A Bamboo Reinforced Cement Water Tank

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Water tanks made from bamboo reinforced cement has been reported in several Asian Countries, the major problem identified is durability. At the Asian Institute of Technology a 6 m³ capacity bamboo reinforced cement tank was constructed in 1983. This tank has been monitored regularly. The paper presents the material estimate, construction procedure and behavior of the tank for the last five years.

INTRODUCTION

Water tanks made from bamboo-cement has been reported in several Asian countries, the major problem identified is durability. Many researchers have investigated the use of bamboo for many structural elements but the analysis and design for water tank is not yet well established.

At the Asian Institute of Technology, a 6 m³ capacity bamboo reinforced cement water tank was constructed in June 1983. The objectives are: to investigate long term behavior and to establish the advantage of using bamboo as reinforcement. This tank has been observed for 5 years.

MATERIALS USED

The total amount of materials used are as follows:

1. For mortar mix (cement:sand:water ratio = 1:2.0:0.35)
   - Cement (Class A): 15 bags @ 50 kg/bag ..... 750 kg
   - Sand (fine, 100% passing BS Sieve No. 25) ..... 1500 kg
   - For concrete mix of water tank (cement:sand:aggregate: water ratio = 1:2.0:3.0:0.45)
   - Cement (Class A): 2 bags @ 50 kg/bag ..... 100 kg
   - Sand (fine and normal size) ..... 200 kg
   - Aggregate (maximum size 10 mm) ..... 300 kg
2. Bamboo splints of average size 2 mm x 15 mm for 2 layers
   - 2 mm x 15 mm x 6900 mm ..... 52 pieces
   - 2 mm x 15 mm x 3200 mm ..... 160 pieces
   - 2 mm x 15 mm x 200 mm ..... 12 pieces

Assuming a bamboo pole with 6 m length, 80 mm diameter and 251 mm circumference and using splint of 15 mm width, the average number of splints obtained per pole is about 12 splints. The total number

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of poles required for two layers is 14 poles.

3. Skeletal steel (6 mm diameter mild steel)

Vertical steel, length 2800 mm ..... 2 pcs.

Horizontal steel:

Wall, length 6590 mm ..... 9 pcs.

Roof, length 1890 mm ..... 2 pcs.

3370 mm ..... 1 pc.

4850 mm ..... 1 pc.

Base, length (900+300) = 1200 mm ..... 21 pcs.

Fig. 1. Bamboo poles of 6 m length and about 80 mm in diameter of brownish color.

Fig. 2. Bamboo splints of 2 mm x 15 mm were interwoven into a mesh.

REINFORCEMENT CAGE

Thyrosostachy Oliveri Gamble (local name Phai Tong) was used as bamboo reinforcement. The ultimate tensile strength of this specie varies from 82.8 N/mm^2 to 505 N/mm^2, compressive strength of seasoned bamboo is 55.3 N/mm^2 [1-4]. Bamboo poles of 6 m length and about 80 mm in diameter of brownwish color (Fig. 1) were selected. The average price is US$ 0.76 for a pole.

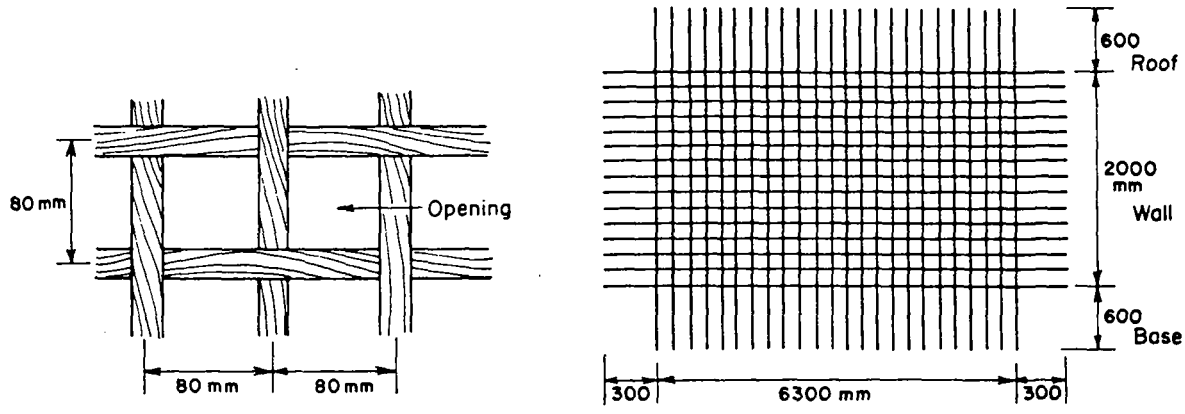

Fig. 3. Spacing and dimension of the bamboo mesh.

Bamboo splints of 2 mm x 15 mm (Fig. 2) of various length were prepared and interwoven into two sets of mesh with opening of 80 mm both ways. The mesh has a total dimension as shown in Fig. 3. These bamboo meshes were bent into cylinders (Fig. 4) to form the reinforcement cage.

Care was taken not to break the bamboo. The outstanding parts were spliced to provide continuity. One layer was placed on each side of the skeletal steel (Fig. 5). The bamboo cylindrical cage was bent at the base and the roof (Fig. 6) by heating. Care was taken not to break or burn the bamboo splints.

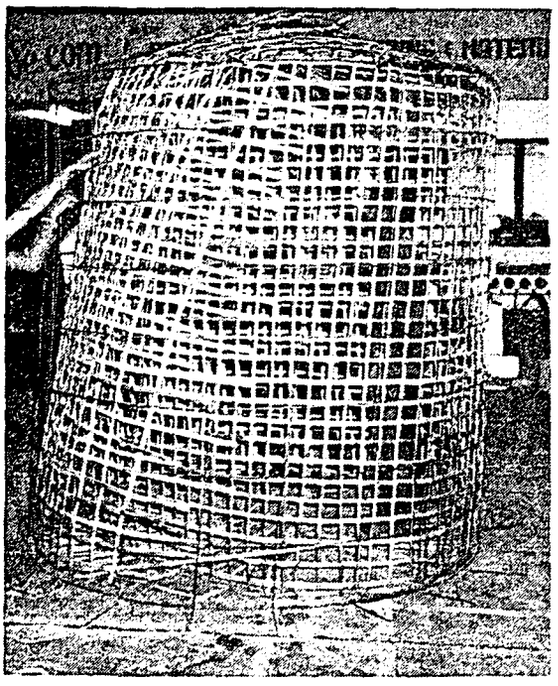

Fig. 4. The bamboo mesh being positioned inside the skeletal steel.

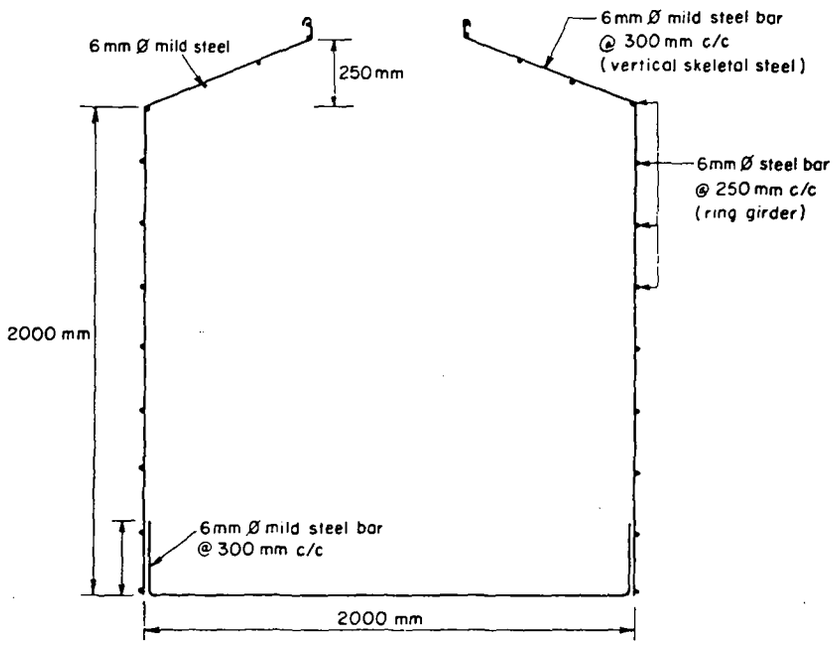

Fig. 5. Details of the skeletal steel reinforcement.

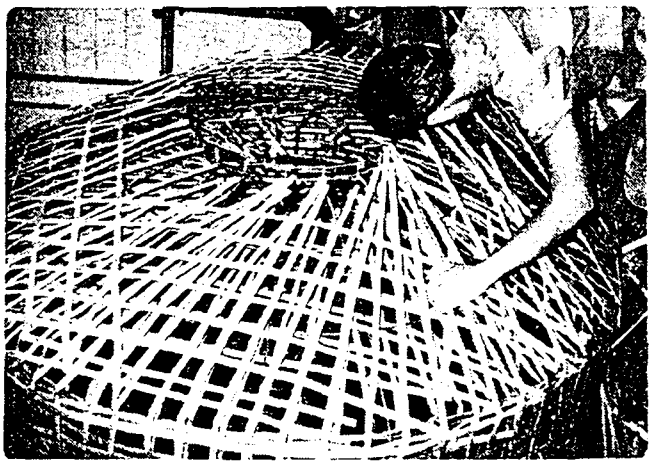

Fig. 6. The roof of the reinforcement cage.

RESIN APLICATION

The problems in the use of bamboo as reinforcement are volume changes, moisture susceptibility, consequent loss of bond and decay [5]. As a precautionary measure, a layer of resin mix was applied to the surface of the bamboo mesh. The resin mix consists of local resin product; oil (derived from rubber tree) and red lime as hardener. The solution can be controlled by proper addition of the oil and resin powder; and by slowly stirring until a level of saturation is achieved. The red lime hardener was added to the oil and resin solution just before application.

The resin mix was applied by brush onto the completed cylindrical bamboo reinforcement cage. The mix was applied to all surfaces (Fig. 7).

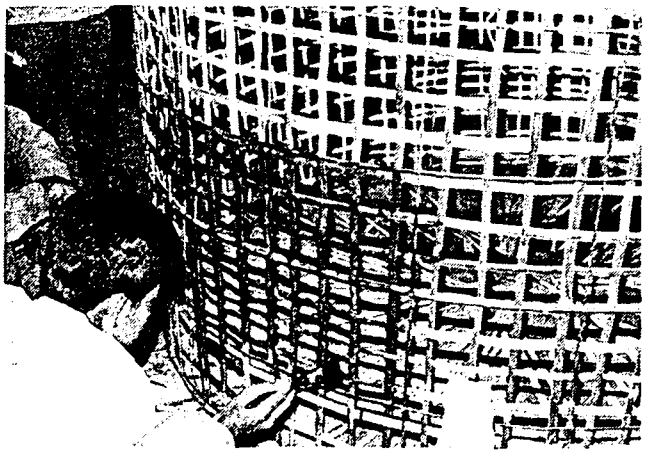

Fig. 7. Applying resin onto the bamboo mesh.

CONSTRUCTION PROCEDURE

A site near the water tower of AIT was selected, cleaned of debris and levelled. A layer of sand was compacted and concreted to a height of 150 mm. After 24 hours, a layer of concrete mix with 1:2:3 cement: sand: coarse aggregate ratio by weight was placed on the base to a height of 10 mm. The

bamboo reinforcement cage was placed in position and concreting of the based was completed.

Accessories such as scour pipe, outlet pipe and overflow pipe were installed (Fig. 8). Plastering was done in two stages starting from the bottom (Fig. 9). A mortar mix of 1:2 cement-sand ratio by weight and 0.35 water-cement ratio was used details of the roof and wall are shown in Fig. 10. The water tank was properly cured before testing.

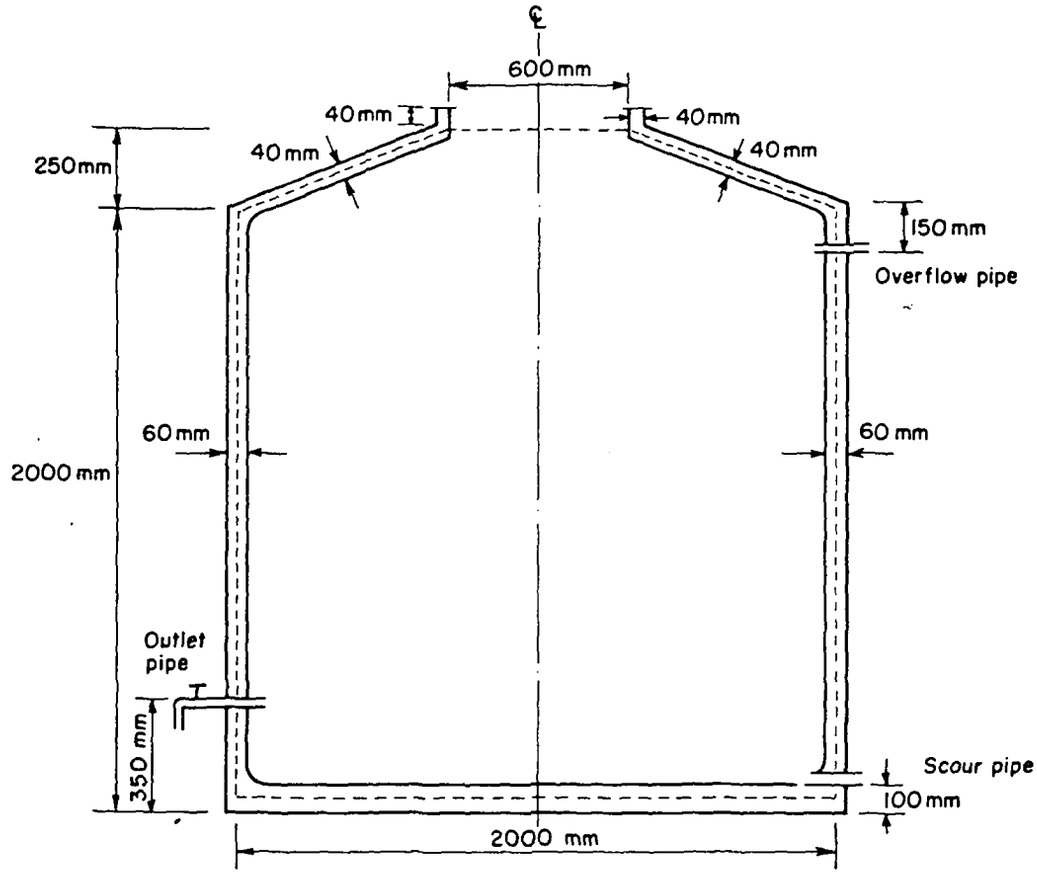

Fig. 8. Location of scour, outlet and overflow pipes.

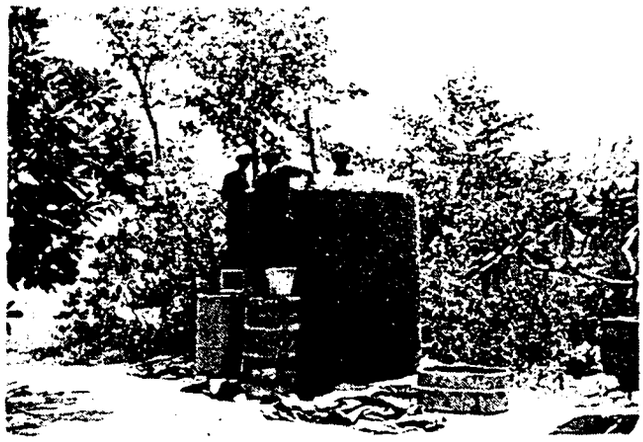

Fig. 9. Plastering the bamboo-cement tank.

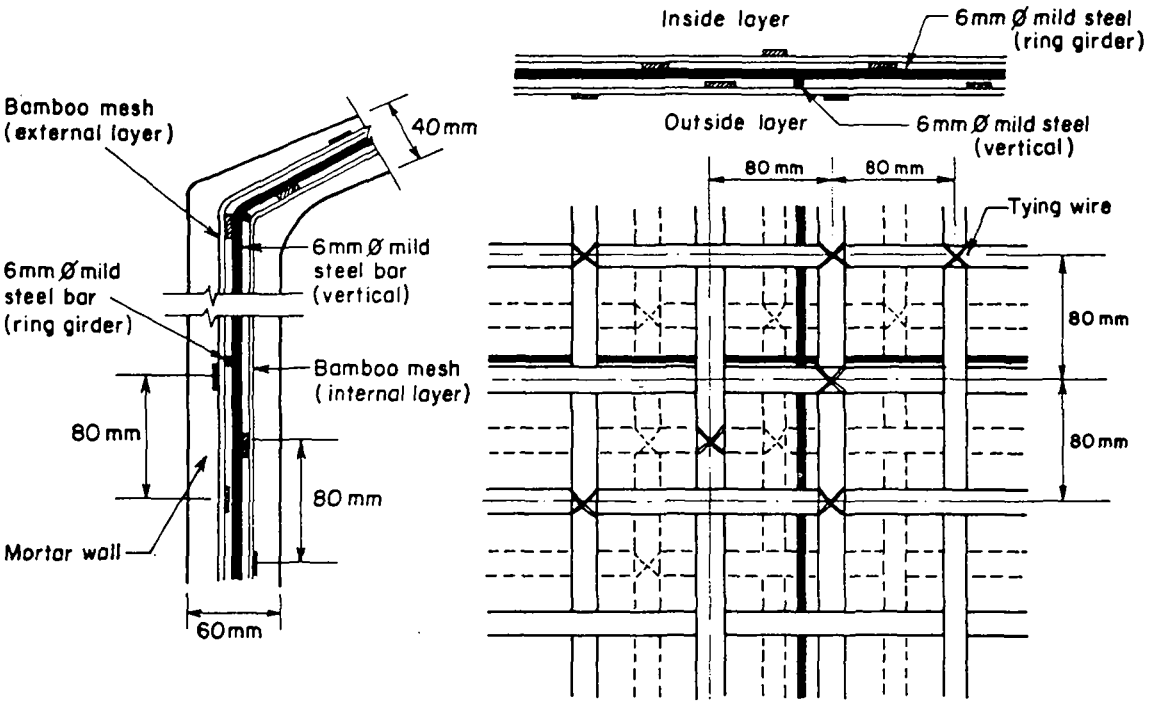

Fig. 10. Details of wall and roof.

OBSERVATION

The tank was kept alternately full and empty of water. The objective is to simulate actual field condition. After five years, the tank has not shown any structural defects (Fig. 11). Bamboo reinforcement 0.3 m from the top was investigated and found in good condition. Observation of the tank will be continued.

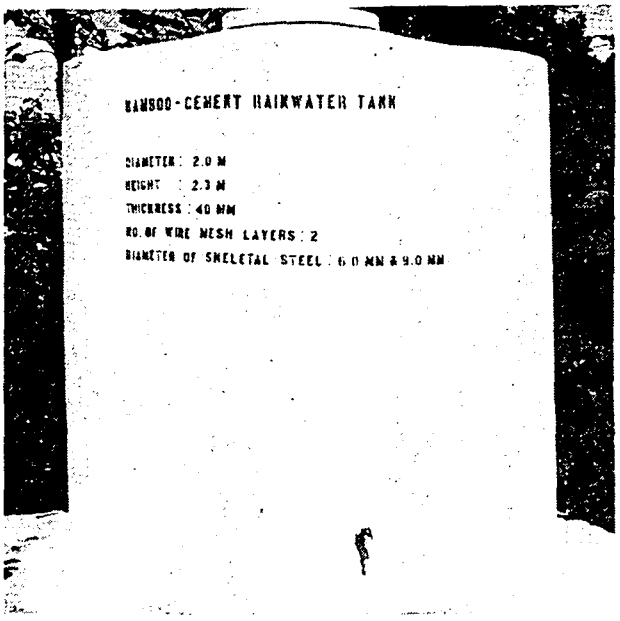

Fig. 11. The bamboo-cement tank after five years.

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