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Wood-bamboo as appropriate technology

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ABSTRACT:

The use of forest materials e.g. timber and bamboo as water conveyance system in the past was known to be as an ancient practice. However modern knowledge of sciences and technology available at higher and lower institutions has proved that forest products, when technically handled, can be developed to a technology of higher standard and become substitute to many modern costly materials used in hydraulic engineering practice e.g. water pipes/tanks for water supply, water filters, irrigation systems, sewage disposal, drainage, road culverts and food storage silos.

For the past fourteen years, Tanzania has developed this technology very well in building up systems of water supply, irrigation, road culverts and food storage in many parts of the country. Some schemes has given constant service to the public for the period of more than twelve years without failure. The cost of the materials, construction and skill applied is very low and justifies the suitability as appropriate technology.

Africa has plentiful of these types of resources e.g. timber and bamboo forests. By taken into consideration the successfulness of this type of techniques in Tanzania, could turn to be important development for African Community as a whole.

Many International Technical Conferences, including those organised by WEDC (Calcuta India 1986) have accepted this technology as viable.

This paper explains briefly about the technology in general and its achievements in Tanzania with possibility of extending the technology to other countries.

INTRODUCTION:

In the past few decades the economies of Third World Countries have declined sharply and there are no signs of recovery for the near future. Because of these economic - resource problems developing countries face acute shortages of a number of construction materials. Among materials that are in short supply are those

used for water conduits, e.g. pipes and tanks. Conventional materials such as plastic, steel and concrete must be often imported. These materials are very expensive and, therefore, often not feasible alternatives for many of the developing countries.

Some developing countries have abundant forest reserves and vast land areas that could be forested. For the past fourteen years researchers in Tanzania have studied the possibility of utilizing forest products, e.g. bamboo and timber, to construct pipes for water conveyance and tanks for water storage.

The results achieved so far are positive and show much promise. The techniques used have major potential as alternative appropriate technologies for the developing countries.

Tanzania now has more than 200 km. of wooden and bamboo pipelines in 40 Villages and about 150,000 People are being supplied with drinking water, irrigation systems and road culverts from these technologies.

AVAILABILITY OF RAW MATERIALS

Bamboo Forest:

Bamboo is a unique group of gigantic grasses the culm of which originates in underground rhizomes. It grows naturally in many countries around the world and species number about 1300. The plant is fully matured at an age of three to four years. The inner diameter varies from species to species, the minimum being 3.5cm. and the maximum 20 cm.

Timber is also used to construct water pipes and tanks, the species used can be of soft or hard wood depending on the availability of resources in the area; the most important will be the control of deforestation.

The forest of bamboos and wood suitable for water conveyance materials e.g. Pine, teak, cyprus, cedar etc. is plentiful and grows in tropical and sub-tropical zones of all continents.

DESIGN AND CONSTRUCTION OF A BAMBOO  
WATER SUPPLY:

After harvesting, the bamboo canes are cut into four meter sections and are drilled through the core to pierce the natural internodes.

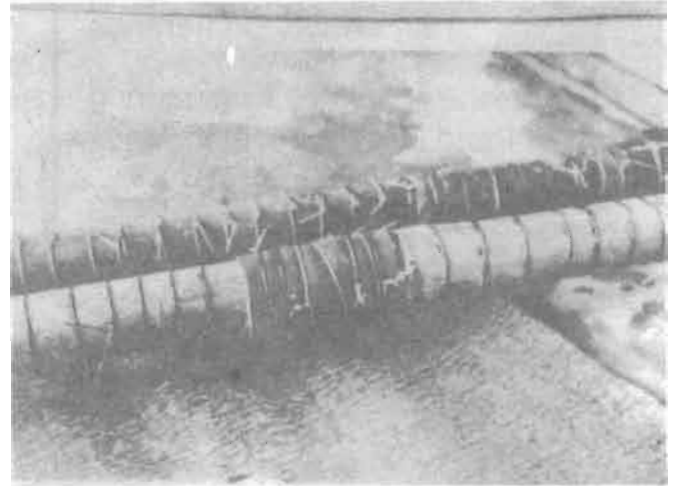
To improve the strength of the bamboo pipe and to enable it to tolerate high water pressure, the outer surface must be reinforced with galvanized steel or tar bath wire bands knotted at about 5 cm intervals. The end of the pipe section is sharpened into a pencil shape to allow joining by means of a polyethylene socket 15 cm in length. When bamboo is unlined inside has a flow C-value 75 (Hazen Williams) and n-value 0.013 (Manning's). For practical purposes the diameter of bamboo pipes unlined should be slightly larger compared to conventional pipe used for similar purposes e.g. a 7.5 cm bamboo pipe will be necessary where a 5 cm plastic pipe is normally used. For the bamboo pipes lined inside with plastic film or bituminous coatings, the adopted C-value is similar to that in plastic pipes designs. The most commonly used diameters for bamboo pipes are 3.5cm, 5cm, 7.5cm, 9cm, 10cm and 12.5cm (See Photograph No. 1 below).



Photograph No. 1  
Bamboo Pipe- Four metre length

System construction and maintenance is carried out by local people who have been trained for the job. A crew of about six men can lay a pipeline of 1.0 km in one day. Maintenance can be carried out by two men, usually village residents.

The normal procedure for designing and constructing conventional water system is generally followed when constructing bamboo pipeline systems. (See Photograph No. 2 below).

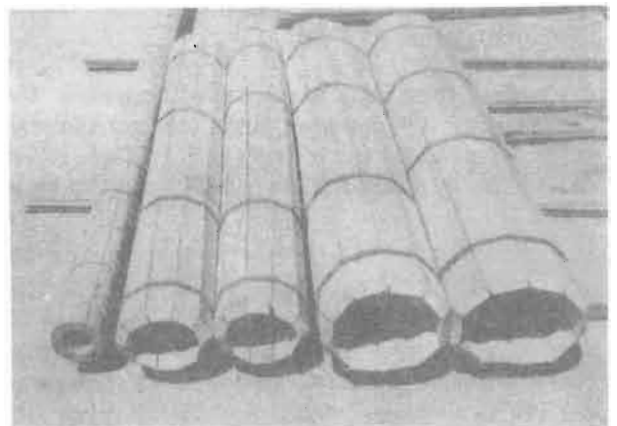


Photograph No. 2  
Bamboo Pipeline in service.

DESIGN AND CONSTRUCTION OF WOODEN MATERIALS:

Wooden pipes and tanks are manufactured at the saw-mill by special planing mill with special cutters which planes a piece of woodstave to a shape of a culvatura so that when all staves are fixed together they can form a round cylindrical tank or pipe. The flow of water in a lined wooden pipe is similar to plastic pipe. For unlined pipes the C-value 125 of Hazen William's formulae is used during systems designs.

Tanks are constructed for use either at ground level or for above ground use. The whole structure is manufactured from timber pieces of sizes 10 cm by 5 cm or 5 cm by 5 cm. Wooden pipes are similarly constructed. Timber for both pipes and tanks is machined to obtain a tongue and groove along the edges for joining purposes. The timber pieces are held together firmly by means of galvanized steel bands (See Photograph No. 3 and No. 4).



Photograph No. 3  
Woodstave Pipes.



Photograph No. 4  
Woodstave tank on ground

Construction of wooden Pipes and Tanks is done in the field after delivery of required timber staves and steel bands at the site laying of a wooden pipeline is done by joining timber staves side by side at cross sectional direction while on longitudinal direction timber staves are joined in a stagared manner. For smaller diameter pipes eg. 6.3 cm downward a polythylene socket joint is provided. Wooden Tanks on ground or on wooden raiser are constructed similar to wooden pipes but on vertical direction. (See Photograph No. 5 and No. 6 below).



Photograph No.5  
Woodstave Pipeline in Operation (60 cm internal diameter).



Photograph No. 6  
Wooden water storage tank on 8m wooden raiser.

#### DURABILITY

##### Bamboo Pipes:

Bamboo is an organic material and is therefore prone to rapid decay after harvesting. Its natural life-span after cutting varies from one to three years. In order to make the material viable and economically competitive bamboo pipes must be treated with preservatives in order to ensure a long service life.

##### Preservation Techniques:

Research during the last 14 years conducted in Tanzania managed to secure the technology of bamboo preservation which is effective, safe and non-environmental polluting. The known preservation techniques are listed as under:-

- The most efficient way of preserving the interior of the bamboo surface is to allow clean water to pass through the pipe with constant saturation all the time denying the interior surface of the pipe from contact with air or bacteria.

In areas where constant water saturation is not feasible interior coating by bituminous paints approved for drinking water contact can be applied. The bituminous paint becomes a barrier preventing air contact with a bamboo interior wall surface. The interior of the pipe can also be coated with tar/bitumen to prevent decay caused by contact with the ground.

The water from surface water sources is led into artificial water purification systems by two stage process:-

1. Horizontal Roughening Filter (HRF) and
2. Slow Sand Filter (SSF), all made of

cheap timber structures and also includes prolonged periods of intermittent sterilization by chlorine solution of limit 10mg/l. In order to prevent termite (white ants) attack the following techniques are adopted:-

- In moderate termite infested areas approximately elevation up to and above (1,500m A.M.S.L) tar treatment alone on bamboo outer surface is sufficient to prevent termite attack.

In areas where termites are abundant eg. below 1,500 A.M.S.L. two types of techniques are applied:-

a) Borax (Timbor) is impregnated in the bamboo fibres. Outer surface is coated by bituminous paint.

b) The admixture of tar/bituminous paint and Pyrethroid (Permethrin/Deltamethrin) is painted on the outer surface of the bamboo.

c) Insecticide (Chlorpyrifos) Dursban 48 is sprayed in the pipe trench surfaces in water emulsion as a soil treatment.

Experience and data obtained in Tanzania shows that a life span of bamboo water system ranges between 10 to 20 years. Some schemes have supplied water constantly in Tanzania for 12 years and still functioning.

#### DURABILITY OF WOODEN MATERIALS:

Durability of average 50 years is guaranteed by impregnating water borne preservative in the material fabricated from soft wood eg. Pine. For hard wood which are naturally durable no preservative treatment is necessary. The preservative impregnated in soft wood fixes in the wood and become non-leachable by water. To make it more safer to people and environment tanks are painted with bituminous paint inside. Inside the wooden pipes a plastic film is lined or the interior surface is coated with bituminous paint.

#### HEALTH ASPECT:

Water analysis conducted in Tanzania, Netherlands and The United Kingdoms showed that water quality at the distribution point is within the approved standard of the World Health Organisation (WHO).

#### ECONOMICS:

The cost of bamboo and wooden material when compared to conventional materials are several times cheaper.

#### BAMBOO:

The cost of bamboo pipes is between 4 to 10 times cheaper than conventional steel and plastic materials, even excluding cost

of transport. The cost of importing these materials to Tanzania was investigated and it was found that a 20 km long plastic pipeline would require thirteen container carrying polythylene rolls.

, The same length of bamboo pipeline would require only one container for the supplementary product such as galvanised steel wire, joints and preservative.

#### COSTS OF WOODEN MATERIALS:

Recently a Swedish Forestry Consultant working with The Swedish Consulting firm, The TEKNICUS was appointed by Swedish (SIDA) and Tanzania Governments jointly to investigate the marketability for use of wooden pipes and tanks in Tanzania.

In its conclusion the report indicated that the wooden materials were very feasible for Tanzania situation. The installation cost per capita for a bamboo water supply system utilising a wooden tank is about US \$ 5.

#### EVALUATION:

In 1986 The Government of the United Republic of Tanzania Commissioned the second evaluation mission for wood-bamboo technology of Tanzania involving higher government technical officials, and Universities (local and overseas) experts. It was concluded that this technology is viable for Tanzania. The raw material is plentiful and very cheap.

Resulting from all these it is assumed that this technology is suitable for other Africa State as well.

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