

SECTION 1
REINFORCEMENT ESTIMATION OF A RCC SLAB

0101. **Reinforcement used in the RCC.**

Two types of steel are used in RCC work. They are

- a. Plain round mild steel bar.
- b. Deformed bar.

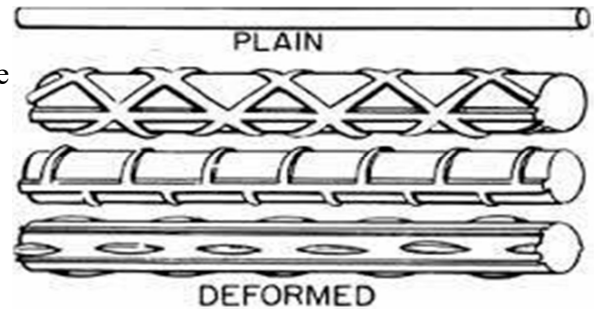


Figure 1-1: Typical Reinforcement

Designation and cross-section area of ASTM standard reinforcing bars are given below:

Table 1-1: Diameter and Nominal Cross-Section Area of ASTM Standard Reinforcing Bars

Bar No.	Diameter (in)	Nominal Area (in ²)
#3	3/8	0.11
#4	4/8	0.20
#5	5/8	0.31
#6	6/8	0.44
#7	7/8	0.60
#8	8/8	0.79
#9	9/8	1.00
#10	10/8	1.27
#11	11/8	1.56

0102. **Cover and Clear Cover in RCC.**

- a. **Cover.** Refers to distance of outer concrete surface from C.G. of steel.
- b. **Clear Cover.** Refers to distance of outer concrete surface from edge of steel.

Figure 1-2: Cover and Clear cover in RCC

Reinforcement covering is necessary for the following reasons:

- (1) To protect reinforcement/steel from weathering effect i.e. corrosion
- (2) To protect from fire.
- (3) The need for adequate adhesion between the steel and concrete.
- (4) The need to create cable and pipe channels without harming the reinforcement

According to the ACI code minimum cover should be maintained in all kind of RCC works. ACI code provisions are given in the following table.

Table 1-2: ACI Code Provisions for Minimum Cover and Clear Cover

	Beam/Column	Slab
Clear cover	1.5 inch	0.75 inch
Cover	2.5 inch	1 inch

0103. Reinforcement Hooks.

In RCC work reinforcements are used in concrete to take tension. To achieve the good performance i.e. strong bond between concrete and steel, hooks are provided at the ends of the all reinforcing bars (especially in plain bars). Typical length of one hook is $9d_b$ to $12d_b$, where d_b is the diameter of the hook bar.

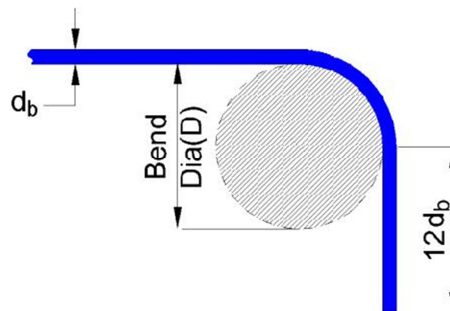


Figure 1-3: Typical 90° hook

0104. Type of Reinforcement Used in Slab.

- a. Straight bar [lies at bottom]
- b. Cranked bar [lies top and bottom depending on cranking]
- c. Extra top [lies at top]

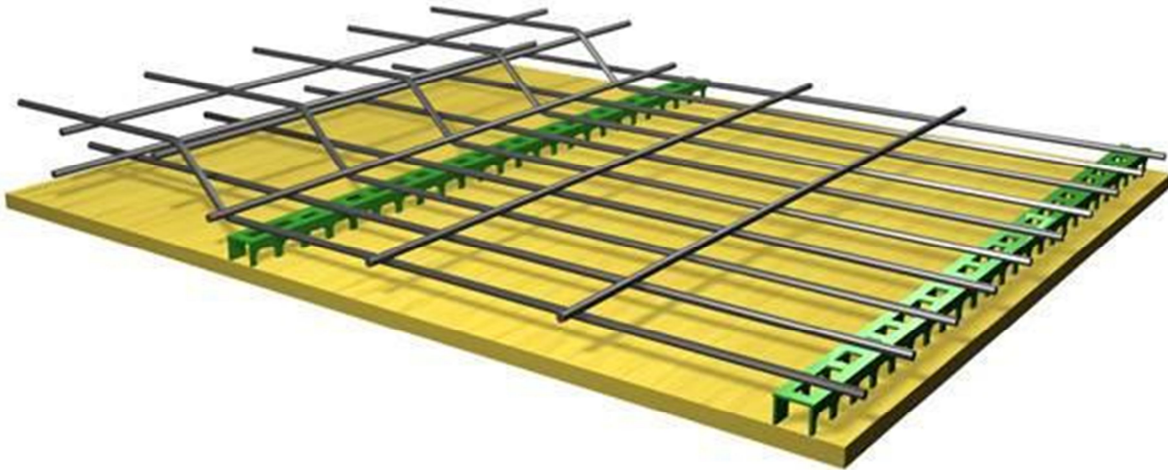


Figure 1-4: Typical Slab Reinforcement Pattern (straight & cranked bar). Rules for slab reinforcement distribution.

- (1) Start with a straight bar and end with a straight bar.
- (2) Cranked bars are in between straight bars.
- (3) Extra tops are in between cranked bar.

0105. Meaning of Legends.

- a. #3@ 6" c/c alternately cranked: #3 bars are distributed at bottom with a spacing 6". First bar should be straight and next bar should be cranked.
- b. 2#3 extra top in between cranked: 2#3 bars are placed in between cranked bars at top position on one side.

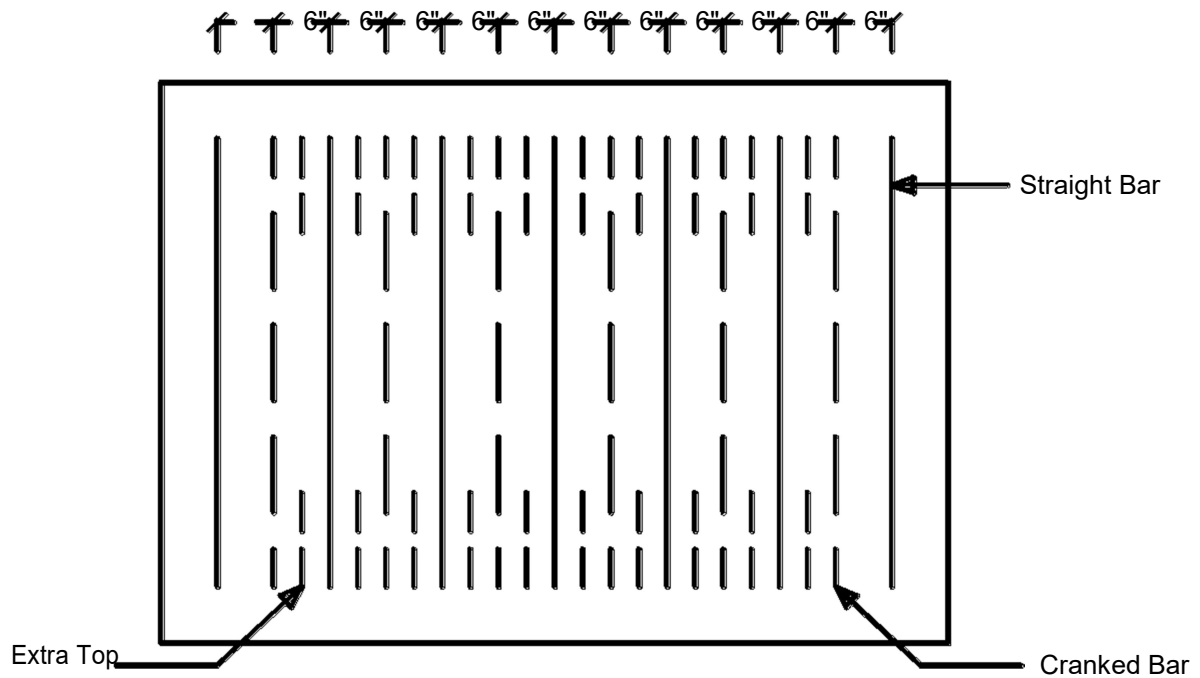


Figure 1-5: Demonstration of Slab Reinforcement Pattern.

0106. Length of a Cranked Bar.

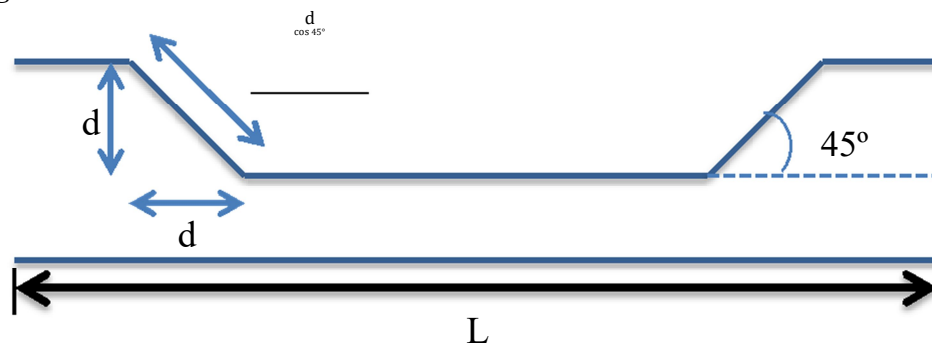


Figure 1-6: Length of a Cranked Bar

Length of straight reinforcement = L

Length of cranked reinforcement = $(L - d - d) + d/\cos 45 + d/\cos 45$

$$= (L - d - d) + 1.42d + 1.42d$$

$$= L + 0.42d + 0.42d$$

Length of cranked reinforcement = Length of straight bar + n

$(0.42d)$ {Where, n = no. of cranked portion}

0107. .Number of Reinforcement (Alternately Cranked Distribution).

a. #3@ 6" c/c alt. ckd.

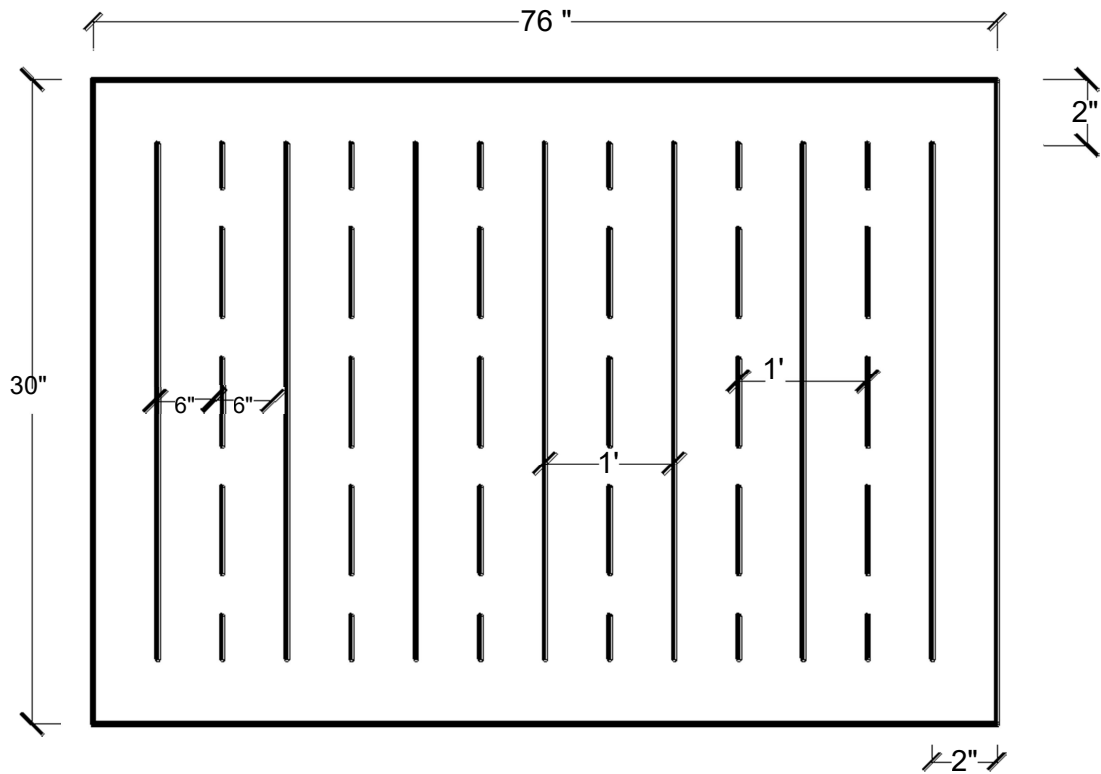


Figure 1-7: Straight and Cranked Reinforcement Distribution

No of straight bars = $(76'' - 2'' - 2'') / 12 + 1 = 6.16 \approx 7$ Nos. (Upper rounding)

No of cranked bars = No of straight bars - 1 = 7 - 1 = 6 Nos.

b. 2#3 extra top in between cranked

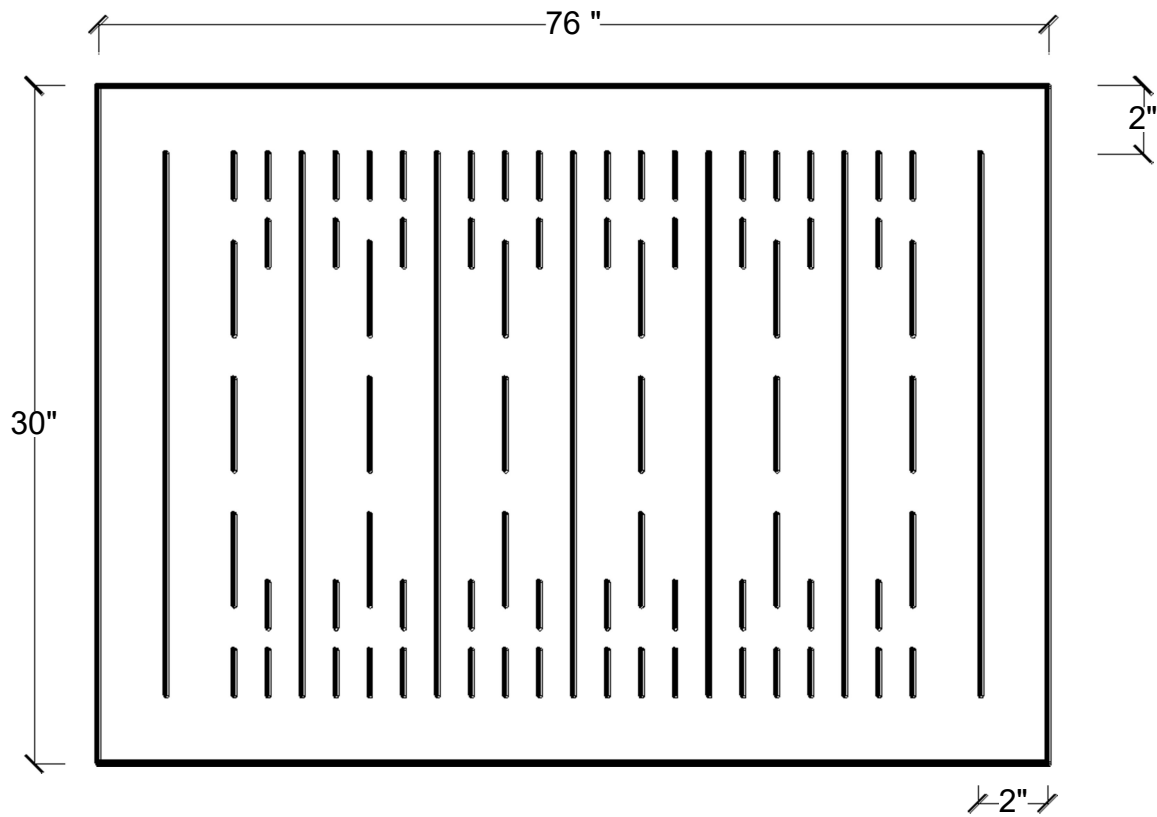


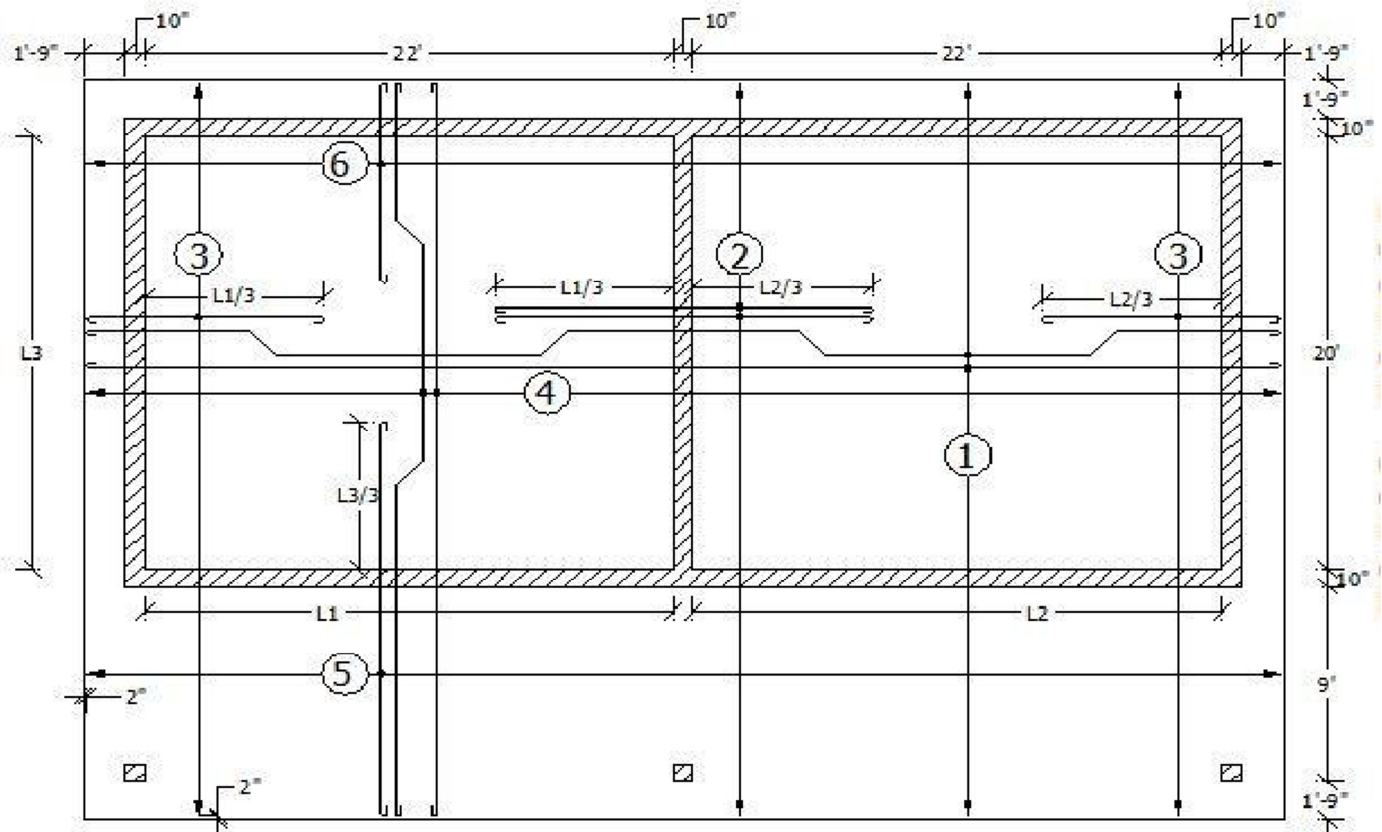
Figure 1-8: Straight, Cranked and Extra Top Distribution

No of extra top (one side) = Space available for extra top x No of extra top
 = (No of cranked bar -1) x 2 = (6-1) x 2 = 10 Nos.

Table 1.3: Nominal Weight of the ASTM standard Reinforcing Bar

U.S. rebar size chart			
Imperial Bar Size	Metric Size (mm)	Mass per unit length	
		lb/ft	(kg/m)
#3	10	0.376	0.561
#4	13	0.668	0.996
#5	16	1.043	1.556
#6	19	1.502	2.24
#7	22	2.044	3.049
#8	25	2.670	3.982
#9	29	3.400	5.071
#10	32	4.303	6.418
#11	36	5.313	7.924
#14	43	7.650	11.41
#18	7	13.60	20.284

0108. Worked Out Problem.



Legends:

- (1) #4 @ 6" c/c alt. ckd
(2) 2#4 extra top in
between ckd. bars
(3) 1#3 extra top in
between ckd. bars

Slab Thickness= 5"

Cover= 1"

- (4) #3 @ 4" c/c alt. ckd
(5) 1#4 extra top in
between ckd. bars
(6) 1#3 extra top in
between ckd. bars

Figure 1-9: Reinforcement Detailing for a 5 inch Slab Supported on Masonry Wall

Reinforcement Estimation

Table 1-4: Calculation of Reinforcement Estimation for the Workout Problem

Bar	Bar Designation	No. [rounded to upper 1]	Length (ft)	Total Length (ft)
Long Direction	#4 Straight	$\frac{34'2'' - 2'' - 2''}{12} + 1 = 35$	$50' - 2'' - 2'' = 49.67'$	1738.33
	#4 Cranked	$35 - 1 = 34$	$49.67' + 4 \times 0.42 \times \left(\frac{4}{12}\right) = 50.23'$	1707.70
	#3 Extra top	$(34 - 1) \times 2 = 66$	$1'9'' - 2'' + 10'' + \frac{22'}{3} = 9.75'$	643.50
	#4 Extra top	$(34 - 1) \times 2 = 66$	$\frac{22'}{3} + 10'' + \frac{22'}{3} = 15.5'$	1023
	#3 Hook	$66 \times 2 = 132$	$10 \times \frac{3}{8} \times \frac{1}{12} = 0.3125$	55.04
	#4 Hook	$(35 + 34 + 66) \times 2 = 270$	$10 \times \frac{4}{8} \times \frac{1}{12} = 0.417$	112.59
Short Direction	#3 Straight	$\frac{50' - 2'' - 2''}{18} + 1 = 76$	$34'2'' - 2'' - 2'' = 33.83'$	2571.33
	#3 Cranked	$76 - 1 = 75$	$33.83' + 4 \times 0.42 \times \left(\frac{3}{12}\right) = 34.13'$	2558.49
	#3 Extra top	$75 - 1 = 74$	$1'9'' - 2'' + 10'' + \frac{20'}{3} = 9.08'$	672.16
	#4 Extra top	$75 - 1 = 74$	$1'9'' - 2'' + 9' + 10'' + \frac{20'}{3} = 18.08'$	1338.16
	#3 Hook	$(76 + 75 + 74) \times 2 = 450$	$10 \times \frac{3}{8} \times \frac{1}{12} = 0.3125$	140.62
	#4 Hook	$74 \times 2 = 148$	$10 \times \frac{4}{8} \times \frac{1}{12} = 0.417$	61.716

Table 2.5: Calculation of Weight of Reinforcement Bars for the Workout Problem

Bar Designation	Total Length (ft)	Weight per unit length (lb/ft)	Weight (lb)
#3	6642	0.376	2498
#4	5982	0.668	3996

