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Case study 11

Twelve cubic metre ferrocement water tank, Thailand

Introduction

Much of the information for this Case Study is taken from a paper presented by Chayatit Vadhanavikkit of Khon Kaen University, Thailand at the Rainwater Catchment Regional Seminar and Workshop, held in Khon Kaen in 1983.

Much work has been carried out in Thailand, both on rainwater catchment systems and on the development of ferrocement as a construction material. Two important institutions, the Environmental Systems Information Center (ENSIC), and the International Ferrocement Information Centre (IFIC), both found at the Asian Institute of Technology (AIT), can be found in Bangkok, Thailand. During the early 1980s a great deal of work was done in Thailand to promote the use of RWH systems for domestic water supply.

Background

Ferrocement is a technology that is well suited to use in developing countries. It requires materials which are commonly available in most sizeable towns throughout the world, tools which are owned by any respectable mason and skill levels which are compatible with those of artisans in most areas of the developing world. It is a technology which has received a great deal of attention over the last 30 or 40 years, and is used diversely for such applications as boat building, low-cost housing and storage tank construction.

This Case Study looks at a ferrocement tank which was developed by the author of the paper mentioned above.

Technical detail

Firstly, it is pointed out that Silica cement was used to construct the tanks. This is because silica cement was more readily available in the area and at a cheaper price. It does, however, have a strength which is only 70% that of

Ordinary Portland Cement (OPC). Silica cement has a slower hardening time, which is favourable under the circumstances as it provides more time for construction work.

Tests were carried out on mortar specimens to find a suitable sand for construction of tanks, and it was noticed that local sands from different sites gave remarkably different results. The tensile strength varied by a factor of 2 and the compressive strength by a factor of 1.7.

Vadhanavikkit points out that different types of wire mesh have different properties which are suitable for different applications. Whereas hexagonal mesh (chicken wire) has low strength and rigidity, it is well-suited to applications where flexibility is required, where corners and changes in contour have to be dealt with. The heavier gauge square wire mesh is more suited to giving strength and rigidity where it is required, in the base for example. The square mesh was also cheaper in this case. The reinforcement chosen consists of 9mm steel rods for the tank skeleton, sandwiched between two layers of 25mm square welded mesh. Vadhanavikkit briefly analyses the structure to show that the stresses in the tank are more than adequately catered for.

The design of the tank is governed by the construction technique rather than by forces present in the finished tank. This is because the stresses set up in the tank are very low compared with the strength of the reinforced mortar. The designer chose a tank with the following specification:

Diameter	2.5m
Height	2.5m
Wall thickness	40mm
Capacity	$12m^3$

Table 1 Initial tank specification

The tank dimensions are shown in Figure1 and materials required are shown in Table 2

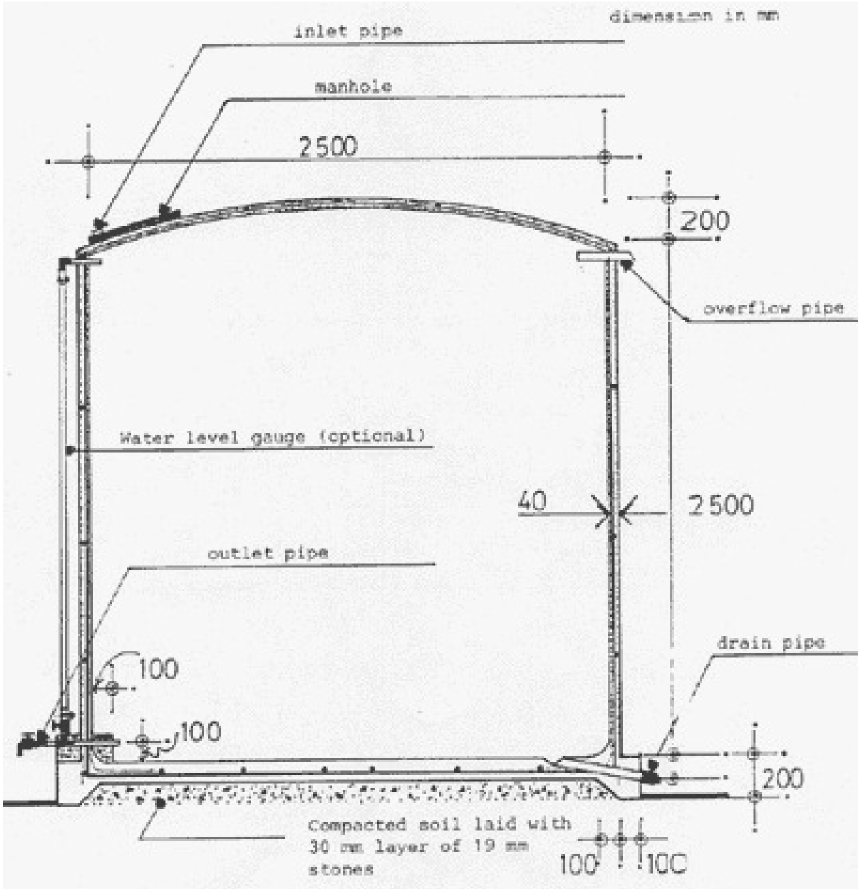

Figure 1 Details and dimensions of the Khon Kaen ferrocement tank (Chayatit

Vadhanavikkit)

No	Material	Quantity
1	Silica cement (50 kg bag)	19 bags
2	Sand	$2m^3$
3	Stones 19mm	$0.7m^3$
4	9mm steel bar	11 bars
5	Square weld mesh (25mm mesh; 0.9 x 30.5m roll)	2 rolls
6	Tying wire	2 kg

7	Pipe fitting	various

Table 2 materials required for the tank

Construction technique

There are three distinct stages in the construction of the ferrocement tank:

Preparation of the skeleton and mesh reinforcement

The first step is to build the tank skeleton. This is done remote from the actual tank site and then cast into the base later. Vadhanavikkit gives the cutting list and configuration for the steel skeleton (not given here). The skeleton has a base, walls and roof, all constructed by sandwiching a 9mm steel rod sub-skeleton between two layers of 25mm square steel mesh (see figure 2 below). The 9mm steel sub-skeleton is made of a series of hoops (5 in all) and vertical members, which forms the tank walls. The base and roof skeletons are formed using a series radial bars and concentric hoops, again sandwiched in wire mesh. The whole assembly is tied well using the tie wire, loose ends being pushed inward to prevent obstruction during the plastering stage.

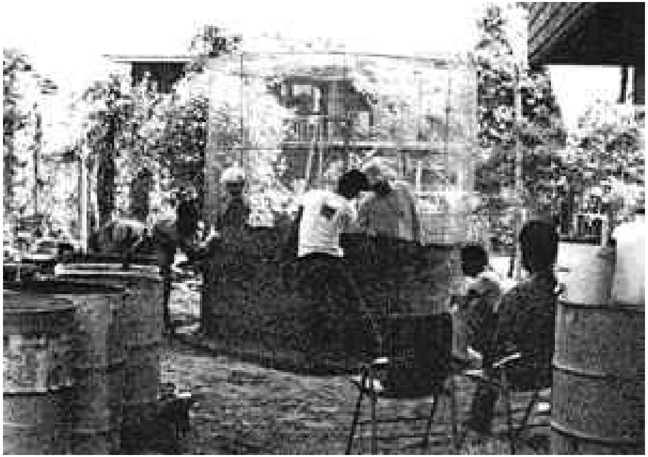

Figure 2 the tank skeleton being moved to site (Chayatit Vadhanavikkit)

Preparing the base

The ground is prepared for the base by laying a 100mm layer of compacted soil and stone aggregate. A 50mm layer of concrete (1:2:4, cement:sand:stone) is laid roughly, the skeleton is then moved into position and a further 50mm of concrete placed on top. The base is then finished using a cement water slurry for water tightness.

Plastering the walls and roof

A mortar mix of 1:3 cement:sand is used. The mortar is applied by hand. Plastic bags are used to protect the hands. The mortar is applied to the skeleton walls from the outside by one person while another person standing inside prevents the mortar falling through (figure 3 shows a partially rendered skeleton). The mortar has to be pushed carefully into the skeletal mesh to prevent voids being present. This core is then given a day to harden and then both inside and out are given a 5-10mm coat of mortar which is trowelled on. Finally, when this mortar has hardened, it is given coat of cement water slurry. The roof plastering is not as critical as it will not have to be water tight. Cement slurry is used liberally at all joints. The tank is cured for 14 days by whichever method is most suitable; sprinkling with water; covering with wet sacks; etc.

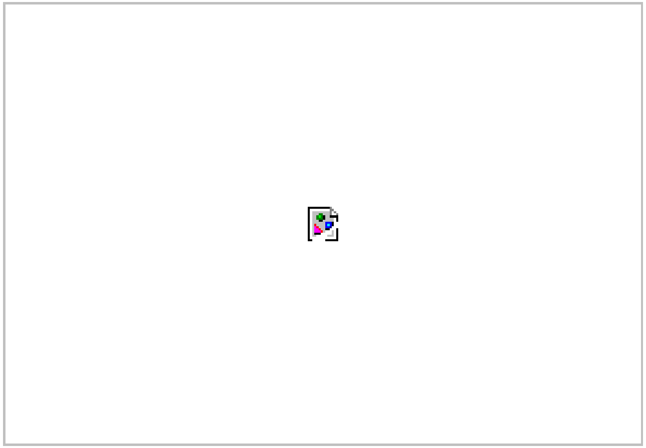

Figure 3 a partially rendered tank skeleton (Chayatit Vadhanavikkit)

Conclusions and observations

Four tanks had been constructed. All had been in constant use since completion (no indication is given of how long a period this was) and there had been no leakage or other problems. Villagers were at first sceptical of the tank because of the thin walls but were soon convinced of the tanks strength.

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