TIMBER-STAVE RESERVOIRS

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A PIPE, MADE FROM WOOD, DATING BACK TO Roman times is still functioning with total satisfaction in London. The water is excellent, but the water source is not known.

How long will the TimberTANK LAST? 50 years? 100 years? Indefinitely?

Timbertank Enterprises Ltd has been building timber stave reservoirs for thirty years, for a variety of applications including town and domestic water storage, chemical storage, clarifiers and waste water treatment plants. With some twenty thousand tank and reservoir installations in New Zealand and over three hundred projects completed in South East Asia, the Pacific and Australia, it is apparent that the concept of the wooden stave reservoir, by virtue of its history and performance, has achieved wide acceptance as a durable and economical method of reservoir construction.

Despite this record a frequently expressed initial concern of the potential customer is the question of the durability of a Timbertank reservoir.
The life of these materials is not known, but the PVC has performed well over the fifteen years Timbertanks has been using it, and the expected life is in excess of 35 years. Replacement cost and installation is between 6 & 10% of the capital cost of the reservoir.
The roof timbers are expected to withstand the full impact of the elements. The intense NZ sun and frequent rain, tests the integrity of Timbertank roofs to the extreme. The shingles (the roof sheathing) do crack and split so one tenth of one per cent of the shingles require attention every five years! Timbertanks replace these shingles at no cost.

THE DURABILITY OF TIMBER STAVE RESERVOIRS
Wood, as a construction material does not have the connotation of permanence which, in the mind of the general public, is associated with concrete and steel, hence the apparent perception that the life expectancy of a reservoir in which the structural components are of wood will not match that of those construction of the former materials.
In New Zealand and Australia, for accountancy purposes, the life of a public supply reservoir is usually twenty years. On this basis many engineers design for a life expectancy of fifty years. While Timbertank Enterprises Ltd can claim to have direct experience dating from the time it built the first wooden stave reservoirs for the town supply at Pokeno, confidence based on knowledge of the performance of preserved timber and of the wire cables used has enabled a life of seventy-five to one hundred years to be predicted.
A Timbertank reservoir is made up of three main elements:- A timber barrel built with treated *Pinus radiata* staves constrained by hot dipped galvanised steel cables: a double liner system consisting of a reinforced polythylene pre-liner and an inner liner of factory welded international food grade PVC or polypropylene: a structural timber roof which as an integral part of the total structure provides stability and protects the liner from ultra violet light.

All components of a Timbertank have been selected and processed to ensure maximum durability. After the stave timber has been machined and cut to length it is pressure treated with chromated copper arsenate salts to a minimum preservative retention of 12.0 kg/m^3 (H4). This is the level of treatment specified in NZ Standard MP3640:1988 for sawn timber in ground contact. The NZ Forest Research Institute nominates a life expectancy of a minimum of seventy-five years within the Pacific area for timber treated to this grade. This means that after a period of seventy-five years less than 5% of the timber will show any sign of deterioration. At this level a reservoir would remain structurally sound. While the theoretical thickness of the staves required to withstand the hydrostatic pressure in a reservoir of a standard design is approximately 20 mm the actual thickness of the tongue and groove staves which is necessary to enable construction is ex 75 mm hence the reservoirs are both robust and fire resistant.
The roof timbers are treated to T.P.A. H3, a level which ensures their durability and provides a more than adequate protection from termite attack.

All metal components used are of hot dipped zinc galvanised steel. The cables are woven from high grade galvanised steel to an international specification developed for the fishing industry. They are heavily greased during manufacture in order to obtain maximum resistance to moisture. The manufacturer rates their life at between 35 to 70 years depending on exposure conditions. Their positioning, on the exterior o the barrel, means that they are in clear view allowing both them and their fastening grips to be easily inspected and tightened or replaced without the operation of the reservoir being disrupted. All cable used is tested to the

requirement of the New Zealand Government Marine Department as laid down in British Standard 183. Timbertank Enterprises Ltd has its own liner fabrication plant, manufacturing liners for concrete and steel tanks as well as its own product. Early experience having demonstrated that this allows advantages in the areas of quality control, customer support and the flexibility to utilise recent developments in membrane material. The material originally used for tank liners was polythene, while butyl rubber was used for reservoir liners. Now PVC liner material specifically formulated for potable water storage is extensively used for both tanks and reservoirs but polypropylene is recommended for applications where a higher tolerance of temperature is required.
Both tanks and reservoirs are fitted with a double liner system. A "sole" consisting of a disc of reinforced polyethylene, one metre greater in diameter than the barrel, is laid over the floor and brought half a metre up the wall of the tank around the entire circumference. The rest of the barrel wall is lined with sheet polyethylene. The PVC or polypropylene liner is then fitted. The double liner system provides added strength and has the advantage that should there be any accidental damage to the floor of the liner the water must travel between the two liners and up the wall of the barrel to leak out between the staves. This ensures that a leak in the base of the reservoir cannot go undetected. Any tear or puncture can be repaired to situ, simply, immediately and permanently by the adhesion of a PVC patch.

Throughout its history Timbertank Enterprises has demonstrated a strong commitment to Research and Development, working in association with Auckland University and consulting engineers with expertise in laminated timber design, seismic design and cyclone design to ensure the maximum durability and performance of the structure.

The life expectancy of a timber stave reservoir is further enhanced by the design concept which permits easy maintenance and the replacement of components with minimal disruption to its operation. Whereas the failure of joint seals in a steel reservoir or corrosion of reinforcing rods and weakening of the cement in concrete structures may not be detectable until well advanced, the condition of the components in a timber stave structure can be evaluated by a simple visual inspection of the exterior. The location of the cables, which function as the tensioning component, on the exterior of the barrel means that any sign of deterioration in them is immediately apparent. While the repair or reconstruction of a concrete or steel reservoir entails an expensive process which results in a lengthy period during which the reservoir is out of service, any component of a timber stave reservoir can be replaced speedily, usually within one working day, causing minimal disruption to its operation. Thus, cables can be replaced or re-tensioned, repairs to the roof carried out, the liner or a stave replaced without damage to, or the destruction of the tank.

MAINTENANCE CONTRACTS
As a result of Local Body reorganisation, **Timbertanks is entering in to maintenance contracts with many Councils**. Under the terms of these contracts Timbertanks visit each reservoir every one, two, three or even four years to carry out the following inspections and maintenance.
The surround of the reservoir will be inspected for any plant growth or land changes which could effect the seismic performance of the reservoir. Remedial work will be carried out, or the need for such work to be done will be reported as appropriate.
The cables shall be inspected for any sign of corrosion and assessed for tightness.
The cable grips shall be inspected for performance and condition and made good as required.
Roof rafters to be inspected for sign of stress, delamination or decay. **Roof substructure** to be inspected to insure that all remains well nailed and secure.
Roof shingles to be inspected to insure that none are missing or badly broken and are well nailed. Check that the "top boards" are well nailed and secure. Make good as required.
Flush out any silt.
Inspect the **pipework flange bolts** and replace if they have badly deteriorated. Check that **the liner** is fully supported at these pipe penetrations and repack with sand as required.
Check the full circumference of the barrel / floor junction to establish that the liner is fully supported, rub out seismic waves, replace sand that has washed away and that there is surplus liner material at this junction. Reposition the liner if it has crept across the barrel floor. Check that the liner is hanging correctly and fully supported at the junction of the floor and barrel wall. Make good as required.
This inspection takes on average four hours but will require the reservoir to be out of service for about half an hour.
It is becoming very apparent that if consistent and well planned regular maintenance is carried out on Timbertank Reservoirs the life of the structure will be almost indefinite. The staves could last 150 years, the cable may need replacing at the earliest at seventy years, and the liner may need replacing at year 35, at an all up cost of 8% of the initial cost.