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(54) IMPROVEMENTS RELATING TO METHODS OF PRODUCING FLEXIBLE TUBULAR STRUCTURES FOR USE IN LINING PASSAGEWAYS

(71) We, INSITUFORM (PIPES & STRUCTURES) LIMITED, a British Company, of 12B Station Road, Ince, Nr. Chester, Cheshire, 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:—

This invention relates to a method of producing flexible tubular structures for use in lining passageways in the manner set forth herein. The invention also relates to tubular structures produced by the method. By the expression "passageways" as used herein is intended to mean the bores of ducts, pipes and channels which may be above or below ground, as well as underground tunnels, passages, sewers and shafts.

By the expression "lining passageways as set forth herein" is meant the known method wherein a tubular structure comprising a tube of felt which is contained in a tube of gas impermeable film is everted into the passageway to be lined and is held against the passageway by fluid pressure. The felt material is soaked with, effectively to become embedded in, a synthetic resin, such as polyester resin, which cures to a hard state forming a rigid lining to the passageway, the felt being embedded in the hard resin so as not to be visible when the resin has set hard. The felt serves the purpose of strengthening the hardened resin particularly against impacts, and also improves the tensile strength of the hardened resin. The tubular structure when the resin is wet, is shaped by means of fluid which presses against the material to shape same against the passageway to be lined.

Whilst the known method has proved extremely valuable for lining passageways, the positioning of the felt tube inside the film creates an inconvenience and when the resin has set hard frequently the film will not either come away cleanly from the hard

resin or will not adhere to it effectively over the entire surface of the resin.

The present invention is concerned with providing a method of producing a flexible tubular structure for use in lining passageways in the manner set forth herein whereby the aforesaid disadvantages are obviated or mitigated.

A method of producing a flexible tubular structure for use in lining passageways in the manner set forth herein wherein a web of felt is coated on one side with a gas impermeable layer of synthetic resin so that the resin bonds to the felt and the coated felt is formed into tubular form with the resin layer to the outside. The felt preferably is of acrylic, polystyrene, polypropylene, polyester or polyurethane fibres and/or filaments and the coating resin may be polyurethane, polypropylene or acrylic resin.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, wherein:—

Fig. 1 is a diagrammatic side view showing how a polyurethane coating is applied to a felt;

Fig. 2 is an enlarged sectional elevation of the felt with a polyurethane coating applied thereto; and

Fig. 3 illustrates the method of applying the lining material to a passageway.

Referring to the drawings, in Fig. 1 a polyester or similar felt is indicated by numeral 10 and a calendar roller indicated by numeral 12. The calendar roller 12 is adapted to apply polyurethane in molten state from a bath 14 so as to form a thin flat film 16 of polyurethane on the side of the felt 10 which is presented to the calendar roller 12, the felt at this stage being a flat web.

The coating is applied under heat and pressure so as to form the composite material illustrated in enlarged detail in Fig.

2 in which the resin is blended to the felt. It will be seen that the film 16 presents a smooth surface finish to the side of the felt 10 to which it is applied. The bonding between the film 16 and the film 10 is mechanical in nature as hereinbefore described. The thus coated felt is formed into a tubular structure with the coating outside.

Fig. 3 shows diagrammatically how a tubular structure composed of the material illustrated in Fig. 2, after being formed into a tubular structure, can be applied to form passageway linings.

In the arrangement shown in Fig. 3 the tubular structure is everted into the passageway by filling the inside of the structure with liquid which buoyantly supports the resin impregnated structure as it passes along the inside of the already everted tube structure before being exerted. The felt 10 may be wetted out with resin after being everted, but certainly before it is applied to the passageway surface.

The coating 16 of course remains with the felt after the lining is formed and will provide a gas impermeable barrier for the lining material, even although the material is subjected to local stressing which causes cracking of the resin and which would, if the coating 16 were not provided, create areas where gas could permeate through the lining material.

The present invention is extremely suitable for the lining of gas mains where leak-proof lining is extremely important.

Instead of the lining being placed in position using only liquid as described in relation to the Fig. 3 embodiment, liquid may be used in conjunction with gas under pressure.

The liquid partially fills the inside of the everting structure so that the portion to be everted floats on the liquid surface. The gas under pressure fills the remainder of the interior space. This partial filling with a liquid so that the liner floats on the surface thereof is useful for larger pipes, but for smaller pipes the liquid will completely

fill the interior of the passageway and the liner will be suspended in the liquid so as to be buoyantly supported thereby before it is everted, as described with reference to Fig. 3.

Other materials for the felt and coating resin may be used. Thus, polystyrene and polypropylene felt can be used with polypropylene and acrylic felt can be used with acrylic resin.

It will be appreciated that manufacture of the tubular structure is much facilitated as compared with the known method, and that the coating 16 will effectively remain with the felt after placement of the tubular structure.

WHAT WE CLAIM IS:—

1. A method of producing a flexible tubular structure for use in lining passageways in the manner set forth herein, wherein a web of felt is coated on one side with a gas impermeable layer of synthetic resin so that the resin bonds to the felt and the coated felt is formed into tubular form with the resin layer to the outside.

2. A method according to Claim 1, wherein the coating resin is of polyurethane and the felt is of polyester or polyurethane fibres and/or filaments.

3. A method according to Claim 2, wherein the layer of polyurethane is applied to the felt by calendering a molten mass onto the felt under the action of heat and pressure.

4. A method of producing a flexible tubular structure for use in lining passageways in the manner set forth substantially as hereinbefore described.

5. A flexible tubular structure produced in accordance with the method of any one of the preceding claims.

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