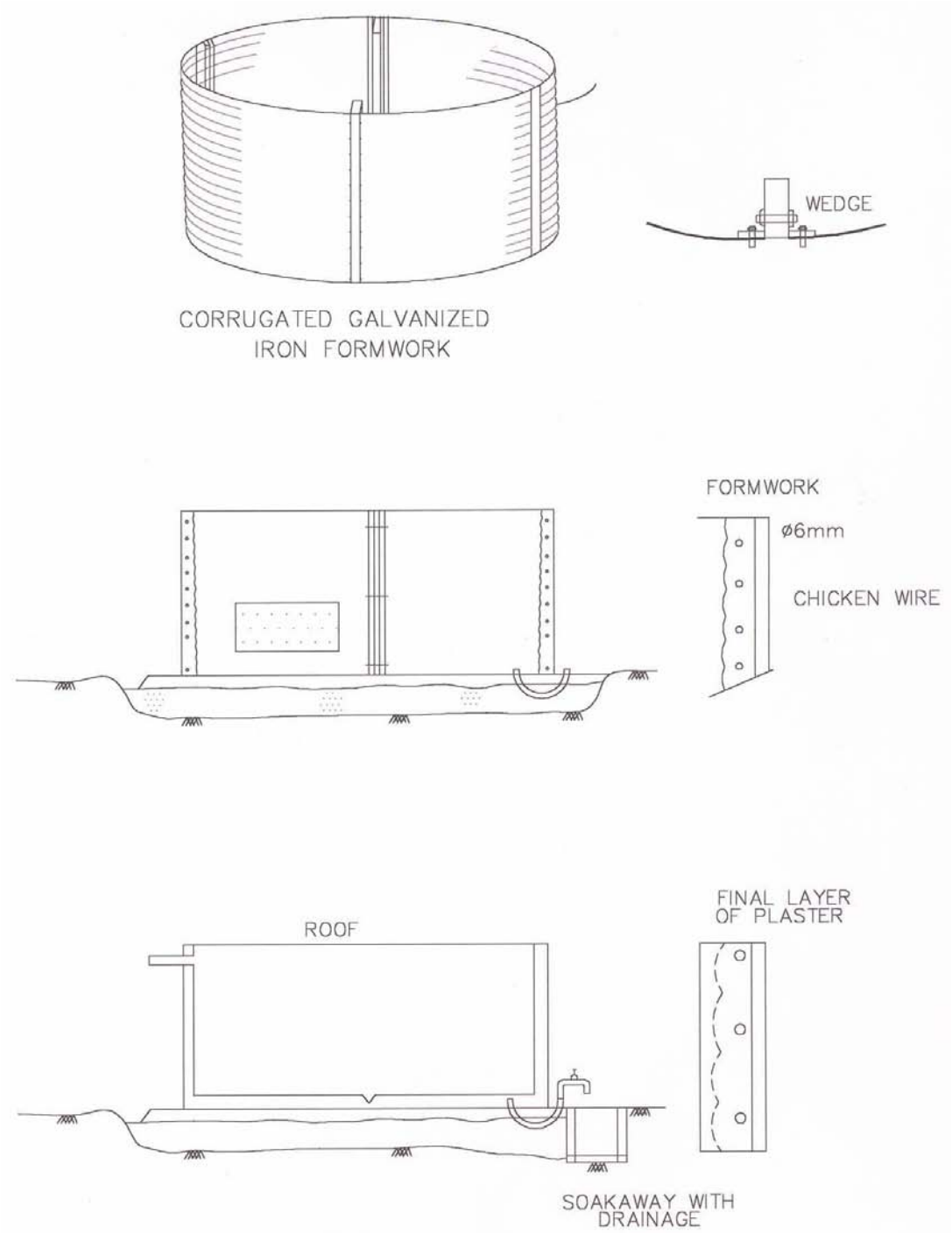
APPENDIX - II : PRINCIPLES OF CONSTRUCTION , MATERIAL AND DESIGN OF FERROCEMENT TANK

Figure A-2.1 : Principles of Construction of Small Ferrocement Standing Tanks



MATERIALS NEEDED FOR FERROCEMENT TANK CONSTRUCTION

Cement

Three types of cement are available in the Indian Market and all the three can be used for ferrocement tank construction:

1. Ordinary Portland Cement (O.P.C.) may be used in normal conditions.
2. Portland Puzolona Cement (P.P.C.) may be used in normal conditions but after checking the mortar setting.
3. High-early-strength Cement (quick setting cement) may be used in cold climatic zones and also in places where early setting and strength gaining is desired.

Sand

Sand from local sources may be checked/ tested and depending upon its properties, can be selected to meet the requirement in terms of silt contents, freedom from chemical pollution and trading. Medium coarse sand with grading may be used for ferrocement jobs.

In order to find strength of mortar for designing, the tank mortar specimens may be made from these local sands. The ratio of cement : sand is 1:2 to 1:3 by volume, and water : cement ratio is 1:3 0.45 by weight (Recommended WC is 0.4) but 0.45 may be used to allow for the variation in the degree of control in the field. The desirable strengths of the mortar are as follows :

Tensile strength at 28 days : 17-30 kg/cm^2
(direct tension test ASTM, C190)

Compressive strength at 28 days : 200 kg/cm^2
(2" cube)

Wire Mesh

The most common wire meshes used for ferrocement are hexagonal wire mesh, square welded mesh and woven square mesh. Use of woven square mesh is preferred for F.C. Water Tanks.

Chemical Admixtures

Selected grade of poresealing compound and plasticizer may be added to the mortar to be used for construction of F.C. Tanks.

Table A-2.1 : Description and Properties of Hexagonal & Square Woven Wire Meshes

- Ultimate Strength 8740 kg/cm^2
- Yield Strength 2100 kg/cm^2
- Modulus of elasticity 93.75×10^4 kg/cm^2

Mesh mm	Size (inch)	Wire diameter commonly available (mm)	Roll size generally available
19	(3/4)	0.5 to 1.2	0.91 to 1.2m x 45.7 m (3 to 4 x 150) for hexagonal mesh
10	(3/8)	0.5 to 1.2	0.75 to 1.5m x 15 to 30 m (2.5 x 100) for square woven mesh
12.5	(1/2)	0.5 to 1.2	-

For water tank construction without the aid of a formwork, the tank reinforcement must be strong enough to hold the weight of mortar applied on it and must also be stiff enough to prevent slumping of motor during plastering. Hence the square woven mesh of grid size 12.5 mm (0.91 × 30.5 m roll size) has been chosen because to its stiffness when compared to hexagonal mesh and cost advantage when compared to welded wire meshes.

Tank Dimensions	$12m^3$ Unit	$15m^3$ Unit
Diameter	2.5 m	2.5m
Area (in plan) of tank	4.90 m^2	4.90 m^2
Height	2.50 m	3.11 m
Wall Thickness	30 mm	30 mm
Actual Volume of container	12.27 m^3	15.19 m^3
Capacity for water storage	12 m^3	15 m^3

The maximum hoop stresses obtained from an analysis of fixes and hinged types connections between the wall and the base are 6.64 kg/cm^2 and 7.18 kg/cm^2 respectively. The maximum bending moment at the base of the wall is 34.20 kg-cm/cm width, which creates a maximum fibre stress of 12.83 kg/cm^2, if the wall is not reinforced.

DESIGN

The stresses occurring in the tank are small and do not exceed event the tensile strength of unreinforced mortar (17 kg/cm^2) hence, in this case, the design of the tank is controlled partly by construction techniques and the sizes of materials available. For ease in construction, the tank reinforcement chosen of 6 mm skeletal steel rods sandwiched between two layers of 12.5 mm squares, woven 20g (0.9 mm) wire G.I. mesh should be used. The distance between the mesh layers should be 13 to 15 mm.

A single tank can be constructed in four days. Construction can be carried out by unskilled labour if good finishing, plastering is not required. Water tightness of the tank is excellent. A waterline or a seepage loss, which is normally visible in a concrete tank when it is first filled with water, does not exist. Villagers may at first be sceptical because of the thickness of the walls of the tank but these reactions, however, will change when the tank shows its remarkable strength.

Casting of Roof for Tanks

Ferrocement roofs for water tanks are also precast over masonry moulds in one piece or in 4 to 6 pieces depending upon size and height of the tank. Jointing method for roof segments is the same as for wall segment. If the roof is in pieces, the pieces are erected, placed in position at the top and supported temporarily. The laps of reinforcement for joints are fixed up and the joints are filled with mortar. Two types of joints between wall and roof can be adopted.

1. The edge cast around the roof is placed in collar provided at the top of the wall (assembled with segments) and the mortar is filled in the wall roof paint.
2. The roof/ roof segment edge beam covers the wall top edge, like a cover

Various stages of construction of Roofing Units for Ferrocement tanks have been shown in Figure A-2.2.

Do's and Don'ts for Ferrocement Tanks

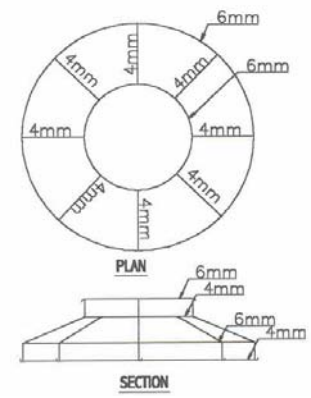
Do's

1. Use the best quality material for constructing the tank.
2. Take all care to see that there are no lose pockets or honey-combed areas in the surface of wall or base of ferrocement tank. If such a defect is detected, repair it by chipping mortar on inside and outside surfaces (exposing the wire mesh in that area) and replastering.
3. Cure F.C. tanks for a minimum of 10 days.
4. Clean the tank from inside atleast twice a year.
5. Keep the top of the tank clean to avoid entry of waste material in the tank.
6. Construct the tank at higher point so that drainage of water is proper or construct a soaking pit and connect it to the tank by a drain.
7. Take all care during mortar application and ensure that the mortar enters behind the seat rods and wires provided as skeletal steel and into the wire mesh layer reinforcement. Ensure that the cover over outer and inner mesh layer is not less than 3 mm.

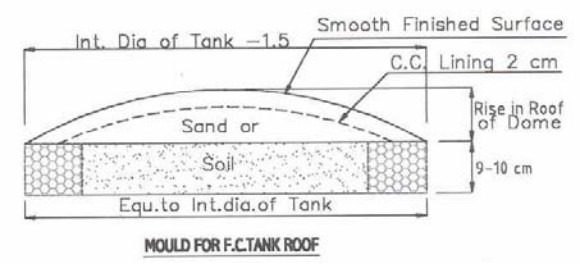
Don'ts

1. Do not allow animals to come near the tank.
2. Do not allow children to climb over the tank.
3. Do not use corrected steel or mesh for construction of the tank.
4. Do not use old stocks of cement for tank construction.
5. Sand to be used should be graded and clean sand having silt contents within 3 percent of the volume. Extra fine or coarse sand must not be used.
6. Do not allow water fittings fixed in the tank to leak, it will not only waste water but may also prove a base for algae growth on fitting joints or surface of the tank and lead to development of bacteria colonies in these.
7. Do not use chemically polluted water on mixing the mortar or curing of ferrocement tank.
8. Do not paint drinking water tank without confirmation of specifications laid down by the Indian Standard Specifications 158 (I.S.–158).

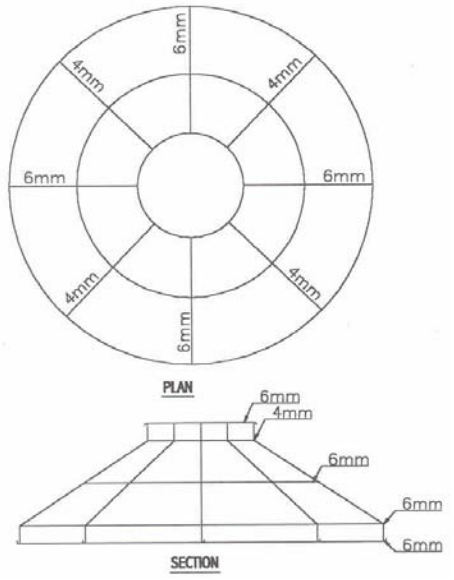
Figure A-2.2 : Mould and Reinforcement Cage for Roof of Ferrocement Water Tanks



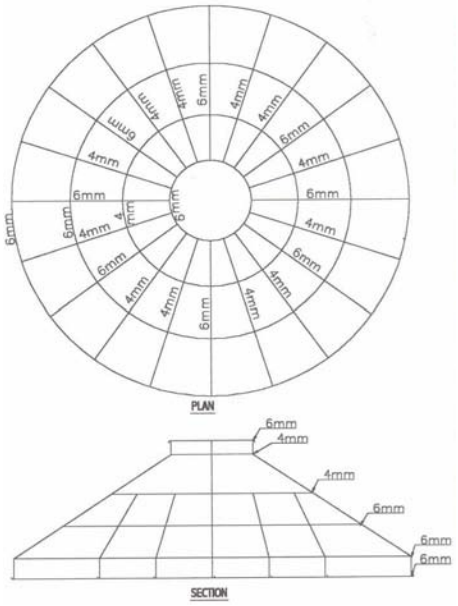
Reinforcement Cage for 60, 65, 75 & 90 cm Diameter F.C. Tanks



Rise of Roof Dome							
Dia of Tank (cm)	65	75/80	90	120	160	200	300
Rise in Roof Dome, (cm)	10	10	10	12	18	20	25



- Reinforcement Cage for Roof of F.C. Tanks of 120, 130, 140 & 160 cm Diameter
- Wire Mesh Reinforcement 1 Layer of 22G×½"×½" G.I. Woven Mesh on inside & outside surfaces



- Reinforcement Cage for Roof of F.C. Tanks of Diameters upto 2.25 m
- Wire Mesh 2-22G×½"×½" G.I. Woven Mesh one on each side

Casting Matrix -	Cement	- 1 Part
	Medium Coarse Graded Sand	- 2 Part
	Water	- 0.4 Parts
	Poresealing Compound	- 0.5 Percent of Cement
	Plasticizer	- 0.5 Percent of Cement