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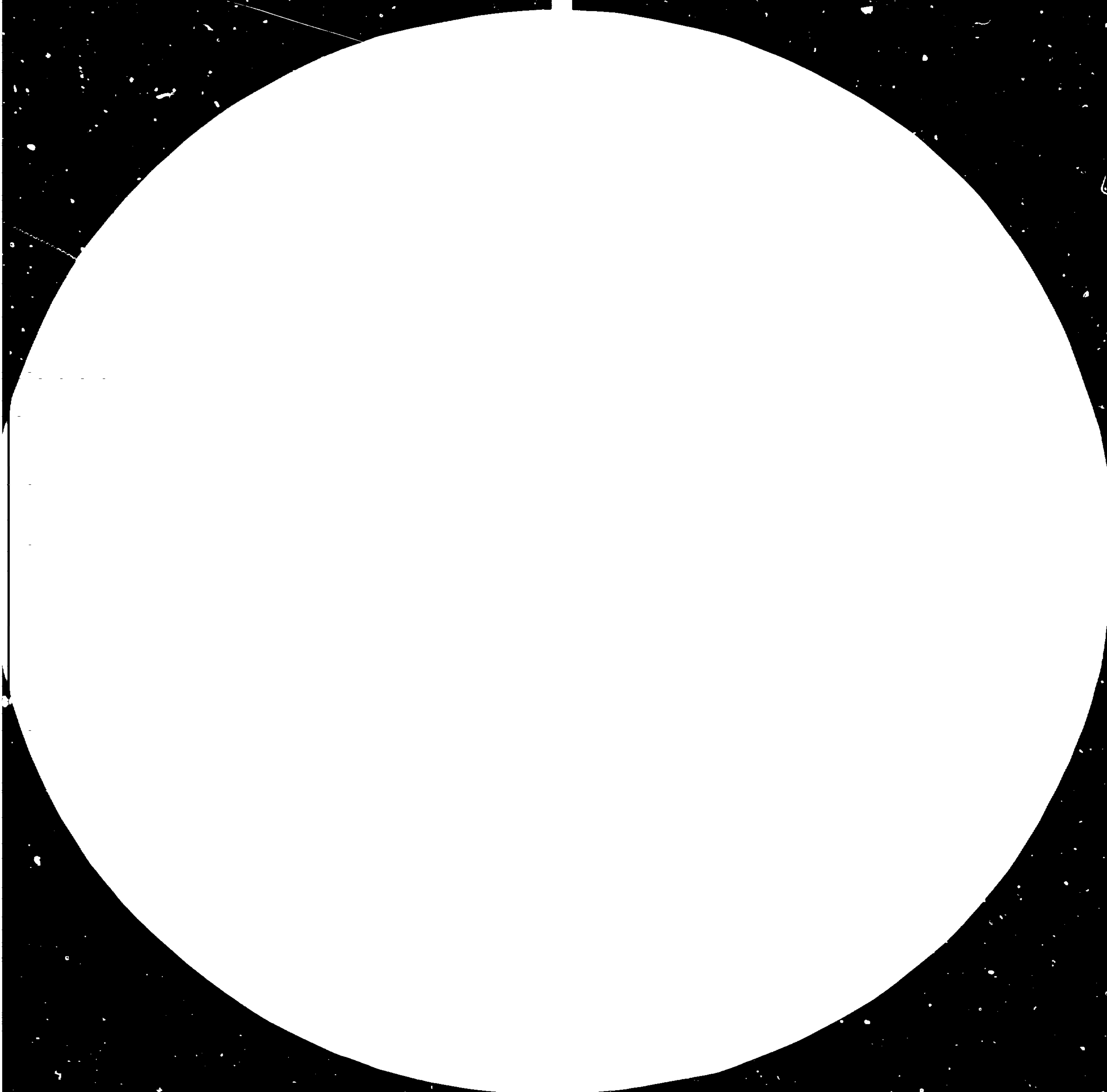

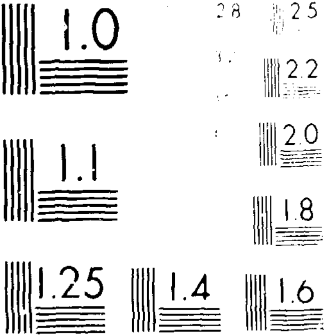
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# PIPE MANUFACTURE, JOINTS, PRESSURE PIPES, STANDARDS, TESTING*

by

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THE ROLLER SUSPENSION METHOD OF MANUFACTURE

Australian machinery for making high strength concrete pipe is used all over the world.

Two unique pipe-making processes were developed in Australia. First there was the spinning process, originated by Humes in 1910 and described in Segment 1.

The roller-suspension process was originated by Rocla in 1943.

It has been successful for three basic reasons -

1. It makes high quality concrete pipe.

2. The machinery is simple, robust, versatile, and relatively cheap.

3. The process is easy for pipe makers to understand and operate.

The machine consists of a horizontal roller on which the pipe mould is suspended.
The pipe mould consists of a steel cylinder (called the mould shell) containing steel rings inside each end. The thickness of the rings determines the thickness of the pipe wall and the machined profile of the rings provides an accurate joint profile.
The mould is suspended on the roller with its rings bearing on the roller at each end. The roller is set in motion, rotating the mould. The speed of rotation is lower than that of the spinning process. Concrete with a very low water/cement ratio (between 0.27 and 0.37) is fed into the mould and carried up and over the roller, to be compressed or "rolled" between the roller and the mould shell. The weight of the concrate adds to the compacting force.
This rolling action is the principle compacting force, but the vibration inherent in the process, and the centrifugal forces present also contribute.
After the pipe is made, the full mould is removed from the machine. When the concrete has gained sufficient strength, the pipe is removed, the empty mould cleaned, the reinforcing cage inserted, and the mould returned to the machine.

The wall thickness, the joint type and the pipe diameter can be changed without alteration to the machine. It is only necessary to place a different type of mould on the roller.

The pipes may be unreinforced, reinforced, elliptically reinforced, or longitudinally prestressed.

Some machines make pipes up to 2.5 metres long, others up to 5 metres long. Pipe diameters range from 150 to 3000 mm.

Machines can be provided to suit the needs of the customer, from basic hand fed machines to sophisticated automatic machines. Rocla uses the simpler installations in country areas where labour may be unskilled, maintenance facilities limited and production requirements modest.

PIPE JOINTS

The type of joint to be used in a pipeline depends on the service requirements.

The flush joint, sometimes referred to as a rebated joint, or tongue and groove joint, is illustrated in Australian Standard 1342-1973. It is used where minor infiltration or leakage at joints is not serious, for example in pipe culverts under roadways and for stormwater drainage.
The "internal" type is used when the pipe diameter is large enough to allow inside access for joint caulking.
The "external" type is used when the pipe diameter is small and caulking must be done from the outside.

Rubber ring joints are used if leakage and infiltration must be prevented, for example in sewer pipes, or if the water in the pipe is under pressure. Two types are used in Australia. The rolling ring joint and the sliding ring joint. The sliding ring type of joint is known by several names, - skid joint, trapped 'O' ring and confined 'O' ring.
In the case of a rolling ring joint, the rubber ring rolls back into position against a shoulder on the pipe spigot as the pipe is jointed. At the same time it is compressed between the spigot and socket.
In the case of a sliding ring joint, the rubber ring is confined in a groove close to the end of the spigot. Therefore it must slide across the lubricated socket surface as the joint is made. This type of joint has the advantage that pipe sockets can be shorter, because the rolling distance required with a rolling joint is avoided.
Alternatively greater joint deflection in the field is possible, if this is required, because the jointing ring is positioned further inside the socket than is the case with a rolling joint.

The rubber ring joint is giving excellent service. It is used world-wide on pipes of many different materials.
However the design of rubber ring joints is not simple and should only be undertaken by experienced joint designers. This is particularly so where high internal pressures are involved.
The designer must consider the effectiveness of the joint under various conditions. For example he must consider the case where a joint is deflected to the permitted maximum, where spigots and sockets are eccentric to one another, where spigots are withdrawn the maximum distance permitted, where sockets are made to the maximum diameter permitted, where spigots are made to the minimum diameter permitted and where rubber rings are made to the minimum length and cord diameter permitted.
A minimum compression must be maintained in the rubber ring under any combination of the above conditions, and the gap between the spigot shoulder and the socket must never be more than that required to prevent the rubber ring being forced through under pressure.
Many pipelines have failed unnecessarily because of bad joint design.

Good quality rubber rings are made by several companies in Australia to Australian Standard 1646-1974. Most of the rubber rings used are made of natural rubber but the standard also covers rings made of synthetic materials for special purposes.

## AUSTRALIAN STANDARDS FOR CONCRETE PIPES

Specifications are of three basic types -

1. Prescription,
   where the Purchaser prepares the product design to withstand the service loads.

   He specifies the raw materials, the product dimensions, the tolerances and the manufacturing procedures. He supervises manufacture to ensure that his wishes are carried out.

   By providing the design he takes the responsibility, and hopes that the product will perform in practice as he predicts. It is natural for him to design conservatively; therefore the product is costly.

2. Design,
   where the Purchaser specifies limiting design stresses in the hope that a product designed by the manufacturer within these limits will not fail under service loads.

   Again, responsibility rests with the Purchaser. He tends to set the limits conservatively to cover his doubts, and the product is costly.

3. Performance,
   where the product must pass tests to make positively sure that it is fit to do the job for which it is intended.

   To obtain a contract manufacturers are motivated to be innovative both in design and manufacturing.

   A safe and cheap product is the result.

Prescription and design specifications must be used for structures which it is not possible to test (eg large buildings).

Performance specifications are used for products which can be tested.

Pipes are made to performance specifications (in the form of national standards) in Australia, Britain, New Zealand and other countries. Pipes made in Australia for particular loads are much lighter, more impermeable, and more durable than their most popular counterparts in North America, where prescription specifications are used.

The Australian Standard for precast concrete drainage pipes is 1342-1973.

It is a performance standard. The pipe design is the responsibility of the manufacturer.

Five classes of pipe are covered, one of which is unreinforced, and four reinforced.

The classes relate to specified external loads.
It must be demonstrated by factory testing that pipes made to the standard can withstand the loads.
In practice Australian pipe manufacturers supply pipes for loads well in excess of the Standard loads and in diameters larger than the Standard diameters.

As well as the load test, pipes may be required to pass a hydrostatic pressure test. Concrete must pass an absorption test. Pipe dimensions are required to be within specified tolerances.

Compared to overseas standards, its requirements are high.

Absorption must be below 6.5% for sewer pipes and 8% for drainage pipes. In U.S.A. the limits are 8.5 or 9% depending on the test method used. In Britain the limit is 6.5% but this figure is misleading because the test method is not nearly as severe as the Australian method.

The ultimate load test is 50% greater than the cracking (or proof) load. In Britain the ultimate load is only 25% greater than the proof load, and in U.S.A. for the heaviest class of pipe the figure is also 25%.

The maximum width of crack permitted under proof load is 0.15 mm in most cases. In Britain and U.S.A. the permitted crack width is 0.25 mm.

The Australian Standard for precast concrete pressure pipes is 1392-1974.

It is essentially a performance standard, but has some design restrictions.

Pipes must pass a pressure test and a load test related to the pressure test. Concrete must pass an absorption test. Pipe dimensions are required to be within specified tolerances.

Absorption must not be greater than 6.5%. In U.S.A. the ASTM specification for R.C. pressure pipes C361 does not require an absorption test. Nor does AWWA Spec C302.

Generally the concrete in pipes made to American standards must have a strength of only 27.6 MPa. Concrete manufactured by Australian processes has a strength of at least 50 MPa. Strengths of 70 MPa are common, particularly in the larger pipe diameters.

COMPARISON WITH PIPES MADE OF OTHER MATERIALS

Every type of pipe has a situation for which it is particularly suited, but the advantages and disadvantages of the different materials are not always appreciated by the user.

Some particular advantages of concrete pipe are as follows :-

Concrete pipe is classed as a rigid pipe. It does not require the same degree of attention to backfilling necessary with flexible pipe. Under load, flexible pipes are not as naturally strong as concrete and must rely heavily on support from the surrounding soil. It is the pipe layer who is responsible for providing the supporting strength.

Concrete pipe has a smooth bore. Pipes with a smooth bore have better flow characteristics than pipes with an internal corrugated profile; therefore it is often possible to use a smaller pipe size if smooth bore pipe is chosen.

The proven long life of high quality concrete pipe must be considered when the economics of a pipe installation are being worked out. The protection given by coatings to pipes made of corrodable materials is often short lived. The cost of replacing pipes under developing areas can be astronomic compared with the original cost of the pipe.

The steel reinforcement in concrete pipes is insurance against accidental overstressing of a pipeline. If a pipeline is accidentally overstressed it may crack, but the elasticity of the steel reinforcement gives it the power to recover (unless of course the overstressing is extreme). The crack will often close when the overload has passed. Also, good concrete in a moist environment has the natural property of being able to heal cracks in its structure. This is called autogenous healing.

PRESTRESSED CONCRETE PRESSURE PIPES

Because the quality of reinforced concrete pipes made by the Australian processes is high, they can be designed to take high internal pressures. (this is in contrast to pipes made by some American processes which aim for high output rather than top quality. Many 'immediate strip' processes are unsatisfactory for the manufacture of reinforced concrete pressure pipe.)

Of course even in Australia a pressure is reached where reinforced concrete pipe becomes prohibitively heavy and costly. This ceiling pressure varies with diameter.

Prestressed concrete pressure pipe can be used below and beyond this point.

Non-cylinder prestressed concrete pressure pipes have been made by Australian processes in Australia and sixteen overseas countries.
Standard sizes range from 500 to 3000mm diameter, and length is five metres.

The following method is currently used:-

A longitudinally prestressed core pipe is made on a roller-suspension machine.

The core is wound with high-tensile steel wire to resist the worst combination of test pressures, operating pressures and external loads.

The wound core pipe is then pressure tested.
Following successful testing, the wire is coated with cement paste, followed by a cement mortar coat, then a second coating of cement paste.

Generally a sliding rubber ring joint is used.

The pipes are commonly designed to comply with British Standard 4625.

Cathodic protection is provided for pipes laid in particularly aggressive environments.

Pipes can be designed to resist test pressures up to 40 atmospheres at the small end of the size range, and up to 15 atmospheres at the large end of the size range.

OVERSEAS ACTIVITIES OF ROCLA

The roller-suspension process is used in all of Rocla's sixteen Australian factories, and in twenty seven overseas countries also, under licence or under an expired licence.

Many of these countries also use related equipment of Rocla design, such as pipe-cage welding machines, wire-straightening machines, wire - winding machines, mortar-coating machines and testing machines.