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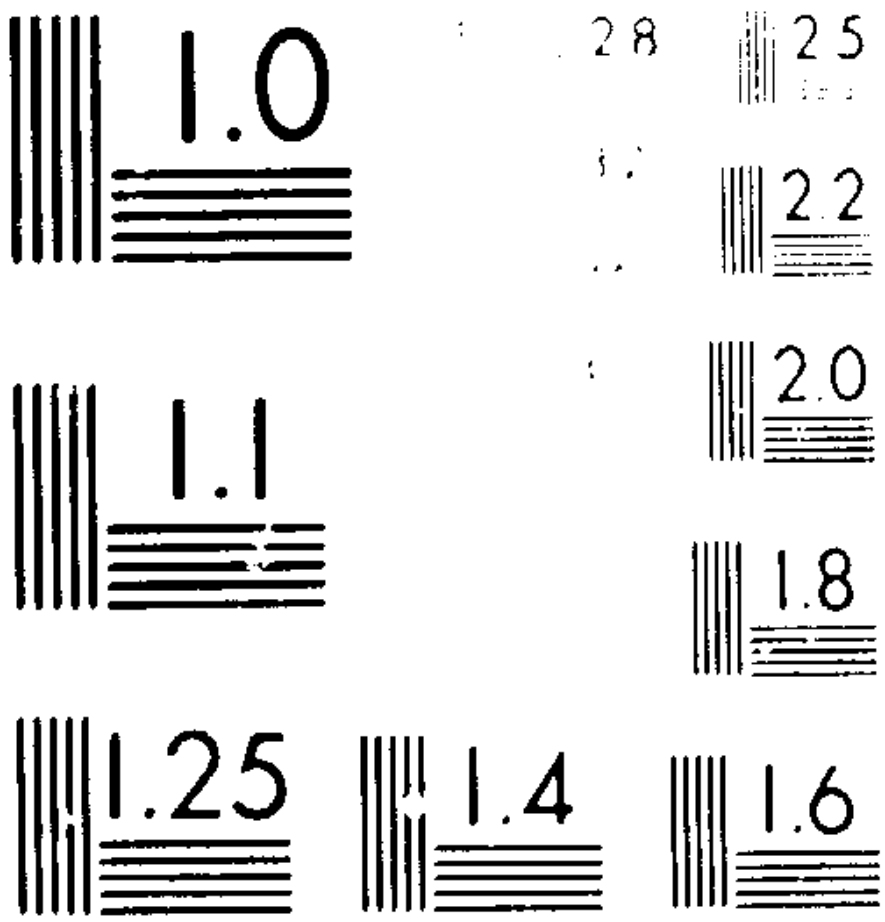
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PIPE INDUSTRY IN AUSTRALIA: VERTICALLY CAST PIPES, PIPE SIZES AND SERVICE CONDITIONS*

by

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The concept of using concrete for conveying water is not new. The Romans used concrete to construct aquaducts which are still standing today. In fact, part of the water line originally designed by the Romans to supply water to the city of Trier on the Mosel River is still in use.

This early use of concrete subsided after the fall of the Roman Empire, and it was not until relatively recently with the modern development of Portland cement that concrete has been able to demonstrate its full potential.

For concrete pipe the first major technological breakthrough occurred in 1910 when two Australians patented the centrifugal spinning process for the manufacture of concrete pipe. This breakthrough was followed by the seperate development of the roller suspension method by other Australians. Both methods of manufacture allow the economic production of top quality impermeable concrete pipe suitable for a widespread variety of uses. Because of these two early developments in concrete pipe technology, Australia has been able to retain its leadership in these processes which are now widely licensed throughout the rest of the world.

The growth of the concrete pipe industry in Australia has resulted in most pipe being produced by three companies - Monier Limited, Rocla Industries Limited and Humes Limited. A number of other smaller companies also manufacture concrete pipe to satisfy localised geographical areas.

As Australia is a large country with its population mainly distributed around the eastern and southern coast covering thousands of kilometers in distance, concrete pipe manufacture has developed on a regional basis to avoid the high freight costs that would occur if only a few manufacturing points existed. Today, Monier Limited, Rocla Industries Limited and Humes Limited have concrete pipe plant in more than sixty seperate locations throughout Australia.

Apart from the benefits this has on freight costs in an area of rapidly rising fuel costs, it has another significant benefit in that it forced the development of the technological processes employed to be flexible to allow economic and efficient production of concrete pipe to meet a variety of market sizes and conditions.

As an adjunct to the manufacturing operations, each company, both individually and through the auspices of the Concrete Pipe Association of Australia, offer services to assist the engineer in his pipeline design and choice of concrete pipe. Design aids, such as load tables for different classes of pipe under different service conditions and hydraulic flow data, are supported by the manufacturers' willingness to offer individual advice where the service conditions are not covered by the readily available published data. Under some conditions, this may result in the supply of concrete pipe individually designed to suit the client's needs.

It was mentioned earlier that the two main processes used in the manufacture of concrete pipe in Australia consist of the centrifugal process and the roller suspension process.

The centrifugal process, which is also known as the spinning process or wet-spinning process, utilises the fact that concrete of relatively low water/cement ratio can be efficiently and thoroughly compacted by the centrifugal force arising from rotating a circular form at high speed. Simultaneously, excess water is forced out of the mix, resulting in a high strength concrete of very low permeability.

As a large majority of concrete pipes are reinforced, the pipe manufacturing cycle begins with the manufacture of the steel reinforcement cage. This is usually done by specially designed machines that allow manufacture of reinforcement for a wide range of pipe diameters and classes. The longitudinal wires are automatically welded to the helical wire as the helix is formed. The pitch of the helix can be varied to suit the load requirements of any pipe

design.

The reinforcement cage is then located inside a steel mould to provide the correct concrete cover. To get the greatest benefit from the reinforcement, it is common in large diameter pipe to place the reinforcement such that it maintains an elliptical cross-section within the mould. When this is done, it is necessary to mark the top of the pipe to ensure the pipe is installed with the reinforcement in its correct orientation.

Once the reinforcement is correctly positioned and the end cap placed, the mould is placed horizontally on rollers connected to a drive unit, which is then activated to commence rotating the pipe mould. Concrete is then discharged into the spinning mould until the required wall thickness has been achieved. As this happens water, which is driven to the inner surface of the pipe is removed. When the pipe machine operator is satisfied that compaction is complete, the spinning is stopped and the pipe in its mould is placed within a low pressure steam chamber until the concrete has developed sufficient strength to enable the finished pipe to be removed from the mould, which is then returned to the manufacturing cycle.

Pipes ranging in diameter from 100 mm to over 3,000 mm with wall thicknesses from about 20 mm to over 275 mm can readily be manufactured using this spinning technique. While the centrifugal spinning and the roller suspension methods of manufacture would account for a very large majority of concrete pipe production in Australia, some pipe, particularly in the larger sizes, is produced in vertical casting. In general, the Australian practice in vertical casting differs from the more common European mechanised processes.

The easiest way to vertically cast pipe is to set up a mould consisting of two vertical steel cylinders the outer one to form the outside diameter of the pipe and the inner one to form the inside diameter or bore. The base must contain a machined ring to form one part of the joint and a removeable ring which can be placed on top to form the other half of the joint. In order to strip the

pipe from this type of mould it is necessary that the outer mould must be able to be expanded and the inner mould must be capable of being collapsed inward to a smaller diameter.

When setting up it is necessary to ensure that all these joints are properly tightened and that the seals which are usually provided are in good order. The steel reinforcement frame can be placed about the inner mould prior to placing the outer mould. Concrete is usually placed from the top with the assistance of a conical top plate to direct it down the walls and it is then compacted by the use of form vibrators.

As you can see this process is not as simple or as quick as the two spinning processes and the moulds can be considerably more expensive. This process is therefore generally reserved for the production of very large diameter pipes, those which are too large to fit onto existing pipe machinery. In this manner pipes up to 3,600 mm diameter have been cast, and with special care and techniques these pipes can still meet the strict requirements of the Australian Standards. It is however, necessary to have strict control not only on the concrete mix design and mixing but also on the pouring and compaction techniques if you are to obtain high quality pipes.

You have also no doubt heard of vertical pipe machinery. This has largely been developed for the European and American market and they can make satisfactory pipes for certain sections of the pipe market. The major problem areas which need to be considered if the use of these machines is contemplated are their high initial cost and the sophisticated control equipment which usually is necessary to operate the largely automatic cycling of these machines. This means that maintenance costs can be high and it is necessary to have the services of an electronics technician available.

It is difficult to use reinforcement with many of the automatic vertical casting machines. Some machines, such as Vihy machines from Denmark rely on basic vibration while others of the packer head type such as Hydrotile, McCracken and

Zublin use a rotary type of head to pack and roll the concrete. Extreme care is necessary to ensure that the reinforcement cage is not picked up with the concrete and twisted. As these pipes are demoulded immediately after casting it is not possible to use elliptical cages: all reinforcement must be circular, which in many cases is not as economical.

Also the degree of compaction is generally lower than that achieved with the Australian processes, hence absorption is greater with less protection to the reinforcement.

Because the external mould is withdrawn from the 2.5 metre high product immediately after casting some slumping of the concrete is inevitable. If the reinforcement cage is rigid the concrete slumps around it and bond between the concrete and the steel is lost. Various methods have been devised to try and overcome this problem, but it remains a problem.

Another drawback is the considerable length of time required to readjust these machines every time it is necessary to change from one pipe size or type to another.

Vertical pipe cast has its place in the range of pipe production. Some specialised pipes can be made by the range of vertical pipe machinery available and for the very large diameter pipe a poured and vibrated pipe can be produced which meets all the stringent requirements of the Australian Standard. Concrete pipe can be used for all major fields of civil engineering involving the transport of water or sewage. Concrete pipe is designed and manufactured fundamentally to resist either external soil loads or internal pressure, and so it is well suited for a variety of applications.

Pipes designed for non-pressure applications are used in sewerage schemes for reticulation and trunk mains for stormwater drains, and as culverts. Pressure applications include town water supply, sewer rising mains and irrigation schemes. A number of different methods of jointing pipes enable this flexibility of use.

To conclude, it is hoped that this brief background to the Australian concrete pipe industry helps to explain the technology as it has developed and to provide a general basis for the remaining two portions of this paper presented by the Concrete Pipe Association of Australia.