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PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in the manufacture of Resin-Aggregate Pipes

We, HUMES LIMITED, a Company incorporated under the laws of the State of Victoria, of 185 William Street, Melbourne, in the State of Victoria, Commonwealth of Australia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to the manufacture of resin-aggregate pipes or composite pipes composed partly of resin-aggregate and partly of concrete or similar material.

It has already been proposed to provide pipes composed of a mixture of a resin, such as epoxy resin or a polyester, and an aggregate for use in conditions where their resistance to chemical and other attack is far superior to that of concrete or other pipes. However, because such resin-aggregate pipes have hitherto included a large proportion of resin, for example, resin in proportions greater than 1 part of resin to 12 parts of aggregate, by weight, they are expensive to manufacture.

It is therefore the primary object of the present invention to provide a resin-aggregate pipe in which the resin is present in proportions less than 1 part of resin to 12 parts of aggregate by weight, and even in such lean proportions as 1 part of resin to 20 or more parts of aggregate by weight thus effecting a substantial reduction in the cost of manufacture.

It is a further object of the invention to provide a resin-aggregate pipe in which a leaner mixture of resin and aggregate is used in one part of the pipe, e.g. the body, than in another or other parts of the pipe, e.g. the faucet, the resin in either part being present in proportions less than 1 part of resin to 12 parts of aggregate by weight. Such pipes will permit

satisfactory fluid tight joints between adjacent lengths of pipes to be obtained.

It is a still further object of the invention to provide a composite pipe composed of concrete or similar material having an external resin-aggregate coating and/or a resin-aggregate lining in which the resin is present in proportions less than 1 part of resin to 12 parts of aggregate by weight. Such pipes have the advantage that a less chemically resistant and cheaper material can be used for those portions of the pipe not subject to chemical attack and the resin-aggregate mixture can be used where chemical attack is likely, for instance, for the lining when the fluid flowing through the pipe is aggressive and/or for the external coating when the medium in which the pipe is to be laid is aggressive.

It has hitherto been considered difficult, if not impossible, to manufacture resin-aggregate pipes in which the resin is present in proportions less than 1 part of resin to 12 parts of aggregate and therefore it is a further object of the invention to provide a method of manufacturing resin - aggregate pipes having such lean mixtures of resin and aggregate.

According to the invention there is provided a resin-aggregate pipe or a composite pipe composed partly of resin-aggregate and partly of concrete or similar material, in which the proportion of resin to aggregate in the pipe or in a part of the pipe is less than 1 part of resin to 12 parts of aggregate by weight. The proportion of resin to aggregate may be equal to or less than 1 part of resin to 13 parts of aggregate.

A method for the manufacture of concrete pipes is already known in which the concrete is moulded and compacted by centrifugal force and pressure in apparatus including a rotatable mould and a compacting roller mounted longitudinally of the mould. How-

[Price 4s. 6d.]

ever this method cannot be satisfactorily used to manufacture resin-aggregate pipes because the tackiness of the resin may cause it to adhere to the compacting roller thus preventing proper compaction of, and the obtaining of a smooth surface on, the pipe. Also the stiffness of the mix prevents the manufacture of faucets by the conventional method.

The apparatus for manufacturing the resin-aggregate pipe of the invention may include a rotatable pipe forming mould, a compacting roller mounted to extend longitudinally of the mould rotatable on an axis parallel to the axis of the mould and movable towards and away from the internal surface of the mould, and means for applying pressure transversely of the compacting roller to the compacting roller urging the compacting roller lengthwise towards the adjacent internal surface of the mould.

The method of the invention for manufacturing a resin-aggregate pipe according to the invention utilizes the latter apparatus and comprises the steps of introducing a pipe formable resin - aggregate mixture in which the proportion of resin to aggregate is less than 1 part of resin to 12 parts of aggregate by weight into the mould, rotating the mould to apply centrifugal force to the mixture to form the pipe, moving the compacting roller into contact with the pipe being formed and rotating the compacting roller at a speed greater than the speed of rotation of the mould, applying pressure to the compacting roller to force the compacting roller against the pipe being formed to compact the mixture, reducing the pressure exerted by the compacting roller on the pipe being formed when portion of the mixture adheres to the compacting roller, increasing the pressure exerted by the compacting roller on the pipe being formed when the difference in the speed of rotation between the mould and the compacting roller causes the adhering portion of the mixture to be cleaned from the compacting roller, and repeating the steps of reducing and increasing the pressure exerted by the compacting roller on the pipe being formed until portion of the mixture no longer adheres to the compacting roller and the pipe is compacted.

After the pipe is moulded it is cured in known manner.

A composite pipe composed partly of resin-aggregate and partly of concrete or similar material may be manufactured in a similar manner, the different materials to form the composite pipe being introduced into the mould separately. Spacers or formers may be used to keep the different materials in their proper positions as they are introduced into the mould.

To manufacture a composite pipe according to the invention composed of concrete or similar material having an external resin-

aggregate coating a pipe formable resin-aggregate mixture in which the proportion of resin to aggregate is less than 1 part of resin to 12 parts of aggregate is introduced into the mould and the coating is formed as a thin walled pipe by the above mentioned method. After the coating is set the concrete part of the pipe is moulded. To manufacture a composite pipe composed of concrete or similar material having a resin-aggregate lining the concrete part of the pipe is first moulded. When the concrete pipe is set the resin-aggregate lining is applied thereto by the method above described.

The resin to be used in the resin-aggregate mixture may be a polyester, an epoxy, a coal tar epoxy, polyurethane, furane, bitumen or pitch. The resin may be used with or without a solvent, diluent, plasticiser, monomer, fungicide or bactericide. The resin may be of the type suitable for use in either hot or cold curing cycles, for example, an epoxy type with a curing agent, an unsaturated polyester with a curing agent, usually a peroxide with or without a promoter such as a metallic naphthanate, or a furane with an acidic curing agent such as sulphuric acid or p toluene sulphonic acid in a suitable solvent or a coal tar epoxy with a curing agent, the 'tar' including a coal tar pitch. Thus the resin may incorporate curing, hardening, accelerating, and promoting agents necessary to cure the pipe.

The aggregate may be crushed basalt, crushed rock of any type, gravel, sand, crushed brick or crushed tile. The particles of the aggregate may be of various sizes and shape. Some materials such as toscanite, quartz, and quartzite have greater resistance to acids such as sulphuric acid than basalt and are preferred if acids such as sulphuric acid are likely to be encountered where the pipes are to be laid. It has been found that stronger pipes are obtained when the aggregate is first artificially dried. For best results when the aggregate is tested for moisture content by drying at 120°C for 3 hours the loss in weight should not exceed 0.5%.

The mixture may include a filler such as silica powder, talc, barytes, stone dust, brick dust, tile dust, carbon black and pigments.

The strength and absorption properties of the pipes will vary with the ratio and type of aggregate, filler and resin.

The curing of the pipe can be done at ambient temperatures but curing will be accelerated by the application of heat. It is known that water will retard curing of pure epoxy and polyester resins but steam curing at atmospheric pressure at a temperature of 150°F has been found not to retard or stay the curing of pipes made in accordance with the invention using epoxy and polyester resins. Although some loss of strength may occur if the pipe is steamed immediately after manu-

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facture and/or subjected to steam for more than 2 hours it has been found generally satisfactory to start steam curing immediately and to continue for 2 hours at 120°F—140°F. The pipe is then removed from the mould. Polyester-aggregate pipes have been stripped satisfactorily after $\frac{1}{2}$ hour steaming at 130°F whilst, with ambient temperatures of 95°F—100°F, polyester-aggregate pipes have been stripped within $\frac{1}{2}$ hour from completion of manufacture without heating.

The pipes according to the invention may include steel reinforcements as used in concrete pipes; however because of the great strength of resin - aggregate pipes reinforcement is not usually needed.

For polyester-aggregate mixtures most normal concrete pipe mould release agents are satisfactory particularly if applied just prior to pipe manufacture. A natural resin varnish was found to be effective with epoxy-aggregate mixtures. Where bonding to a steel mould can be expected a hard grease applied over a warm mould was effective. Paper mould liners attached to the mould by adhesives may also be used.

Normal pan or paddle mixers as used in the concrete industry are satisfactory for mixing the resin and aggregate and other ingredients. The dry materials can be mixed first then the premixed liquid ingredients added. If the resin is high in viscosity or solid a steam jacketed mixer may be used. Mixing times for a polyester-aggregate mixture may be 1 minute for the dry materials and $1\frac{1}{2}$ minutes after adding the resin. Fine fillers may be added last of all and may be mixed in the mixture for 1 minute.

A suitable resin-aggregate mixture to form the pipe of the invention is as follows (parts are by weight)

- 10.6 $\frac{1}{4}$ " size crushed basalt
- 6.6 sand of a grading suitable for the production of high quality concrete
- 1.0 fine filler (talc)
- 1.04 polyester, curing agent and additives.

In the testing of pipe samples produced in accordance with the invention in respect of their chemical resistance properties no observable effect occurred on polyester-aggregate, coal tar epoxy-aggregate and epoxy-aggregate samples when tested for 1 year in closed bottles containing respectively 5% lactic acid, 5% sulphuric acid, 5% acetic acid, 5% hydrochloric acid, 5% nitric acid. Concrete control samples tested under the same conditions were seriously corroded.

In the testing of similar pipe samples in respect of their weathering, water resistance and absorption properties—

(1) No observable effect occurred on the samples after exposure for 1 year to weather and to 1472 hours in an Atlas Weatherometer,

(2) When tested to Australian Standard A35—1957 the absorption of the samples was less than 0.6% whereas high quality spun concrete pipes absorbed 4 to 5%. Air dried samples of pipes according to the invention absorbed less than 1% water after 18 months immersion in water,

(3) Abrasion resistance tests on cubes of 1—18 resin/aggregate samples in a tumbler charged with water and sand indicated that they abraded less than the same size cubes of asbestos cement, concrete and earthenware.

Internal water pressure tests of samples of pipes according to the invention showed ultimate circumferential tensile strengths up to 700 to 1600 p.s.i. for 1/18 polyester-aggregate pipe. The same pipe showed a compressive strength of 10500 to 13000 p.s.i.

Impact tests indicated that pipes according to the invention had an impact resistance superior to concrete and earthenware pipes in a falling weight test.

In septic sewage tests pipes according to the invention exposed to a septic sewer for 1 year showed no effect whereas adjacent concrete pipes corroded seriously in the same period.

The following table illustrates the effect of the method of compaction on absorption in respect of a pipe according to the invention.

50

55

60

65

70

75

80

85

90

95

1 part polyester resin

Method of Compaction	% Absorption by A.S.A37—1957 Method	% Absorption after 1 month <u>air</u> dried sample in water
By method of patent application	$\begin{cases} 0.55 \\ 0.25 \\ 0.34 \end{cases}$	$\begin{cases} 0.32 \\ 0.21 \\ 0.19 \end{cases}$
Vibrated	4.7	0.55
Spun and Screeded	1.64	0.64
Vibrated while weight applied to Surface	3.8	0.70
Compressed at 700 psi.	—	1.9
Spun	—	2.2
Compressed at 1100 p.s.i.	—	3.6
Rammed	—	5.8

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4. The pressure is then reduced allowing the roller to attain its original speed. The speed differential between the mould 8 and the roller 4 causes the roller to be cleaned of the adhering material. Pressure is then re-applied on the resin-aggregate mixture and these steps are repeated as long as some of the mixture adheres to the roller. When this no longer occurs and compaction is completed, the pipe is cured and removed from the mould.

WHAT WE CLAIM IS:—

1. A resin-aggregate pipe or a composite pipe composed partly of resin-aggregate and partly of concrete or similar material, in which the proportion of resin to aggregate in the pipe or in a part of the pipe is less than 1 part of resin to 12 parts of aggregate by weight.
2. A resin-aggregate pipe or a composite pipe according to claim 1, wherein the proportion of resin to aggregate in the pipe or in part of the pipe is between 1 part of resin to 12 parts of aggregate by weight and 1 part of resin to 20 parts of aggregate by weight.
3. Method of manufacturing a resin-aggregate pipe or a composite pipe as claimed in claim 1 or claim 2, utilizing a rotatable pipe forming mould, a compacting roller mounted to extend longitudinally of the mould rotatable on an axis parallel to the axis of the mould and movable towards and away from the adjacent internal surface of the mould, and means for applying pressure transversely of the compacting roller to urge the compacting roller towards the adjacent inner surface of the mould, the method comprising the steps of introducing a pipe formable resin-aggregate mixture in which the proportion of resin to aggregate is less than 1 part of resin to 12 parts of aggregate by weight into the mould, rotating the mould to apply centrifugal force to the mixture to form the pipe, moving the compacting roller into contact with the pipe being formed and rotating the compacting roller at a speed greater than the speed of rotation of the mould, applying pressure to the compacting roller to force the compacting roller against the pipe being formed to compact the mixture, reducing the pressure exerted by the compacting roller on the pipe being formed when portions of the mixture adhere to the compacting roller, increasing the pressure exerted by the compacting roller on the pipe being formed when the difference in the speed of rotation between the mould and the compacting roller causes the adhering portion of the mixture to be cleaned from the compacting roller, and repeating the steps of reducing and increasing the pressure exerted by the compact-

ing roller on the pipe being formed until portions of the mixture no longer adhere to the compacting roller and the pipe is compacted.

4. Method according to claim 3, wherein the proportion of resin to aggregate in the mixture is between 1 part of resin to 12 parts of aggregate by weight and 1 part of resin to 20 parts of aggregate by weight.

5. Method of manufacturing a resin-aggregate pipe or a composite pipe as claimed in claim 1 or claim 2, utilizing a rotatable pipe forming mould, a compacting roller mounted to extend longitudinally of the mould rotatable on an axis parallel to the axis of the mould and movable towards and away from the adjacent internal surface of the mould, and means for applying pressure transversely of the compacting roller to urge the compacting roller lengthwise towards the adjacent inner surface of the mould, the method comprising the steps of introducing a pipe formable monomer - polymerization catalyst-aggregate mixture in which the proportion of monomer to aggregate is less than 1 part of monomer to 12 parts of aggregate by weight into the mould, rotating the mould to apply centrifugal force to the mixture to form the pipe, rotating the compacting roller at a speed greater than the speed of rotation of the mould out of contact with the pipe being formed, moving the compacting roller into contact with the pipe being formed, applying pressure to the compacting roller to force the compacting roller against the pipe being formed to compact the mixture, reducing the pressure exerted by the compacting roller on the pipe being formed when portions of the mixture adhere to the compacting roller, increasing the pressure exerted by the compacting roller on the pipe being formed when the difference in the speed of rotation between the mould and the compacting roller causes the adhering portion of the mixture to be cleaned from the compacting roller, repeating the steps of reducing and increasing the pressure exerted by the compacting roller on the pipe being formed until portions of the mixture no longer adhere to the compacting roller and the pipe is compacted, and then heat curing the formed pipe so that the monomer is converted into resin.

6. Method according to claim 5, wherein the proportion of monomer to aggregate in the mixture is between 1 part of monomer to 12 parts of aggregate by weight and 1 part of monomer to 20 parts of aggregate by weight.

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4. The pressure is then reduced allowing the roller to attain its original speed. The speed differential between the mould 8 and the roller 4 causes the roller to be cleaned of the adhering material. Pressure is then re-applied on the resin-aggregate mixture and these steps are repeated as long as some of the mixture adheres to the roller. When this no longer occurs and compaction is completed, the pipe is cured and removed from the mould.

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2. A resin-aggregate pipe or a composite pipe according to claim 1, wherein the proportion of resin to aggregate in the pipe or in part of the pipe is between 1 part of resin to 12 parts of aggregate by weight and 1 part of resin to 20 parts of aggregate by weight.
3. Method of manufacturing a resin-aggregate pipe or a composite pipe as claimed in claim 1 or claim 2, utilizing a rotatable pipe forming mould, a compacting roller mounted to extend longitudinally of the mould rotatable on an axis parallel to the axis of the mould and movable towards and away from the adjacent internal surface of the mould, and means for applying pressure transversely of the compacting roller to urge the compacting roller towards the adjacent inner surface of the mould, the method comprising the steps of introducing a pipe formable resin-aggregate mixture in which the proportion of resin to aggregate is less than 1 part of resin to 12 parts of aggregate by weight into the mould, rotating the mould to apply centrifugal force to the mixture to form the pipe, moving the compacting roller into contact with the pipe being formed and rotating the compacting roller at a speed greater than the speed of rotation of the mould, applying pressure to the compacting roller to force the compacting roller against the pipe being formed to compact the mixture, reducing the pressure exerted by the compacting roller on the pipe being formed when portions of the mixture adhere to the compacting roller, increasing the pressure exerted by the compacting roller on the pipe being formed when the difference in the speed of rotation between the mould and the compacting roller causes the adhering portion of the mixture to be cleaned from the compacting roller, and repeating the steps of reducing and increasing the pressure exerted by the compact-

ing roller on the pipe being formed until portions of the mixture no longer adhere to the compacting roller and the pipe is compacted.

4. Method according to claim 3, wherein the proportion of resin to aggregate in the mixture is between 1 part of resin to 12 parts of aggregate by weight and 1 part of resin to 20 parts of aggregate by weight.

5. Method of manufacturing a resin-aggregate pipe or a composite pipe as claimed in claim 1 or claim 2, utilizing a rotatable pipe forming mould, a compacting roller mounted to extend longitudinally of the mould rotatable on an axis parallel to the axis of the mould and movable towards and away from the adjacent internal surface of the mould, and means for applying pressure transversely of the compacting roller to urge the compacting roller lengthwise towards the adjacent inner surface of the mould, the method comprising the steps of introducing a pipe formable monomer - polymerization catalyst-aggregate mixture in which the proportion of monomer to aggregate is less than 1 part of monomer to 12 parts of aggregate by weight into the mould, rotating the mould to apply centrifugal force to the mixture to form the pipe, rotating the compacting roller at a speed greater than the speed of rotation of the mould out of contact with the pipe being formed, moving the compacting roller into contact with the pipe being formed, applying pressure to the compacting roller to force the compacting roller against the pipe being formed to compact the mixture, reducing the pressure exerted by the compacting roller on the pipe being formed when portions of the mixture adhere to the compacting roller, increasing the pressure exerted by the compacting roller on the pipe being formed when the difference in the speed of rotation between the mould and the compacting roller causes the adhering portion of the mixture to be cleaned from the compacting roller, repeating the steps of reducing and increasing the pressure exerted by the compacting roller on the pipe being formed until portions of the mixture no longer adhere to the compacting roller and the pipe is compacted, and then heat curing the formed pipe so that the monomer is converted into resin.

6. Method according to claim 5, wherein the proportion of monomer to aggregate in the mixture is between 1 part of monomer to 12 parts of aggregate by weight and 1 part of monomer to 20 parts of aggregate by weight.

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