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CONVENTION APPLICATION FOR A PATENT

$60.00 $60.00

We SHELTER ENGINEERING LIMITED and M J McKENDRY LIMITED,
both New Zealand companies

of 54 Leeds Street, Christchurch, New Zealand, and
26 Telfourd Place, Christchurch, New Zealand, respectively

hereby apply for the grant of a Patent for an invention entitled:

"METHOD OF CONSTRUCTION"

which is described in the accompanying complete specification.

This application is a Convention application, and is based on an
Application for a Patent or similar protection made under:-


address for service is care of G.R. CULLEN & COMPANY, Patents
Attorneys, of 289 Queen Street, Brisbane, in the State of
Queensland, Commonwealth of Australia.

DATED this THIRTEENTH day of NOVEMBER, 1981.

SHELTER ENGINEERING LIMITED and
M J McKENDRY LIMITED

By their Patent Attorneys,
G.R. CULLEN & COMPANY

To:
The Commissioner of Patents.
METHOD OF CONSTRUCTION

SHELTER ENGINEERING LTD and McKENDRY M.J. LTD.

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(57) Claim

1. A method of constructing a rigid shell structure comprising:
   inflating an inflatable sealed envelope formed from an elastic membrane, encasing the outer surface of the envelope with reinforcing and applying to the envelope and reinforcing a settable material which after application hardens to be self supporting.
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Name of Applicants SHELTER ENGINEERING LIMITED and M J McKENDRY LIMITED
Address of Applicants 54 Leeds Street, Christchurch, New Zealand and 26 Talfourd Place, Christchurch, New Zealand, respectively

Actual Inventor: DAVID GORDON ASHTON


COMPLETE SPECIFICATION FOR THE INVENTION ENTITLED:

"METHOD OF CONSTRUCTION"

The following statement is a full description of the invention including the best method of performing it known to us:
This invention relates to a method of constructing rigid shell structures and more particularly but not exclusively to the construction of structures which are used for storage of liquid such as water storage tanks.

Water storage tanks constructed from concrete are well known and are in wide usage on farms or in areas where there is no water reticulation. Such tanks are generally of cylindrical shape with a flat base portion and a conical or flat roof portion. The tanks are typically constructed from reinforced concrete and are normally fabricated in a construction yard and then transported to the site where they are to be used. Unfortunately the transportation of these tanks can often result in damage thereto. Such damage can, for example, be in the form of cracks in the wall due to stresses set up in the tank during transportation or during loading to and unloading from the transporter. Such damage during delivery can in severe cases render the tank unusable or in other cases can reduce the effective service life of the tank.

The normal method of construction of such tanks is to first form the base of the tank allowing an extension of the wall reinforcing beyond the base. Boxing or shuttering is then erected on the inside to the reinforcing which is lightly nailed followed by a hand-spread or sprayed plaster mix. Following formation of the wall the roof is formed by erection of suitable boxing or shuttering and reinforcing following which plaster is poured. The boxing or shuttering within the
tank is removed through an opening in the roof once the concrete has cured. The interior of the tank is then plastered.

This method of construction is time consuming and labour intensive. As skilled workers are normally required the final cost of the tank includes a high proportion of labour costs.

Tanks of this type have a limited service life due to the porosity of the concrete from which they are formed. Over a period of time therefore the tanks lose their ability to effectively retain water or other liquids therein and this usually results in the tank needing to be replaced.

The object of the present invention is to provide a method of constructing rigid shell structures which is straightforward and less expensive than those hitherto known.

According to a first broad aspect of the invention there is provided a method of constructing a rigid shell structure comprising inflating an inflatable sealed envelope formed from an elastic membrane, encasing at least part of the outer surface of the envelope with reinforcing and applying to the envelope and reinforcing a settable material which after application hardens to be self supporting.

In the following more detailed description of the invention reference will be made to the accompanying drawings in which:-

Figure 1 is a sectioned elevational view of a water tank constructed according to the method of the invention,
Figure 2 is a sectional plan view of the tank shown in Figure 1, and

Figure 3 is a detailed sectional elevational view of the base, membrane and reinforcing prior to application of the settable material, and

Figure 4 is a detailed sectioned elevational view showing a method of forming an opening in the roof of the tank shown in Figures 1 and 2.

Whilst the specific disclosure which will follow relates to a rigid shell structure which is primarily useful for the storage of water: the shell structure according to the invention can be used for other purposes such as the storage of fluids, the storage of granular material, a dangerous goods store, a shed or the like.

The tank 10 is constructed around a former which is formed by an inflatable sealed envelope 11. The sealed envelope 11 is constructed from an elastic material membrane such as, for example, butyl rubber. The envelope 11 is constructed according to known methods and is pre-shaped to approximate the shape of the final structure. For example when a tank 10 of the type illustrated in the drawings is being constructed the inflatable envelope is of essentially cylindrical shape. An opening (not shown) into the envelope is provided for attachment to a source of pressurised air.

The base 12 of the tank 10 is formed in accordance with known procedure and in the case of a water tank is of circular
shape with internal reinforcing. Hairclip reinforcing 13 is provided around the periphery of the base. Base 12 is normally cast from concrete and has a diameter which is slightly larger than the diameter of the inflated sealed envelope 11.

The envelope 11 is placed on the base 12 and then inflated by pressurised air from an air source. When inflated the envelope 11 provides a substantially vertical wall portion 14 and a domed roof portion 15. The wall portion 14 curves into the base as shown more clearly at 14a in Figure 3.

Chain link mesh 17 is then wrapped around the periphery of the envelope 11 and is tied into the hairclip reinforcing 13 of the base 12.

Wire 18, of for example 8 gauge, is then placed around the top of the chain link mesh 17 to draw this onto the curved transition 15a between the domed top portion and wall portion 14 of envelope 11. Square mesh 19 is then placed over the domed top 15 and tied at 20 onto the top of the chain mesh 17.

A helical coil (not shown in the interests of clarity of drawing) of high tensile wire, for example 10 gauge, is then wound around the reinforcing to complete the reinforcement structure.

In the preferred form of the invention wire ties 21 are vulcanised onto the roof portion 15 of the envelope 11. Preferably these ties 21 are vulcanised onto the roof portion 15 of the envelope 11 during its construction. The ties 21 are attached as shown to the square mesh 19 so that there is a
mechanical tie between the inflated envelope and the reinforcing which will be in the roof of the structure. This means that the domed roof portion 15 of the envelope is mechanically supported by mesh 19 once the inflation pressure is removed.

Further air pressure is then applied to the envelope 11 so that the envelope is pressed out against the mesh and in fact bulges into the openings in the mesh as can be seen in Figure 3.

A settable material such as concrete 22 or foamed polyurethane is then sprayed, plastered, or otherwise applied to the reinforcing and inflated envelope. In the preferred form of the structure concrete is used and this can have additives to prevent it from slumping. Additives could also include an adhesive to ensure that the cement adheres to the envelope though this is not strictly necessary as a mechanical bond is set up between the concrete, reinforcing and envelope once the concrete has been applied and set.

When the concrete is applied to the structure it is firstly forced into the area 23 between the curved lower portion 14a of the envelope wall 14 and the base 12 thereby forming an internal strengthening cove 24.

When a manhole or opening 25 is to be formed in the roof 26 of the tank 10 an opening 27, in the position where the manhole is to be situated, is formed in the membrane. As can be seen in Figure 4 of the drawings the peripheral edge portion
28 of the cutaway portion of the membrane is provided with slots 29 whereby the edge portion 28 can be located over the wire members 30 of the square mesh reinforcing 19. A sacrificial area 31 of membrane material is adhered to in the side surface of the membrane to close the opening 25. A steel ring 32 is placed on the sacrificial membrane 31 and functions as a former for the settable material when it is applied to the reinforcing envelope structure and therefore defines the periphery of the manhole of the finished structure.

Once the first layer of settable material such as concrete has cured a second coat can be applied though in most situations where concrete is being used the second coating is basically only a texturising layer. With concrete it is usual to allow a 24 hour curing period before the second layer is applied.

Once the second layer has cured the steel ring former 32 is lifted and the sacrificial area 31 of membrane is cut away. The manhole is thus formed.

In the preferred form the envelope 11 is left within the structure as this provides an internal sealing liner. This means that if any cracks appear in the wall of the structure during transportation thereof the water tightness of the tank is not lost due to the presence of the membrane lining. A tank constructed according to the method of this invention can thus be transported with greater assurance as any cracking which may occur does not impair the use of the tank. In addition the
membrane when formed of a material such as a butyl rubber is long lasting and the problems normally associated with porosity in conventional concrete tanks are not experienced with tanks constructed according to the present invention.

The method according to the invention thus provides a means of constructing a rigid shell structure which does not require the formation of fixed boxing or shuttering as is the case with conventional methods of constructing water tanks, like storage tanks or sheds. The shape of the tank is dictated by the inflated envelope which is covered with the reinforcing mesh and rigidity is imparted to the whole structure by the settable material. The construction method is such that if required a tank can be manufactured in situ rather than with the present method of construction where manufacture must take place in a construction yard following which the finished structure is transported to the site of use. The tank is longer lasting and robust due to the internal sealing membrane.
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A method of constructing a rigid shell structure comprising inflating an inflatable sealed envelope formed from an elastic membrane, encasing the outer surface of the envelope with reinforcing and applying to the envelope and reinforcing a settable material which after application hardens to be self supporting.

2. The method according to claim 1 wherein the elastic membrane is formed from butyl rubber.

3. The method according to claim 1 or 2 wherein the sealed envelope is located on a support surface which is to become an integral part of the rigid shell structure.

4. The method according to claim 3 wherein the reinforcing is coupled to the support surface.

5. The method according to claim 4 wherein the reinforcing is tied into reinforcing members protruding from said support surface.

6. The method according to any one of the preceding claims wherein the sealed envelope is mechanically tied to at least part of said reinforcing prior to application of the settable material.

7. The method according to any one of the preceding claims wherein the settable material is a foamed plastics material.

8. The method according to any one of claims 1 to 6 wherein the settable material is concrete.

9. A method of constructing a rigid shell structure as claimed in claim 1 and substantially as herein described.
10. A method of constructing a rigid shell structure comprising inflating a sealed envelope on a support surface, encasing the inflated envelope within reinforcing, coupling said reinforcing to the support surface, applying the envelope and encasing reinforcing at least one layer of a settable material and allowing said settable material to cure.

11. The method as claimed in claim 10 wherein the support surface is formed by a base member having coupling members which are mechanically coupled to said encasing reinforcing.

12. The method as claimed in claim 10 or 11 wherein the envelope is further inflated after said encasing reinforcing is positioned thereabout.

13. The method as claimed in claim 10, 11 or 12 wherein the encasing reinforcing is formed by square mesh and chain link mesh with coiled wire encircling at least part thereof.

14. The method as claimed in claim 12 wherein the sealed envelope is of cylindrical shape such that when inflated it forms a substantially vertical side wall portion extending up from said support surface and a domed top portion.

15. The method as claimed in claim 14 wherein chain link mesh is located about said side wall portion with the upper portion thereof constrained to follow the contour of said envelope at the transition between said side wall and domed top portions, said upper portion of the chain link mesh being tied to square mesh located about said domed top portion.
16. The method as claimed in claim 15 wherein coiled wire is wrapped about said square mesh and chain link mesh reinforcing.

17. The method as claimed in any one of claims 14 to 16 wherein the domed top portion of the sealed envelope is mechanically coupled to the reinforcing.

18. The method as claimed in claim 17 wherein ties are connected to the membrane surface at the domed top portion and these ties are connected to the reinforcing.

19. The method as claimed in any one of claims 10 to 18 wherein the settable material is at least one layer of concrete.

20. The method as claimed in any one of claims 10 to 18 wherein the settable material is a foamed plastics material.

21. The method as claimed in any one of claims 10 to 20 wherein the envelope is formed from a butyl rubber material.

22. The method as claimed in any one of claims 11 to 19 and 21 wherein the base is a concrete slab.

23. The method as claimed in any one of claims 10 to 22 wherein the envelope is removed following application and setting of said settable material.

24. A method as claimed in claim 10 and substantially as herein described.

25. A rigid shell structure when formed according to any one of claims 1 to 9.

26. A rigid shell structure when formed according to any one of claims 10 to 24.
27. A water tank when formed according to any one of claims 10 to 24.

28. A water tank substantially as herein described with reference to the accompanying drawings.

DATED THIS THIRTEENTH DAY OF NOVEMBER, 1981.

SHELTER ENGINEERING LIMITED and

M J MCKENDRY LIMITED

By their Patent Attorneys,

G.R. CULLEN & COMPANY.
Including the best method of performing it known to us:

FIG. 1.

FIG. 2.