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✓ Weight of the bar in 1 meter length:

- Weight of the reinforcement bar for 1m length
  $=d^2/162$ kg

Where d= diameter of bar in mm

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✓ Number of Bars :

- Space = distance within which bars are to be laid

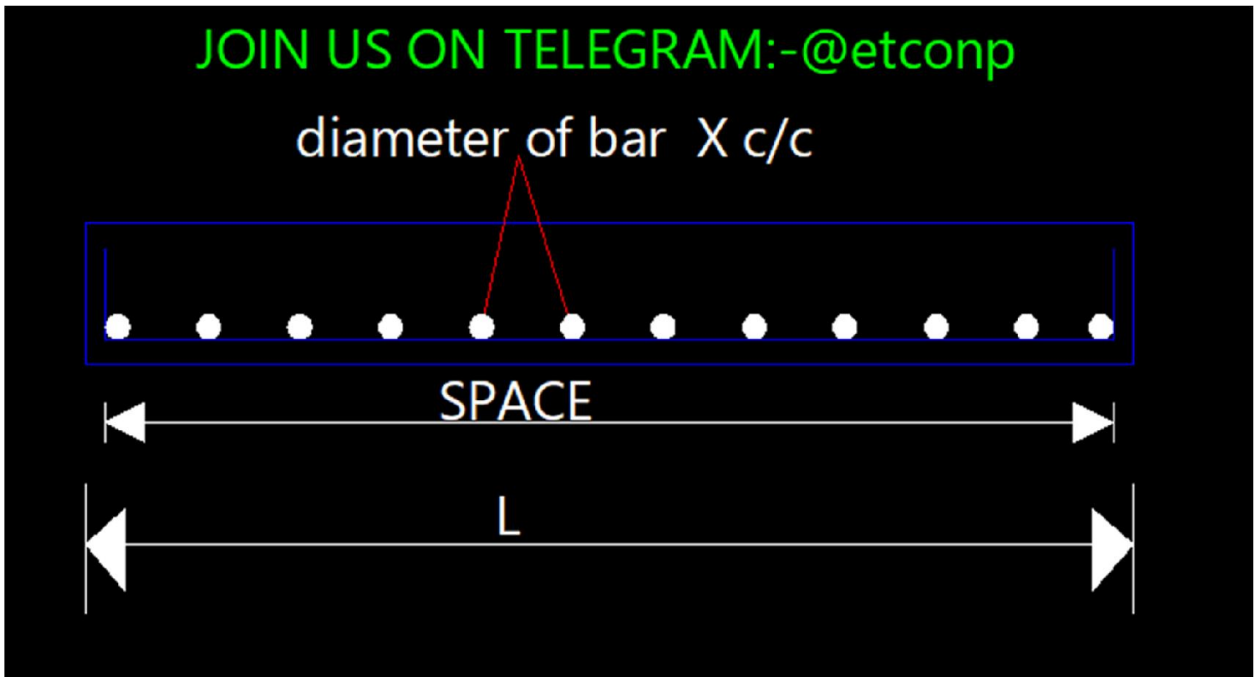
Space = L-2 X cover

Therefore,

Number of bars= $\frac{(L-2 \times cover)}{C/C \text{ spacing of bars}}$

- Number of stirrups in a beam

Number of stirrups = $\frac{\text{Length of beam} - 2 \times cover}{C/C \text{ spacing of stirrups}} + 1$



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Dia. Of Bar (mm)	Wt. of 1m length of Bar (kg)
6	0.22
8	0.39
9	0.50
10	0.62
12	0.89
16	1.58
18	2.00
20	2.46
22	2.98
25	3.85

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✓ Length of steel bars

1. 90° Bend
2. 180° bend
3. Overlap
4. For bent up bars
5. Lateral ties on vertical stirrups
6. Bent-up and hook

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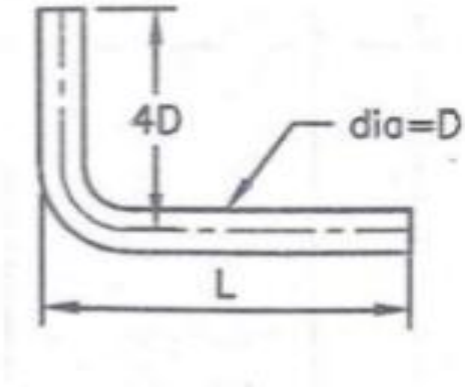
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1. 90° Bend

- Extra length for one bend= 4D
- Therefore, length of bar = L + 4D

Where L= length of the bar

D= diameter of the bar



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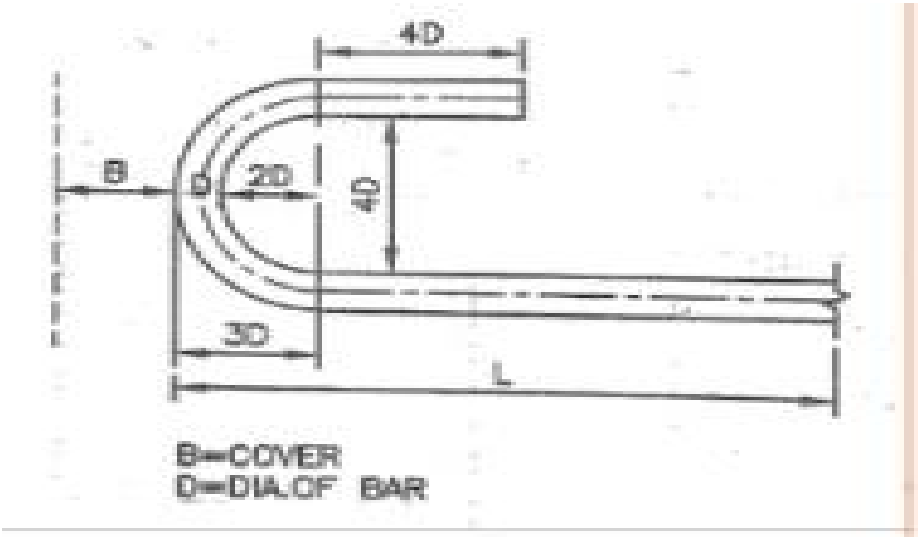
2. 180° Bend

B= Cover

D= Diameter of the bar

- Extra length for one hook =9D
- If hook is at one end, total length of bar= L + 9D
- If hook is at both ends,

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



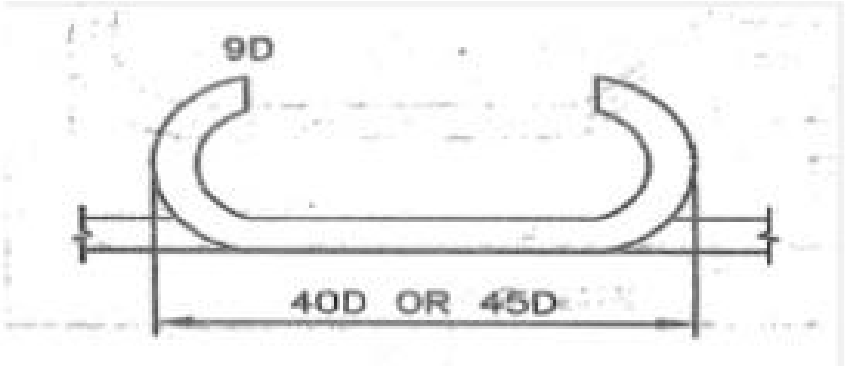
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3. Overlap

- For bars in tension
  Extra length = 40D + 9D + 9D
  = 58D (for mild steel bars)
  = 68.5D (for deformed steel bars)

- For bars in compression ,
  Extra length= 45D (for mild steel bars)



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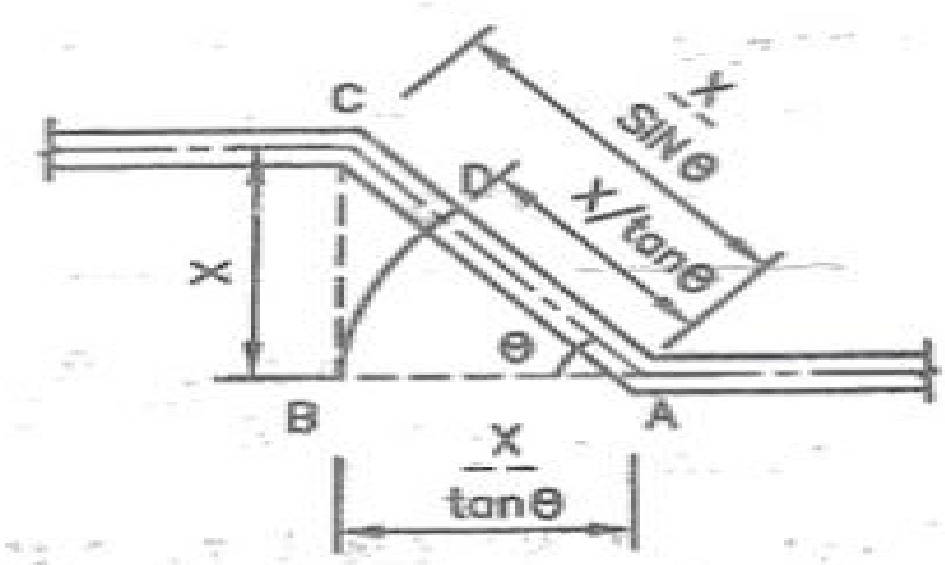
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4. For bent up bars

- CD= X/sinθ – X/ tanθ
  = X[1/ sinθ – 1/tanθ]
- If the bar is bent up at 45°, θ=45°

Therefore CD= X[1.414- 1.0]
= 0.414x
= 0.45x

Therefore, for bar bent up at 45°, Extra length= 0.45x



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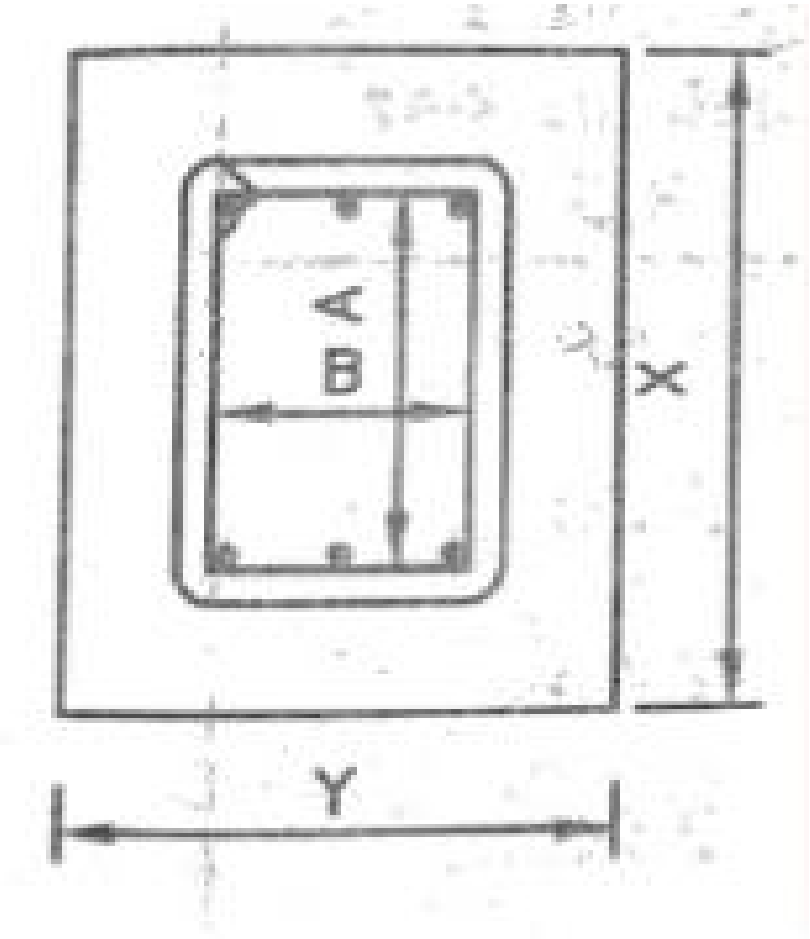
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5. Lateral ties or vertical stirrups

- Let X and Y are the outer dimensions of beam/column
- A= X -2 x cover – 2 x diameter of ring bar
- B= Y – 2 x cover – 2 x diameter of ring bar
- Length of 2 hooks = 2 x 12D or 0.15m

Therefore,

Length of ring bar = 2 (A+B) + 24D



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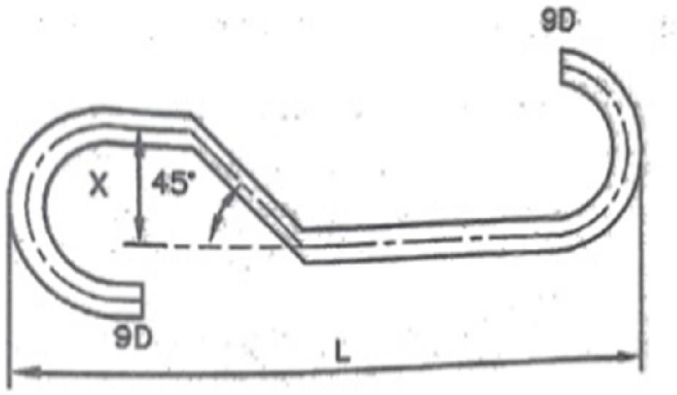
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6. Bent-up and hook

- Length of two hooks = 9D + 9D
- Extra length for one bent = 0.45X

Therefore,

Total length of bar = L + 9D + 9D + 0.45x



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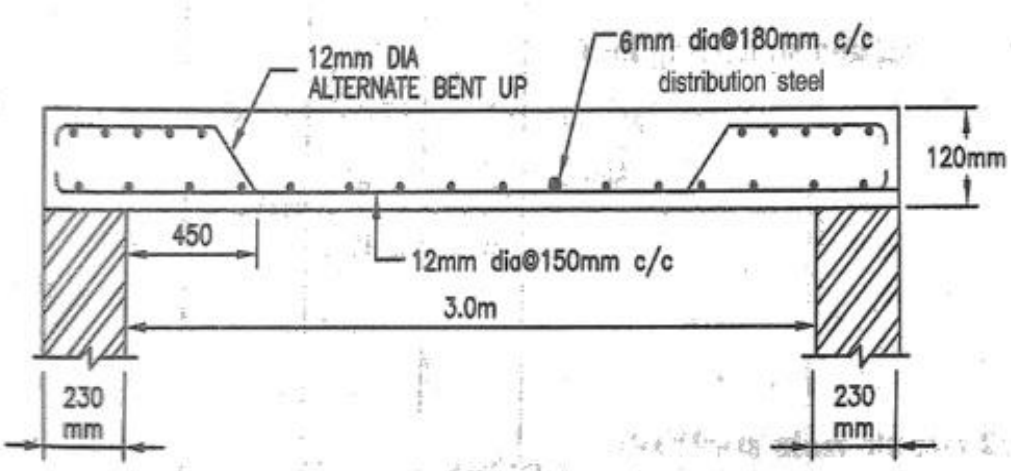
Example

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Example 1

- A room has a clear dimension 3.0m × 7.0m . It has an R.C.C slab as shown in fig.
- Top and Bottom cover is 20mm and end cover 50mm.



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Calculate the following,

1) cement concrete for slab (1:1.5:3)
2) centering and shuttering for slab
3) Weight of 12mm Φ bars
4) Weight of 6 mm Φ distribution steel bars
5) Abstract for approximate estimate
6) Cement, sand, Aggregate for slab
7) Percentage steel in slab
8) Cost of slab per m.
9) Prepare bar bending schedule

weight of steel bars 12mm Φ @ 0.9 kg/m
6mm Φ @ 0.22 kg/m



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Item no	Item Description	No.	Length (m)	Breadth (m)	Height (m)	Quantity
1	Cement concrete for slab : (1:1.5:3) L=7.0+0.23 +0.23 =7.46 m B=3+0.23 +0.23 =3.46 m	1	7.46	3.46	0.12	3.09 cu.m
2	Centering and shuttering for Slab	1	7.0	3.0		21.0
	Bottom	2	7.46		0.15	2.24
	Sides	2	3.46		0.15	1.04 24.28 sq. m.

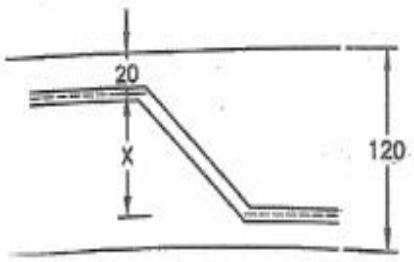
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3. 12 MM MAIN STEEL BARS @ 150 MM C/C ALTERNATE BENT UP.

- L = 3+ 0.23 + 0.23 +[2 × 9 × 0.012] (two hooks) – [2 × 0.05] (cover)
  = 3.58 m (straight length of bar)

- Span = 7 + 0.23+ 0.23 – [2 × 0.05] (cover)
  = 7.36 m



- No. of bars = $\frac{7.36}{0.15} + 1$
  = 50 nos.

➢ Extra length of bent up bars

- Length = 0.45x

Where x = 0.12 - 2 × 0.02 (cover) - 0.012 (bar)
= 0.068 m

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Item no	Item Description	No	Length (m)	Breadth (m)	Unit Weight (m)	Quantity
3.	12 mm main steel bars @ 150 mm c/c alternate bent up. L =3.58+0.45x =3.58+0.45×0.068 =3.61m	50	3.61		0.9 kg/m	162.45 kg

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4. 6 MM DIA. DISTRIBUTION STEEL @ 180 MM C/C BARS AT BOTTOM:

- Hook length = 9d
  = 9 × 0.006
  = 0.054 < 0.075 (mini. Hook length)

- L = 7 + 0.23 + 0.23 + [2 × 0.075] (hook) -
  [2 × 0.05] (cover)
  = 7.51m

- Width of slab = 3 + 0.23 + 0 23 – [2 × 0.05]
  = 3.36m

- No. of bars = $\frac{3.36}{0.18} + 1$
  = 19.66
  ≈ 20 nos.

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- Bars at top :

- Width of slab at one end for Bent up bar at top
  = 0.23 + 0.45 - 0.068 - 0.05 (cover)
  = 0.562 m

- No. of bars at one end
  $= \frac{0.562}{0.18} + 1$

  =4.12
  say 5 nos.

- No. of bars at both ends
  = 2 × 5
  = 10 nos.

- Total no. of bars = 20 + 10
  = 30 nos.

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Item no	Item Description	No	Length (m)	Breadth (m)	Unit Weight (m)	Quantity
4.	6 mm dia. Distribution steel. @ 180 mm c/c L = 7 + 0.23 + 0.23 + 2 × 0.075 (hook) - 2 × 0.05 (cover) = 7.51 m Total no. of bars = 20 + 10 = 30 nos	30	7.51		0.22 Kg/m	49.56 kg

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No	Item	Qty.	Per	Rate	Amount Rs.
1.	Cement concrete for slab (1:1.5:3)	3.09	Cu. m	8800.00	27192.00
2	Centering and shuttering for slab	24.28	Sq. m	100.00	2428.00
3	12 mm Φ bars (HYSD bars)	162.45	Kg	45	7310
4	6 mm Φ bars (mild steel)	49.56	Kg	45	2230
5	Labour for cutting,bending and placing steel = 162.45 + 49.56 = 212.01 kg	212.01	Kg	5	1060
				Total Rs.	40,220/-
				Add 5% contingencies Rs.	2011/-
				Grand total Rs.	42,231/-
				Say Rs.	42,300/-

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6. Cement, Sand, Aggregate for slab :

- Volume of dry concrete $= 1.52 \times 3.09$
  $= 4.70\ m^3$
- Cement $= \frac{1}{5.5} \times 4.70 = 0.855\ m^3$

  Now, $\frac{0.855}{0.035} = 24.43$ bags
- Sand $= \frac{1.5}{5.5} \times 4.70$
  $= 1.28\ m^3$
- Aggregate $= \frac{3}{5.5} \times 4.70 = 2.56\ m^3$

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7. Percentage of steel in slab :

- Volume of steel $= \frac{\text{mass}}{\text{density}}$

$$= \frac{212.01}{7850}$$

$$= 0.027\ m^3$$

- Volume of concrete = 3.09 m^3

- Percentage of steel $= \frac{\text{volume of steel}}{\text{volume of concrete}} \times 100$

$$= \frac{0.027}{3.09} \times 100$$

$$= 0.873\ \%$$

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8. Cost of slab per m^2

- L = 7 + 0.23 + 0.23
  = 7.46 m
- B = 3 + 0.23 + 0.23
  = 3.46 m

Total area = 7.46 × 3.46 = 25.81 m^2

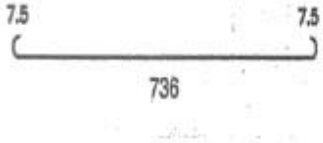
- Cost of slab per m^2 = $\frac{42300}{25.81}$

= 1638.89 Rs.
Say 1640.00 Rs.

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9. BAR BENDING SCHEDULE

Dia of bar	Shape and length of bar (cm)	Length (m)	No	Total length (m)	Unit weight (Kg/m)	Total weight (kg)
12 mm Φ main steel		3.61	50	180.5	0.9	162.45
6 mm Φ distribution steel		7.51	30	225.3	0.22	49.56
					Total =	212.01 kg

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Example 2

- Calculated the quantities of the following items for a beam shown in figure.

(a) reinforced concrete (1:2:4) for beam

or

(a) form work for beam

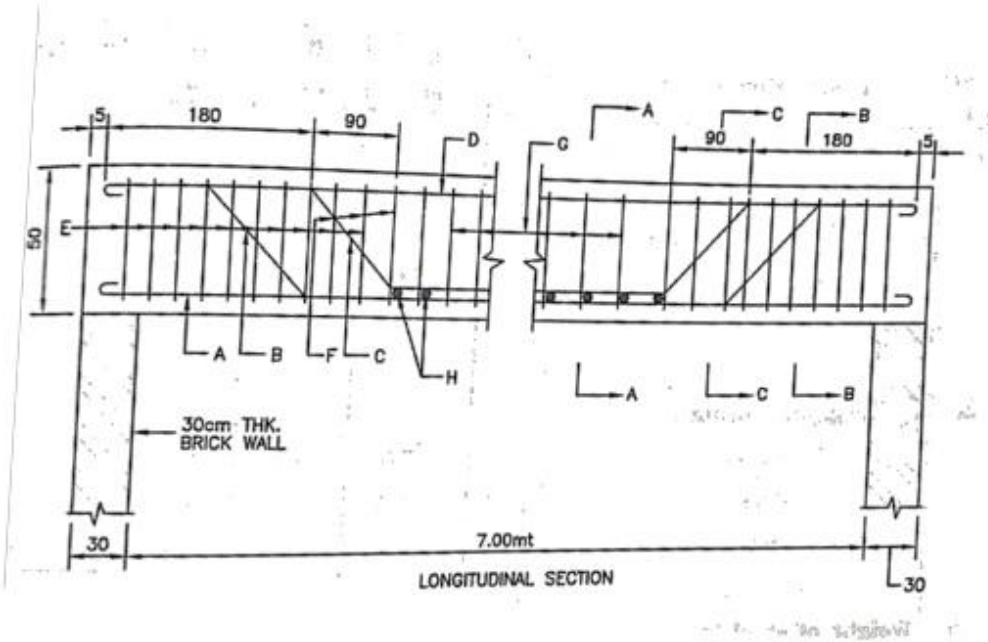
(b) weight of steel in kg

(c) prepare bar bending schedule.

(d) percentage steel w.r.t. reinforced concrete

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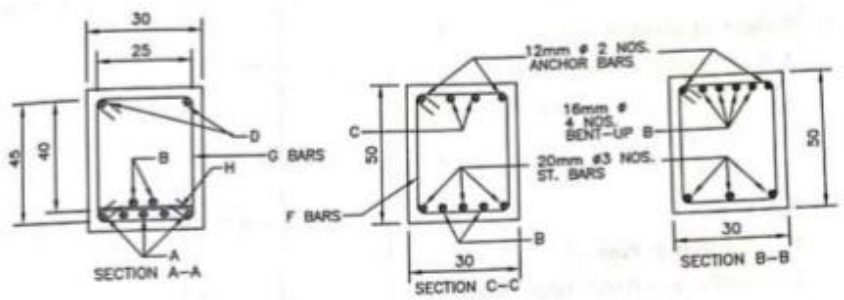
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LONGITUDINAL SECTION

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References:-

A= 20mm Ø STRAIGHT BAR 3NOS. @ 2.5 kg/mt.
B= 16mm Ø BENT UP BAR 2NOS. @1.6 kg/mt.
C= 16mm Ø BENT UP BAR 2NOS. @1.6 kg/mt.
D= 12mm Ø ANCHOR BAR 2NOS. @0.89 kg/mt.
E= 10mm Ø STIRRUPS 10cm c/c @ 0.62 kg/mt.
F= 8mm Ø STIRRUPS @ 15cm c/c @ 0.40 kg/mt.
G= 6mm Ø STIRRUPS @ 21cm c/c @ 0.22 kg/mt.
H= 20mm Ø PINS @ 21cm c/c @ 0.25 kg/mt.

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Item no	Item Description	No	Length (m)	Breadth (m)	Unit Weight (kg/m)	Quantity
(a)	Reinforced concrete (1:2:4) for beam L = 7 + 0.3 + 0.3 = 7.6 m B = 0.30 m H = 0.50 m Or	1	7.6	0.30	0.50	1.14 m^3
(a)	Formwork for beam :					
	Bottom	1	7	0.3	-	2.10 m^2
	Sides	2	7.6	-	0.5	7.60 m^2
	Ends	2	-	0.3	0.5	0.30 m^2 10.0 m^2

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Item no.	Item Description	No.	Length (m)	Unit weight (Kg/m)	Total weight (kg)
	Weight of steel in kg : A = 20 mm Φ straight bars L = 7 + 0.3 + 0.3 + [2×9×0.02](two hooks) – [2× 0.05] (cover) = 7.86 m No. of bars = 3	3	7.86	@2.5	58.95 kg
(b)	H = 20 mm Φ pins : L = 0.3 – [2× 0.025] (side cover) = 0.25 m No. of pins = span/spacing+1 Span = 7.6 – [2× 0.05] – [2×1.8] + [2×0.9] = 2.10 m Nos. = 2.10/0.21 +1 = 11 nos.	11	0.25	@2.5	6.88 kg

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Item no.	Item Description	No.	Length (m)	Unit weight (Kg/m)	Total weight (kg)
	B = 16 mm Φ bent up bar L = straight length of bar + [2×0.45x] Straight length = 7.6 + [2×9×0.016](hook) - [2×0.05] = 7.79 m X = 0.5 – [2×0.025] (cover) - [2×0.010] (stirrups) – 0.016 = 0.41 m L = 7.79 + [2×0.45×0.41] = 8.16 m No. of bars = 2 nos.	2	8.16	@1.6	26.11 kg
	D = 12 mm Φ anchor bar L = 7.6 + [2×9×0.012] (two hook) - [2×0.05] (cover) = 7.72 m	2	7.72	@0.89	13.74 kg

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Item no.	Item Description	No.	Length (m)	Unit weight (Kg/m)	Total weight (kg)
	E = 10 mm Φ stirrups : A = 0.5 – [2×0.025] – [2×0.010] = 0.43 m B = 0.3 – [2×0.025] – [2×0.010] = 0.23 m L = 2(A+B) + 24D (minimum hook length) = 2(0.43+0.23) + 24×0.010 = 1.56m Nos. = 2(1.8/0.1+1) = 38 nos.	38	1.56	@0.62	36.75 kg
	F = 8 mm Φ stirrups : A = 0.5 – [2×0.025] – [2×0.008] = 0.434 m B = 0.3 – [2×0.025] – [2×0.008] = 0.234 m				

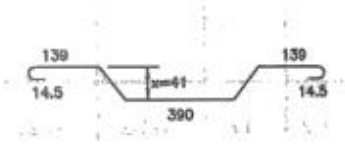
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Item no.	Item Description	No.	Length (m)	Unit weight (Kg/m)	Total weight (kg)
	L = 2 (A+B) + 24 D (hook) = 2 (0.434 + 0.234) + 24×0.008 = 1.53 m Nos. = 2(0.9/0.15) = 12 nos. No stirrup is shown at the end. Therefore 1 is not added.	12	1.53	@0.40	7.34 kg
	G = 6 mm Φ stirrups: A = 0.5 – [2×0.025] – [2×0.006] = 0.438 m B = 0.3 – [2×0.025] – [2×0.006] = 0.238 m L = 2 (A+B) + 0.15 (minimum hook length) = 2 (0.438 + 0.238) + 0.15 = 1.502 m Nos. = (7.6 – [2×1.8] – [2×0.9]) / 0.21 = 10.47 nos. =11 nos.	11	1.502	@0.22	3.36 kg

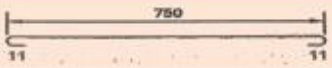
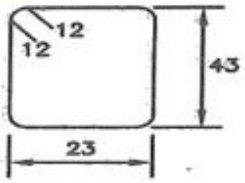
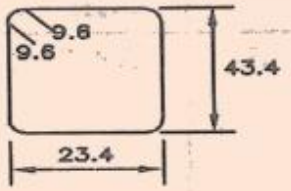
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Dia mm	Shape size cm	Length (m)	No.	Total length (m)	Unite weight (kg/m)	Total weight (kg)
A type 20 mm		7.86	3	23.58	2.5	58.95
B type 16 mm	 Straight = 760 – [2×5] – 2 × 180 = 390 Top straight = 180 - 41 = 139	8.16	2	16.32	1.6	26.11
C type 16 mm	 Straight = 760 – [2×5] – [2×180] – [2×90 = 210 Top straight = 180	8.13	2	16.26	1.6	26.0

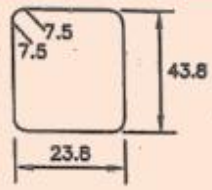
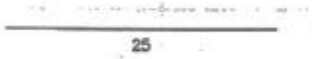
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Dia mm	Shape size cm	Length (m)	No.	Total length (m)	Unite weight (kg/m)	Total weight (kg)
D type 12 mm		7.72	2	15.44	0.89	13.74
E type 10 mm	 Hook = 12d = 12×1.0 =12 cm	1.56	38	59.28	0.62	36.75
F type 8 mm	 Hook=12d=12×8=9.6cm Minimum hook length is larger of 12 Φ or 7.5 cm.	1.53	12	18.36	0.40	7.34

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Dia mm	Shape size cm	Length (m)	No.	Total length (m)	Unite weight (kg/m)	Total weight (kg)
G type		1.502	11	16.52	0.22	3.63
H type 20 mm		0.25	11	2.75	2.5	6.88

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(d) Percentage steel w.r.t. reinforced concrete

- volume of steel = $\frac{\text{mass}}{\text{density}}$

  = 179.40/7850

  = 0.0228 m^3

- volume of concrete = 1.14 m^3

- % steel = $\frac{\text{volume of steel}}{\text{volume of concrete}} \times 100$

  = 0.0228/1.14 × 100

  = 2%.

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Example 3

- A reinforced cement concrete column is shown in figure. Calculate the quantities of the following items.

1) 1 : 2 : 4 cement concrete for column and footing.

   or

   formwork for column and footing.
2) Steel for column and footing in kg.
3) Bar bending schedule
4) Number of cement bags for 1 : 2 : 4 R.C.C

   or

4) Sand and aggregate for 1:2:4 concrete.

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Example 3

- A reinforced cement concrete column is shown in figure. Calculate the quantities of the following items.

1) 1 : 2 : 4 cement concrete for column and footing.

   or

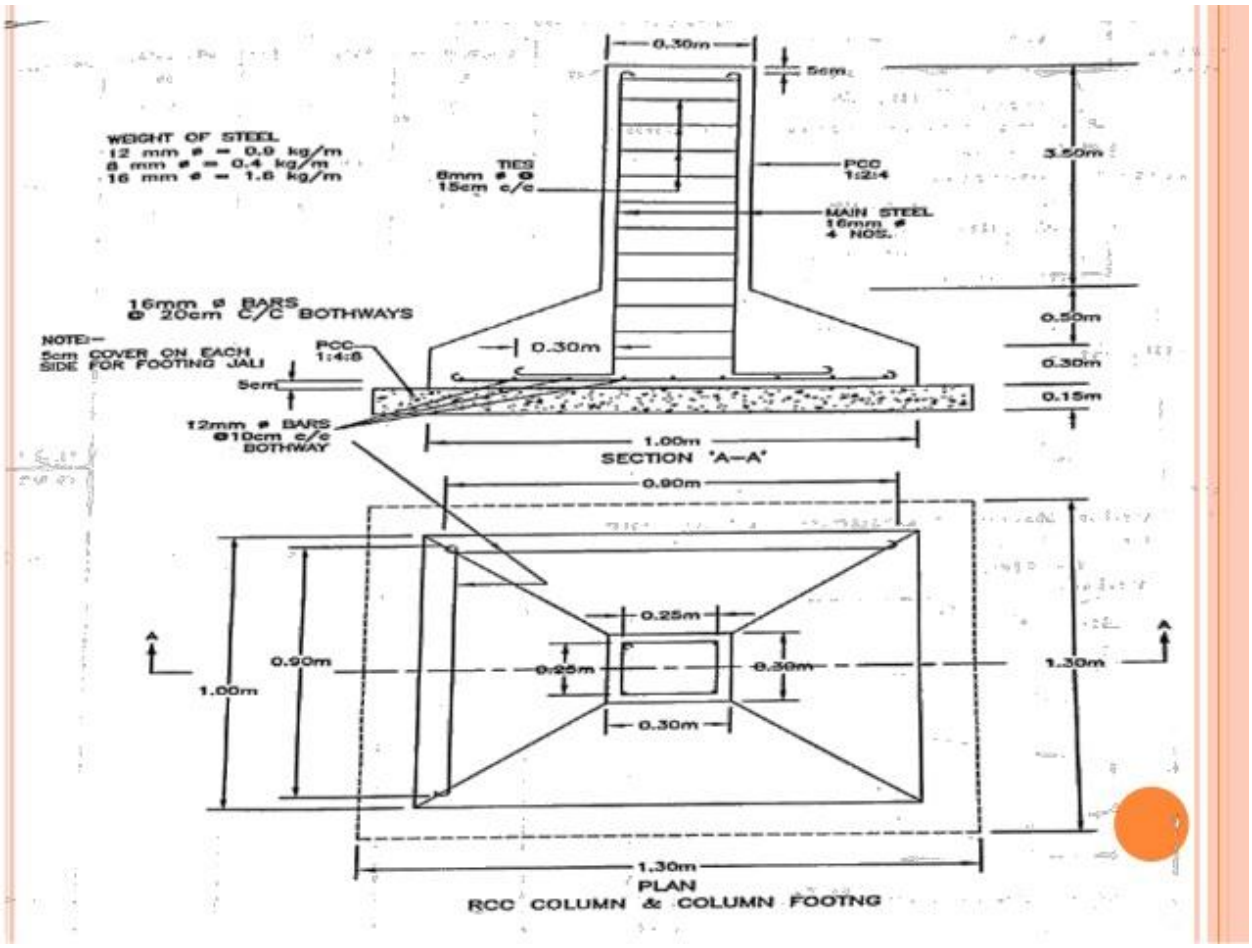
   formwork for column and footing.
2) Steel for column and footing in kg.
3) Bar bending schedule
4) Number of cement bags for 1 : 2 : 4 R.C.C

   or

4) Sand and aggregate for 1:2:4 concrete.

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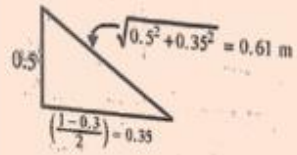
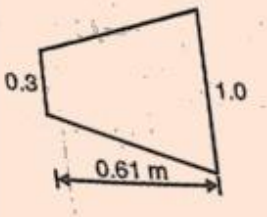
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Item no	Item Description	No.	Length (m)	Breadth (m)	Height (m)	Quantity
1.	1 : 2 : 4 cement concrete for column and footing					
	For column :	1	3.5	0.3	0.3	0.32 m^3
	Footing without slope Area at bottom of footing A1 =1 × 1 = 1 m^2 Area at top of footing A2 = 0.3 × 0.3 = 0.09 m^2 Volume of sloping portion $= \frac{h}{3}(A1 + A2 + \sqrt{A1\,A2})$ $= \frac{0.5}{3}(11 + 0.09 + \sqrt{1 \times 0.09})$ =0.23 m^3	1	1	1	0.3	0.30 m^3 0.23 m^3 0.85 m^3

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Item no	Item Description	No.	Length (m)	Breadth (m)	Height (m)	Quantity
Or 1.	Formwork for column and footing For column For footing   A = 4 × (0.3+1) × 0.61 / 2 = 1.59 m²	4	-	0.3	3.5	4.2 m²
						1.59 m²
	At the edge of footing	4	1.0	-	0.3	1.20 m²
						6.99 m²

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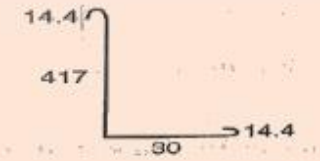
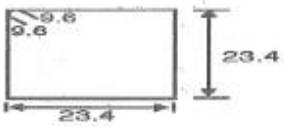
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Item no.	Item Description	No.	Length (m)	Unit weight (Kg/m)	Total weight (kg)
	No.of lateral ties $= \frac{[3.5 + 0.5 + 0.3 - (2 \times 0.05) - (2 \times 0.012)]}{0.15} + 1$ = 28.84 =29 nos.	29	1.13	@0.4	13.11 kg
	Footing bars 12 Φ bars @ 100 mm c/c both ways L= 0.9 + 2 × 9 × 0.012 = 1.12 m No. of bars = 0.9/0.10 + 1 = 10 nos.	2×10	1.12	@0.9	20.26 kg
				Total =	63.73 kg

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3. BAR BENDING SCHEDULE

Dia mm	Shape size cm	Length (m)	No.	Total length (m)	Unite weight (kg/m)	Total weight (kg)
16 Φ Column Bars		4.76	4	19.04	1.6	30.46 Kg
8 Φ lateral Ties		1.13	29	32.77	0.4	13.11 Kg
12 Φ footing Bars		1.12	20	22.4	0.9	20.16 Kg
					Total wt.	63.73 Kg

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4. Number of cement bags for 1 : 2 : 4 R.C.C

- total concrete = 0.85 m^3
- volume of dry concrete = 0.85 × 1.52 = 1.292 m^3

- 1 : 2 : 4 = 7
- cement = 1 / 7 × 1.292 = 0.184 m3 = 0.184 / 0.035 = 5.26 bags

or

4. Sand and aggregate for 1:2:4 concrete :

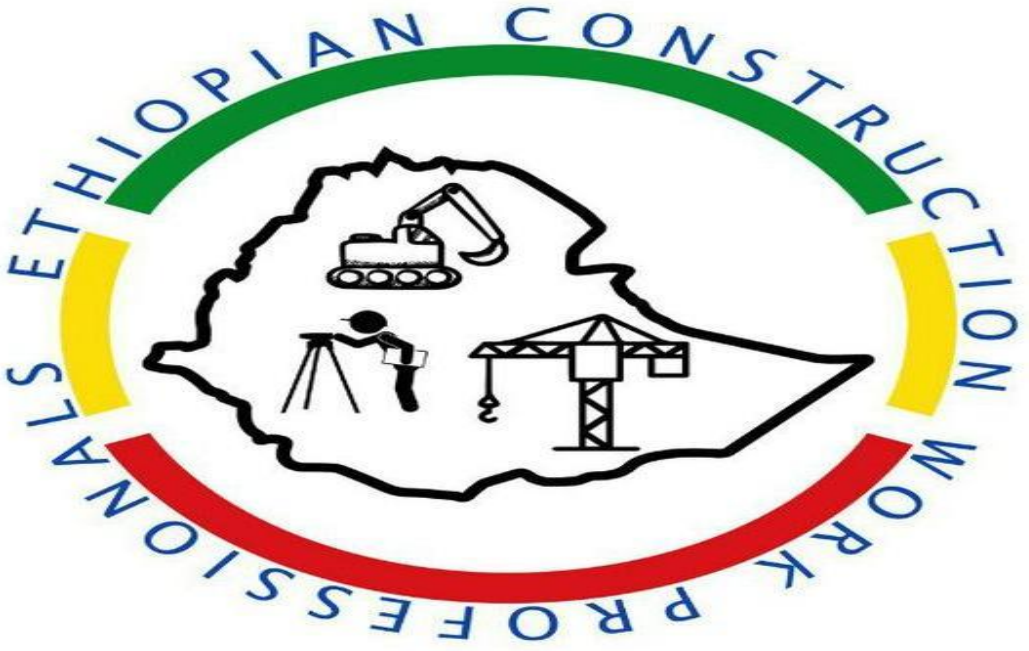
- 1 : 2 : 4 = 7
- volume of dry concrete = 1.292 m^3

- sand = 2 / 7 × 1.292 = 0.37 m3
- aggregate = 4 / 7 × 1.292 = 0.74 m^3

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