

MANHOLES

CONCRETE MANHOLE WALLS

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1. DESIGN OF WALLS

1.01 In general the design of concrete manhole walls to be employed will be governed by the nature of the soil and the depth of the excavation as discussed in Part 3, G43.118.1. In no case, however, shall concrete manhole walls consist of less than 6 inches of sound concrete of the grade specified in G45.140.1.

1.02 Ordinarily, the detail plans will indicate the thickness of the walls and also whether or not the concrete is to be reinforced. If the plans call for a light wall and upon excavating it is found that the soil is of a fluid nature, the matter should be discussed with the supervisor or inspector to determine whether a heavier wall should be built.

Concrete Manhole Walls—Normal Construction

1.03 The following tables show the wall thickness and reinforcement required, if any, for concrete walls of manholes to be constructed in firm soil or fluid soil. It will be noted in the tables, that the variations in the thickness of concrete walls and the amount of vertical reinforcement required varies only with the depth of the manhole walls. In the designs for concrete walls specified in the tables it has been assumed that the entire lateral pressure on the walls will be carried by the vertical reinforcement. For this reason the length of the manhole wall has no effect on the thickness of concrete or the amount of reinforcement required.

NORMAL CONSTRUCTION
DESIGN OF WALLS FOR CONCRETE MANHOLES
CONSTRUCTED IN FIRM SOILS

Depth of Manhole Floor Below Surface of Street	Plain Walls		Reinforced Walls			
	Thickness of Walls (Inches)	Thickness of Walls (Inches)	Vertical Reinforcement using Deformed Bars		Vertical Reinforcement using Plain Bars	
			Size	Spacing	Size	Spacing
8 ft. 0 in or less	6	6	none	none	none	none
8 ft. 6 in.	7	6	$\frac{3}{8}$ in. Round $\frac{1}{2}$ in. Round	8 in. O. C. 12 in. O. C.	$\frac{3}{8}$ in. Round $\frac{1}{2}$ in. Round	7 $\frac{1}{2}$ in. O. C. 9 in. O. C.
9 ft. 0 in.	7 $\frac{1}{2}$	6	$\frac{3}{8}$ in. Round $\frac{1}{2}$ in. Round	6 in. O. C. 10 in. O. C.	$\frac{3}{8}$ in. Round $\frac{1}{2}$ in. Round	5 $\frac{1}{2}$ in. O. C. 7 in. O. C.
9 ft. 6 in.	8	6	$\frac{3}{8}$ in. Round $\frac{1}{2}$ in. Round	5 $\frac{1}{2}$ in. O. C. 9 in. O. C.	$\frac{3}{8}$ in. Round $\frac{1}{2}$ in. Round	5 in. O. C. 6 $\frac{1}{2}$ in. O. C.
10 ft. 0 in.	8 $\frac{1}{2}$	6	$\frac{3}{8}$ in. Round $\frac{1}{2}$ in. Round	4 in. O. C. 8 in. O. C.	$\frac{3}{8}$ in. Round $\frac{1}{2}$ in. Round	4 in. O. C. 6 in. O. C.
10 ft. 6 in.	9	6	$\frac{3}{8}$ in. Round $\frac{1}{2}$ in. Round	4 in. O. C. 7 in. O. C.	$\frac{3}{8}$ in. Round $\frac{1}{2}$ in. Round	4 in. O. C. 6 in. O. C.
11 ft. 0 in.	10	6	$\frac{1}{2}$ in. Round	6 in. O. C.	$\frac{1}{2}$ in. Round	5 in. O. C.
11 ft. 6 in.	10 $\frac{1}{2}$	6	$\frac{1}{2}$ in. Round	5 in. O. C.	$\frac{1}{2}$ in. Round	4 $\frac{1}{2}$ in. O. C.
12 ft. 0 in.	11	6 $\frac{1}{2}$	$\frac{1}{2}$ in. Round	5 in. O. C.	$\frac{1}{2}$ in. Round	4 $\frac{1}{2}$ in. O. C.
12 ft. 6 in.	12	6 $\frac{1}{2}$	$\frac{1}{2}$ in. Round $\frac{3}{8}$ in. Round	4 $\frac{1}{2}$ in. O. C. 7 in. O. C.	$\frac{1}{2}$ in. Round $\frac{3}{8}$ in. Round	4 $\frac{1}{2}$ in. O. C. 5 $\frac{1}{2}$ in. O. C.
13 ft. 0 in.	12 $\frac{1}{2}$	7	$\frac{1}{2}$ in. Round $\frac{3}{8}$ in. Round	4 $\frac{1}{2}$ in. O. C. 7 in. O. C.	$\frac{1}{2}$ in. Round $\frac{3}{8}$ in. Round	4 $\frac{1}{2}$ in. O. C. 5 $\frac{1}{2}$ in. O. C.
13 ft. 6 in.	13	7	$\frac{3}{8}$ in. Round	6 $\frac{1}{2}$ in. O. C.	$\frac{3}{8}$ in. Round	5 in. O. C.
14 ft. 0 in.	14	7 $\frac{1}{2}$	$\frac{3}{8}$ in. Round	6 $\frac{1}{2}$ in. O. C.	$\frac{3}{8}$ in. Round	5 in. O. C.
14 ft. 6 in.	14 $\frac{1}{2}$	7 $\frac{1}{2}$	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	5 $\frac{1}{2}$ in. O. C. 8 in. O. C.	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	5 in. O. C. 6 in. O. C.
15 ft. 0 in.	15	8	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	5 $\frac{1}{2}$ in. O. C. 8 in. O. C.	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	5 in. O. C. 6 in. O. C.
16 ft. 0 in.	Requires Reinforcement	9	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	5 $\frac{1}{2}$ in. O. C. 7 $\frac{1}{2}$ in. O. C.	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	5 in. O. C. 6 in. O. C.
17 ft. 0 in.		9 $\frac{1}{2}$	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	4 $\frac{1}{2}$ in. O. C. 7 in. O. C.	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	4 $\frac{1}{2}$ in. O. C. 6 in. O. C.
18 ft. 0 in.		10	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	4 in. O. C. 6 in. O. C.	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	4 in. O. C. 5 $\frac{1}{2}$ in. O. C.
19 ft. 0 in.		11	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	4 in. O. C. 5 $\frac{1}{2}$ in. O. C.	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	4 in. O. C. 5 $\frac{1}{2}$ in. O. C.
20 ft. 0 in.		11 $\frac{1}{2}$	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	3 $\frac{1}{2}$ in. O. C. 5 $\frac{1}{2}$ in. O. C.	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	3 $\frac{1}{2}$ in. O. C. 5 $\frac{1}{2}$ in. O. C.
21 ft. 0 in.		12 $\frac{1}{2}$	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	3 $\frac{1}{2}$ in. O. C. 5 in. O. C.	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round	3 $\frac{1}{2}$ in. O. C. 5 in. O. C.
22 ft. 0 in.		13	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round $\frac{3}{4}$ in. Round	3 in. O. C. 4 $\frac{1}{2}$ in. O. C. 6 $\frac{1}{2}$ in. O. C.	$\frac{3}{8}$ in. Round $\frac{3}{4}$ in. Round $\frac{3}{4}$ in. Round	3 in. O. C. 4 $\frac{1}{2}$ in. O. C. 6 $\frac{1}{2}$ in. O. C.
23 ft. 0 in.		14	$\frac{3}{4}$ in. Round	4 $\frac{1}{2}$ in. O. C.	$\frac{3}{4}$ in. Round	4 $\frac{1}{2}$ in. O. C.
24 ft. 0 in.		14 $\frac{1}{2}$	$\frac{3}{4}$ in. Round	4 in. O. C.	$\frac{3}{4}$ in. Round	4 in. O. C.

**NORMAL CONSTRUCTION
DESIGN OF WALLS FOR CONCRETE MANHOLES
CONSTRUCTED IN FLUID SOILS**

Depth of Manhole Floor Below Surface of Street	Plain Walls	Reinforced Walls				
	Thickness of Walls (Inches)	Thickness of Walls (Inches)	Vertical Reinforcement using Deformed Bars		Vertical Reinforcement using Plain Bars	
			Size	Spacing	Size	Spacing
8 ft. 0 in or less	9	6	½ in. Round	6 in. O. C.	½ in. Round	4 in. O. C.
8 ft. 6 in.	10	6½	½ in. Round	6 in. O. C.	½ in. Round	4 in. O. C.
9 ft. 0 in.	11	7	½ in. Round	5½ in. O. C.	½ in. Round	4 in. O. C.
9 ft. 6 in.	12	7½	½ in. Round	5 in. O. C.	½ in. Round	4 in. O. C.
10 ft. 0 in.	13	8	½ in. Round	4½ in. O. C.	½ in. Round	3½ in. O. C.
10 ft. 6 in.	14	8½	½ in. Round	4 in. O. C.	½ in. Round	3½ in. O. C.
11 ft. 0 in.	15	9	⅝ in. Round	6 in. O. C.	⅝ in. Round	4 in. O. C.
11 ft. 6 in.	16	9½	⅝ in. Round	5½ in. O. C.	⅝ in. Round	4 in. O. C.
12 ft. 0 in.	Requires Reinforcement	10	⅝ in. Round	5½ in. O. C.	⅝ in. Round	4 in. O. C.
12 ft. 6 in.		10½	⅝ in. Round	5 in. O. C.	⅝ in. Round	4 in. O. C.
13 ft. 0 in.		11	⅝ in. Round ¾ in. Round	4½ in. O. C. 6 in. O. C.	⅝ in. Round ¾ in. Round	4 in. O. C. 5 in. O. C.
13 ft. 6 in.		11½	⅝ in. Round ¾ in. Round	4 in. O. C. 6½ in. O. C.	⅝ in. Round ¾ in. Round	4 in. O. C. 4½ in. O. C.
14 ft. 0 in.		12	¾ in. Round	5½ in. O. C.	¾ in. Round	4½ in. O. C.
14 ft. 6 in.		12½	¾ in. Round	5½ in. O. C.	¾ in. Round	4½ in. O. C.
15 ft. 0 in.		13	¾ in. Round	5 in. O. C.	¾ in. Round	4½ in. O. C.
16 ft. 0 in.		14	¾ in. Round	4½ in. O. C.	¾ in. Round	4½ in. O. C.
17 ft. 0 in.		15	¾ in. Round	4 in. O. C.	¾ in. Round	4 in. O. C.
18 ft. 0 in.		16½	⅞ in. Round	5 in. O. C.	⅞ in. Round	5 in. O. C.
19 ft. 0 in.		18	⅞ in. Round	4½ in. O. C.	⅞ in. Round	4½ in. O. C.
20 ft. 0 in.		19½	⅞ in. Round	4 in. O. C.	⅞ in. Round	4 in. O. C.
21 ft. 0 in.		20½	⅞ in. Round	4 in. O. C.	⅞ in. Round	4 in. O. C.
22 ft. 0 in.		22	1 in. Square	6 in. O. C.	1 in. Square	6 in. O. C.
23 ft. 0 in.		23½	1 in. Square	5½ in. O. C.	1 in. Square	5½ in. O. C.
24 ft. 0 in.		25	1 in. Square	5 in. O. C.	1 in. Square	5 in. O. C.

1.04 In addition to the vertical reinforcement given in the above tables, it will be necessary to provide some horizontal reinforcement to act as a binder and prevent the development of vertical cracks in the manhole walls. For walls up to 12 inches thick, the horizontal reinforcement should consist of round bars 3/8 inch diameter or larger spaced 12 inches on centers. For walls more than 12 inches thick, the horizontal reinforcement should consist of round bars 5/8 inch diameter or larger spaced 12 inches on centers.

1.05 The vertical reinforcing bars should be of a length sufficient to extend from the bottom of the concrete floor to within one inch of the top of the manhole roof. The horizontal reinforcing bars should be of a length sufficient to extend to within one inch of the outside surfaces of the two adjacent walls.

Concrete Manhole Walls—Two-way Reinforcement

1.06 In certain locations, as for example when space is limited because of other underground structures, manhole construction might be facilitated if the over-all length or width could be reduced by a few inches without affecting the inside dimensions of the manhole. In such circumstances the reduction in wall thickness obtainable through the substitution of two-way reinforced wall design for the normal vertically reinforced design should be considered.

1.07 For a two-way reinforced wall, it is assumed that the wall is supported at the ends in addition to the top and bottom. This requires that both the depth of the manhole and the length of the wall be considered in the design. The following tables show the wall thickness and reinforcement required for two-way reinforced walls for manholes of various depths and lengths to be constructed in firm soil or fluid soil. The diagonal walls and the walls adjacent to the diagonal walls of V or Modified V Type manholes should be designed for vertical reinforcement only as specified in 1.03.

**DESIGN OF TWO-WAY REINFORCED
WALLS FOR CONCRETE MANHOLES
CONSTRUCTED IN FIRM SOIL**

Depth of Manhole Floor Below Surface of Street (Feet)	Length of Manhole Wall (Feet)	Thickness of Wall (Inches)	Vertical Reinforcement		Horizontal Reinforcement	
			Diameter of Round Deformed Bars (Inches)	Spacing of Reinforcing Bars (Inches)	Diameter of Round Deformed Bars (Inches)	Spacing of Reinforcing Bars (Inches)
16	9	7½	½	12	⅝	6
	11	7½	⅝	8	⅝	6
	13	8	⅝	7	¾	8
	15	8	⅝	6	¾	8
18	9	8½	½	12	¾	7½
	11	9	⅝	10	¾	7
	13	9	⅝	7	¾	7
	15	9½	⅝	6	¾	6½
20	9	8½	½	12	¾	7½
	11	10	½	12	¾	6
	13	10½	⅝	8	¾	6
	15	10½	⅝	6	¾	6
22	9	9	½	12	¾	7
	11	10½	½	12	¾	6
	13	11½	⅝	12	¾	5½
	15	12	⅝	6	¾	5
24	9	9½	½	12	¾	6½
	11	11	½	12	¾	5½
	13	12½	⅝	12	¾	5
	15	13	⅝	7	¾	4½

DESIGN OF TWO-WAY REINFORCED
WALLS FOR CONCRETE MANHOLES
CONSTRUCTED IN FLUID SOIL

Depth of Manhole Floor Below Surface of Street (Feet)	Length of Manhole Wall (Feet)	Thickness of Wall (Inches)	Vertical Reinforcement		Horizontal Reinforcement	
			Diameter of Round Deformed Bars (Inches)	Spacing of Reinforcing Bars (Inches)	Diameter of Round Deformed Bars (Inches)	Spacing of Reinforcing Bars (Inches)
16	9	12	$\frac{5}{8}$	8	$\frac{3}{4}$	5
	11	12½	$\frac{3}{4}$	7	$\frac{3}{4}$	5
	13	13	$\frac{3}{4}$	6	1	8½
	15	13	$\frac{3}{4}$	5½	1	8½
18	9	13	$\frac{5}{8}$	12	1	8½
	11	14½	$\frac{3}{4}$	9½	1	7½
	13	15	$\frac{3}{4}$	6	1	7
	15	15	$\frac{3}{4}$	5	1	7
20	9	14	$\frac{5}{8}$	12	1	7½
	11	16	$\frac{5}{8}$	10	1	6½
	13	17	$\frac{3}{4}$	6½	1	6
	15	17	$\frac{3}{4}$	5	1	6
22	9	14½	$\frac{5}{8}$	12	1	7½
	11	17	$\frac{5}{8}$	10	1	6
	13	19	$\frac{5}{8}$	8	1	5½
	15	19½	$\frac{3}{4}$	6	1	5½
24	9	15	$\frac{5}{8}$	12	1	7
	11	17½	$\frac{5}{8}$	10	1	6
	13	20½	$\frac{5}{8}$	8	1	5
	15	21½	$\frac{3}{4}$	6	1	5

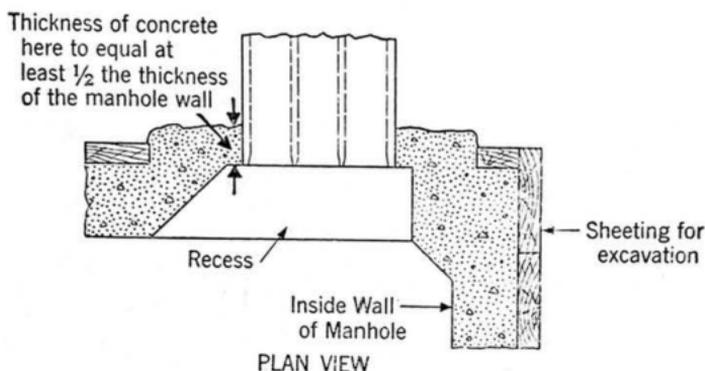
1.08 For depths and wall lengths different from those specified in the table, select the thickness of wall and reinforcement spacing for the next greater depth or length.

1.09 For the upper 1/2 of the depth of the excavation where the spacing of the horizontal reinforcement for the wall is 6 inches or less, each alternate horizontal bar may be omitted; where the spacing given in the tables is greater than 6 inches, the spacing may be increased to 12 inches.

1.10 The length of the horizontal and vertical reinforcing bars shall be as specified in 1.05.

2. DUCT ENTRANCE RECESSES

2.01 Where recesses are to be constructed at the duct entrances, it is essential that sufficient concrete be placed between the face of the recess and the wall of the excavation to provide a water-tight bond between the manhole wall and the conduit. The thickness of this concrete should equal at least $\frac{1}{2}$ the thickness of the manhole wall. Thus, for an 8-inch recess in a 6-inch wall, it will be necessary to extend the excavation around the conduit at least 5 inches to provide space for the concrete.



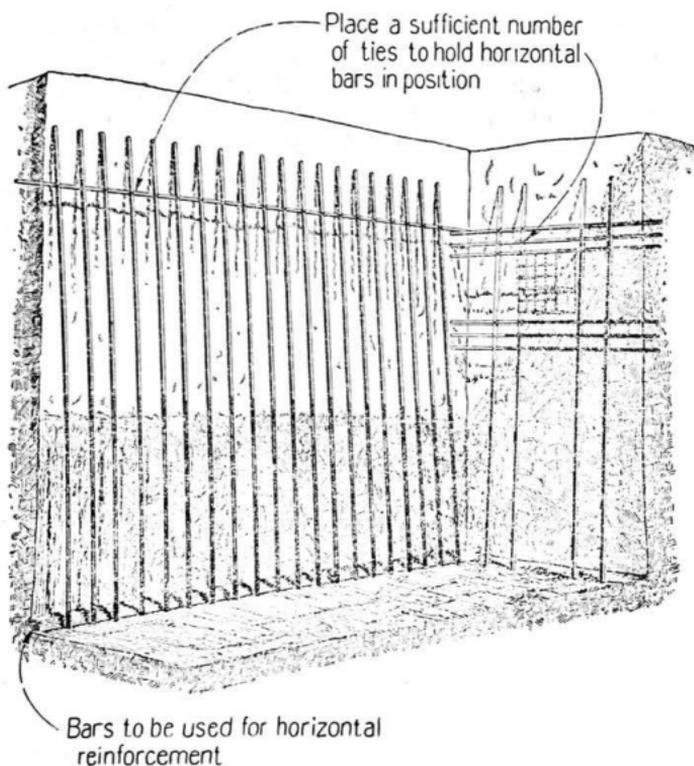
3. PLACING REINFORCEMENT

Normal Construction

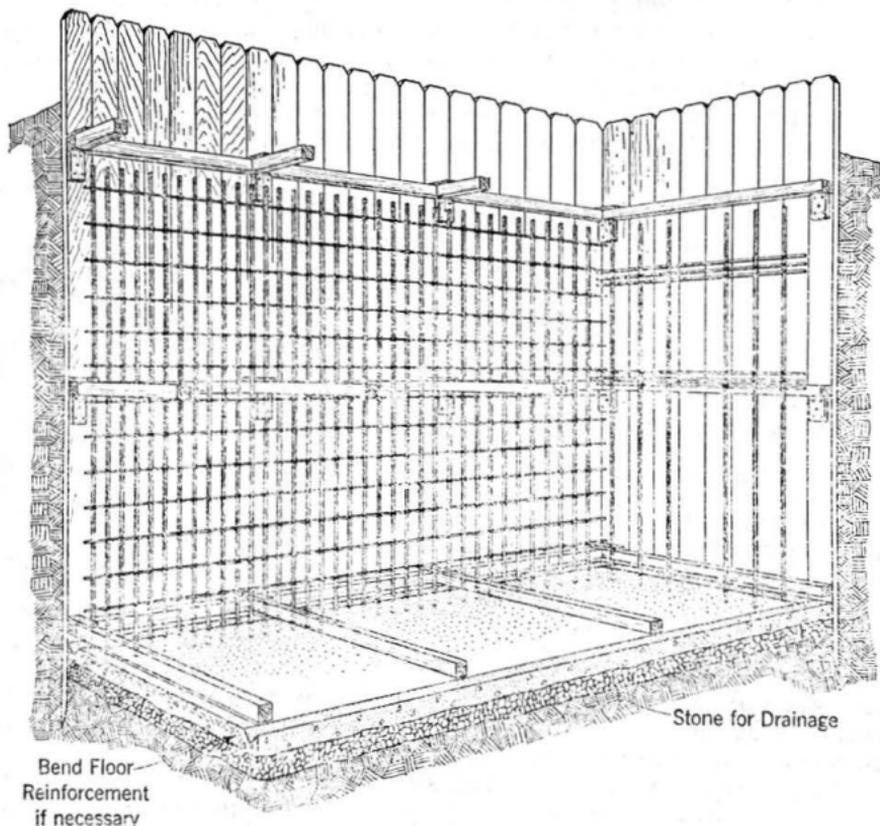
3.01 In preparing to place the reinforcing, the horizontal bars may be laid on the floor of the excavation or on the concrete of the floor if it has already been placed. The horizontal reinforcing, when in position, shall be between the vertical reinforcing and the sheeting or wall of the excavation.

3.02 The vertical reinforcing bars are placed with the proper spacing, in an inclined position with the upper ends resting against the sheeting or wall of the excavation and the lower ends resting on the bottom of the excavation one inch from the line of the inside surface of the manhole wall. If the concrete for the floor has already been poured the vertical rods should be placed in the proper position in the fresh concrete.

ASSEMBLING REINFORCEMENT



3.03 After the vertical bars are in place the horizontal bars should be raised into position and tied to the vertical reinforcing with 14- or 16-gauge soft annealed iron wire or approved bar ties. When the reinforcing bars for each wall have been assembled the reinforcement should be braced away from the wall until it is in the proper vertical position.



3.04 The top horizontal bars should be placed one inch above the bottom surface of the roof. With the top bars in this position, the roof reinforcing bars can later be laid across these bars to hold the roof reinforcement securely in its proper place.

Two-way Reinforcement

3.05 The reinforcement for two-way reinforced walls shall be placed as specified in 3.01 and 3.02 except that the horizontal bars shall be placed one inch from the inner surface of the manhole walls. The vertical reinforcement will be between the horizontal bars and the sheeting or wall of the excavation.

4. REINFORCING AROUND DUCT ENTRANCES

4.01 It will be necessary to omit some of the reinforcing at duct entrances in the end and side walls of manholes where the normal spacing of the bars will not leave a clear space for the entrance. To compensate for this, three bars of the same size as those used for the vertical reinforcement should be placed horizontally both above and below the duct entrances. The bars should be spaced 3 inches on centers and, so far as practicable, should extend 18 inches beyond both sides of the duct entrances, as shown in the two preceding illustrations.

4.02 Where two-way reinforcement is employed extra vertical bars should be placed around the duct entrance in addition and similar to the extra horizontal bars as specified in 4.01.

5. PLACING FORMS

5.01 After the reinforcement for the wall has been installed, the concrete forms should be placed as specified in G43.120.5 taking care that the pulling-in irons and all necessary inserts are provided in the proper positions.

6. PLACING CONCRETE

6.01 Place the concrete of the class specified in G45.140.1 following the procedures for mixing and placing as outlined in G45.150.1.

6.02 If the forms are assembled progressively as the concrete is placed, pour the concrete to about the level of the top of the first tier of forms before placing the next tier. Place the bracing for the forms as each group of sections is placed. The bracing for the walls of the excavation should be taken out progressively as the forms are filled with concrete.

6.03 An effort should be made to place the walls and roof at one pouring, if practicable. If for any reason it becomes necessary to stop operations before the walls are completed, a construction joint of the type described in G45.150.1 should be provided.