/SFt for Ceiling = 60.0 rupees, along with material and installation.
2. Rate/SFt for Ceiling off-set = 60.0 rupees, along with material and installation.
3. Rate/running feet for Ceiling border = 35.0 rupees along with material and installation.
4. Rate/each round ceiling light = 350.0 rupees
Solution :-
Size of room = 20' x 30'
Area of False Ceiling = 20' x 30' = 600 Ft²
Length of False Ceiling off-set = (20' + 28') x 2 = 96.0Ft
Area of False Ceiling off-set = L x B = 96' x 1' = 96.0 Ft²
Length of Ceiling border :-
Peripheral length "L" = (L+B) x 2 = (20'+30') x 2 = 100 Ft

1. Cost amount for Ceiling = Area of Ceiling x Rate/Ft² for Ceiling
   = 600 x 60
   = 36,000 rupees
2. Cost amount for Ceiling Off-set = Area of Ceiling off-set x Rate/Ft² for Ceiling
   = 96.0 x 60
   = 5760.0 rupees
3. Cost amount for Ceiling border = length of Ceiling border x Rate/ running feet
   = 100 x 35
   = 3500 rupees
4. Cost of Ceiling lights = Rate/each light x no. of lights
   = 350 x 30
   = 10,500 rupees
5. Total Cost = 36,000 + 5760 + 3500 + 10500 = 55,760 rupees

Note :- If any Ceiling to be design with heavy decoration with expensive light then,
the calculation of False-Ceiling will be done interms of Ceiling area only but
the rate/Ft² will be more than normal rates
Types of Wood:

1. Teak Wood - Very expensive - Used for Doors and windows
2. Sal-wood - Economical - Used for Door Frames
3. Flush wood - Cheaper - Used for Door Shutters
4. Plywood - Economical Used for Wardrobes, Shelves and Cup-board
5. Nova pan - Cheaper - used for Tables and Chairs [with dust partials of wood]
6. Rubber wood - Cheaper - but not recommended, as it has expansion and contraction due to weather conditions

In olden day people use to measure the quantity of wood required to make Doors & Window and according to measurement they will buy the wood from the market and let the carpenter to make Doors & Windows on Site. Presently Doors & Windows are available in ready-made to safe the time and to get rid of man-power

Problem -1:-
Find Cost of Doors, of Size 3'6" x 7' along with Door shutter and Door frame if,
no. of Doors = 6 and section of Door frame = 3"x3"
Rate / Door frame = 2600 rupees and for Door shutter Rate / ft² = 110.0 rupees

Solution:-
1. Door Frames:
Given rate for each Door frame of size 3'6" x 7' with section of frame 3" x 3" = 2600 rupees
No. of Door frames = 6
Cost for Door frames = 2600 x 6 = 15,600/-
2. Door Shutters:
Given size of Door = 3'6" x 7'
= 42" x 84"

Size of Door shutter area = L x H = 36" x 81" = 2916"² = 20.25 Ft²

length of Door shutter = 42" - 3" - 3" = 36"

Height of Door Shutter = 84" - 3" = 81"

= 2916 / 12²
= 20.25 Ft²

For Door Shutter given rate / Ft² = 110.0 rupees

No. of Shutters = 6

Cost for Door Shutters = 110.0 x 20.25 x 6
= 13,365/- rupees

Total cost for 6 Door Frames & Door Shutters = 15600 + 13365 = 28,965/-

Door shutters will be selling in terms of area.

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**Problem -2:-**

Find Cost of Windows, of Size 3' x 4' along with Window shutter and Window frame if,

no. of Windows = 4 and section of window frame = 3"x3"

Rate / Window frame = 2800 rupees and for Window shutter Rate / Window Shutter = 900.0 rupees

**Solution:-**

1. Window Frames:

Given rate for each Window frame of size 3' x 4' with section of frame 3"x3"=3200 rupees

No. of window frames = 4

Cost for window frames = 2800 x 4 = 11200/-
2. Window Shutters:
size of each window shutter = 13.5" x 42"

length of Window shutter = 36" - 3" - 3" - 3" = 27"
providing two shutter panels .= 27 / 2
in each window .= 13.5"

Height of Window Shutter = 48" - 3" - 3" = 42"

Given Rate/each window shutter = 900.0
No. of Shutters = 2 in each widow
No. of Windows = 4
Cost for Window Shutters = 900 x 2 x 4
.= 7200/- rupees

Total cost for 4 Window Frames & Window Shutters = 11200 + 7200 = 18,400/-
Wall Putty :- (Available in a form of Powder or Paste provided on Walls and Ceilings).
Wall putty is provided on walls and ceiling to reduce the friction and to have smooth surface. It is provided in two coats and rubbed with sandpaper. Thickness of wall putty layer = 3mm. Water is added to wall putty powder to make paste out of it, and paste will be pasted on walls. Standard weight of wall putty / m$^3$ = 849.0kgs.
It is available in bags of 5kg, 10kg, 20kg and 40kgs.

**Problem-1 :-**
Find no. of wall putty bag required and cost amount for the given details,
wall surface area = 1200 Ft$^2$
Ceiling area = 800 Ft$^2$
Rate/bag = 1200 rupees (for 40kg bag)
Also find labour charges if rate/ft$^2$ = 5.0/- rupees

**Solution :-**
1. Area of wall putty = wall surface area + ceiling area
   . = 1200 + 800
   . = 2000 Ft$^2$
   . = 185.901 m$^2$

2. Thickness of wall putty layer = 3mm = 0.003m

3. Volume of wall putty = area of wall putty x thickness of wall putty
   . = 185.901 x 0.003
   . = 0.557 m$^3$

4. Standard weight of wall putty/m$^3$ = 849.0kgs
   
   1.0m$^3$ = 849.0kgs
   0.557m$^3$ = ? Kgs
   . = 0.557 x 849
   . = 472.893 kgs

5. No. of wall putty bags required = 472.893/40
   . = 11.822 or approximately equal to 12 bags

6. Rate/bags = 1200/- rupees
7. Cost amount required = 1200 x 12 = 14400/- rupees.

8. Labour charges:
   Rate/Ft² = 5.0/- rupees
   wall putty area = 2000 Ft²

   Total Labour charges = 5.0 x 2000 = 10,000/- rupees.

---

**PAINT CALCULATIONS**

Primer Paint :- (white wash)
Primer paint (white wash) is applied to plastered area before applying Emulsion paint to walls. so that the paint shall have required good looking view.

Standard :-
1.0 litre of Primer paint will cover 40.0 Ft² area

---

**Problem-1 :-**
For an Area of 6500.0Ft² (plastered surface area), Find how many litres of white Primer is required.

Solution :-
According to standard, 1.0 litre of Primer paint will cover 40.0 Ft² area.

\[
40.0 \text{ Ft}^2 = 1.0 \text{ litre} \\
6500.0 \text{ Ft}^2 = ? \text{ Litre} \\
= 6500 / 40 \\
= 162.5 \text{ litres}
\]
Each bucket of Primer paint is of 20.0 litre
Cost of each bucket = 3000/- rupees

No. of Primer Bucket required = required primer in litres / primer in each bucket
  .= 162.5/20
  .= 8.125 or approximately equal to 9 Primer Bucket required.

Cost amount required = Rate/bucket x no. of bucket
  .= 3000 x 9
  .= 27,000/- rupees

Emulsion and Enamel Paint :-

Types of Paints:
1. Emulsion Paint or Water Bond Paint-------- used for Plastering area
2. Enamel Paint or Oil Bond Paint ---------- used for Doors and Windows

Standards for Double coat of Paint:
1. 1.0 Litre of Emulsion paint will cover 4.2 m² area or 45 Ft² area
2. 1.0 Litre of Enamel paint will cover 4.5 m² area or 50 Ft² area

[a]. Price of External Emulsion paint is expensive, as it is expose to Sun rays but never get fade out, also expose to rain water but never get wash out. Emulsion paint will works as rain-coat to building.

[b]. Price of Internal paint is economical, as it is not expose to Sun-rays and Rain water.
Problem-1 :-
From the given plan of two rooms find Internal Emulsion paint required & External Emulsion paint required in litres, and Enamel paint required in litres for Doors, if thickness of Slab = 6" Height of Ceiling = 10'
Size of Door = 3'6" x 7' External wall thickness =9"
Internal wall thickness = 6"

![Plan of two rooms](image)

Solution :-
(i). Internal Emulsion paint :-
1. Ceiling area:
   (a). Room-1 = L x B = 13' x 10'8"
      = 13' x 10.666'
      = 138.658 Ft^2

   (b). Room-2 = L x B = 11'4" x 10'8"
      = 11.333' x 10.666'
      = 120.877 Ft^2

2. Wall surface area :-
   (a). Room-1 = L x D = 47.332' x 10'
      = 473.32 Ft^2

D = Height of Ceiling = 10'
Peripheral length of wall 'L' = (L+B) x 2
      = ( 13' + 10.666' ) x 2
      = 47.332 Ft
(b). Room-2 = L x D  
  = 43.998' x 10'  
  .= 439.98 \text{ Ft}^2

D = Height of Ceiling = 10'  
Peripheral length of wall 'L' = (L+B) x 2  
  .= ( 11.333' + 10.666' ) x 2  
  .= 43.998 \text{ Ft}

3. Deduction of Door area = L x D x no.s  
  .= 3'6" x 7' x 2  
  .= 3.5' x 7' x 2  
  .= 49.0 \text{ Ft}^2

4. Total internal paint area = 138.658 + 120.877 + 473.32 + 439.98 - 49.0 = 1123.835 \text{ Ft}^2

According to Standards 1.0 litre of Emulsion paint will cover 45.0 \text{ Ft}^2 area

\[
\frac{45.0\text{ ft}^2}{1.0 \text{ litre}} = 1.0 \text{ litre} \\
\frac{1123.835 \text{ ft}^2}{45} = 25 \text{ litres}
\]

Rate/litre = 160/- rupees  
Cost amount required = 160 x 25 = 4000/- rupees

(ii). External Emulsion paint :-  
1. External paint area = L x D  
  .= 76.998' x 10.5'  
  .= 808.479 \text{ Ft}^2  
External Peripheral length of wall 'L' = (L+B) x 2  
  .= ( 26.333' + 12.166' ) x 2  
  .= 76.998 \text{ Ft}  
D = Height of Ceiling = 10'  
Slab thickness = 6" = 0.50'

2. Deduction of Door area = L x D x no.s  
  .= 3'6" x 7' x 2  
  .= 3.5' x 7' x 2  
  .= 49.0 \text{ Ft}^2

3. Total External paint area = 808.479' - 49.0' = 759.479 \text{ Ft}^2
According to Standards 1.0 litre of Emulsion paint will cover 45.0 \( \text{ft}^2 \) area

\[
\begin{align*}
45.0 \text{ft}^2 &= 1.0 \text{ litre} \\
759.479 \text{ ft}^2 &= ? \text{ Litre} \\
&= \frac{759.479}{45} \\
&= 16.877 \text{ or approximately equal to } 17 \text{ litres}
\end{align*}
\]

Rate/litre = 180/- rupees
Cost amount required = 180 x 17 = 3060/- rupees

(iii). Enamel paint for Doors :-
Size of Door = 3'6" x 7'
No. of Doors = 2
Enamel paint Area = \( L \times D \times 2 \times \text{no. of Doors} \)
\[
= 3'6" \times 7' \times 2 \times 2 \\
= 3.5' \times 7' \times 2 \times 2 \\
= 98.0 \text{ ft}^2
\]

According to Standards 1.0 litre of Enamel paint will cover 50.0 \( \text{ft}^2 \) area

\[
\begin{align*}
50.0 \text{ ft}^2 &= 1.0 \text{ litre} \\
98.0 \text{ ft}^2 &= ? \text{ Litre} \\
&= \frac{98.0}{50} \\
&= 1.96 \text{ or approximately equal to } 2 \text{ litres}
\end{align*}
\]

Rate/litre = 170/- rupees
Cost amount required = 170 x 2 = 340.0/- rupees

Note:-
To find area of Enamel paint for Doors, Front and back surface area of Door should be added, and side area shall not be added, because the oil paint or Enamel paint will be thick in nature, which will be harder to apply on the surface of Door. To make it thin, Turpentine (thinner) shall be added so that the paint brush will play softly.

Turpentine will make thick Enamel paint to thin Enamel paint, which increases the quantity of paint and this increased quantity of paint will cover internal and side area of Doors.
Surface Area of Door = L x D (front area) + L x D (back area)

.= L x D x 2
The dia for Steel bar or Reinforcement bar comes between 6mm to 40mm.  
(Re-bars = Reinforcement bars = Steel-bars)

**Types of Steel:**

1. **Mild- Steel**  (Plain steel bar)  
   Available dia of bar = 6mm and 8mm

2. **Tor- Steel**  (Twisted steel bar which has anchorage on it)  
   Available dia of bar = 8mm, 10mm, 12mm, 16mm, 20mm up to 40mm

**General Practice:**

(i). The diameter of Steel bar used for Main and Distribution bars are above 8mm but in India for Slabs, Dia 8mm bar can be used.
(ii). The diameter of Steel bar used for Stirrups are 6mm and 8mm.

3. **Meaning or Full form of equation:**

   (i). 12Ø16mm = 12 steel bars of diameter 16mm

   (ii). Ø16mm@150mm = diameter of steel bar is 16mm at an spacing of 150mm (clear spacing)

   (iii). Ø20mm@200mm c/c = diameter of steel bar is 20mm at an spacing of 200mm (centre to centre).
4. Types of Footing meshes commonly used :-
   a. Plain Footing mesh
   b. Mesh with hooks
   c. Mesh with up-projection
   d. Raft mesh

5. For G+2 or G+3 building, Diameter of Steel-Bar commonly used for the following :
   a. Footings : Ø8mm and Ø10mm commonly used for Footing Meshes in India.
   b. Columns : 6Ø12mm (main bars) and Ø8mm@100mm or 4"
   c. Plinth Beams : 6Ø10mm (main bars) and Ø8mm@100mm or 4"
   d. Floor Beams : 6Ø12mm (main bars) and Ø8mm@100mm or 4"
   e. Floor Slab : Ø8mm@100mm or 4" or Ø10mm@100mm or 4" (mesh in both direction)
   f. Stair-case : Waist slab mesh Ø10mm@100mm and Handrail mesh Ø8mm@100mm
   g. Water tank below ground level : Bottom & top slab mesh Ø8mm@100mm
      Shear wall mesh : Ø10mm@100mm
   h. Over head water tank on roof level : Bottom & top slab mesh Ø10mm@100mm
      Shear wall mesh : Ø12mm@100mm
1. Standard length of each Steel bar all over the world = 12.0 m or 40 Ft.

2. Spacing:
The distance between two steel bar is called as Spacing

   (i). Clear Spacing = The distance from face of steel bar to another face of Steel bar
   (ii). Centre to Centre Spacing = The distance from centre of steel bar to another centre of steel bar

3. No. of bars = (opposite length / spacing) + 1

Problem-1 ;- Find no. of x-bars and y-bars with spacing 0.10m for a given footing mesh
Solution : The Steel bars provided in x-direction is called as x-bars and The Steel bars provided in y-direction is called as y-bars

(i). No. of x-bars = (opposite length / spacing) + 1
= (0.90 / 0.10) + 1
= 10 bars in x-direction

(ii). No. of y-bars = (opposite length / spacing) + 1
= (1.2 / 0.10) + 1
= 13 bars in y-direction

Problem-2 :- Find no. of x-bars and y-bars with spacing 4 inch for a given footing mesh

Solution : The Steel bars provided in x-direction is called as x-bars and The Steel bars provided in y-direction is called as y-bars

(i). No. of x-bars = (opposite length / spacing) + 1
= (42" / 4") + 1
= 11.5 bars
= approximately equal to 12 bars in x-direction

(ii). No. of y-bars = (opposite length / spacing) + 1
= (48" / 4") + 1
= 13 bars in y-direction
4. **Over-lap length :-**

Each over-lap length = 50d (Practically)
where d = dia of bar
(over-lap length means Joining to steel bar with extra length of Steel bar)

![Extra Length = Over-lap Length](image)

Theoretical Standards for Over-lap length:-
1. For Compressive member (vertical member) Standard over-lap length = 40d
   (Vertical over-lap)

2. For Tensile member (Horizontal member) Standard over-lap length = 50d
   (Horizontal over-lap)

**Problem -1 :- Find length of steel bars including over-lap length from the given figure**

if dia of bars are:- 12mm, 16mm and 20mm

![6m](image)

Solution:- Length of steel bar = Total length + over-lap length

Length of steel bar = \( L + 50D \)

1. Length of bar, if dia of bar = 12mm = \( L + 50D = 6.0m + 50 \times 0.012m = 6.60m \)
2. Length of bar, if dia of bar = 16mm = \( L + 50D = 6.0m + 50 \times 0.016m = 6.80m \)
3. Length of bar, if dia of bar = 20mm = \( L + 50D = 6.0m + 50 \times 0.020m = 7.00m \)

\[
\begin{align*}
12\text{mm} &= ? \text{m} \\
16\text{mm} &= ? \text{m} \\
20\text{mm} &= ? \text{m}
\end{align*}
\]

Since 1m = 1000mm
\[
\begin{align*}
. &= 12/1000 \\
. &= 16/1000 \\
. &= 20/1000
\end{align*}
\]

. = 0.012m \\
. = 0.016m \\
. = 0.020m
Problem -2 :- Find length of steel bars including over-lap length from the given figure
if dia of bars are:- 12mm, 16mm and 20mm

Solution:- Length of steel bar = Total length + over-lap length
Length of steel bar = \( L + 50D \)

12mm = ? Ft
Since 1" = 25.4mm
\[ = \frac{12}{25.4} \] = 0.472"
\[ = 0.472/12 \] = 0.0393 Ft

1. Length of bar, if dia of bar = 12mm = \( L + 50D = 20' + 50 \times 0.0393' = 21.965 \) Ft
2. Length of bar, if dia of bar = 16mm = \( L + 50D = 20' + 50 \times 0.0524' = 22.62 \) Ft
3. Length of bar, if dia of bar = 20mm = \( L + 50D = 20' + 50 \times 0.0656' = 23.28 \) Ft

Problem -3 :- Find length of steel bars including over-lap length from the given figure
if dia of bars are:- 12mm, 16mm and 20mm

Solution:- Length of steel bar = Total length + over-lap length
Length of steel bar = \( L + 50D \)

8" = ? Ft
Since 1ft = 12"
\[ = \frac{8}{12} \] = 0.666 Ft
\[ = 0.666 \] = 0.0393 Ft

12mm = ? Ft
Since 1" = 25.4mm
\[ = \frac{12}{25.4} \] = 0.472"
\[ = 0.472/12 \] = 0.0393 Ft

0.472" = ? Ft
Since 1ft = 12"
\[ = \frac{0.472}{12} \] = 0.0393 Ft
1. Length of bar, if dia of bar = 12mm = L + 50D = 22.666’ + 50 x 0.0393’ = 24.631 Ft
2. Length of bar, if dia of bar = 16mm = L + 50D = 22.666’ + 50 x 0.0524’ = 25.286 Ft
3. Length of bar, if dia of bar = 20mm = L + 50D = 22.666’ + 50 x 0.0656’ = 25.946 Ft

5. Bend Length
Each Bend length = 16d (Practically)
where d = dia of bar

Problem -1 :-

Find length of steel bars including Bend length from given the figure
if dia of bars are:- 12mm, 16mm and 20mm

Solution:- Length of steel bar = Total length + Bend length
Length of steel bar = L + 16D

12mm = ? M 16mm = ? M 20mm = ? M
Since 1.0m = 1000mm Since 1.0m=1000mm Since 1m = 1000mm
.= 12/1000 .= 16/1000 .= 20/1000
.= 0.012m .= 0.016m .= 0.020m

1. Length of bar, if dia of bar = 12mm = L + 16D = 3.0 + 16 x 0.012 = 3.192m
2. Length of bar, if dia of bar = 16mm = L + 16D = 3.0 + 16 x 0.016 = 3.256m
3. Length of bar, if dia of bar = 20mm = L + 16D = 3.0 + 16 x 0.020 = 3.32m
Problem -2 :-

Find length of steel bars including Bend length from the given figure
if dia of bars are:- 12mm, 16mm and 20mm

Solution:- Length of steel bar = Total length + Bend length
Length of steel bar = \( L + 16D \)

\[
\begin{align*}
5" & = ? \text{ Ft} \\
12mm & = ? \text{ Ft} \\
0.472" & = ? \text{ Ft} \\
\text{Since 1ft} & = 12" \\
\text{Since 1"} & = 25.4 \text{mm} \\
\text{Since 1ft} & = 12" \\
.= 5/12 & = 12/25.4 \quad \text{.= 0.472/12} \\
.= 0.416 \text{ Ft} & = 0.472" \\
& = 0.0393 \text{ Ft}
\end{align*}
\]

1. Length of bar, if dia of bar = 12mm = \( L + 16D = 8.416' + 16 \times 0.0393' = 9.044 \text{ Ft} \)
2. Length of bar, if dia of bar = 16mm = \( L + 16D = 8.416' + 16 \times 0.0524' = 9.254 \text{ Ft} \)
3. Length of bar, if dia of bar = 20mm = \( L + 16D = 8.416' + 16 \times 0.0656' = 9.465 \text{ Ft} \)

6. Hook Length :-

Each Hook length = 9D

where \( d \) = dia of bar

Total length of steel bar including Hook lengths = \( L + 9D + 9D = L + 18D \)

Problem -1 :-

Find length of steel bars including Hook length
from the given figure if dia of bars are:- 6mm, 8mm and 10mm

Solution:- Length of steel bar = Total length + Bend length
Length of steel bar = \( L + 18D \)

\[
\begin{align*}
6mm & = ? \text{ M} \\
8mm & = ? \text{ M} \\
10mm & = ? \text{ M} \\
\text{Since 1.0m} & = 1000\text{mm} \\
\text{Since 1.0m} & = 1000\text{mm} \\
\text{Since 1.0m} & = 1000\text{mm} \\
.= 6/1000 & = 8/1000 \quad \text{.= 10/1000} \\
.= 0.006m & = 0.008m \quad \text{.= 0.010m}
\end{align*}
\]
1. Length of bar, if dia of bar = 6mm = \( L + 18D = 0.90 + 18 \times 0.006 = 1.008\)m
2. Length of bar, if dia of bar = 8mm = \( L + 18D = 0.90 + 18 \times 0.008 = 1.044\)m
3. Length of bar, if dia of bar = 10mm = \( L + 18D = 0.90 + 18 \times 0.010 = 1.080\)m

**Problem -2 :-** Find length of steel bars including Hook length from the given figure if dia of bars are:- 6mm, 8mm and 10mm

![Diagram](image)

**Solution:-** Length of steel bar = Total length + Bend length

\[
\text{Length of steel bar} = L + 18D
\]

- 6mm = ? Inch \(0.236\)" = ? Ft \(0.0196\) = \(0.50\) Ft
- Since 1" = 25.4mm
- \(\frac{6}{25.4}\) = \(0.236\)"
- \(\frac{6}{12}\) = \(0.50\) Ft

1. Length of bar, if dia of bar = 6mm = \(L + 18D = 4.5' + 18 \times 0.0196' = 4.852'\)
2. Length of bar, if dia of bar = 8mm = \(L + 18D = 4.5' + 18 \times 0.0262 = 4.971'\)
3. Length of bar, if dia of bar = 10mm = \(L + 18D = 4.5' + 18 \times 0.0328 = 5.090'\)

**Problem-3 :-** Find length of Stirrup from the given figure if dia of Stirrup = 6mm and 8mm

![Diagram](image)

**Solution :-** Ø = 6mm & 8mm for Stirrup or Tie

(i). Length of Stirrup or Tie = \(L + 18D\) where 'L' = \((L + B) \times 2\)

\[
= 1.40 + 18 \times 0.006 = 1.508m
\]

- 6mm = ? M \(\frac{6}{1000}\) = \(0.006\)m
- Since 1.0m= 1000mm

- 8mm = ? M \(\frac{8}{1000}\) = \(0.008\)m

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(ii). Length of Stirrup or tie  = \( L + 18D \) where 'L' = \( (L + B) \times 2 \)
\[ \begin{align*}
  &\rightarrow 1.40 + 18 \times 0.008 \\
  &\rightarrow 1.544\text{m} \\
  &\rightarrow 1.40\text{m}
\end{align*} \]

**Problem-4 :-**
Find length of Stirrup from the given figure
if dia of Stirrup = 6mm and 8mm

**Solution :-**
Given \( \varnothing = 6\text{mm} \& 8\text{mm} \) for Stirrup or Tie

6mm = ? inch  
Since 1" = 25.4mm  
\[ \rightarrow 6/25.4 \rightarrow 0.236" \]

8mm = ? inch  
Since 1" = 25.4mm  
\[ \rightarrow 8/25.4 \rightarrow 0.314" \]

(i). Length of Stirrup or tie  = \( L + 18D \) where 'L' = \( (L + B) \times 2 \)
\[ \begin{align*}
  &\rightarrow 42" + 18 \times 0.236" \\
  &\rightarrow 46.248" \\
  &\rightarrow 3.854\text{ Ft}
\end{align*} \]

(ii). Length of Stirrup or tie  = \( L + 18D \) where 'L' = \( (L + B) \times 2 \)
\[ \begin{align*}
  &\rightarrow 42" + 18 \times 0.314" \\
  &\rightarrow 47.652" \\
  &\rightarrow 3.971\text{ Ft}
\end{align*} \]

7. **Concrete Cover:-**
The gap or distance between Steel bar and shuttering is called as Concrete Cover. Concrete Cover is provided in concrete to give strength to the concrete and to safe reinforcement from atmospheric temperature, Rain water and Rust (Corrosion).

**Condition:-**
(i). If the length or width of item is less than or equal to 0.3m or 12" then cover=25mm or 1"
(ii). If the length or width of item is between 0.4m to 0.5m or 16" to 20" then cover=50mm or 2"
(iii). If the length or width of item is greater than or equal to 0.6m or 24" then cover=100mm or 4"
Types of Covering block :-
(1). Steel covering block (2). Wooden block (3). C:M block (4). PVC block (5). Piece of Stones

Problem -1 :-
From the given figure find
(i). Length of Stirrups
(ii). No. of Stirrups
if Height of Column = 2.70m ; spacing = 0.10m
dia of stirrup = 8mm

Solution :-
(i). According to condition, deduction of Concrete Cover from four sides of Column
if Length or width of item is less than or equal to 0.30m then cover = 1" = 25mm = 0.025m

\[
L = 0.30 - 0.025 - 0.025 = 0.25m \\
B = 0.25 - 0.025 - 0.025 = 0.20m \\
L = (L+B) \times 2 = 0.90 + 18 \times 0.008 = 0.90 + 0.144 = 1.044m
\]

\[
\text{Length of Tie or Stirrup} = L + 18D = 1.044 + 18 \times 0.008 = 1.044 + 0.144 = 1.188m
\]

(ii). No. of Stirrups = (Height of Column / spacing ) + 1
\[
= (2.7 / 0.10 ) + 1 = 28 \text{ ties or stirrups}
\]

Problem -2 :-
From the given figure find
(i). Length of Stirrups
(ii). No. of Stirrups
if Height of Column = 9 Ft ; spacing = 4"
dia of stirrup = 8mm
Solution :-

(i). According to condition, deduction of Concrete Cover from four sides of Column if Length or width of item is less than or equal to 1.0 Ft then cover = 1" = 25mm = 0.025m

\[ L = 12" - 1" - 1" = 10" \]
\[ B = 9" - 1" - 1" = 7" \]
\[ L = (L+B) \times 2 \]
\[ L = (10" + 7") \times 2 = 34" \]
\[ = 39.652" \]
\[ = 39.652 / 12 \]
\[ = 3.304 \text{ Ft} \]

\[ \text{Length of Tie or Stirrup} = L + 18D \]
\[ = 34" + 18 \times 0.314 \]
\[ = 39.652" \]
\[ = 3.304 \text{ Ft} \]

\[ 8\text{mm} = \text{? Inch} \]
\[ 4" = \text{? Ft} \]
\[ \text{Since} \ 1" = 25.4\text{mm} \]
\[ \text{Since} \ 1' = 12" \]
\[ .= 8/25.4 \]
\[ .= 4/12 \]
\[ .= 0.314" \]
\[ .= 0.333 \text{ Ft} \]

(ii). No. of Stirrups = \( \frac{\text{Height of Column}}{\text{spacing}} \) + 1
\[ = \left( \frac{9'}{0.333} \right) + 1 \]
\[ = 28.02 \text{ ties or stirrups} \]
\[ = \text{approximately equal to} \ 28 \text{ ties} \]

Problem -3 :-

From the given figure find

(i). Length of x-bar and y-bar  (ii). No. of x-bar and y-bar

if spacing = 0.10m
Solution :-

(i). According to condition, deduction of Concrete Cover from four sides of footing
if Length or width of item is less than or equal to 0.60m then cover = 4''=100mm = 0.10m
1. Length of x-bar = 1.20 - 0.10 - 0.10 = 1.0m
2. Length of y-bar =1.0 - 0.10 - 0.10 = 0.80m

(ii). No. of x and y bars
(a). No. of x-bar = (opposite length /spacing) + 1
   .= (0.80/0.10) +1
   .= 9 bars

(b). No. of y-bar = (opposite length /spacing) + 1
   .= (1.0/0.10) +1
   .= 11 bars

Problem -4 :-

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From the given figure find
(i). Length of x-bar and y-bar
(ii). No. of x-bar and y-bar
if spacing = 4"

Solution :-
(i). According to condition, deduction of Concrete Cover from four sides of footing
if Length or width of item is less than or equal to 0.60m then cover = 4" = 100mm=0.10m
1. Length of x-bar = 4'6" - 4" -4" = 3'10"
2. Length of y-bar =4' - 4" - 4" = 3'4"

(ii). No. of x and y bars
(a). No. of x-bar = (opposite length /spacing) + 1
   = (40"/4") +1
   = 11 bars

(b). No. of y-bar = (opposite length /spacing) + 1
   = (46"/4") +1
   = 12.5 bars
   = approximately equal to 13 bars
8. Crank Bar :-
each crank length = 0.42D
where D = Depth of Slab or Beam - Top & Bottom cover
Mostly Cranking is done in Slab and Beams.

Length of Crank bar = L + 0.42D + 0.42D
= L + 0.84D
where D = Depth of Slab or Beam - Top & Bottom cover

There are three types of bars:-
(i). Straight Bar : Steel bar which is linear (straight) in length is called as straight bar.
(ii). Crank Bar : Steel bar which is bent up at an angle of 45 degree is called as Crank bar.
(iii). Extra Bar : Steel bar which is provide under each crank is called as Extra bar.

Conditions for providing Crank bar:-
(1). If the span between two columns supporting the Slab is less than or equal to 4.0 m or 12 Ft then straight bar is enough to carry the load of Slab.
(2). If the span between two columns supporting the Slab is greater than 4.0 m or 12 Ft then Crank bar is provided in the Slab to balance the load and stresses developing at the corner of Slab. Cranking should be done at a distance of L/4 from corner of Slab.

9. Extra bar

The length of each Extra bar = (L/4) + 50D

where D = dia of bar;  L = length of Crank bar including crank length

L/4 is 1/4th length of slab

50D is over-lap length
Problem-1: From the given figure find,
(i). Length of x-bar and y-bar; (ii). No. of x-bars and y-bars
(iii). Length of Extra bar in x & y-direction; (iv). No. of Extra bar
Solution :-
According to conditions, 1 inch concrete cover shall be deducted from four sides of Slab

(i). Length of x-bar and y-bar

(a). Length of x-bar = length of slab + crank length - concrete cover from both side of slab

\[ \text{Length of x-bar} = L + 0.42D + 0.42D - 1" - 1" \]
\[ = L + 0.84D - 0.025 - 0.025 \]
\[ = 4.5m + 0.84D - 0.025m - 0.025m \]
\[ = 4.5 + 0.84 \times 0.10 - 0.025 - 0.025 \]
\[ = 4.534m \]

\[ D = \text{Depth of Slab - top cover - bottom cover} \]
\[ D = 0.15 - 0.025 - 0.025 \]
\[ D = 0.10m \]

(b). Length of y-bar = breadth of slab + crank length - concrete cover from both side of slab

\[ \text{Length of y-bar} = L + 0.42D + 0.42D - 1" - 1" \]
\[ = L + 0.84D - 0.025 - 0.025 \]
\[ = 4.7m + 0.84D - 0.025m - 0.025m \]
\[ = 4.7 + 0.84 \times 0.10 - 0.025 - 0.025 \]
\[ = 4.734m \]

\[ D = \text{Depth of Slab - top cover - bottom cover} \]
\[ D = 0.15 - 0.025 - 0.025 \]
\[ D = 0.10m \]

(ii). No. of x-bar and y-bars

Given spacing = 100mm = 0.10m

(a). No. of x-bars = (opposite length / spacing) + 1
\[ = (4.1/0.1) + 1 \]
\[ = 42 \text{ bars} \]

(b). No. of y-bars = (opposite length / spacing) + 1
\[ = (3.9/0.1) + 1 \]
\[ = 40 \text{ bars} \]

(iii). Length of Extra-bar in x and y direction

(a). The length of each Extra bar in x-direction = (L/4) + 50D
where \( D = \text{dia of bar; } L = \text{length of Crank bar including crank length} \)

Given dia of bar = 8mm = 0.008m
\[ = (4.534/4) + 50 \times 0.008 \]
\[ = 1.533m \]
(b). The length of each Extra bar in y-direction = \(\frac{L}{4} + 50D\)
where D = dia of bar; L = length of Crank bar including crank length
Given dia of bar = 8mm = 0.008m
\[= \frac{4.734}{4} + 50 \times 0.008\]
\[= 1.583\text{m}\]

(iv). No. of Extra-bars in x and y-direction
(a). No. of Extra-bar in x-direction = no. of x-bars x 2
\[= 42 \times 2 = 84\text{ bars}\]

(b). No. of Extra-bar in y-direction = no. of y-bars x 2
\[= 40 \times 2 = 80\text{ bars}\]

**WEIGHT OF STEEL BAR CALCULATIONS**

(a). Density of Steel = 7850 kgs/m\(^3\)
(b). Density of Steel = 0.00785 kgs/mm\(^3\)

Formulas :-
There are four formulas to find weight of Steel bar in kgs/m, which ever is convenient, can be used.

1. Weight of Steel bar in kgs / m
   \[= \text{Area of Steel bar} \times \text{Density of Steel}\]
   \[= \pi/4 \times d^2 \times \text{Density of Steel}\]
   If dia = 8mm
   Weight of Steel bar in kgs / m
   \[= \pi/4 \times 8^2 \times 0.00785\]
   \[= 0.39\text{ kgs/m}\]

2. Weight of Steel bar in kgs / m = Volume of Steel bar x Density of Steel
   \[= \text{Area of Steel bar} \times \text{length of bar} x \text{Density of Steel}\]
   \[= \pi/4 \times d^2 \times L \times \text{Density of Steel}\]
   If dia = 8mm
   \[= \pi/4 \times 0.008^2 \times 1.0 \times 7850\]
   \[= 0.39\text{ kgs/m}\]
3. According to Thumb Rule :-
Weight of Steel bar in kgs / m \( .= \frac{d^2}{162} \)
where \( d \) = dia of bar in mm
and 162 is constant value

If dia = 8mm
Weight of Steel bar in kgs / m \( .= \frac{8^2}{162} \)
\( .= 0.39 \text{ kgs/m} \)

4. According to Mohammed Haroon's Rule :-
Weight of Steel bar in kgs / m \( .= \frac{\text{Area of Steel bar}}{127} \)
where \( d \) = dia of bar in mm
\( .= \frac{\pi/4 \times d^2}{127} \)

If dia = 8mm
Weight of Steel bar in kgs / m \( .= \frac{\pi/4 \times 8^2}{127} \)
\( .= 0.39 \text{ kgs/m} \)

Problem - 1 :-
Find weight of Steel bar from given diagram

\[ \text{Solution :-} \]
According to Thumb Rule :-
Weight of Steel bar in kgs / m \( .= \frac{d^2}{162} \)
where \( d \) = dia of bar in mm
and 162 is constant value

If dia = 16mm
Weight of Steel bar in kgs / m \( .= \frac{16^2}{162} \)
\( .= 1.58 \text{ kgs/m} \)

Given length of bar = 20.5m
weight of steel bar \( = \text{weight of steel bar/m} \times \text{length of bar} \)
\( .= 1.58 \times 20.5 \)
\( .= 32.39 \text{ kgs} \)
**Problem -2 :-**
Find weight of Steel bar from given diagram

![Steel bar diagram](image)

**Solution :-**
According to Thumb Rule :-

Weight of Steel bar in kgs / m \(=\frac{d^2}{162}\)

where \(d =\) dia of bar in mm \(=\frac{16^2}{162}\)

and 162 is constant value \(= 1.58\) kgs/m

Weight of Steel bar in kgs / Ft \(=\frac{d^2}{531.36}\)

Since 1.0m = 3.28Ft \(=\frac{16^2}{531.36}\)

162 x 3.28 = 531.36

or 0.481 x 3.28 = 1.58 kgs/m

Given length of steel bar = 40Ft

Weight of Steel bar \(=\) Weight / Ft \(\times\) length of steel bar
\(= 0.481 \times 40\)
\(= 19.24\) kgs

**Problem -3 :** On a site about 55 no. of Steel bars of dia 12mm have been unloaded from Truck, Find (i). weight of Steel bars and (ii). Required amount to pay the bill, if Rate of Steel/kg = 48.0 rupees.
Solution :-

Note: Standard length of Steel bar all over the world = 12.0m or 40 Ft.

Given dia of bar = 12mm; Standard length of each bar = 40 Ft

Weight of Steel bar in kgs / Ft = \( \frac{d^2}{531.36} \)

\( = \frac{12^2}{531.36} \)

\( = 0.27 \text{ kgs/Ft} \)

(i). Weight of Steel bar = Weight / Ft \times \text{length of steel bar} \times \text{no. of bars}

\( = 0.27 \times 40 \times 55 \)

\( = 594.0 \text{ kgs} \)

(ii). Amount required = weight of steel bars in kgs \times \text{Rate / kgs}

\( = 594.0 \times 48 \)

\( = 28,512.0 \text{ rupees} \)

Problem -4 :-

For a given plan of footing find

(i). Weight of Steel required for making plain footing meshes if, spacing = 4"

Footing mesh details: 11Ø12mm in x-direction; 13Ø16mm in y-direction

and no. of footings = 12

(ii). No. of Steel bars required, of length 40Ft

(iii). Bill of Quantities for Footing Reinforcement if Rate of steel /kg = 48.0 rupees.
Solution :-
According to condition, deduction of Concrete Cover from four sides of Footing
if Length or width of item is greater than or equal to 0.60m then cover = 4" = 100mm

(i). x-bar calculation:-
1. Length of x-bar = 4'6" - 4" - 4" = 3'10"
2. No. of x-bars = 11
3. Total length of x-bar = 11 x 3'10" (no. of x-bars X length of each x-bar)
   .= 11' x 3.833
   .= 42.163Ft
4. Given dia of x-bar = 12mm:
5. Weight of Steel bar in kgs / Ft
   .= \frac{d^2}{531.36}
   .= \frac{12^2}{531.36}
   .= 0.27 kgs/Ft
6. Total weight of Steel required = weight/Ft x Total length of x-bar x no. of footings
   .= 0.27 x 42.163 x 12
   .= 136.608 kgs steel required of Ø12mm

(ii). y-bar calculation:-
1. Length of y-bar =4' - 4" - 4" = 3'4"
2. No. of y-bars = 13
3. Total length of y-bar = no. of y-bars x length of each y-bar
   .= 13 x 3'4"
   .= 13' x 3.333
   .= 43.329Ft
4. Given dia of y-bar = 16mm

5. Weight of Steel bar in kgs / Ft. = \( \frac{d^2}{531.36} \)
   = \( \frac{16^2}{531.36} \)
   = 0.481 kgs/Ft

6. Total weight of Steel required = weight/Ft x Total length of y-bar x no. of footings
   = 0.481 x 43.329 x 12
   = 250.094 kgs steel required of Ø16mm

(iii). Total weight of steel required for 12 footing meshes of Ø12mm & Ø16mm
weight of x-bars required               = 136.608 kgs for Ø12mm
weight of y-bars required               = 250.094 kgs for Ø16mm

(iv). No. of Steel bars required of length 40Ft.
    (a). Ø12mm
    1. Standard length of each steel bar = 40 Ft.
    
    2. Dia of steel bar for x-bar  = 12mm

    3. Weight of Steel bar in kgs / Ft = \( \frac{d^2}{531.36} \)
       = \( \frac{12^2}{531.36} \)
       = 0.27 kgs/Ft

    4. weight of each steel bar of length 40' = 0.27 x 40 = 10.8 kgs

    5. No. of Steel bars of length 40' required = weight of steel required / weight of each
       of Ø12mm = 136.608 / 10.8 steel bar
       = 12.648 or approximately equal to 13 bars of Ø12mm required.

    For 12.648 steel bars the required weight of steel = 136.608 (required weight of steel)
    For 13 Steel bars the required weight of steel = 10.8 x 13 = 140.4 kgs (Actual weight of steel)

    (b). Ø16mm
    1. Standard length of each steel bar = 40 Ft.
    2. Dia of steel bar for y-bar  = 16mm
    3. Weight of Steel bar in kgs / Ft = \( \frac{d^2}{531.36} \)
       = \( \frac{16^2}{531.36} \)
       = 0.481 kgs/Ft
4. weight of each steel bar of length 40' = 0.481 x 40 = 19.24 kgs

5. No. of Steel bars of length 40' required = wt. of steel required / wt. of each Steel bar of Ø12mm.
   = 250.094 / 19.24
   = 12.998 or approximately equal to 13 bars of Ø16mm required.

For 12.998 steel bars the required weight of steel = 250.094 (required weight of steel)
For 13 Steel bars the required wt of steel = 19.24 x 13 = 250.12 kgs (Actual wt. of steel)

(iv). Bill of Quantities for Footing reinforcement:-

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Description</th>
<th>Unit</th>
<th>Rate/unit</th>
<th>Total Quantity</th>
<th>Total Amount</th>
<th>Remark</th>
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<tr>
<td></td>
<td>Dia of bar</td>
<td>Kgs</td>
<td>in Rupees</td>
<td>Actual weight of Steel required in kgs</td>
<td>Required bars of 40' length</td>
<td>Rupees</td>
</tr>
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<td>Ø12mm</td>
<td>Kgs</td>
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<td>140.400</td>
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<td>6739.200</td>
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<td>Ø16mm</td>
<td>Kgs</td>
<td>48.00</td>
<td>250.120</td>
<td>13</td>
<td>12005.760</td>
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<td>21556.704</td>
<td></td>
</tr>
</tbody>
</table>

Contingencies mean: Expenses which is likely to happen in future, which may happen or may not happen.
**Problem-2:-**
For a given plan of footing find
(i). Weight of Steel required for making footing meshes with hooks
(ii). No. of Steel bars required, of length 40Ft
(iii). Bill of Quantities for Footing Reinforcement
Footing mesh details:
Ø12mm@100mm or 4" in x-direction and Ø16mm@100mm or 4" in y-direction
no. of footings = 8 spacing = 4" and Rate of steel/kg = 48.0 rupees.

![Footing Reinforcement Diagram]

**Solution :-**
(i). x-bar calculation:-

Total length of bar = L + 9D + 9D = L + 18D

where D = dia of bar

According to condition, deduction of Concrete Cover from four sides of Footing
if Length or width of item is greater than or equal to 0.60m or 2' then cover=4"=100mm

"L" = 4" - 4" - 4" = 3'4" = 3.333'

dia of x-bar = 12mm = 0.0393'

1. Length of x-bar = L + 18D
   = 3.333' + 18 x 0.0393'
   = 4.04'

12mm = ? Ft
since 1"=25.4mm

1" = 0.787mm

.

= 0.472" = ? Ft
since 1ft = 12"

= 0.0393ft
2. No. of x-bar = (opposite length / spacing) + 1
   .= (40"/4") + 1
   .= 11 bars

3. Total length of x-bar = no. of x-bars x length of each x-bar
   .= 11 x 4.04'
   .= 44.44'

4. Given dia of x-bar = 12mm

5. Weight of Steel bar in kgs / Ft
   .= \( \frac{d^2}{531.36} \)
   .= \( \frac{12^2}{531.36} \)
   .= 0.27 kgs/Ft

6. Total weight of Steel required = weight/Ft x Total length of x-bar x no. of footings
   .= 0.27 x 44.44 x 8
   .= 95.99 kgs steel required of \( \varnothing 12 \)mm

(ii). y-bar calculation:

Total length of bar
   .= L + 9D + 9D
   .= L + 18D

where D = dia of bar
According to condition, deduction of Concrete Cover from four sides of Footing if Length or width of item is greater than or equal to 0.60m or 2' then cover = 4"

"L" = 4' - 4" - 4" = 3'4" = 3.333'

\[ \text{Dia of y-bar} = 16\text{mm} = 0.0524' \]

1. Length of y-bar = \( L + 18D \)
   
   \[ = 3.333' + 18 \times 0.0524' \]
   
   \[ = 4.276' \]

\[ \text{Dia of y-bar} = \frac{16}{25.4} \text{mm} \]

2. No. of y-bar = \( \frac{\text{opposite length}}{\text{spacing}} + 1 \)
   
   \[ = (40''/4'') + 1 \]
   
   \[ = 11 \text{ bars} \]

3. Total length of y-bar = no. of y-bars x length of each y-bar
   
   \[ = 11 \times 4.276' \]
   
   \[ = 47.036' \]

4. Given dia of y-bar = 16mm

5. Weight of Steel bar in kgs / Ft
   
   \[ = \frac{d^2}{531.36} \]
   
   \[ = \frac{16^2}{531.36} \]
   
   \[ = 0.481 \text{ kgs/Ft} \]

6. Total weight of Steel required = weight/Ft x Total length of y-bar x no. of footings
   
   \[ = 0.481 \times 47.036 \times 8 \]
   
   \[ = 180.994 \text{ kgs steel required of } \phi 16\text{mm} \]
(iii). Total weight of steel required for 8 footing meshes of Ø12mm & Ø16mm

weight of x-bars required = 95.99 kgs for Ø12mm
weight of y-bars required = 180.994 kgs for Ø16mm

(iv). No. of Steel bars required of length 40Ft.
(a). Ø12mm
1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar for x-bar = 12mm

3. Weight of Steel bar in kgs / Ft
   .= $d^2/531.36$
   .= $12^2/531.36$
   .= 0.27 kgs/Ft

4. weight of each steel bar of length 40' = 0.27 x 40 = 10.8 kgs

5. No. of Steel bars of length 40' required = wt of steel required / wt of each steel bar
   of Ø12mm
   .= 95.99 / 10.8
   .= 8.88 or approximately equal to 9 bars of Ø12mm required.

For 8.88 steel bars the required weight of steel = 95.99 (required weight of steel)
For 9 Steel bars the required weight of steel = 10.8 x 9 = 97.2 kgs (Actual weight of steel)

(b). Ø16mm
1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar for y-bar = 16mm

3. Weight of Steel bar in kgs / Ft
   .= $d^2/531.36$
   .= $16^2/531.36$
   .= 0.481 kgs/Ft

4. weight of each steel bar of length 40' = 0.481 x 40 = 19.24kgs

5. No. of Steel bars of length 40' required = wt. of steel required /wt of each steel bar
   of Ø12mm
   .= 180.994 / 19.24
   .= 9.407 or approximately equal to 10 bars of Ø16mm required.

For 9.407 steel bars the required weight of steel = 180.994 (required weight of steel)
For 10 Steel bars the required wt of steel = 19.24 x 10 = 192.4 kgs (Actual wt. of steel)
(iv). Bill of Quantities for Footing reinforcement:-

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<th>S.no.</th>
<th>Description</th>
<th>Unit</th>
<th>Rate/unit</th>
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<th>Total Amount</th>
<th>Remark</th>
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<td>Dia of bar</td>
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<td>in Rupees</td>
<td></td>
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Contingencies mean: Expenses which is likely to happen in future, which may happen or may not happen.

Problem-3:-
For a given plan of footing find
(i). Weight of Steel required for making footing meshes
(ii). No. of Steel bars required, of length 40Ft
(iii). Bill of Quantities for Footing Reinforcement
Footing mesh details: Ø12mm@100mm or 4" in x-direction & y-direction
if no. of footings = 14; spacing = 4" and Rate of steel /kg = 48.0 rupees.
Solution:-
Total length of bar = \( L + 6'' + 6'' \)
\[ = L + 12'' \]

\( L' \) = length of \( x \) & \( y \) bar after deduction of concrete cover
6'' = Given Projection of Steel bar for footing mesh

(i). \( x \)-bar calculation:-
According to condition, deduction of Concrete Cover from four sides of Footing
if Length or width of item is greater than or equal to 0.60m or 2' then cover=4"=100mm

" \( L'' = 4' - 4'' - 4'' = 3'4'' = 3.333' \)
1. Length of \( x \)-bar \( = L + 6'' + 6'' \)
\[ = L + 12'' \]
\[ = 3.333' + 1' \]
\[ = 4.333' \]
2. No. of x-bar = (opposite length / spacing) + 1
   .= (40"/4") + 1
   .= 11 bars

3. Total length of x-bar = no. of x-bars × length of each x-bar
   .= 11 × 4.333’
   .= 47.663’

4. Given dia of x-bar = 12mm

5. Weight of Steel bar in kgs / Ft
   .= \( \frac{d^2}{531.36} \)
   .= \( \frac{12^2}{531.36} \)
   .= 0.27 kgs/Ft

6. Total weight of Steel required = weight/Ft × total length of x-bar × no. of footings
   .= 0.27 × 47.663’ × 14
   .= 180.166 kgs steel required of Ø12mm

(ii). y-bar calculation:-
According to condition, deduction of Concrete Cover from four sides of Footing
if Length or width of item is greater than or equal to 0.60m or 2’, then cover = 4” = 100mm

"L" = 4’ - 4" - 4" = 3’4" = 3.333’

1. Length of y-bar = L + 6" + 6"
   .= L + 12"
   .= 3.333’ + 1’
   .= 4.333’

2. No. of y-bar = (opposite length / spacing) + 1
   .= (40"/4") + 1
   .= 11 bars

3. Total length of y-bar = no. of y-bars × length of each y-bar
   .= 11 × 4.333’
   .= 47.663’

4. Given dia of y-bar = 12mm
5. Weight of Steel bar in kgs / Ft
   \( = \frac{d^2}{531.36} \)
   \( = \frac{12^2}{531.36} \)
   \( = 0.27 \text{ kgs/Ft} \)

6. Total weight of Steel required = weight/Ft x Total length of y-bar x no. of footings
   \( = 0.27 \times 47.663' \times 14 \)
   \( = 180.166 \text{ kgs steel required of } \varnothing12\text{mm} \)

(iii). Total weight of steel required for 14 footing meshes of \( \varnothing12\text{mm} \)

weight of x-bars required = 180.166
weight of y-bars required = 180.166

Total required weight of steel = 360.332 kgs

(iv). No. of Steel bars required of length 40Ft.

1. Standard length of each steel bar = 40 Ft.

2. Dia of steel bar for x-bar & y-bar = 12mm

3. Weight of Steel bar in kgs / Ft
   \( = \frac{d^2}{531.36} \)
   \( = \frac{12^2}{531.36} \)
   \( = 0.27 \text{ kgs/Ft} \)

4. weight of each steel bar of length 40' = 0.27 \times 40 = 10.8 \text{ kgs} \)

5. No. of Steel bars of length 40' required = \frac{\text{wt of steel required}}{\text{wt of each steel bar}}
   \( = \frac{360.332}{10.8} \)
   \( = 33.36 \text{ or approximately equal to 34 bars of } \varnothing12\text{mm required} \)

For 33.36 steel bars the required weight of steel = 360.332 \text{ (required weight of steel)}
For 34 Steel bars the required wt of steel = 10.8 \times 34 = 367.20 \text{ kgs (Actual wt of steel)}

(iv). Bill of Quantities for Footing reinforcement:-
### BILL OF QUANTITIES FOR FOOTING REINFORCEMENT

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<tr>
<th>S.no.</th>
<th>Description</th>
<th>Unit</th>
<th>Rate/unit</th>
<th>Total Quantity</th>
<th>Total Amount</th>
<th>Remark</th>
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Contingencies mean: Expenses which is likely to happen in future, which may happen or may not happen.

**Problem-4 :-**

For a given plan of Neck Column find

(i). Weight of Steel required for Main bars and Stirrups.
(ii). No. of Steel bars required, of length 40Ft
(iii). Bill of Quantities for Neck Column Reinforcement if Rate of steel /kg = 48.0 rupees.

If no. of Columns = 12 size of column = 12" x 12"
Height of CRS above G.L = 1.0Ft.
Depth of excavation = 5Ft
Depth of footing = 3Ft
Thickness of pcc bed 4"

Reinforcement details for Neck column :-
(a). Main bars = 6 Ø 12mm (b). Stirrups = Ø 8mm @ 100mm or 4"
Solution :-

(i). Neck Column Main bars calculations:-

"L" = Depth of Excavation - thickness of pcc bed - thickness of Covering block

L = 5’ - 4” - 2”
L = 5’ - 6”
L = 4.5’

Dia of Main bar = 12mm = 0.0393 Ft

Bend length = 16D : Over-lap length = 50D

1. The length of each Main bar = L + 16D + 50D + Ht. of CRS

   = L + 66D + Ht. of CRS
   = 4.5’ + 66 x 0.0393 + 1’
   = 8.093 Ft

2. No. of Main bars = 6

3. Total length of Main bar = length of each main bar x no. of main bars

   = 8.093’ x 6
   = 48.558’

4. Dia of Main bar = 12mm
3. Weight of Steel bar in kgs / Ft  
\[ d^2 / 531.36 \]
\[ = 12^2 / 531.36 \]
\[ = 0.27 \text{ kgs/Ft} \]

6. Weight of Steel required = \( wt./\text{Ft} \times \text{Total length of Main-bar} \times \text{no. of Neck columns} \)
\[ = 0.27 \times 48.558' \times 12 \]
\[ = 157.327 \text{ kgs steel required of } \phi 12 \text{mm} \]

(ii) Neck Column Stirrups or Ties calculations:

Hook length = 9D  
Two Hook length = 9D x 2 = 18D  
where D = dia of bar  
Length of each Tie = \( L + 18D \)  
\( L = \text{length of Tie after deduction of 1" Concrete Cover from four sides of Column with out hook length.} \)
\[ L = (L+B) \times 2 \]
\[ L = (10" + 10") \times 2 \]
\[ = 40" = 3.333' \text{ Ft} \]
\[ \text{since } 1" = 25.4 \text{ mm} \]
\[ D = \text{dia of Stirrup} = 8\text{mm} = 0.0262 \text{ Ft} \]
\[ = 8/25.4 \]
\[ = 0.3149" = ? \text{ Ft} \]

1. Length of Tie = \( L + 18D \)  
\[ = 3.333' + 18 \times 0.0262 \]
\[ = 3.804' \]

2. No. of Ties = \( \text{Ht. of neck column} / \text{spacing} + 1 \)
\[ = (5.5' / 0.333') + 1 \]
\[ = 17.51 \text{ or approximately equal to } 18 \text{ stirrups} \]
Given spacing = 4" = 0.333Ft

Ht. of neck column = Depth of excavation - thickness of pcc - thickness of covering block + Ht. of CRS
= 5' - 4" - 2" +1'
= 5' -0.5' + 1'
= 5.5ft

3. Total length of Stirrup = length of each Stirrup x no. of Stirrups
= 3.804' x 18
= 68.472 Ft

4. Dia of Stirrup = 8mm

3. Weight of Steel bar in kgs / Ft
= \( \frac{d^2}{531.36} \)
= \( \frac{8^2}{531.36} \)
= 0.1204 kgs/Ft

6. Weight of Steel required = weight/Ft x Total length of Stirrup x no. of Neck columns
= 0.1204 x 68.472' x 12
= 98.928 kgs steel required of Ø 8mm

(iii). Total weight of steel required for 12 no. of Columns of Ø12mm & Ø8mm

weight of Main bars required = 157.327 kgs
weight of Stirrups required = 98.928 kgs

(iv). No. of Steel bars required of length 40Ft.
(a). Ø 12mm
1. Standard length of each steel bar = 40 Ft.

2. Dia of steel bar for Main bar = 12mm

3. Weight of Steel bar in kgs / Ft
= \( \frac{d^2}{531.36} \)
= \( \frac{12^2}{531.36} \)
= 0.27 kgs/Ft
4. weight of each steel bar of length 40’ = 0.27 x 40 = 10.8 kgs

5. No. of Steel bars of length 40’ required = wt. of steel required / wt. of each steel bar
   = 157.327 / 10.8
   = 14.56 or approximately equal to 15 bars of Ø12mm required.

For 14.56 steel bars the required weight of steel = 157.327 (required weight of steel)
For 15 Steel bars the required wt. of steel = 10.8 x 15 = 162.0 kgs (Actual wt. of steel)

(b). Ø 8mm

1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar for Stirrups = 8mm
3. Weight of Steel bar in kgs / Ft = $d^2/531.36$
   = $8^2/531.36$
   = 0.1204 kgs

4. weight of each steel bar of length 40’ = 0.1204 x 40 = 4.816 kgs

5. No. of Steel bars of length 40’ required = wt of steel required / wt of each steel bar
   = 98.928 / 4.816
   = 20.54 or approximately equal to 21 bars of Ø8mm required.

For 20.54 steel bars the required weight of steel = 98.928 (required weight of steel)
For 21 Steel bars the required wt. of steel = 4.816 x 21 =101.136 kgs (Actual wt. of steel)

(v). Bill of Quantities for Neck column reinforcement:

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<th>S.no.</th>
<th>Description</th>
<th>Unit</th>
<th>Rate/unit in Rupees</th>
<th>Total Quantity</th>
<th>Total Amount in Rupees</th>
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<td>in kgs</td>
<td>Required bars of</td>
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Contingencies mean: Expenses which is likely to happen in future, which may happen or may not happen.
Problem-5 :-
For a given plan of Plinth beam find
(i). Weight of Steel required for Main bars and Stirrups.
(ii). No. of Steel bars required, of length 40Ft
(iii). Bill of Quantities for Plinth beam Reinforcement if Rate of steel /kg = 48.0 rupees.

size of Plinth beam = 9" x 12" size of column = 9" x 12"

Reinforcement details for Plinth beams :-
(a). Main bars = 6 Ø 10mm 
(b). Stirrups = Ø 8mm@ 100mm or 4"
Solution:

(i). Plinth beam main bar calculations:

(a). Plinth beam along horizontal axis

Given size of Column = 9" x 12"
No. of Plinth beams along horizontal axis = 3
Length of Plinth beam including column length = 27'6"
1. Length of each Main bar = 27'6" - 1" - 1"
   = 27'4" (Deduction of 1" concrete cover from both side)
   = 27.333'
2. No. of Main bars = 6
3. Total length of Main bars
   = length of each Main bar x no. of Main bars x no. of Plinth beams
   = 27.333' x 6 x 3
   = 491.994'

(b). Plinth beam along vertical axis

Given size of Column = 9" x 12"
No. of Plinth beams along vertical axis = 3
Length of Plinth beam including Column length = 25'6"
1. Length of each Main bar = 25'6" - 1" - 1"
   = 25'4" (Deduction of 1" concrete cover from both side)
   = 25.333'
2. No. of Main bars = 6
3. Total length of Main bars = length of each Main bar x no. of Main bars x no. of Plinth beams
   = 25.333' x 6 x 3
   = 455.994'

(c). Total length of Main bars along horizontal and vertical axis :-
length of steel bar along horizontal axis = 491.994'
length of steel bar along vertical axis = 455.994'
Total length of Main bars = 947.988'

(d). Weight of steel required for Main bars :-
1. Total length of Main bars = 947.988 Ft
2. Dia of Main bar = 10mm
3. Weight of Steel bar in kgs / Ft = \( \frac{d^2}{531.36} \)
   = \( \frac{10^2}{531.36} \)
   = 0.1881 kgs/Ft
4. Total weight of Steel required = weight/Ft x Total length of Main bars
   = 0.1881 x 947.998
   = 178.316 kgs steel required of Ø 10mm

(ii). Plinth beam - Stirrups calculations:-
Stirrups are provided in plinth beam up to Plinth beam length, excluding Columns
Size of Column = 9" x 12"

Length of Plinth beam along horizontal axis excluding Column length
= 27.6" - 9" - 9" - 9" = 27.5' - 0.75' - 0.75' - 0.75' = 25.25'
No. of Plinth beam along horizontal axis = 3
Length of Plinth beam along vertical axis = 25'6" - 12" - 12" - 12"
excluding Column length = 25.5' - 1' - 1' - 1'
No. of Plinth beam along vertical axis = 3

Total length of Plinth beam = 25.25' x 3 + 22.5' x 3
= 143.25Ft

Length of each Stirrup = L + 18D
where 'L' = length of stirrup after deduction of 1" concrete cover
'D' = dia of Stirrup = 8mm = 0.0262 Ft

L = (L + B) x 2
= (7" + 10) x 2
= 34"
= 2.833 Ft

8mm = ? Ft
since 1" = 25.4mm
= 8/25.4
= 0.3149" = ? Ft
since 1ft = 12"
= 0.3149/12
= 0.0262 ft

1. Length of each Stirrup = L + 18D
= 2.833 + 18 x 0.0262
= 3.304'

2. No. of Stirrups = (length of Plinth beam / spacing) + 1
Given spacing = 100mm
= (143.25 / 0.333) + 1
= 431.18 or approximately equal to 432 Ties

3. Total length of Stirrups = length of each Tie x no. of Ties
= 3.304 x 432
= 1427.328 Ft

4. Dia of Stirrup = 8mm

5. Weight of Steel bar in kgs / Ft = $d^2/531.36$
= $8^2/531.36$
= 0.1204 kgs/Ft

6. Total weight of Steel required = weight/Ft x Total length of stirrup
= 0.1204 x 1427.328'
= 171.850 kgs steel required of Ø 8mm
(iii). Total weight of steel required for Plinth beams of Ø10mm & Ø8mm

weight of Main bars required = 178.316 kgs
weight of Stirrups required = 171.850 kgs

(iv). No. of Steel bars required of length 40Ft.

(a). Ø 10mm
1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar for Main bar = 10mm
3. Weight of Steel bar in kgs / Ft = \( \frac{d^2}{531.36} \)
   = \( \frac{10^2}{531.36} \)
   = 0.1881 kgs/Ft
4. weight of each steel bar of length 40' = 0.1881 x 40 = 7.524 kgs
5. No. of Steel bars of length 40' required = wt. of steel required / wt. of each steel bar
   = 178.316 / 7.524
   = 23.69 or approximately equal to 24 bars of Ø10mm required.

For 23.69 steel bars the required weight of steel = 178.316 kgs (required wt. of steel)
For 24 Steel bars the required wt. of steel = 7.524 x 24 = 180.576 kgs (Actual wt of steel)

(b). Ø 8mm
1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar for Stirrups = 8mm
3. Weight of Steel bar in kgs / Ft = \( \frac{d^2}{531.36} \)
   = \( \frac{8^2}{531.36} \)
   = 0.1204 kgs
4. weight of each steel bar of length 40' = 0.1204 x 40 = 4.816 kgs
5. No. of Steel bars of length 40' required = wt of steel required / wt of each steel bar
   = 171.850 / 4.816
   = 35.68 or approximately equal to 36 bars of Ø8mm required.

For 35.68 steel bars the required weight of steel = 171.850 kgs (required wt of steel)
For 36 Steel bars the required wt of steel = 4.816 x 36 = 173.376 kgs (Actual wt of steel)
(v). Bill of Quantities for Plinth beam reinforcement:-

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Description</th>
<th>Unit</th>
<th>Rate/unit</th>
<th>Total Quantity</th>
<th>Total Amount</th>
<th>Remark</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Dia of bar</td>
<td>Kgs</td>
<td>in Rupees</td>
<td>Actual weight of Steel required bars of Rupees in kgs</td>
<td>Required bars of Rupees in kgs 40' length</td>
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<tr>
<td>1</td>
<td>Ø10mm</td>
<td>Kgs</td>
<td>48.00</td>
<td>180.576</td>
<td>24</td>
<td></td>
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<tr>
<td>2</td>
<td>Ø8mm</td>
<td>Kgs</td>
<td>48.00</td>
<td>173.376</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>16989.696</td>
<td></td>
</tr>
</tbody>
</table>

Add 10% wastage 1698.970
Add 5% Contingencies 849.485
Total 19538.150

Contingencies mean: Expenses which is likely to happen in future, which may happen or may not happen.

**Problem-6 :-**

From the given plan and section Dwg. of Floor Column Find

(i). Weight of Steel required for Main bars and Stirrups.

(ii). No. of Steel bars required, of length 40Ft

(iii). Bill of Quantities for Floor Column Reinforcement if Rate of steel /kg = 48.0 rupees.

Size of Column = 9” x 12” ; Height of Ceiling = 10’

No. of Floor Columns = 6 and Thickness of Floor Slab = 6”

Reinforcement Details for Floor Columns:

(a). Main bars = 6 Ø12mm (b). Stirrups = Ø8mm@100mm or 4"

![Plan of Column](image-url)
### Solution :-

(i). Floor Column Main bars calculations:

1. Length of each Main bar :-

   "L" = Height of Ceiling + Thickness of Floor Slab + Over-lap length

   \[
   L = 10' + 6" + 50D
   \]

   since 1" = 25.4mm

   \[
   L = 10' + 0.5' + 50 \times 0.0393'
   \]

   \[
   L = 12.465'
   \]

   Dia of Main bar = 12mm = 0.0393 Ft

   Over-lap length = 50D

   \[
   L = \frac{0.472}{12}
   \]

   \[
   L = 0.0393\text{ft}
   \]

2. No. of Main bars = 6
3. Total length of Main bar = length of each main bar x no. of main bars
   .= 12.465' x 6
   .= 74.79'

4. Dia of Main bar = 12mm

3. Weight of Steel bar in kgs / Ft
   .= \( d^2 / 531.36 \)
   .= \( 12^2 / 531.36 \)
   .= 0.27 kgs/Ft

6. Total wt of Steel required = wt/Ft x Total length of Main-bar x no. of Floor columns
   .= 0.27 x 74.79' x 6
   .= 121.159 kgs steel required of Ø12mm

(ii). Floor Column Stirrups or Ties calculations:-

Hook length = 9D
Two Hook length = 9D x 2 = 18D
where D = dia of bar
Length of each Tie = L + 18D
L = length of Tie after deduction of 1" Concrete Cover from four sides of Column with-
out hook length
L = (L+B) x 2
L = (7" + 10") x 2
L = 34" = 2.833Ft
D = dia of Stirrup = 8mm = 0.0262 Ft
since 1"=25.4mm
.= 8/25.4

1. Length of Tie = L + 18D
   .= 2.833' + 18 x 0.0262
   .= 3.304'

2. No. of Ties = (Ht. of Ceiling / spacing) +1
   .= (10' / 0.333') +1
   .= 31.03 or approximately equal to 31 stirrups
Given spacing = 4" = 0.333Ft
Note: Stirrups shall be provided up to ceiling height only.

3. Total length of Stirrup = length of each Stirrup x no. of Stirrups
   = 3.304' x 31
   = 102.424 Ft

4. Dia of Stirrup = 8mm

3. Weight of Steel bar in kgs / Ft
   = \( \frac{d^2}{531.36} \)
   = \( \frac{8^2}{531.36} \)
   = 0.1204 kgs/Ft

6. Total wt of Steel required = wt/Ft x Total length of Stirrup x no. of Floor Columns
   = 0.1204 x 102.424' x 6
   = 73.991 kgs steel required of Ø 8mm

(iii). Total weight of steel required for 6 no. of Columns of Ø12mm & Ø8mm

weight of Main bars required = 121.159 kgs
weight of Stirrups required = 73.991 kgs

(iv). No. of Steel bars required of length 40Ft.
(a). Ø 12mm
1. Standard length of each steel bar = 40 Ft.

2. Dia of steel bar for Main bar = 12mm
3. Weight of Steel bar in kgs / Ft
   = \( \frac{d^2}{531.36} \)
   = \( \frac{12^2}{531.36} \)
   = 0.27 kgs/Ft

4. weight of each steel bar of length 40' = 0.27 x 40 = 10.8 kgs

5. No. of Steel bars of length 40' required = wt of steel required / wt of each steel bar
   = 121.159 / 10.8
   = 11.21 or approximately equal to 12 bars of Ø12mm required.

For 11.21 steel bars the required weight of steel = 121.159 (required weight of steel)
For 12 Steel bars the required wt of steel = 10.8 x 12 = 129.6 kgs (Actual wt of steel)
(b). Ø 8mm
1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar for Stirrups = 8mm
3. Weight of Steel bar in kgs / Ft \(= \frac{d^2}{531.36}\)
\(= \frac{8^2}{531.36}\)
\(= 0.1204\) kgs
4. weight of each steel bar of length 40' = 0.1204 x 40 = 4.816 kgs
5. No. of Steel bars of length 40' required = \(\frac{\text{wt of steel required}}{\text{wt of each steel bar}}\)
\(= \frac{73.991}{4.816}\)
\(= 15.36\) or approximately equal to 16 bars of Ø8mm required.

For 15.36 steel bars the required weight of steel = 73.991 (required weight of steel)
For 16 Steel bars the required wt of steel = 4.816 x 16 = 77.056 kgs (Actual wt of steel)

(v). Bill of Quantities for Floor Columns reinforcement:-

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Description</th>
<th>Unit</th>
<th>Rate/unit (in Rupees)</th>
<th>Total Quantity</th>
<th>Total Amount (in Rupees)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dia of bar</td>
<td>Kgs</td>
<td>Actual weight of Steel required in kgs</td>
<td>40' length</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Ø12mm</td>
<td>Kgs</td>
<td>48.00</td>
<td>129.600</td>
<td>12</td>
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<td>2</td>
<td>Ø8mm</td>
<td>Kgs</td>
<td>48.00</td>
<td>77.056</td>
<td>16</td>
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<td></td>
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<td>Add 10% wastage</td>
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<td></td>
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<tr>
<td></td>
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<td></td>
<td>Add 5% Contingencies</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Contingencies mean : Expenses which is likely to happen in future, which may happen or may not happen.
Problem-7 :-
For a given plan & Section Dwg. of Floor beams find
(i). Weight of Steel required for Main bars and Stirrups.
(ii). No. of Steel bars required, of length 40Ft
(iii). Bill of Quantities for Floor beam Reinforcement if Rate of steel /kg = 48.0 rupees.

Floor beam details: size of Floor beam = 9" x 12" size of column = 9" x 12"

Reinforcement details for Floor beams:
(a). Main bars = 6 Ø 12mm (b). Stirrups = Ø 8mm @ 100mm or 4"
Solution :-
(i). Floor beam main bars calculations:-

(a). Floor beam along horizontal axis"
Given size of Column = 9" x 12"
No. of Floor beams along horizontal axis = 3
Length of Floor beam including column length = 28'6"

1. Length of each Main bar = 28'6" - 1" - 1"
   .= 28'4" (Deduction of 1" concrete cover from both side)
   .= 28.333'

2. No. of Main bars = 6

3. Total length of Main bars = length of each Main bar x no. of Main bars x no. of Floor beams
   .= 28.333' x 6 x 3
   .= 509.994'

(b). Floor beam along vertical axis"

Given size of Column = 9" x 12"
No. of Floor beams along vertical axis = 3
Length of Floor beam including Column length = 26'6"

1. Length of each Main bar = 26'6" - 1" - 1"
   .= 26'4" (Deduction of 1" concrete cover from both side)
   .= 26.333'

2. No. of Main bars = 6

3. Total length of Main bars = length of each Main bar x no. of Main bars x no. of Floor beams
   .= 26.333' x 6 x 3
   .= 473.994'

(c). Total length of Main bars along horizontal and vertical axis :-

length of steel bar along horizontal axis: = 509.994
length of steel bar along vertical axis = 473.994'
Total length of Main bars = 983.988'
(d). Weight of steel required for Main bars:
1. Total length of Main bar = 983.988 Ft
2. Dia of Main bar = 12mm
3. Weight of Steel bar in kgs / Ft = \( \frac{d^2}{531.36} \)
   \[ = \frac{12^2}{531.36} \]
   \[ = 0.27 \text{ kgs/Ft} \]
4. Total weight of Steel required = weight/Ft x Total length of Main bars
   \[ = 0.27 \times 983.998 \]
   \[ = 265.679 \text{ kgs steel required of } \Phi 12mm \]

(ii). Floor beam - Stirrups calculations:

Stirrups are provided in Floor beam up to Floor beam length, excluding Column length. Size of Column = 9" x 12"

Length of Floor beam along horizontal axis = 28'6" - 9" - 9" - 9"
   = 28.5' - 0.75' - 0.75' - 0.75'
   = 26.25'

No. of Floor beam along horizontal axis = 3

Length of Floor beam along vertical axis = 26'6" - 12" - 12" - 12"
   = 26.5' - 1' - 1' - 1'
   = 23.5'

No. of Floor beam along vertical axis = 3

Total length of Floor beam = 26.25' x 3 + 23.5' x 3
   = 149.25Ft
Length of each Stirrup = \( L + 18D \)

where 'L' = length of stirrup after deduction of 1" concrete cover

'D' = dia of Stirrup = 8mm = 0.0262 Ft

\[
L = (L + B) \times 2 \\
= (7" + 10) \times 2 \\
= 34" \\
= 2.833 \text{ Ft}
\]

1. Length of each Stirrup = \( L + 18D \)

\[
= 2.833 + 18 \times 0.0262 \\
= 3.304' 
\]

2. No. of Stirrups = (length of Floor beam / spacing) + 1

Given spacing = 100mm

\[
= (149.25 / 0.333) + 1 \\
= 449.198 \text{ or approximately equal to 450 Ties}
\]

3. Total length of Stirrups = length of each Tie x no. of Ties

\[
= 3.304 \times 450 \\
= 1486.8 \text{ Ft}
\]

4. Dia of Stirrup = 8mm

5. Weight of Steel bar in kgs / Ft

\[
= \frac{d^2}{531.36} \\
= \frac{8^2}{531.36} \\
= 0.1204 \text{ kgs/Ft}
\]

6. Total weight of Steel required = weight/Ft x Total length of stirrup

\[
= 0.1204 \times 1486.8 \\
= 179.01 \text{ kgs steel required of Ø 8mm}
\]

(iii). Total weight of steel required for Floor beams of Ø12mm & Ø8mm

weight of Main bars required = 265.679 kgs
weight of Stirrups required = 179.01 kgs

(iv). No. of Steel bars required of length 40Ft.

(a). Ø 12mm

1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar for Main bar = 12mm

3. Weight of Steel bar in kgs / Ft  
   \[ = \frac{d^2}{531.36} \]
   \[ = \frac{12^2}{531.36} \]
   \[ = 0.27 \text{ kgs/Ft} \]

4. Weight of each steel bar of length 40' = 0.27 x 40 = 10.8 kgs

5. No. of Steel bars of length 40' required  
   \[ = \frac{\text{wt of steel required}}{\text{wt of each steel bar}} \]
   \[ = \frac{265.679}{10.8} \]
   \[ = 24.59 \text{ or approximately equal to 25 bars of Ø12mm required.} \]

For 24.59 steel bars the required wt of steel = 265.679 kgs  (required wt of steel)
For 25 Steel bars the required wt of steel = 10.8 x 25 = 270.0 kgs  (Actual wt of steel)

(b). Ø 8mm

1. Standard length of each steel bar = 40 Ft.

2. Dia of steel bar for Stirrups = 8mm

3. Weight of Steel bar in kgs / Ft  
   \[ = \frac{d^2}{531.36} \]
   \[ = \frac{8^2}{531.36} \]
   \[ = 0.1204 \text{ kgs} \]

4. Weight of each steel bar of length 40' = 0.1204 x 40 = 4.816 kgs

5. No. of Steel bars of length 40' required  
   \[ = \frac{\text{wt of steel required}}{\text{wt of each steel bar}} \]
   \[ = \frac{179.01}{4.816} \]
   \[ = 37.16 \text{ or approximately equal to 38 bars of Ø8mm required.} \]

For 37.16 steel bars the required weight of steel = 179.01 kgs  (required weight of steel)
For 38 Steel bars the required wt of steel = 4.816 x 38 = 183.008 kgs  (Actual wt of steel)

(v). Bill of Quantities for Floor beam reinforcement:-
### BILL OF QUANTITIES FOR FLOOR BEAMS REINFORCEMENT

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Description</th>
<th>Unit</th>
<th>Rate/unit</th>
<th>Total Quantity</th>
<th>Total Amount</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dia of bar</td>
<td>Kgs</td>
<td>in Rupees</td>
<td>Actual weight of Steel required in kgs</td>
<td>40' length</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Required bars of Rupees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Ø12mm</td>
<td>Kgs</td>
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<td>270.000</td>
<td>25</td>
<td>12960.000</td>
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<tr>
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<td>Ø8mm</td>
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Contingencies mean: Expenses which is likely to happen in future, which may happen or may not happen.

**Problem-8:**

For a given plan & Section Dwg. of Floor Slab find

(i). Weight of Steel required for Main bars and Extra bars

(ii). No. of Steel bars required, of length 40Ft

(iii). Bill of Quantities for Floor Slab Reinforcement if Rate of steel /kg = 48.0 rupees.

Size of Floor beam = 9" x 12"        Size of column = 9" x 12"        Slab thickness = 6"

Reinforcement details for Floor Slabs:-

(a). Slab mesh = Ø 10mm@100mm or - (b). Extra bar = Ø 8mm@ 100mm or 4"

![Plan showing Floor Slab Details](image)
Solution :-
According to conditions, 1 inch concrete cover shall be deducted from 4 sides of Slab

**SLAB-1:-**

(i). Main bar and Distribution bar calculation (Slab-1) :-

1. Length of x-bar
   \[ L + 0.42D + 0.42D - 1" \]
   \[ L + 0.84D - 1" \]
   \[ 14.625' + 0.84D - 1" \]
   \[ 1" = 0.0833' \]
   \[ 4" = 0.333' \]

2. Length of y-bar
   \[ L + 0.42D + 0.42D - 1" \]
   \[ L + 0.84D - 1" \]
   \[ 14.125' + 0.84D - 1" \]
   \[ 1" = 0.0833' \]
   \[ 4" = 0.333' \]

3. No. of x-bars
   \[ \frac{\text{Opp. length}}{4"} + 1 \]
   \[ 40 \text{ bars} \]

4. No. of y-bars
   \[ \frac{\text{Opp. length}}{4"} + 1 \]
   \[ 41.5 \text{ bars or approximately equal to 42 bars} \]
5. Total length of x-bar & y-bar = length of x-bar x no. of x-bars + length of y-bar x no. of y-bars
   = 14.821 x 40 + 14.321 x 42
   = 1194.322 Ft

(ii). Extra- bar calculation (Slab-1) :- Extra bar = Ø 8mm@ 100mm or 4"
1. The length of each Extra bar in x-direction = (L/4) + 50D
   where D = dia of bar;  L = length of Crank bar including crank length
   Given dia of bar = 8mm = 0.0262' .= (14.821'/4) + 50 x 0.0262'
   .= 5.015'

2. The length of each Extra bar in y-direction = (L/4) + 50D
   where D = dia of bar;  L = length of Crank bar including crank length
   Given dia of bar = 8mm = 0.0262' .= (14.321'/4) + 50 x 0.0262'
   .= 4.89'

8mm=? Ft
since 1"=25.4mm
 .= 8/25.4
 .= 0.3149" = ? Ft
since 1ft = 12"
 .= 0.3149/12
 .= 0.0262ft

3. No. of Extra-bar in x-direction = no. of x-bars x 2
   .= 40 x 2 = 80 bars

4. No. of Extra-bar in y-direction = no. of y-bars x 2
   .= 42 x 2 = 84 bars

5. Total length of Extra bar = length of each Extra bar in x-direction x no. of Extra bar in x-direction + length of each Extra bar in y-direction x no. of Extra bar in y-direction
   .= 5.015' x 80 + 4.58 x 84
   .= 785.92 Ft
SLAB-2:-
(i). Main bar and Distribution bar calculation (Slab-2) :-

1. Length of x-bar  \( = L + 0.42D + 0.42D - 1'' \)
\( = L + 0.84D - 1'' \)
\( = 13.875' + 0.84D - 1'' \)
\( = 13.875' + 0.84 \times 4'' - 1'' \)
\( = 13.875' + 0.84 \times 0.333 - 0.0833' \)
\( = 14.071' \)

\( D = \text{Depth of Slab} - \text{top cover} - \text{bottom cover} \)
\( 1'' = 0.0833' \)
\( D = 6'' - 1'' - 1'' \)
\( 4'' = 0.333' \)
\( D = 4'' \)

2. Length of y-bar  \( = L + 0.42D + 0.42D - 1'' \)
\( = L + 0.84D - 1'' \)
\( = 14.125' + 0.84D - 1'' \)
\( = 14.125' + 0.84 \times 4'' - 1'' \)
\( = 14.125' + 0.84 \times 0.333 - 0.0833' \)
\( = 14.321' \)

3. No. of x-bars  \( = \frac{\text{opposite length}}{\text{spacing}} + 1 \)
\( = \frac{13'\ 4''}{4''} + 1 \)
\( = 40 \text{ bars} \)

4. No. of y-bars  \( = \frac{\text{opposite length}}{\text{spacing}} + 1 \)
\( = \frac{12'9''\ 4''}{4''} + 1 \)
\( = 39.25 \text{ bars or approximately equal to 40 bars} \)

5. Total length of x-bar & y-bar  \( = \text{length of x-bar x no. of x-bars} + \text{length of y-bar x no. of y-bars} \)
\( = 14.071 \times 40 + 14.321 \times 40 \)
\( = 1135.68 \text{ Ft} \)

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website: www.quantitysurveyindia.com ; Ph. no. +91 40 23512686 ; +91 9550259317
(ii). Extra- bar calculation (Slab-2) :- Extra bar = Ø 8mm@ 100mm or 4"

1. The length of each Extra bar in x-direction = (L/4) + 50D
   where D = dia of bar;  L = length of Crank bar including crank length
   Given dia of bar = 8mm = 0.0262'
   = (14.071'/4) + 50 x 0.0262'
   = 4.827'

2. The length of each Extra bar in y-direction = (L/4) + 50D
   where D = dia of bar;  L = length of Crank bar including crank length
   Given dia of bar = 8mm = 0.0262'
   = (14.321'/4) + 50 x 0.0262'
   = 4.89'

3. No. of Extra-bar in x-direction = no. of x-bars x 2
   = 40 x 2 = 80 bars

4. No. of Extra-bar in y-direction = no. of y-bars x 2
   = 40 x 2 = 80 bars

5. Total length of Extra bar = length of each Extra bar in x-direction x no. of Extra bar in x-direction + length of each Extra bar in y-direction x no. of Extra bar in y-direction
   = 4.827' x 80 + 4.89 x 80
   = 777.36 Ft

SLAB-3:-
(i). Main bar and Distribution bar calculation (Slab-3) :-

1. Length of x-bar = L + 0.42D + 0.42D - 1"
   = L + 0.84D - 1"
   = 14.625' + 0.84D - 1"
   = 14.625' + 0.84 x 4" - 1"
   = 14.625' + 0.84 x 0.333 - 0.0833'
   = 14.821'

   D = Depth of Slab - top cover - bottom cover
   1" = 0.0833'
   D = 6" - 1" - 1"
   4" = 0.333'
   D = 4"
2. Length of y-bar

\[ \text{= L} + 0.42D + 0.42D - 1" \]
\[ \text{= L} + 0.84D - 1" \]
\[ \text{= 12.375'} + 0.84D - 1" \]
\[ \text{= 12.375'} + 0.84 \times 4" - 1" \]
\[ \text{= 12.375'} + 0.84 \times 0.333 - 0.0833' \]
\[ \text{= 12.571'} \]

3. No. of x-bars

\[ \text{= (opposite length / spacing) + 1} \]
\[ \text{= (11'3"/ 4") + 1} \quad \text{Opp. length = internal breadth of Slab} \]
\[ \text{= (135"/ 4") +1} \quad \text{Given spacing = 4"} \]
\[ \text{= 34.75 bars or approximately equal to 35 bars} \]

4. No. of y-bars

\[ \text{= (opposite length / spacing) + 1} \]
\[ \text{= (13'6"/ 4") + 1} \quad \text{Opp. length = internal length of Slab} \]
\[ \text{= (162"/ 4") +1} \quad \text{Given spacing = 4"} \]
\[ \text{= 41.5 bars or approximately equal to 42 bars} \]

5. Total length of x-bar & y-bar = length of x-bar x no. of x-bars + length of y-bar x no. of y-bars

\[ \text{= 14.821 x 35 + 12.571 x 42} \]
\[ \text{= 1046.717 Ft} \]

(ii). Extra- bar calculation (Slab-3):

1. The length of each Extra bar in x-direction = \( \frac{L}{4} + 50D \)
   where \( D = \text{dia of bar} \); \( L = \text{length of Crank bar including crank length} \)
   Given dia of bar = 8mm = 0.0262'
   \[ \text{= (14.821'/4) + 50 x 0.0262'} \]
   \[ \text{= 4.705'} \]

2. The length of each Extra bar in y-direction = \( \frac{L}{4} + 50D \)
   where \( D = \text{dia of bar} \); \( L = \text{length of Crank bar including crank length} \)
   Given dia of bar = 8mm = 0.0262'
   \[ \text{= (12.571'/4) + 50 x 0.0262'} \]
   \[ \text{= 4.452'} \]

3. No. of Extra-bar in x-direction = no. of x-bars x 2
   \[ \text{= 35 x 2 = 70 bars} \]

4. No. of Extra-bar in y-direction = no. of y-bars x 2
   \[ \text{= 42 x 2 = 84 bars} \]
5. Total length of Extra bar = length of each Extra bar in x-direction x no. of Extra bar in x-direction + length of each Extra bar in y-direction x no. of Extra bar in y-direction
   = 4.705' x 70 + 4.452 x 84
   = 703.318 Ft

SLAB-4:-
(i). Main bar and Distribution bar calculation (Slab-4) :-
1. Length of x-bar = L + 0.42D + 0.42D - 1"
   = L + 0.84D - 1"
   = 13.875' + 0.84D - 1"
   = 13.875' + 0.84 x 4" - 1"
   = 13.875' + 0.84 x 0.333 - 0.0833'
   = 14.071'

   D = Depth of Slab - top cover - bottom cover 1" = 0.0833'
   D = 6" - 1" - 1" 4" = 0.333'

2. Length of y-bar = L + 0.42D + 0.42D - 1"
   = L + 0.84D - 1"
   = 12.375' + 0.84D - 1"
   = 12.375' + 0.84 x 4" - 1"
   = 12.375' + 0.84 x 0.333 - 0.0833'
   = 12.571'

3. No. of x-bars = (opposite length / spacing) + 1
   = (11'3"/ 4") + 1  Opp. length = internal breadth of Slab
   = (135"/4") +1  Given spacing = 4"
   = 34.75 bars or approximately equal to 35 bars

4. No. of y-bars = (opposite length / spacing) + 1
   = (12'9"/ 4") + 1  Opp. length = internal length of Slab
   = (153"/4") +1  Given spacing = 4"
   = 39.25 bars or approximately equal to 40 bars

5. Total length of x-bar & y-bar = length of x-bar x no. of x-bars + length of y-bar x no. of y-bars
   = 14.071 x 35 + 12.571 x 40
   = 995.325 Ft
(ii). Extra-bar calculation (Slab-4) :- Extra bar = Ø 8mm @ 100mm or 4"

1. The length of each Extra bar in x-direction = (L/4) + 50D
   where D = dia of bar;  L = length of Crank bar including crank length
   Given dia of bar = 8mm = 0.0262'
   .= (14.071'/4) + 50 x 0.0262'
   .= 4.827'

2. The length of each Extra bar in y-direction = (L/4) + 50D
   where D = dia of bar;  L = length of Crank bar including crank length
   Given dia of bar = 8mm = 0.0262'
   .= (12.571'/4) + 50 x 0.0262'
   .= 4.452'

3. No. of Extra-bar in x-direction = no. of x-bars x 2
   .= 35 x 2 = 70 bars

4. No. of Extra-bar in y-direction = no. of y-bars x 2
   .= 40 x 2 = 80 bars

5. Total length of Extra bar = length of each Extra bar in x-direction x no. of Extra bar
   in x-direction + length of each Extra bar in y-direction x no. of Extra bar in y-direction
   .= 4.827' x 70 + 4.452 x 80
   .= 694.05 Ft

(a). Total length of Main & Distribution bar for all Slabs :-

<table>
<thead>
<tr>
<th>Slab</th>
<th>Length (Ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slab-1</td>
<td>1194.322</td>
</tr>
<tr>
<td>Slab-2</td>
<td>1135.68</td>
</tr>
<tr>
<td>Slab-3</td>
<td>1046.717</td>
</tr>
<tr>
<td>Slab-4</td>
<td>995.325</td>
</tr>
<tr>
<td>Total</td>
<td>4372.044</td>
</tr>
</tbody>
</table>

(b). Total length of Extra-bar for all Slabs :-

<table>
<thead>
<tr>
<th>Slab</th>
<th>Length (Ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slab-1</td>
<td>785.92</td>
</tr>
<tr>
<td>Slab-2</td>
<td>777.36</td>
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<tr>
<td>Slab-3</td>
<td>703.318</td>
</tr>
<tr>
<td>Slab-4</td>
<td>694.05</td>
</tr>
<tr>
<td>Total</td>
<td>2960.648</td>
</tr>
</tbody>
</table>
Weight of Steel required for Slab Mesh:
1. Given Dia of Slab Mesh = 10mm  Slab mesh = \( \bar{10}\) mm@100mm or 4"

2. Weight of Steel bar in kgs / Ft  
   \[ = \frac{d^2}{531.36} \]
   \[ = \frac{10^2}{531.36} \]
   \[ = 0.1881 \text{ kgs/Ft} \]

3. Total weight of Steel required = weight/Ft x Total length main bars
   \[ = 0.1881 \times 4372.044 \]
   \[ = 822.381 \text{ kgs steel required of } \bar{10}\text{mm} \]

No. of Steel bars required of length 40Ft:
1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar  = 10mm
3. Weight of Steel bar in kgs / Ft  
   \[ = \frac{d^2}{531.36} \]
   \[ = \frac{10^2}{531.36} \]
   \[ = 0.1881 \text{ kgs/Ft} \]

4. weight of each steel bar of length 40'  
   \[ = 0.1881 \times 40 = 7.524 \text{ kgs} \]

5. No. of Steel bars of length 40' required  
   = wt of steel required / wt of each steel bar
   \[ = \frac{822.381}{7.524} \]
   \[ = 109.301 \text{ or approximately equal to 110 bars of } \bar{10}\text{mm required.} \]

For 109.301 steel bars the required wt of steel = 822.381 kgs (required wt of steel)
For 110 Steel bars the required wt of steel=7.524 x 110 = 827.64 kgs (Actual wt of steel)

Weight of Steel required for Extra-bar:
1. Given Dia of Extra-bar = 8mm  Extra-bar = \( \bar{8}\) mm@100mm or 4"

2. Weight of Steel bar in kgs / Ft  
   \[ = \frac{d^2}{531.36} \]
   \[ = \frac{8^2}{531.36} \]
   \[ = 0.1204 \text{ kgs/Ft} \]

3. Total weight of Steel required = weight/Ft x Total length of Extra-bar
   \[ = 0.1204 \times 2960.648' \]
   \[ = 356.462 \text{ kgs steel required of } \bar{8}\text{mm} \]
No. of Steel bars required of length 40Ft. :

1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar = 8mm
3. Weight of Steel bar in kgs / Ft = \( \frac{d^2}{531.36} \)
   \( = \frac{8^2}{531.36} \)
   \( = 0.1204 \) kgs/Ft

4. weight of each steel bar of length 40' = \( 0.1204 \times 40 = 4.816 \) kgs

5. No. of Steel bars of length 40' required = \( \frac{\text{Wt of steel required}}{\text{wt of each steel bar}} \)
   \( = \frac{356.462}{4.816} \)
   \( = 74.016 \) or approximately equal to 74 bars of Ø8mm required.

Bill of Quantities for Floor Slab reinforcement:-

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Description</th>
<th>Unit</th>
<th>Rate/unit</th>
<th>Total Quantity</th>
<th>Total Amount</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dia of bar</td>
<td>Kgs</td>
<td>in Rupees</td>
<td>Actual weight of Steel required in kgs</td>
<td>40' length</td>
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</tr>
<tr>
<td>1</td>
<td>Ø10mm</td>
<td>Kgs</td>
<td>48.00</td>
<td>827.640</td>
<td>110</td>
<td>39726.720</td>
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<tr>
<td>2</td>
<td>Ø8mm</td>
<td>Kgs</td>
<td>48.00</td>
<td>356.462</td>
<td>74</td>
<td>17110.176</td>
</tr>
</tbody>
</table>

Add 10% wastage 5683.690
Add 5% Contingencies 2841.845
Total 65362.430

Contingencies mean : Expenses which is likely to happen in future, which may happen or may not happen.
(a). Slab mesh calculations :-

1. length of x-bar
   \[\text{length} = L - 1" - 1" + 0.42D \times 4\]
   \[= 28'6" - 1" - 1" + 1.68D\]
   \[= 28'4" + 1.68 \times 4"\]
   \[= 28.333' + 1.68 \times 0.333\]
   \[= 28.892 \text{ Ft}\]

   \[D = \text{Depth of Slab} - \text{top cover} - \text{bottom cover}\]
   \[D = 6" - 1" - 1"
   \[= 4"\]

   \[1" = 0.0833'\]
   \[4" = 0.333'\]

2. length of y-bar
   \[\text{length} = L - 1" - 1" + 0.42D \times 4\]
   \[= 26'6" - 1" - 1" + 1.68D\]
   \[= 26'4" + 1.68 \times 4"\]
   \[= 26.333' + 1.68 \times 0.333\]
   \[= 26.892 \text{ Ft}\]

   Opp. Length = breadth of Slab - width of Floor beams
   \[\text{Opp.length} = 26'6" - 9" \times 3 = 24.25'\]
3. No. of x-bars \[ = \frac{\text{Opp. length}}{\text{spacing}} + 1 \]
\[ = \frac{24.25}{0.333} + 1 \]
\[ = 73.82 \text{ or approximately equal to 74 bars} \]

Opp. Length = Length of Slab - width of Floor beams
Opp.length = 28'6" - 9" x 3 = 26.25'

4. No. of y-bars \[ = \frac{\text{Opp. length}}{\text{spacing}} + 1 \]
\[ = \frac{26.25}{0.333} + 1 \]
\[ = 79.82 \text{ or approximately equal to 80 bars} \]

5. Total length of x-bar & y-bar = 28.892 x 74 + 26.892 x 80 = 4289.368 Ft

6. Weight of Steel bar in kgs / Ft \[ = \frac{d^2}{531.36} \]
Dia of Slab Mesh = 10mm \[ = \frac{10^2}{531.36} \]
\[ = 0.1881 \text{ kgs/Ft} \]

7. Weight of Steel required for Slab Mesh = 0.1881 x 4289.368 = 806.830 kgs

8. weight of each steel bar of length 40' = 0.1881 x 40 = 7.524 kgs

9. No. of Steel bars of length 40' required = wt of steel required / wt of each steel bar
\[ = \frac{806.830}{7.524} \]
\[ = 107.234 \text{ or approximately equal to 108 bars of Ø10mm required.} \]

For 107.234 steel bars the required weight of steel = 806.830 kgs (required wt of steel)
For 108 Steel bars the required wt of steel=7.524 x 108 = 812.592 kgs(Actual wt of steel)

(b). Extra-bar calculations :-

8mm=? Ft \[ = 0.3149" = ? \text{ Ft} \]
since 1"=25.4mm since 1ft = 12"
\[ = \frac{8}{25.4} \]
\[ = 0.3149/12 \]
\[ = 0.0262\text{ft} \]

1. length of each Extra-bar in x-direction = (L/2) +50D x 4
\[ = \frac{28.892}{2} + 50 \times 0.0262 \times 4 \]
\[ = 19.686 \text{ Ft} \]
2. length of each Extra-bar in y-direction \[= \frac{L}{2} + 50D \times 4\]
\[= \frac{26.892}{2} + 50 \times 0.0262 \times 4\]
\[= 18.686 \text{ Ft}\]

3. No. of Extra-bar in x-direction = 74
4. No. of Extra-bar in y-direction = 80
5. Total length of Extra-bar \[= 19.686 \times 74 + 18.686 \times 80 = 2951.644 \text{ Ft.}\]

6. Weight of Steel bar in kgs / Ft \[= \frac{d^2}{531.36}\]
Dia of Extra-bar = 8mm \[= \frac{8^2}{531.36}\]
\[= 0.1204 \text{ kgs/Ft}\]

7. Weight of Steel required for Extra-bar \[= 0.1204 \times 2951.644 = 355.377 \text{ kgs}\]
8. weight of each steel bar of length 40' \[= 0.1204 \times 40 = 4.816 \text{ kgs}\]

9. No. of Steel bars of length 40' required \[= \frac{\text{wt of steel required}}{\text{wt of each steel bar}}\]
\[= \frac{355.377}{4.816}\]
\[= 73.79 \text{ or approximately equal to 74 bars of } \phi 8\text{mm required.}\]

For 73.79 steel bars the required weight of steel \[= 355.377 \text{ kgs} \text{ (required wt of steel)}\]
For 74 Steel bars the required wt of steel \[= 4.816 \times 74 = 356.384 \text{ kgs} \text{ (Actual wt of steel)}\]

(c). Bill of Quantities for Floor Slab reinforcement:

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Description</th>
<th>Unit</th>
<th>Rate/unit</th>
<th>Actual weight of in kgs</th>
<th>Required bars of 40' length</th>
<th>Total Amount in Rupees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ø10mm</td>
<td>Kgs</td>
<td>48.00</td>
<td>812.592</td>
<td>108</td>
<td>39004.416</td>
</tr>
<tr>
<td>2</td>
<td>Ø8mm</td>
<td>Kgs</td>
<td>48.00</td>
<td>356.384</td>
<td>74</td>
<td>17106.432</td>
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<td></td>
<td>Total</td>
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<td></td>
<td></td>
<td>Add 10% wastage</td>
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<td>Add 5% Contingencies</td>
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<td>Total</td>
<td>64527.475</td>
</tr>
</tbody>
</table>

Contingencies mean: Expenses which is likely to happen in future, which may happen or may not happen.
Problem-9 :-

For a given plan & Section Dwg. of Dog-leg Stair-case find

(i). Weight of Steel required for Main bars, Distribution bars, Extra bars and Hand Rail mesh. Thickness of Waist Slab and Landing = 6"
(ii). No. of Steel bars required, of length 40Ft
(iii). Bill of Quantities for Stair-case Reinforcement if Rate of steel /kg = 48.0 rupees.

Reinforcement details :-
(a). Waist Slab mesh = Ø 10mm@100mm or 4"
(b). Landing mesh = Ø 10mm@100mm or 4"
(c). Extra bar = Ø 8mm@100mm or 4"
(d). Handrail mesh = Ø 8mm@100mm or 4"
(i). Waist Slab (S1&S2) :-
Note:-
(a). while providing Steel mesh in waist slab , 1" concrete cover shall be deducted from each side of waist slab's x-bar and add over-lap length of 50D on each side of y-bar to join hand-rail mesh
(b). Each Crank Length = 0.42D
   where D = Depth of Slab -Top and Bottom concrete cover
   D = 6" - 1" - 1" = 4" or 0.333 Ft
(c). formula used to find, no. of bars = [ opposite length / spacing ] + 1

Given dia of main bar = 10mm
   10mm = ? Ft
   . = 10 / 25.4
   . = 0.3937" = ? Ft
   . = 0.3937 / 12
   . = 0.0328 Ft

1. length of x-bar . = 4' + 11.18' + 3' + 0.42D x 2 - 1" - 1"
   . = 4' + 11.18' + 3' + 0.42 x 0.333 x 2 - 0.1666
   . = 18.293 Ft

2. length of y-bar . = 3.5' + 50D x 2
   . = 3.5' + 50 x 0.0328 x 2
   . = 6.78' Ft

3. No. of x -bar . = [ 3'4'' / 4' ] + 1
   . = [ 3.333' / 0.333' ] + 1
   . = 11 bars

4. No. of y -bar . = [ 11.01 / 4'' ] + 1
   . = [ 11.01 / 0.333 ] + 1
   . = 34.06
   . = approximately equal to 34 bars

5. Total Length of Steel -bars = length of x -bar x no. of x -bars + length of y -bar x no. of y -bars
   . = 18.293 x 11 + 6.78 x 34 = 431.743 Ft
6. Dia of bar for waist slab mesh in both direction = 10 mm

According to thumb rule :-

[ i ]. weight of steel bar in kgs / m = \( \frac{d^2}{162} \)

\[ \frac{10^2}{162} = 0.617 \text{ kgs / m} \]

[ ii ]. weight of steel bar in kgs / Ft = \( \frac{d^2}{531.48} \)

\[ \frac{10^2}{531.48} = 0.188 \text{ kgs / Ft} \]

8. Total weight required = weight / Ft x Total length x no. of waist slab

\[ = 0.188 \times 431.743 \times 2 \]

\[ = 162.335 \text{ kgs} \]

(ii). Extra bar Calculations:

Extra bar = Ø 8mm @ 100mm / 4"

8mm = ? Ft

\[ \frac{8}{25.4} \]

\[ = 0.3149 \]

\[ \frac{0.3149}{12} \]

\[ = 0.0262 \text{ Ft} \]

Note:- Extra bar is provided at a distance of \( \frac{L}{4} \) from corner of Slab where \( L = \) length of x-bar including crank length

Length of each extra bar = \( \frac{L}{4} \) + over-lap length

\[ = \frac{L}{4} + 50 \text{ D} \]

1. Length of each extra bar in x-direction = \( \frac{11.459}{4} \) + 50 x 0.0262

\[ L = 11.18 + 0.42D \times 2 \]

\[ L = 11.18 + 0.42 \times 0.333 \times 2 \]

\[ L = 11.459 \text{ Ft} \]

2. No. of Extra bar in x-direction = No. of main bar in x-direction x 2

\[ = 11 \times 2 = 22 \]

3. Total length of Extra-bar in x-direction = length of Extra-bar x no. of Extra-bars

\[ = 4.174 \times 22 = 91.828 \text{ Ft} \]

4. Dia of Extra bar in x-direction = 8 mm ; Extra bar = Ø 8mm @ 100mm / 4"

According to thumb rule :-

[ i ]. weight of steel bar in kgs / m = \( \frac{d^2}{162} \)

\[ \frac{8^2}{162} = 0.395 \text{ kgs / m} \]

[ ii ]. weight of steel bar in kgs / Ft = \( \frac{d^2}{531.48} \)

\[ \frac{8^2}{531.48} = 0.1204 \text{ kgs / Ft} \]

5. Total weight required for Extra-bar = weight / Ft x Total length x no. of Waist Slabs

\[ = 0.1204 \times 91.828 \times 2 \]

\[ = 22.112 \text{ kgs} \]
(iii). Landing mesh (L1&L2) :-
Note:-- while doing calculation of Reinforcement for Landing, no need to find length of x-bar as it has already added with waist slab x-bar length. All is need is to find length of y-bar only.

1. length of y-bar
   .= 7' - 1" - 1"
   .= 7' - 0.1666'
   .= 6.983' Ft

2. No. of y-bar
   = \[ \frac{6.8333}{4"} \] + 1

width of landing-1 = 3' = \[ \frac{6.8333}{0.333} \] + 1
width of landing-2 = 4' = 21.52 or approximately equal to 22 bars
Total width = 3' + 4' = 7'
\[ = 7' - 1" - 1" \text{ [ concrete cover ]} \]
\[ = 6.8333\text{Ft} \]

3. Total Length of y-bar
   .= length of y-bar x no. of y-bars
   .= 6.983 x 22 = 153.626 Ft

According to thumb rule :-

[ i ]. weight of steel bar in kgs / m = \( \frac{d^2}{162} \)
\[ = \frac{10^2}{162} = 0.617 \text{ kgs / m} \]

[ ii ]. weight of steel bar in kgs / Ft = \( \frac{d^2}{531.48} \)
\[ = \frac{10^2}{531.48} = 0.188 \text{ kgs / m} \]

4. Total weight required for y-bar = weight / Ft x Total length
\[ = 0.188 x 153.626 \]
\[ = 28.881 \text{ kgs} \]

(iv). Hand-Rail mesh :-

1. length of x-bar
   .= 11.18' - 1" - 1"
   .= 11.18' - 0.1666'
   .= 11.013 Ft

2. length of y-bar
   .= 3' - 1" - 1"
   .= 3' - 0.1666'
   .= 2.833 Ft

3. No. of x-bar
   = \[ \frac{2'10"}{4"} \] + 1
L=3'-1"-1" = 2'10"
\[ = \left[ \frac{2.8333}{0.333'} \right] + 1 \]
\[ = 9.508 \text{ bars or approximately equal to 10 bars} \]
4. No. of y-bar = \[11.01 / 4" \] + 1
   \[= \frac{11.01}{0.333} \] + 1
   \[= 34.06\]
   \[= \text{approximately equal to 34 bars}\]

5. Total Length of Steel bar = length of x-bar x no. of x-bars + 
   length of y-bar x no. of y-bars
   \[= 11.013 \times 10 + 2.833 \times 34 = 206.452 \text{ Ft}\]

6. Dia of bar for Hand Rail mesh in both direction = 8 mm
   According to thumb rule:
   
   [i]. weight of steel bar in kgs / m = \frac{d^2}{162} 
   \[= \frac{8^2}{162} = 0.395 \text{ kgs / m}\]
   
   [ii]. weight of steel bar in kgs / Ft = \frac{d^2}{531.48} 
   \[= \frac{8^2}{531.48} = 0.1204 \text{ kgs / Ft}\]

   Total weight of steel required = weight / Ft x Total length x no. of Handrails
   \[= 0.1204 \times 206.452 \times 4\]
   \[= 99.427 \text{ kgs}\]

Total weight of steel required:

1. S1&S2 10mm 162.335
2. landing 1&2 10mm 57.763
   Total \[220.098\]
3. Extra bar 8mm 22.112
4. Handrail 8mm 99.427
   Total \[121.539\]

**No. of Steel bars required of length 40Ft. :**

(a). Ø=10mm Required wt. of steel = 220.098kgs

1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar = 10mm
3. Weight of Steel bar in kgs / Ft \[= \frac{d^2}{531.36}\]
   \[= \frac{10^2}{531.36} = 0.1881 \text{ kgs/Ft}\]
4. weight of each steel bar of length 40' \[= 0.1881 \times 40 = 7.524 \text{ kgs}\]
5. No. of Steel bars of length 40' required = wt of steel required / wt of each steel bar
   = 220.098 / 7.524
   = 29.25 or approximately equal to 30 bars of Ø10mm required.

For 29.25 steel bars the required weight of steel = 220.098 kgs (required wt of steel)
For 30 Steel bars the required wt of steel = 7.524 x 30 = 225.72 kgs (Actual wt of steel)

(b). Ø = 8mm
   Required wt. of steel = 121.539kgs

1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar = 8mm
3. Weight of Steel bar in kgs / Ft = \( d^2 \)/531.36
   = 8^2 / 531.36
   = 0.1204 kgs/Ft

4. weight of each steel bar of length 40' = 0.1204 x 40 = 4.816 kgs

5. No. of Steel bars of length 40' required = wt of steel required / wt of each steel bar
   = 121.539 / 4.816
   = 25.23 or approximately equal to 26 bars of Ø8mm required.

For 25.23 steel bars the required weight of steel = 121.539 kgs (required wt of steel)
For 26 Steel bars the required wt of steel = 4.816 x 26 = 125.216 kgs (Actual wt of steel)

**Bill of Quantities for Stair-case reinforcement:**

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Description</th>
<th>Unit</th>
<th>Rate/unit</th>
<th>Total Quantity</th>
<th>Total Amount</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dia of bar</td>
<td>Kgs</td>
<td>in Rupees</td>
<td>Actual weight of Steel required</td>
<td>in Rupees</td>
<td>in kgs</td>
</tr>
<tr>
<td>1</td>
<td>Ø10mm</td>
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Contingencies mean : Expenses which is likely to happen in future, which may happen or may not happen.
Problem-10 :-
For a given plan & Section Dwg. of Kitchen Room find
(i). Weight of Steel required for Kitchen Platform, Room Chajja, and Window
sun-shade (arch type)  (ii). No. of Steel bars required, of length 40Ft and
(iii). Bill of Quantities for Miscellaneous item Reinforcement.
if Rate of steel /kg = 48.0 rupees.
Reinforcement details :- Miscellaneous item mesh = Ø 8mm@100mm or 4"
Thickness = 4" for all Slabs  wall thickness = 4"

Size of window-1 = 4' x 4'
Size of window-2 = 4'6" x 4' (Arch Type)
Size of door = 3' x 7'
Size of Chajja = 10'6" x 2'

Solution :-
Note :- Dividing kitchen platform in to two parts and with each part add 4" bearing
i.e., thickness of wall. Also deduct 1" concrete cover from both ends.

(a). Kitchen Platform :-  Part-1:
1. length of x-bar .= length of platform + wall thickness from both end - 1" concrete
cover from both side
   .= 10' + 4" + 4" - 1" - 1"
   .= 10'6" = 10.5'
2. length of y-bar = Breadth of platform + wall thickness - 1" concrete cover from both side
   \[= 2' + 4" - 1" - 1" = 2'2" = 2.166'\]

3. No. of x-bars = (Opp.length / spacing) + 1
   \[= (2.166'/0.333') + 1 = 7.504\text{ or approximately equal to 8 bars}\]

4. No. of y-bars = (Opp.length / spacing) + 1
   \[= (10.5'/0.333') + 1 = 32.531\text{ or approximately equal to 33 bars}\]

5. Total length of bar = 10.5' x 8 + 2.166 x 33 = 155.478 Ft

Part-2:
1. length of x-bar = length of platform + wall thickness - 1" concrete cover from both side
   \[= 2' + 4" - 1" - 1" = 2'2" = 2.166'\]

2. length of y-bar = Breadth of platform + wall thickness from both end - 1" concrete cover from both side
   \[= 10'6" + 4" + 4" - 1" - 1" = 11'\]

3. No. of x-bars = (Opp.length / spacing) + 1
   \[= (11'/0.333') + 1 = 34.03\text{ or approximately equal to 34 bars}\]

4. No. of y-bars = (Opp.length / spacing) + 1
   \[= (2.166'/0.333') + 1 = 7.504\text{ or approximately equal to 8 bars}\]

5. Total length of bar = 2.166' x 34 + 11' x 8 = 161.644 Ft

Total length of part-1 and part-2: = 155.478' + 161.644' = 317.122'
(b). Room chajja :-

1. length of x-bar = length of Chajja + wall thickness - 1" concrete cover from both side
   \[= (2' + 4"
\[= 2'2" = 2.166']

2. length of y-bar = Breadth of Chajja + wall thickness from both end - 1" concrete cover from both side
   \[= (10'6" + 4" + 4" - 1" - 1"
\[= 11' \]

3. No. of x-bars = (Opp.length / spacing) + 1
   \[= (11'/0.333') + 1
\[= 34.03 or approximately equal to 34 bars

4. No. of y-bars = (Opp.length / spacing) + 1
   \[= (2.166'/0.333') + 1
\[= 7.504 or approximately equal to 8 bars

5. Total length of x-bar & y-bar = 2.166' x 34 + 11' x 8 = 161.644 Ft

(c). Window Sun-shades :-

window-1: size = 4' x 4'

Note:- Add 4" bearing with length of window i.e., thickness of wall ,
Also deduct 1" concrete cover from both ends.

1. length of x-bar = length of window + wall thickness from both end - 1" concrete cover from both side
   \[= 4' + 4"
\[= 4"6" = 4.5'

2. length of y-bar = projection length of sunshade + wall thickness - 1" concrete cover from both side
   \[= 2' + 4"
\[= 2'2" = 2.166'

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3. No. of x-bars \( = \frac{\text{Opp. length}}{\text{spacing}} + 1 \)
\( = \frac{2.166'}{0.333'} + 1 \)
\( = 7.504 \text{ or approximately equal to 8 bars} \)

4. No. of y-bars \( = \frac{\text{Opp. length}}{\text{spacing}} + 1 \)
\( = \frac{4.5'}{0.333'} + 1 \)
\( = 14.51 \text{ or approximately equal to 15 bars} \)

5. Total length of bar \( = 4.5' \times 8 + 2.166 \times 15 = 68.49 \text{ Ft} \)

**window-2:**

Size = 4'6" x 4'

Note: Add 4" bearing with length of window i.e., thickness of wall, Also deduct 1" concrete cover from both ends.

Linear length of window = 4'6" + 4" + 4" = 5'2"

Height of arch always 1Ft

Segmental Arc Length

\[ L = \frac{8B - 2R}{3} \]

where

\[ R = \text{radius of circle} \]

\[ B = V \left( R^2 + H^2 \right) \]

\[ B' = V \left( 2.583^2 + 1^2 \right) \]
\( = 2.769 \)

\[ L'' = \frac{8 \times 2.769 - 2 \times 2.583}{3} \]
\( = 5.662 \text{ Ft} \)

1. Length of x-bar \( = \) length of window - 1" concrete cover from both side
\( = 5.662 - 1" - 1" \)
\( = 5.662 - 0.166 = 5.496' \)

2. Length of y-bar \( = \) projection length of sunshade - 1" concrete cover from both side
\( = 2' + 4" - 1" - 1" \)
\( = 2'2" = 2.166' \)

3. No. of x-bars \( = \frac{\text{Opp. length}}{\text{spacing}} + 1 \)
\( = \frac{2.166'}{0.333'} + 1 \)
\( = 7.504 \text{ or approximately equal to 8 bars} \)

4. No. of y-bars \( = \frac{\text{Opp. length}}{\text{spacing}} + 1 \)
\( = \frac{5.496'}{0.333'} + 1 \)
\( = 17.504 \text{ or approximately equal to 18 bars} \)
5. Total length of bar = 5.496' x 8 + 2.166 x 18 = 82.956 Ft.

Total length for both window W1&W2 = 68.49 + 82.956 = 151.446 Ft.

(d). Total length for miscellaneous item :-

1. Kitchen platform = 317.122
2. Room Chajja = 161.644
3. Sun-shade = 151.446
Total = 630.212 Ft.

Dia of bar for Miscellaneous item mesh in both direction = 8 mm

According to thumb rule :-

[ i ]. weight of steel bar in kgs / m = \(\frac{d^2}{162}\).
\[\text{weight} = \frac{8^2}{162} = 0.395 \text{ kgs / m}\]

[ ii ]. weight of steel bar in kgs / Ft = \(\frac{d^2}{531.48}\).
\[\text{weight} = \frac{8^2}{531.48} = 0.1204 \text{ kgs / Ft}\]

Total weight of steel required = weight / Ft x Total length
\[= 0.1204 \times 630.212\]
\[= 75.877 \text{ kgs}\]

No. of Steel bars required of length 40Ft. :

Required wt. of steel = 75.877kgs
1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar = 8mm
3. Weight of Steel bar in kgs / Ft = \(\frac{d^2}{531.36}\).
\[= \frac{8^2}{531.36} = 0.1204 \text{ kgs/Ft}\]

4. weight of each steel bar of length 40' = 0.1204 x 40 = 4.816 kgs

5. No. of Steel bars of length 40' required = wt of steel required / wt of each steel bar
\[= \frac{75.877}{4.816}\]
\[= 15.75 \text{ or approximately equal to 16 bars of Ø8mm required.}\]

For 15.75 steel bars the required weight of steel = 75.877 kgs (required wt of steel)
For 16 Steel bars the required wt of steel = 4.816 x 16 = 77.056 kgs (Actual wt of steel)
Bill of Quantities for Miscellaneous item reinforcement:-

<table>
<thead>
<tr>
<th>BILL OF QUANTITES FOR MISCELLANEOUS ITEM REINFORCEMENT</th>
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<tbody>
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<td>S.no.</td>
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Contingencies mean: Expenses which is likely to happen in future, which may happen or may not happen.

Problem-11 :-
For a given plan & Section Dwg. of Sump (water tank below ground level) find
(i). Weight of Steel required
(ii). No. of Steel bars required, of length 40Ft
(iii). Bill of Quantities for Rectangular Sump Reinforcement if Rate of steel /kg=48.0 rupees.
Reinforcement Details:
Bottom and Top Slab mesh = Ø10mm@100mm
Shear Wall mesh = Ø12mm@100mm
Size of Sump = 10' x 8' x 6'6"  Thickness of bottom and top slab = 6"
Solution :-

(i). Bottom and Top Slab mesh Calculations :-

Note:- while providing Steel mesh in bottom and top slab, 1" concrete cover shall be deducted from each side of Slab.

1. Length of x-bar
   .= 10' - 1" - 1"
   .= 10' - 0.166'
   .= 9.833 Ft

2. Length of y-bar
   .= 8' - 1" - 1"
   .= 8' - 0.1666'
   .= 7.833 Ft

3. No. of x-bars
   .= \left\lfloor \frac{7.833}{0.333} \right\rfloor +1
   .= 24.52 approximately 25

4. No. of y-bars
   .= \left\lfloor \frac{9.833}{0.333} \right\rfloor +1
   .= 30.52 approximately 31

   formula used to find, no. of bars = \left\lfloor \frac{\text{opposite length}}{\text{spacing}} \right\rfloor + 1

   Note:- End bars will not be deducted from each side of cover i.e., 7 - 2 = 5 bars shall be considered.

5. Total length of x-bar and y-bar = 9.833 x 25 + 7.833 x 31 = 488.648 Ft

Deduction of Cover from top slab mesh :-

Length of x-bar
   .= 2'

Length of y-bar
   .= 2'

No. of x-bars
   .= \left\lfloor \frac{2'}{0.333} \right\rfloor +1
   .= 7

No. of y-bars
   .= \left\lfloor \frac{2'}{0.333} \right\rfloor +1
   .= 7

Total length of Steel bar for cover = 2 x 5 + 2 x 5 = 20 Ft
Total length of Steel bar required = 488.648 - 20 = 468.648 Ft
6. Dia of bar for Bottom and Top Slab mesh = 10 mm
According to thumb rule: Slab mesh: Ø 10mm @ 100mm / 4"

[ i ]. weight of steel bar in kgs / m = \( \frac{d^2}{162} \). = \( \frac{10^2}{162} \) = 0.617 kgs / m

[ ii ]. weight of steel bar in kgs / Ft = \( \frac{d^2}{531.48} \). = \( \frac{10^2}{531.48} \) = 0.188 kgs / Ft

7. wt required for bottom and top slab mesh = weight / Ft x Total length x no. of Slabs
.= 0.188 x 468.648 x 2
.= 176.211 kgs

(ii). Shear Wall along horizontal axis :-

![Shear Wall Diagram]

1. Length of x-bar = 10' - 1" - 1" + 50D x 2
.= 10' - 0.1666' + 50 x 0.03937 x 2
.= 13.77 Ft

2. Length of y-bar = 5.5' + 3" + 3" + 16D x 2
.= 5.5 + 0.5' + 16 x 0.03937 x 2
.= 7.259 Ft

3. No. of x-bars = \([\frac{5.333}{0.333}] + 1\)
L=5.5'- 1" - 1"
.= 17.015 approximately 17
L= 5.333Ft

4. No. of y-bars = \([\frac{9.833}{0.333}] + 1\)
L=10'-1"-1"
.= 30.52 approximately 31
L= 9.833Ft

5. Total length of Steel bar = 13.77 x 17 + 7.259 x 31 = 459.119 Ft
(iii). Shear wall along vertical axis:-

1. Length of x-bar  
   = 8' - 1" - 1"  
   = 8' - 0.1666'  
   = 7.833 Ft

2. Length of y-bar  
   = 5.5' + 3" + 3" + 16D x 2  
   = 5.5 + 0.5' + 16 x 0.03937 x 2  
   = 7.259 Ft

3. No. of x-bars  
   = \[ \frac{5.333}{0.333} + 1 \]  
   = 0.03937Ft

4. No. of y-bars  
   = \[ \frac{7.833}{0.333} + 1 \]  
   = 24.52 approximately 25

5. Total length of x-bar = 7.833 x 17 + 7.259 x 25 = 314.636 Ft

6. Dia of bar for Shear wall mesh = 12 mm

According to thumb rule :-

[ i ]. weight of steel bar in kgs / m = \( \frac{d^2}{162} \)  
   = \( \frac{12^2}{162} \)  
   = 0.888 kgs / m

[ ii ]. weight of steel bar in kgs / Ft = \( \frac{d^2}{531.48} \)  
   = \( \frac{12^2}{531.48} \)  
   = 0.271 kgs / Ft

7. Total weight required  
   = weight / Ft x Total length x no. of walls  
   = 0.271 x 773.755 x 2  
   = 419.375 kgs
No. of Steel bars required of length 40Ft.

(a). Ø = 10mm

1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar = 10mm
3. Weight of Steel bar in kgs / Ft = \( \frac{d^2}{531.36} \)
   \( = \frac{10^2}{531.36} \)
   \( = 0.1881 \text{ kgs/Ft} \)
4. weight of each steel bar of length 40' = 0.1881 x 40 = 7.524 kgs
5. No. of Steel bars of length 40' required = wt of steel required / wt of each steel bar
   = 176.839 / 7.524
   = 23.503 or approximately equal to 24 bars of Ø10mm required.

For 23.503 steel bars the required weight of steel = 176.839 kgs (required wt of steel)
For 24 Steel bars the required wt of steel = 7.524 x 24 = 180.576 kgs (Actual wt of steel)

(b). Ø = 12mm

1. Standard length of each steel bar = 40 Ft.
2. Dia of steel bar = 12mm
3. Weight of Steel bar in kgs / Ft = \( \frac{d^2}{531.36} \)
   \( = \frac{12^2}{531.36} \)
   \( = 0.271 \text{ kgs/Ft} \)
4. weight of each steel bar of length 40' = 0.271 x 40 = 10.84 kgs
5. No. of Steel bars of length 40' required = wt of steel required / wt of each steel bar
   = 419.375 / 10.84
   = 38.68 or approximately equal to 39 bars of Ø12mm required.

For 38.68 steel bars the required weight of steel = 419.375 kgs (required wt of steel)
For 39 Steel bars the required wt of steel = 10.84 x 39 = 422.76 kgs (Actual wt of steel)
### Bill of Quantities for Sump reinforcement:

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<th>Rate/unit</th>
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<th>Total Amount</th>
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<td>Kgs</td>
<td>in Rupees</td>
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Add 10% wastage 2896.013
Add 5% Contingencies 1448.006
Total 33304.147

Contingencies mean: Expenses which is likely to happen in future, which may happen or may not happen.
Density of Steel = 7850 kgs/m
Density of Steel = 0.00785 kgs/mm

**Problem-1 :-**
Find weight of Solid Square bar

**Solution :-**
Standard formulas :-
1. weight of Square Steel bar in kgs/m = volume of steel bar x Density of steel
dimension in metres 
   \[= 0.008 \times 0.008 \times 1.0 \times 7850\]
   \[= 0.5024 \text{ kgs/m}\]

2. weight of Square Steel bar in kgs/m = area of bar x Density of steel
dimension in mm 
   \[= 8 \times 8 \times 0.00785\]
   \[= 0.5024 \text{ kgs/m}\]

According to thumb rule :
3. weight of Square Steel bar in kgs/m = Area of bar / 127
dimension in mm 
   \[= (8 \times 8) / 127\]
   \[= 0.503 \text{ kgs/m}\]

**Problem-2 :-**
Find weight of Solid Square bar

**Solution :-**
weight of Square Steel bar in kgs/Ft = Area of bar / 416.56
\[= (8 \times 8) / 416.56\]
\[= 0.1536 \text{ kgs/ Ft}\]
Problem-3 :-
Find weight of Solid Square bar

Solution :-

weight of Square Steel bar in kgs/Ft = Area of bar / 416.56
= (8 x 8) / 416.56
= 0.1536 kgs/ Ft

length of solid square bar = 20'
Weight of Solid square bar = 0.1536 x 20' = 3.072 kgs

Problem-4 :-
Find weight of Flat plate

Solution :- since 1" = 25.4mm
25.4 x 2 = 50.8mm

section of Flat plate = 50.8mm x 2mm
weight of Steel bar in kgs/Ft = Area of bar / 416.56
= (50.8 x 2) / 416.56
= 0.243 kgs/ Ft

length of Flat plate = 8'
Weight of Flat plate = 0.243 x 8' = 1.944 kgs

Problem-5 :-
Find weight of angle plate

Solution :- since 1" = 25.4mm
25.4 x 4 = 101.6mm

section of Flat plate = 101.6mm x 2mm
weight of Steel bar in kgs/Ft = Area of bar / 416.56
= (101.6 x 2) / 416.56
= 0.487 kgs/ Ft

length of Angle plate = 12'
Weight of Angle plate = 0.487 x 12' = 5.844 kgs

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Problem-6 :-
Find weight of Hollow square pipe

Solution :-

\[ L = (L+B) \times 2 = (2+2) \times 2 = 8" \]

since 1" = 25.4mm
8 x 25.4 = 203.2mm
Thickness of pipe = 2mm

section of Flat plate = 203.2mm x 2mm

weight of Steel bar in kgs/Ft
\[ = \frac{\text{Area of bar}}{416.56} \]
\[ = \frac{(203.2 \times 2)}{416.56} \]
\[ = 0.975 \text{ kgs/Ft} \]

length of Hollow square pipe = 18'
Weight of Hollow square pipe = 0.975 x 18' = 17.55 kgs

Problem-7 :-
Find weight of Hollow round pipe

Solution :-

\[ \text{since } 1" = 25.4\text{mm} \]
\[ 1.5" = 25.4 \times 1.5 = 38.1\text{mm} \]
\[ D = 38.1\text{mm} \]
\[ R = 19.05\text{mm} \]
\[ L = 2 \times \pi \times r = 2 \times \pi \times 19.05 = 119.69\text{mm} \]

Thickness of pipe = 2mm

section of Flat plate = 119.69mm x 2mm

weight of Steel bar in kgs/Ft
\[ = \frac{\text{Area of bar}}{416.56} \]
\[ = \frac{(119.69 \times 2)}{416.56} \]
\[ = 0.574 \text{ kgs/Ft} \]

length of Round Hollow pipe = 20'
Weight of Round Hollow pipe = 0.574 x 20' = 11.48 kgs
Problem-8 :-
Find weight of i-Beam

Solution :-

1" = 25.4mm
6" = ?
6 x 25.4 = 152.4mm
4" = ?
4 x 25.4 = 101.6mm

Dividing c/s of i-beam in three parts
Area-1 = 152.4mm x 2mm = 304.8mm$^2$
Area-2 = 101.6mm x 2mm = 203.2mm$^2$
Area-3 = 152.4mm x 2mm = 304.8mm$^2$
Total area = 812.8mm$^2$

1. weight of i-beam in kgs/Ft = Area of bar / 416.56
   . = 812.8 / 416.56
   . = 1.951 kgs/ Ft

2. weight of i-beam in kgs/ft = Area of bar x Density of steel
   Area in mm$^2$
   . = 812.8 x 0.00785
   . = 6.38kgs/m
   . = 6.38 / 3.28
   . = 1.945 kg/Ft

3. weight of i-beam in kgs/ft = Area of bar x Density of steel
   Area in m$^2$
   . = 0.0008128 x 7850
   . = 6.38kgs/m
   . = 6.38 / 3.28
   . = 1.945 kg/Ft

length of i-beam = 20'
Weight of i-beam = 1.951 x 20 = 39.02 kgs
Problem-9 :-
Find weight of Square plate

Solution :-

Weight of Square plate in kgs
= Volume of plate x Density of steel
Dimension in metres
= 0.254 x 0.254 x 0.002 x 7850
1" = 25.4mm
10" = 25.4 x 10 = 254mm
254mm = 0.254m

Problem-10 :-
Find weight of Round plate

Solution :-

Weight of Round plate in kgs
= Volume of plate x Density of steel
Dimension in metres
= Area of plate x thickness of plate x Density of steel
1" = 25.4mm
15" = 25.4 x 15 = 381mm
381mm = 0.381m

Problem-11 :-
From the given figure find

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184
(i). Weight of Steel structure for pipes and square plates and
(ii). No. of pipes required to make this frame.

Section of pipe 2"x2" Thickness of pipe = 2mm
Square plate = 12" x 12" x 2mm

Solution :-

(a). Frame calculation:-
1. length of pipe in horizontal direction = 24'
   No. of pipes of length = 4
2. length of pipe in vertical direction = 20'
   No. of pipes of length = 5
3. Height of Column = 12'
   No. of pipes = 4
4. Total length = 24' x 4 + 20' x 5 + 12' x 4 = 244 Ft

Section of pipe = 2"x2"

L = (2"+2") x 2 = 8" = 203.2mm
Thickness = 2mm

L = (L+B) x 2 = (2"+2")x2 = 8"

since 1" = 25.4mm

8 x 25.4 = 203.2mm

Thickness of pipe = 2mm

section of Flat plate = 203.2mm x 2mm

weight of Steel bar in kgs/Ft = Area of bar / 416.56

= (203.2 x 2) / 416.56

= 0.975 kgs/Ft

5. Total length of Hollow square pipe = 244'

Weight of Hollow square pipe required = 0.975 x 244' = 237.9 kgs

6. No. of pipes required = Total length required / length of each pipe

Standard length of Square pipe = 20'

= 244 / 20

= 12.2 pipes

(b). Square Plate :-

Size of Square plate = 12" x 12" x 2mm

No. of Square plate = 4

Weight of Square plate in kgs = Volume of plate x Density of steel x No. of plates

Dimension in metres

1" = 25.4mm

12" = 25.4 x 12 = 304.8mm

304.8mm = 0.304m

= 0.304 x 0.304 x 0.002 x 7850 x 4

= 5.803 kgs
(c). Total weight of Steel required = Weight of frame + Weight of Square plate
  \[= 237.9 + 5.803 \]
  \[= 243.703 \text{kgs} \]

**Problem-11 :-**
From the given figure find
(i). Weight of Steel structure for pipes and square plates and
(ii). No. of pipes required to make this frame.

**Solution :-**

(a). Frame calculation:-
1. length of pipe in horizontal direction = 15'
   No. of pipes of length = 2
2. length of pipe in vertical direction = 24'
   No. of pipes of length = 9
3. Height of Column = 16'
   No. of pipes = 4
4. length of inclined pipe = \(8.5 \times 2 = 17'\)
   No. of pipes = 7

5. Total length = 15' x 2 + 24' x 9 + 16' x 4 + 17 x 7 = 429.0 Ft

Section of pipe = 1.5" x 1.5"
L = (L+B) x 2
L = (1.5" + 1.5") x 2 = 6" = 152.4mm
since 1" = 25.4mm
6 x 25.4 = 152.4mm
Thickness of pipe = 2mm
section of Flat plate = 152.4mm x 2mm

6 x 25.4 = 152.4mm

weight of Steel bar in kgs/Ft
= Area of bar / 416.56
= (152.4 x 2) / 416.56
= 0.731 kgs/ Ft

6. Total length of Hollow square pipe = 429'

7. Weight of Hollow square pipe required = 0.731 x 429 = 313.599 kgs

8. No. of pipes required = Total length required / length of each pipe
Standard length of Square pipe = 20'
= 429 / 20
= 21.45 pipes

(b). Square Plate -
Size of Square plate = 9" x 9" x 2mm
No. of Square plate = 4

Weight of Square plate in kgs
= Volume of plate x Density of steel x No. of plates
Dimension in metres
= 0.2286 x 0.2286 x 0.002 x 7850 x 4
1" = 25.4mm
9" = 25.4 x 9 = 228.6mm
228.6mm = 0.2286m

= 3.281 kgs

(c). Total weight of Steel required = Weight of frame + Weight of Square plate
= 313.599 + 3.281
= 316.88 kgs
Problem-12 :- From the given figure find
(i). Weight of Steel structure for pipes and square plates and
(ii). No. of pipes required to make this frame.

Dia of pipe = 2"
Thickness of pipe = 2mm
Dia of round plate = 15"  thickness of plate = 2mm

Solution :-
(a). Frame calculation:-
1. length of pipe in horizontal direction = 14'
   No. of pipes of length = 2
2. length of pipe in vertical direction = 20'
   No. of pipes of length = 9
3. Height of Column = 18'
   No. of pipes = 4
4. length of Arch pipe = 15.154'
   No. of pipes = 5

Segmental Arc Length = L = (8B - 2R)/3
where     'R' = radius of circle
          B' = V (R^2 + H^2)
'B' = V (7^2 + 2.5^2)
   .= 7.433'
"L" = (8 x 7.433 - 2 x 7) / 3
   .= 15.154' Ft
5. Total length = 14' x 2 + 20' x 9 + 18' x 4 + 15.154 x 5 = 355.77 Ft

Dia of pipe = 2'' = 50.8mm Radius = 25.4mm
L = 2 x π x r = 2 x π x 25.4 = 159.59mm
Thickness of pipe = 2mm

section of Flat plate = 159.59mm x 2mm
weight of Steel bar in kgs/Ft = Area of bar / 416.56
= (159.59 x 2) / 416.56
= 0.766 kgs/ Ft

6. Total length of Round Hollow pipe = 355.77'

7. Weight of Round Hollow pipe required = 0.766 x 355.77 = 272.519 kgs

8. No. of pipes required = Total length required / length of each pipe
Standard length of Round pipe = 20'
= 355.77 / 20
= 17.78 pipes

(b). Round Plate :-
Dia of Round plate = 15'' ; T = 2mm No. of Round plate = 4

Weight of Round plate = Volume of plate x Density of steel x No. of plates
Dimension in metres = Area of plate x thickness of plate x Density of steel x no.s
1'' = 25.4mm
15'' = 25.4 x 15 = 381mm
381mm = 0.381m
= (π/4) x 0.381^2 x 0.002 x 7850 x 4
= 7.159 kgs

(c). Total weight of Steel required = Weight of frame + Weight of Round plate
= 272.519 + 7.159
= 279.678 kgs
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