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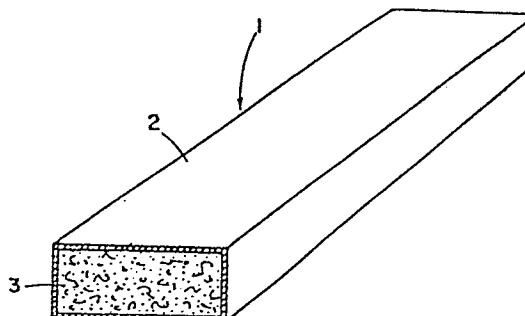
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⑤④ **Peripherally stressed composite structural units.**

⑤⑦ Prestressed composite structural elements, such as columns and beams comprise an open hollow member which is defined by enclosing walls which walls have internal and external side means, a first shear stress being applied to the said external side means and a filler material in said elements having an opposing shear pre-stress.



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"Peripherally stressed Composite Structural Units"

The present invention is concerned in general with structural elements and more particularly with prestressed composite structural elements.

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Structural engineers have shown that composite material can include the beneficial characteristics of each of the materials of which the composite is fabricated. Thus, for example, reinforced concrete beams provide the compression characteristics of concrete and the tensile characteristics of steel.

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It is known that the characteristics of the composite steel and concrete structural element are improved by prestressing the metallic rods which are included in concrete beams. The prestressing for example puts a pre-tensile stress on the metallic rod that is put into the concrete beam which in turn places a compressive stress on the concrete. This reactionary stress on the concrete improves among other things the Poissons ratio of the composite elements.

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Engineers and scientists are continuously searching for new and improved composites. One of the problems with present day beams is that while they are extremely resistive to tensile and compressive stresses they tend to buckle under certain adverse conditions.

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Thus it has long been a problem to find a beam that is more resistant to buckling than the presently available composite structures.

5 Accordingly it is an object of the present invention to provide new and improved composite structural elements in which the above-referred to disadvantages are substantially reduced or overcome. According to the present invention a composite structural element is provided; said element comprising:

10 an open hollow structure,
 said structure defined by wall means,
 said wall means having internal side means and external side means,
 a first shear stress applied to said external sides, and
15 a filler material in said structure having an opposing shear pre-stress.

A further feature of the present invention provides a method of fabricating such a structure. The method comprises the steps of:

20 forming a hollow structure,
 placing the hollow structure under a first pressure,
 inserting a settable filler under a second pressure into said hollow structure, and
 substantially maintaining said pressure while said filler
25 sets.

Yet another feature of the invention provides a periphery stress composite structural element.

Yet another feature of the present invention provides for



the external walls of the structure being metallic while said settable filler being concrete.

Yet another feature of the invention provides for a sandwich construction of said peripheral stress composite wherein prestressed metallic rod means is inserted within said composite element and wherein said walls of said structure are metallic and said fillable material is concrete, said walls being peripherally prestressed while said concrete is also prestressed. To obtain the above-described sought-for results the filler injection pressure must be a function of such things as the:

- a) profile cross-section of the element;
- b) thickness of the metal wall;
- c) length of the element; and
- d) injection pressure variation with time - from zero to final nominal pressure.

Yet another feature provides for a perforated outer wall through which the filler can extrude and solidify as dendrites attached to the outer wall of the element. The inner part of the element is fabricated as are the previously shown elements.

The operation and the utilization of the present invention will be more fully apparent from the description of a preferred embodiment taken in conjunction with the following drawings, in which:

Fig. 1 is a pictorial showing of an embodiment of the composite structural element;

Fig. 2 is a cross-section of another embodiment of the composite structural element which includes rod means;



Fig. 3 is a cross-section of another embodiment of the composite structural element including liner means between the filler and the shell;

Fig. 4 is a cross-section of an embodiment of the composite structure which includes dendrite anchoring;

Fig. 5 is a pictorial showing of one method of fabricating the composite structural elements;

Fig. 6 is a pictorial showing of yet another embodiment having a multiplicity of different pressures; and

Fig. 7 is a pictorial showing of a composite element having a general "T" shape.

The composite structural element generally shown in pictorial form in Fig. 1 is shown as a rectangular beam 11. The beam is comprised of a walled hollow structure having a settable filler material 12 therein. The walled structure is shown as having top wall 13, bottom wall 14, side wall 16 and opposite side wall 17. The walls preferably are of steel and the settable material is preferably of concrete. However other composite materials are within the scope of the invention. In addition it must be noted that while the rectangular block is shown a cylindrical or other shaped composite structural element is also within the scope of this invention.

The cross-section showing of Fig. 2 includes a central rod 18 that also may be prestressed. Here again while a rectangular rod 18 is shown the rod as well as the structure may be cylindrical. In addition while one rod is shown in the structure 19 of Fig. 2,



more than one rod may be used. The placement of the rod or rods can also vary. The composite structure may also use inter alia Wirand* concrete, or other fiber reinforced concretes.

In 19 the filler material is shown as filler material 21, the top wall is wall 22, the bottom wall is wall 23, the side walls are shown as walls 24 and 26. It should be noted that here again cylindrical structure, triangular or other shaped structure can also be used,

In Fig. 3 the composite comprises an outer shell 41 preferably of metal. A liner or liners 42 surround the inner periphery of the shell. The filler is shown at 43. The filler under pressure forces the liner on the inner side of the shell to form a bonded surface between the shell and the filler. This method may protect the outer shell from the chemical action of the filler and vice versa. Also, the line adds sandwich properties to the outer stressed shell. There may be one or more liners made of a similar or different material. The bond between the liner and the shell or the liner and other liners may be accomplished by other means as well as by means of the pressures shown in Fig. 1.

Fig. 4 shows an interesting variation of the composite structural element 45 and the use thereof. The outer shell is shown as 46. There are a plurality of apertures 47 in the outer shell. The filler 48 is inserted into the outer shell under pressure P_I . The outer shell is however first placed in the ground 49 which exerts

*Wirand - Trade name of the Battelle developed metallic fibre reinforced concrete.



a pressure P_E on the element 45. When the filler is subjected to the pressure P_I , the filler is forced through the apertures to form dendrite-like roots. This embodiment is especially useful for anchoring piers in extremely moist, soft soil, such as sand for
5 example.

In Fig. 5 there is a diagrammatic showing of a pressurized chamber 27 in which the composite structural element is fabricated. Means are provided in the chamber for pressurizing the chamber. More particularly an inlet valve 28 leads from a high
10 pressure line at pressure P_E . The high pressure line is shown as line 29. The high pressure chamber is shown as having a top wall 31, a bottom wall 32 and side walls 33 and 34. The composite device 36 in the chamber 27 is shown as cylindrically shaped. A filler 37 is forced into the hollow cylindrical element 36 by a piston 38
15 acting through piston rod 39. The piston asserts a pressure P_I on the filler material 37. The piston maintains the pressure on the filler material while it is setting. Additionally the pressure P_E is maintained in the chamber 27 during the process of fabricating the composite element 36.

20 The embodiment of Fig. 5 demonstrates a composite element 56 fabricated using a plurality of prestressing pressures. The composite element comprises an outer shell subjected to a transverse pressure P_E and a longitudinal pressure P_1 . The shell surrounds a first filler filled compartment 58 having filler therein subjected
25 to a longitudinal pressure P_2 during the filling and setting process. An inner shell 59 defines yet another compartment 61. The shell 59 is preferably metal and subjected to a pressure P_3 which may be equal to, greater than the pressures P_1 and/or P_2 or may even be negative.



The inner compartment contains a filler or a rod at pressure P_4 which may be negative or less than, more than or equal to the other pressures.

Thus the composite element utilizes filler material that
5 is extremely resistant under compression and external material that is extremely resistant to tensile stresses. The materials are joined together while pressure is exerted on the hollow container and on the filler material in substantially normal directions. The resultant composite is a structural element that is extremely re-
10 sistant to buckling as well as capable of withstanding extreme compressive and tensile forces. The structural element is fabricated by maintaining a shear pressure on the hollow structure while maintaining a compressive stress on the filler as it hardens. In addition a reinforcing type rod or rods under tensile stresses may be
15 inserted into the filler and retained there during the hardening process.

The structure may undergo stress release treatment, if necessary. The "T" shaped composite element of Fig. 7 is especially useful for interconnecting other composites. The element of Fig. 7
20 is also a composite as taught herein. Other coupling shapes could of course be used.

While the principles of the invention have been described above in connection with specific apparatus and applications, it is to be understood that this description is made by way of example
25 only and not as a limitation on the scope of the invention.



CLAIMS:

1. A composite structural element comprising:
a hollow structure,
said structure defined by wall means,
said wall means having internal and external side means,
a first shear stress on said external sides, and
a settable filler material in said structure having a compressive stress thereon.
2. The composite structural element of Claim 1, wherein said hollow structure is cylindrical in cross-section.
3. The composite structural element of Claims 1 and 2, wherein said hollow structure is made of metallic material and said filler material is cement.
4. The composite structural element of Claim 3, wherein reinforcing rod means are located within said set filler material.
5. The composite structural element of anyone of Claims 1, 3 or 4, wherein said hollow structure is rectangular in cross-section.
6. The composite structural element of anyone of Claims 1 to 5, wherein liner means are included between said hollow structure and said filler material.
7. The composite structural element of anyone of Claims 1 to 6,

wherein said wall means comprises apertures therein enabling dendrites to form responsive to said compressive stress.

8. The composite structural element of anyone of Claims 1 to 7, wherein said hollow structure is divided by a plurality of walls into separated and defined hollow compartments, filler means in at least some of said plurality of compartments and a plurality of compressive stresses on said compartments and said walls separating said compartments.

9. The method of fabricating the composite structural elements of the preceding claims, said method comprising the steps of:

forming a hollow structure,
placing the hollow structure under a first pressure,
inserting a settable filler under a second pressure into
said hollow structure, and
maintaining said pressures while said filler sets.

10. The method of Claim 9, wherein said first and second pressures are normal to each other.

11. The method of fabricating a composite structural element of anyone of Claims 1 to 8 according to claims 9 or 10, wherein said first pressure is equal to 80 kg per sq. cm. and wherein said second pressure is equal to 100 kg per sq. cm.

12. The method of Claim 9, wherein said first pressure is applied normal to the sides, top and bottom of said hollow structure and wherein said second pressure is applied normal to the cross-

section of the opening of said open hollow structure.

13. The method of fabricating the composite structural element of anyone of Claims 9 to 12, wherein said open hollow structure is fabricated from steel and said filler material is concrete.

14. The composite structural element of anyone of Claims 1 to 8, wherein said element is characterized to couple together other composite structural elements.

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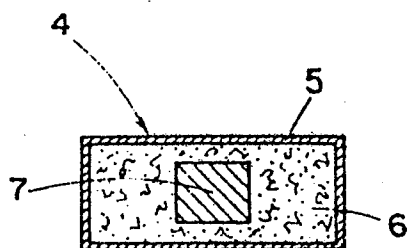


Fig. 2

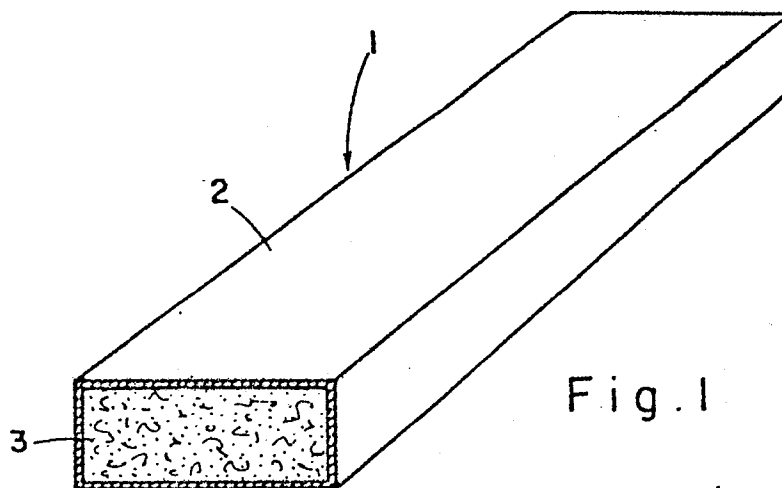


Fig. 1

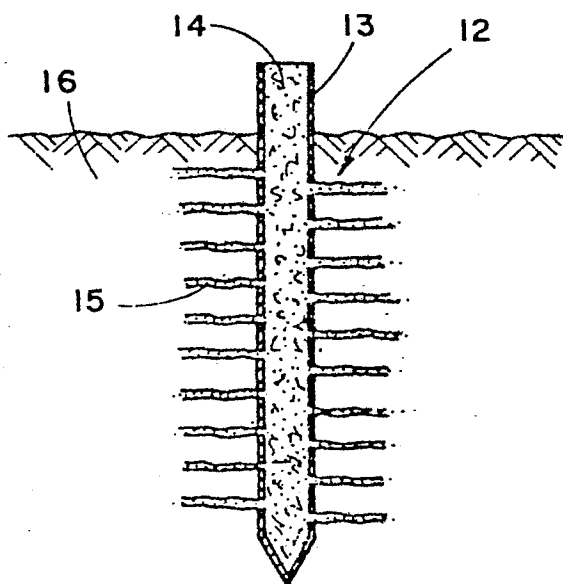


Fig. 4

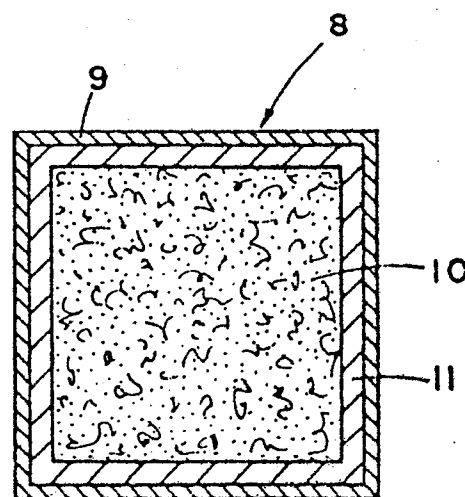


Fig. 3

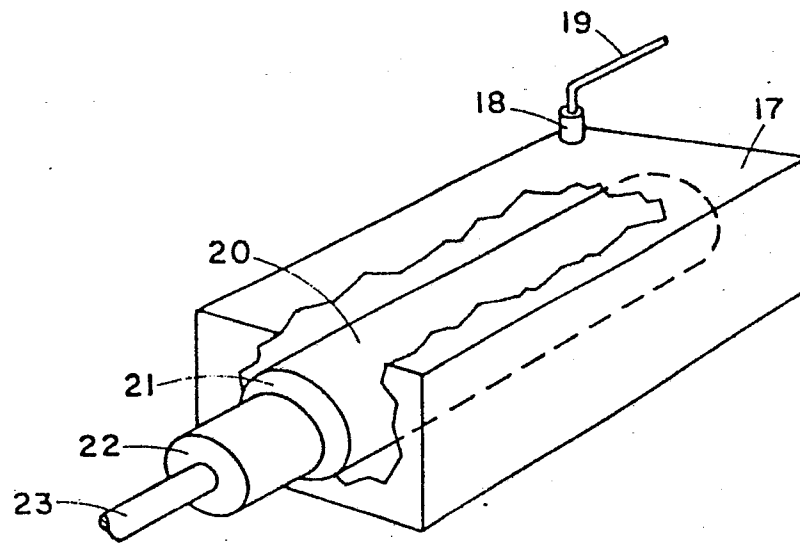


Fig. 5

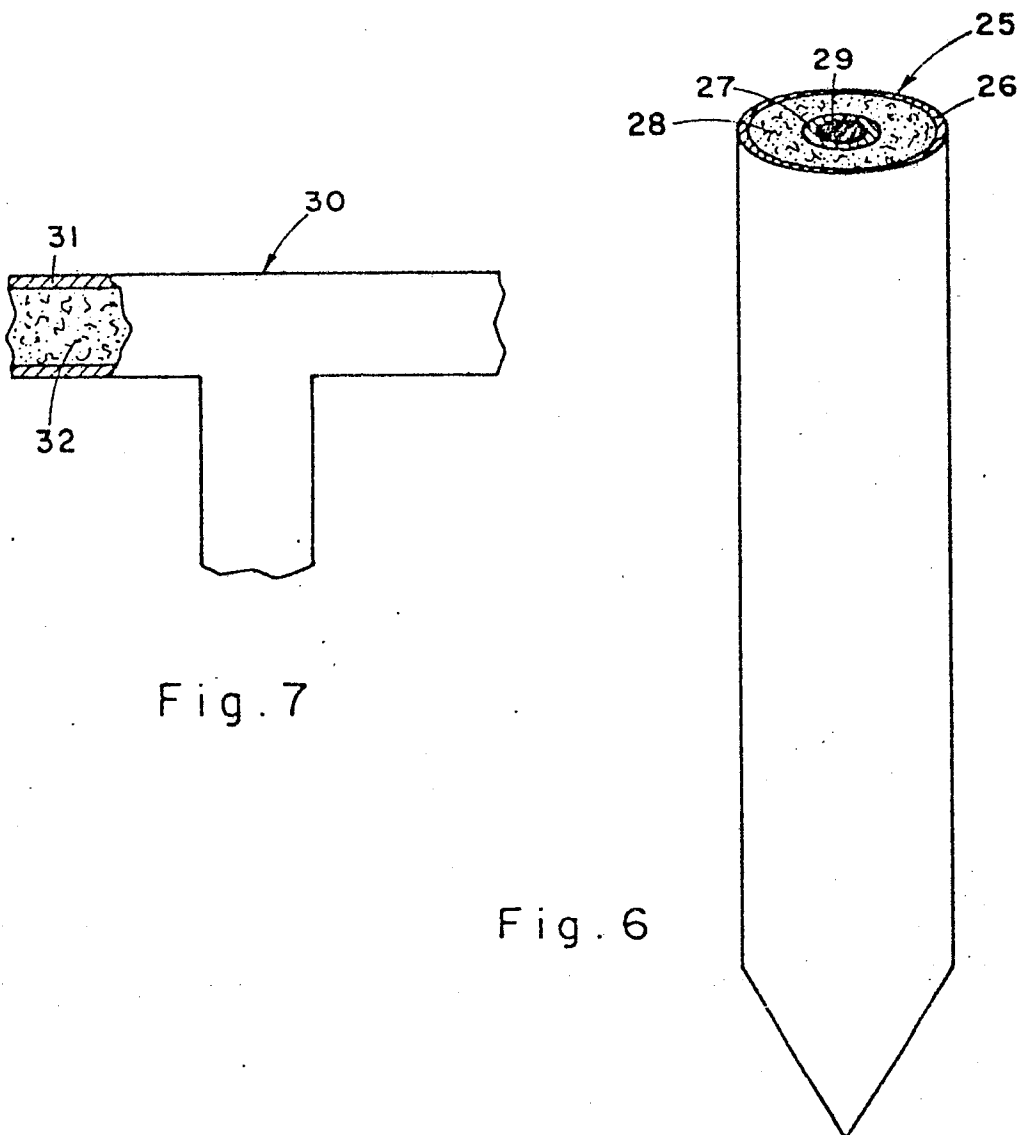


Fig. 7

Fig. 6