For LIBRARY

2 1 7
8 3 R E

SWISS ASSOCIATION FOR TECHNICAL ASSISTANCE
साटा स्विस प्राविधिक सहायता संघ
SWISS TECHNICAL COOPERATION / SWISS TECHNICAL ASSISTANTS PROGRAM
ADDRESS: EKANTA KUNA JAWALAKHEL P.O.BOX 113 KATHMANDU NEPAL
CABLE : SATA KATHMANDU PHONE: 21205
TELEX NO. 245

Community Water Supply and Sanitation
Programme

Western Development Region
Pokhara, Nepal

KD 5439

Review of Ba..co-cement Experiences in Indonesia

H.A. Heynen
July 1983

217 1777

Introduction

At the invitation of the Dutch Ministry of Foreign Affairs the author participated in a joint Indonesian-Dutch mission to evaluate the West Java Rural Water Supply Project OTA 33/J 7, based in Bandung.

During the two-and-a-half week stay (April 1983) in Indonesia, the author had the opportunity to learn a lot about water supply and sanitation in rural West Java and it was illuminating and refreshing to discuss common activities and problems with project staff working in a similar but still very much different project (environment).

The OTA-33 project has also experimented with ferro-cement and bamboo-cement reservoir construction and this visit provided a good occasion to tap their experiences in this field. Next to OTA-33 the organisation Yayasan Dian Desa in Yogyakarta has constructed very many ferro-cement and bamboo-cement tanks with community selfhelp. It would have been nice to visit Yogyakarta to meet with Dian Desa staff but unfortunately the time schedule did not allow this. Dian Desa's experiences are therefore only reflected in this paper sofar as they have been relayed by OTA-33 staff.

LIBRARY, INTERNATIONAL REFERENCE
CENTRE FOR COMMUNITY WATER SUPPLY
AND SANITATION (IRC)
P.O. Box 93190, 2509 AD The Hague
Tel. (070) 814911 ext. 141/142
RN: ~~05439~~ ISN 1777
LO: 217 83RE

The importance of Ferro-cement and Bamboo-cement for the CWSS-programme in Pokhara.

Until now nearly all reservoirs in the CWSS-programme are constructed in stone masonry with an arched roof. The structures are standardized in sizes of 9, 16, 22, 30 and 36 m^3. A standard design for a 2.5 m^3 tank is also in use but this design does not have an arch.

The design for these tanks originate from Cameroon. They have been slightly adapted and have been widely constructed in our project area. Unfortunately there are quite a few drawbacks to these tanks:

1. They are costly in stones, sand, cement and skilled labour.

2. They are costly in the transportation of materials (to often high places in the mountains).

3. Extra costs are involved for the transportation of arch-frames (moulds used to support the arch at the time of construction). These frames had to be carried by porter to the construction site and must be returned after use. Especially returning the frames to the roadhead is a perpetual headache because after the tank is completed there is usually not much interest to bring the frames back.

4. A lot of the tanks are leaking because Nepali craftsmen are quite capable of making strong mud masonry structure but the same technique does not ensure water tightness of a construction. Even after many years of training the project seems not to have succeeded to retain its technicians so that they are able to make properly bonded, waterproof reservoirs. Too often they fall back in their traditional building style.

5. The stone quality is not really very good for leakproof construction.

6. Planning problems occur due to the limited number of arch frames and the many, often remote places where they have to be used.

Many of these problems do not apply to Cameroon and thus this type of water tanks may there still be technically and economically appropriate. However in Nepal it is rapidly becoming too expensive and inefficient to keep on constructing in this way.

Ferro-cement construction which requires a radical break with traditional Nepali style building and is at the same time 50-70% cheaper as compared to our present standard design, offers a better method for future water supply construction work.

As has been discussed in an earlier paper by H. Mueller on the same subject (1), ferro-cement has already a history in the programme. Ferro-cement construction work as such poses no difficulties for the project engineers and overseers, however its increased implementation has been hampered by the lack of well-trained technicians. This flaw is now been corrected by a practical training course in July 1983 in which 18 of the more senior technicians will construct two 10 m^3 ferro-cement storage tanks in a rehabilitation project. It is hoped that this practical course will provide the programme the skilled manpower to build the majority of the tanks in the upcoming construction season in ferro-cement.

Though ferro-cement is gradually becoming a well-documented construction material (2, 3) less is known about the properties and abilities of bamboo-cement. Still, bamboo-cement can turn out to be a quite attractive to ferro-cement especially for the construction of smaller volumes of tanks - say 1 to 5 m^3. Bamboo-cement is again a lot cheaper than ferro-cement mainly because the wiremesh needed for ferro-cement is relatively

expensive in Nepal (US $3.5 per m^2). Furthermore the weaving of bamboo is indigenous to Nepal and so bamboo-cement makes use of local material and local skills.

Bamboo-cement especially appeals to the CWSS project in Pokhara for three reasons:

1. 1 - 5 m^3 storage tanks, break-pressure tanks and interruption chambers could be cheaply constructed.

2. Development of one or two standard bamboo-cement reservoir designs may provide schools, health-posts and individuals with a possibility to build a small tank.

3. The trying-out of bamboo-cement construction work and the atmosphere of "research" that is created may appeal to our staff to come forward with their own ideas and improvements on this and hopefully other project related building techniques.

Bamboo-cement Experiences in Indonesia

Bamboo-cement construction techniques are still young and the experiences limited. Therefore it was a very nice opportunity for the author to visit Indonesia and talk to a few people who had actually constructed bamboo-cement tanks.

Bamboo-cement tanks have been constructed on a trial basis by OTA-33 in West-Java and on a large scale by Dian Desa in Mid-Java.

OTA-33, being a government project, is very much bound to the official norms of the Ministry of Public Works. Due to the efforts of OTA-33 this Ministry is now convinced of the advantages and structural quality of ferro-cement construction. Bamboo crete, however, is still not acceptable to the engineers of that Ministry and it is therefore that the expatriates of OTA-33 could only go as far as trying out a few bamboo-cement tanks. Dian Desa as a private organisation has more liberty to apply

this new technique and has done this with a lot of success in the region around Yogyakarta.

The following paragraphs are based on personal observations and discussions with OTA-33 staff.

The construction of Bamboo-cement tanks does not seem to pose great problems. The weaving technique required is easily understood by everyone.

The main problems with bamboo-cement are related to the bonding between the cement and the bamboo, and the shrinkage of the bamboo after curing.

The poor bonding between the cement and the bamboo does not allow the complete (relatively high) tensile strength of the bamboo to be used. Three ways to improve this poor bonding are suggested:

1. The bamboo reinforcement strips are alternately laid skin up and skin down.

2. The bamboo is woven is a square mesh with a 3-4 cm heart-to-heart interval.

3. Each crossing in the bamboo framework is tied with binding wire. This will not only increase the bond but will also result in a more rigid framework.

The shrinking of bamboo in the bamboo crete is a bigger headache. Obviously the magnitude of shrinkage depends on the original moisture content. The shrinkage of mature culms of different species of bamboos is more than that of immature ones and may range from 4 to 16 percent in wall thickness and 3 to 12 percent in diameter.

To avoid excessive shrinking the following considerations should be taken into account:

1. Older bamboo has a lower moisture content, a higher tensile strength and is more durable.

2. Because the outer layer of the culms contains a higher percentage of fibres it is stronger, more durable and has a lower moisture content than the inner layer.

3. The bottom portion of the culm contains more fibre than the middle and top portions, resulting in the same advantages as under two.

4. In the dry season the overall moisture content of the culm is quite a lot less than in the rainy season. Culm should therefore be cut and used in the dry season.

There are further a number of treatment methods that reduce the water absorption of bamboo and increases its life time. These methods require however chemicals and equipment and by using those one would before long have lost the low cost advantage of bamboo cement. Such methods have therefore not been considered.

When constructing the bamboo-cement tank one further has to keep in mind to wet the bamboo frame thoroughly before plastering. This wetting will prevent the bamboo to absorb water from the wet concrete around it. If absorption would be allowed cracks would appear in the drying concrete due to the swelling of the bamboo. Also it is important to arrange for proper curing, avoiding if possible exposure to direct sunshine, as this may cause excessive drying thus leading to cracks.

In Indonesia 2.5 m^3 to 10 m^3 tanks have been constructed. About the durability of the 10 m^3 tanks no information is available but the 2.5 and 4.5 m^3 sizes are doing well.

The few hundred tanks constructed under the Dian Desa programme are also [illegible] function well without too many failures.

Conclusion

Although there are certainly problems associated with bamboo-cement especially with regard to bonding and shrinking it still seems that for volumes up to 5 m^3 bamboo-cement may well be a viable option. Certainly a bamboo-cement tank will not have the same lifetime as a ferro-cement tank but a lifetime of say 8 - 10 years is quite acceptable relative to the cost of construction.

The visit to Indonesia and the discussion with project staff has convinced the author that there is certainly some reason to continue the bamboo-cement trials. At present the CWSS-programme is not in the position to apply bamboo-cement in its projects because it has not sufficient experience with the material but may be bamboo-cement will in the future become a useful addition to ferro-cement especially for smaller construction work. If only that could be achieved it would already contribute greatly the development of rural Nepal and the progress of the individual farmers.

Acknowledgement

The author wishes to thank Helvetas for their kind approval to his trip to Indonesia. The helpful discussions with ir. A. Tuinhof/IWACO, ir. B. van Bronckhorst and ing. R. van Kerkvoorden CTA-33 are gratefully acknowledged.

References

1. Mueller H.

   A review of ferro-cement and bambco-cement activities in the CWSS programme, Western Development Region, Pokhara, March 1983.

2. International Ferrocement Information Centre, IFIC/AIT.
   Journal of Ferrocement.

3. American Concrete Institute
   State-of-the-art report on ferrocement
   Report no. ACI 549 R-82
   Concrete International, August 1982

4. Yayasan Dian-Desa
   Bak Penampung Air Bambu Semen

5. West Java Rural Water Supply Project
   Ir. A. Tuinhof
   Pilot project on low cost water collectors in Singakerta, Indonesia, November 1979.

6. Yayasan Dian-Desa
   Winarto
   Rural Rainwater Cistern Design in Indonesia.
   Hawaii, 1982