



20th WEDC Conference

Colombo, Sri Lanka, 1994

AFFORDABLE WATER SUPPLY AND SANITATION



## Affordable water storage structures

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WIRE-REINFORCED CEMENT mortar tanks involving a methodology based on ferrocement technology is found to be an ideal replacement for the hitherto adopted conventional random rubble masonry & R.C structures especially in Community Water Supply Schemes. The conventional constructions involved amongst others:

- high construction costs;
- long construction times;
- large quantities of a wide assortment;
- of building materials;
- large numbers of skilled labour;
- large spaces for construction.

### Design considerations

Wire-reinforced-cement mortar construction involves a compatible but a slightly different technology from ferrocement. In ferrocement there is a very dense mesh of woven or welded reinforcing wires that has to have a minimum value of wire per unit volume of the composite, whereas in wire-reinforced-tanks the quantities of straight wire reinforcement used fall far below this minimum value.

The structural advantages of wire-reinforced- mortar over conventional reinforced concrete for water tank construction are its ability to resist shrinkage cracking during curing, its resistance to severe cracking under tensile loading and the possibility to construct with minimal or no formwork.

To achieve the maximum strength the tank should ideally be designed with the walls curved in both horizontal and vertical directions, thereby allowing the water loading to be distributed over all of the tank structure and preventing critical breaking stresses developing at any section. However, this involves elaborate and complex formwork and skill and hence a cylindrical shape with a flat floor and integrated self supporting cupola roof is adopted as a standard.

For smaller capacity tanks the floor is constructed continuous with the walls with a rigid joint. However, it is recommended to provide independent foundations for the walls of larger tanks.

Wall of uniform thickness ranging from 40 to 65 mm depending on the size of the tank could be designed either with walls free to move or rigidly joined to floors. It is assumed that the liquid contained in the tank would give only hoop tension forces within the walls and is free to move. GI straight wire-reinforcement is placed transversely on the wall to resist the hoop tension developed

thus. To prevent shrinkage cracks or cracks developing due to loading on the walls, a woven wire mesh is used on the walls under the hoop wire. A fillet is provided internally at the wall floor joint to arrest possible cracking due to tensile stresses; 6.3 mm M.S skeletal vertical steel is used continuous from floor to roof. The roof is designed in a cupola with a manhole at the crown.

The same reinforcement is continued at increased spacing in the cupola. Thickness of the roof is always maintained thinner than that of the wall.

### Material used

Ordinary Portland cement and moderately coarse sand of uniform grain structure are used in the construction. Mortar mix of 1:3 (cement: sand) with a water cement ratio of 0.5 is ideally suited.

As no formwork is used, the mesh used has to be stiff and suitable for retention of mortar when applied freely using latham plaster technique. Several types of mesh could be used for this purpose, but the GI woven wire mesh (No 4 of SWG 20 or 18 wire) which is freely available in the local market is found to be a more suitable replacement for the more expensive, but hard to find 15 x 20 mm GI expanded metal mesh which proved to be the ideal mesh for this type of construction.

### Comparison with conventional structures

Wire-reinforced-cement mortar tanks having the following main advantages in comparison with the conventional RC or masonry tanks are more suitable for low cost rural water supply schemes.

- Comparatively small space required for construction.
- Very little excavation involved.
- Over 50% saving on construction time.
- Over 50% saving on construction cost.
- Lightness of the structure (less than a quarter of that of a RC tank).
- Very little of a small assortment of locally available building materials used.
- Low requirement of skilled labour.
- Fine finish and an attractive final appearance.
- Reduction in pipe cost due to the possibility of using PVC.
- Simple maintenance and repairs.
- No formwork involved.

- Easy transfer of technology - The method of construction is very similar to the one used for constructing traditional wattle & daub houses in the rural areas.

### Construction cost

All the other factors directly or indirectly contribute to the considerable cost saving achieved in wire-reinforced-cement mortar tank over conventional structures. The recorded saving would be over 50% for tanks of smaller capacities and about 65% for those of larger capacities. For e.g. As per actual costs, in 1991 a 50000 litre conventional masonry tank cost around Rs 300,000 whereas the comparative cost of a wire-reinforced-cement mortar tank was only around Rs. 100,000.

### Transfer of technology

Construction of wire-reinforced-cement mortar tanks require very little skills and supervision, other than a guidance on the details of the technicalities involved. From the observations made so far it is quite evident that the average mason could acquire skills to construct a wire-reinforced-cement mortar tank on his own after involvement in the construction of one or two tanks under proper guidance and supervision.

The basic technical requirements involved are similar to other civil construction works of which the average, artisan at village level is aware. However, guidance and assistance should be given in certain areas where special attention is required.

The technology could be transferred only through direct involvement of the people in actual construction.

The average Sri Lankan village tradesman is a jack of all trades. Being the only skilled person in the village or being one such amongst a few, a village tradesmen acquire skills in all trades involved in minor construction activities such as masonry, carpentry, steel works etc. Tradesmen of this nature could easily acquire the additional skill of constructing wire-reinforced-cement mortar tanks in the course of their work.

### Conclusion

Smaller capacity tanks usually used for domestic water storage are either galvanised iron, fibre glass, brick masonry or concrete. The expensive galvanised iron tanks tend to corrode and deteriorate within 5 - 10 years even with careful maintenance. Fibre glass tanks too are less durable. With constant exposure to direct sunlight. It loses its flexibility and tend to become brittle. Masonry tanks, especially brick structures develop cracks with the initial stress concentration and open out in time to cause several leakages. Wire-reinforced-cement mortar tanks are found to be cheaper than all the above and would be durable too. The present cost of construction of these tanks is around Rs 3000 - 4000 per M<sup>3</sup> (£40 - £55 per M<sup>3</sup>).

Repairs in all other tanks call for special equipment like welding equipment or special skills whereas in the wire-reinforced-cement mortar tanks repairs could be handled without any special skills or equipment. An analysis of the construction costs reveal that approximately 25 - 30 % of it is on labour. This and the fact that the skilled labour requirement is minimal indicates that in community water supply schemes the overall cost of construction could be further reduced by way of promoting voluntary community labour.

Tanks of capacities up to 50000 litres (50 m<sup>3</sup>). with integrated roofs have been successfully constructed using this technology during the recent past. Open tanks could be built for very large capacities, this way. The oldest tanks constructed thus are over 5 years in constant use to-date.

It has been proven beyond doubt that wire-reinforced-cement mortar tanks would be an ideal replacement for the conventional tanks and fabricated tanks of other material in both domestic and small scale rural water supplies, mainly by virtue of its low cost, simpler technology & quicker construction time.

In conclusion, it may be said that the wire-reinforced-cement mortar technology would be most appropriate for the water sector in Sri Lanka and other developing countries of the world and that there is a wide scope for developing this low cost technology for the benefit of the masses in numerous other ways.

