

A RAILWAY SLEEPER

FIELD OF THE INVENTION

5

This invention relates to a railway sleeper. In particular the invention relates to a railway sleeper which may be used as a replacement railway sleeper for timber railway sleepers and therefore will be described in this context. However, it should be appreciated that the railway sleeper may be used for other applications.

10

Railway sleepers are called ties in some countries so use of the term sleeper in this specification also refers to tie.

BACKGROUND OF THE INVENTION

15

Worldwide, the railway industry installs millions of railway sleepers each year. A significant number of these sleepers are used to maintain existing lines while the rest are used to construct new railway lines. The materials traditionally utilised for new railway sleepers are timber, concrete or steel.

20

Timber railway sleepers generally perform well, but changes in environmental awareness and rapidly diminishing supplies of high quality hardwoods have reduced their long held advantages. Further, the cost of timber railway sleepers is increasing year on year. With millions of timber railway sleepers requiring replacement each year in existing railway lines, there has been difficulty in finding suitable replacement railway sleepers from alternative materials.

25

Concrete railway sleepers have gained increasing acceptance, but their stiffness typically limits their use to locations where complete sleeper replacement is undertaken or where new track is constructed. Due to their increased depth (approximately 280mm compared to 120mm for hardwood timber) concrete sleepers cannot be readily used to replace single sleepers.

30

Further, this increased depth of the concrete railway sleepers also requires significantly more ballast than timber railway sleepers. Also concrete sleepers have a much higher stiffness than timber railway sleepers, making them unsuitable to replace timber railway sleepers in many applications where some compliance is desired.

The high weight of concrete sleepers (about three to four times that of timber sleepers) makes them expensive to transport and difficult to handle with conventional timber railway sleeper replacement technology.

Steel railway sleepers can be interspersed with timber sleepers but they are generally too light, have poor bearing characteristics, and require high maintenance.

A further difficulty with using steel or concrete to produce replacement timber railway sleepers is that the current fastening systems used for timber cannot be utilised. Accordingly, an alternative fastening system needs to be purchased and stocked as does the associated installation equipment. Also, training in the alternative fastening system needs to be undertaken by railway workers who are used to installing timber railway sleepers.

OBJECT OF THE INVENTION

It is an object of the invention to overcome or alleviate one or more of the above disadvantages or provide the consumer with a useful or commercial choice. It is the preferred object of this invention to enable railway sleepers to be produced with a similar depth/size as hardwood timber sleepers.

It is a further preferred object of the invention to allow railway sleepers to be produced with similar stiffness characteristics as hardwood timber sleepers.

It is a still further preferred object of the invention to allow railway sleepers to be produced with a weight similar to that of hardwood timber sleepers.

It is a still further preferred object of the invention to allow railway sleepers to be
5 produced cost effectively.

It is a still further preferred object of the invention to allow railway sleepers to be produced that have excellent durability and are able to resist biological and chemical attack.

10

It is a still further preferred object of the invention to allow railway sleepers to be produced that have no environmental restrictions that affect storage, handling and, eventually, disposal.

15 SUMMARY OF THE INVENTION

In one form, although not necessarily the broadest or only form, the invention resides in a railway sleeper comprising a body having a top face on which railway rails are located and a bottom face for placement on a ground surface, said body being formed
20 from:

- a polymer concrete comprising an amount of polymer resin and an amount of filler; and
- a plurality of fibre composite sandwich panels, each sandwich panel having a pair of fibre composite skins with a structural core material located
25 therebetween;

wherein the fibre composite sandwich panels extend longitudinally within said body.

Within this patent specification the general term polymer concrete is intended to mean a mixture of aggregate and polymer where the polymer substitutes for the
30 Portland cement used in more conventional concrete.

Preferably said body is moulded and includes two formed rail seats. The rail seats may include a recess to accommodate a foot of one of said railway rails. A raised portion may be located on one or both sides of the recess within the top. The raised portion may include an inclined portion. The inclination of the raised portion may be the same as the inclination of a bottom part of a rail to be located within the recess.

The polymer concrete normally includes an amount of polymer resin and an amount of filler.

10

The filler in the polymer concrete may include an amount of a light aggregate with a specific gravity less than that of the resin. The filler may include an amount of a heavy aggregate with a specific gravity larger than that of the resin. Polymer concrete used to form the body may include only the light aggregate. Alternatively, the polymer concrete used to form the body may include the light aggregate and the heavy aggregate. Normally, the polymer concrete that is used to form the body is a combination of polymer concrete that solely includes the light aggregate and polymer concrete that includes both the heavy aggregate and the light aggregate.

The polymer concrete in said first portion of the body may have a resin content in the range 25 to 30% by volume. The polymer concrete in the first portion of the body may have a resin content in the range 50 to 60% by volume when no heavy aggregate is used.

The resin in the polymer concrete may be any suitable polyester, vinylester, phenolic, epoxy or polyurethane resin or combination of resins dependent on the desired structural and corrosion resistant properties of the polymer concrete. Preferably, the resin content is from 25 to 30% by volume when heavy aggregate is used and from 50 to 60% when no heavy aggregate is used.

30

The light aggregate with a specific gravity less than that of the resin can be any type of light aggregate or combination of light aggregates dependent on the desired

structural and corrosion resistant properties of the polymer concrete. Usually, the light aggregates have a specific gravity of 0.5 to 0.9. Preferably, the light aggregate has a specific gravity that is close to the specific gravity of the resin. The light aggregates usually make up 20 to 25% by volume of the polymer concrete when heavy aggregate is used and 40 to 50% when no heavy aggregate is used. Preferably, the light aggregate consists at least substantially of cenospheres. The cenospheres normally have a specific gravity of approximately 0.7 and are 20-300 microns in size. Alternately, hollow glass microspheres with a similar specific gravity and volume may be used.

10

The heavy aggregate with a specific gravity larger than that of the resin can be any type of heavy aggregate or combination of heavy aggregates dependent on the desired structural and corrosion resistant properties of the polymer concrete. The heavy aggregates usually make up 40-60% by volume of the polymer concrete in those portions of said polymer concrete where said heavy aggregate is used.

15

A first portion of said body may be formed from a first polymer concrete that includes an insignificant amount of the heavy aggregate, and a second portion of said body formed from a second polymer concrete that includes a mixture of the heavy aggregate and the light aggregate.

20

Said second portion of the body may be an upper portion of the sleeper and said first portion comprise the volume between said sandwich panels.

25

Preferably the heavy aggregate is crushed hard rock, more preferably crushed basalt. The crushed basalt may have a particle size 5 to 7 mm. Preferably the basalt makes up between 40-50% by volume of the polymer concrete. The basalt normally has a specific gravity of approximately 2.8. Alternately, sand that has a similar specific gravity as basalt may be used. Preferably the sand makes up between 50-60% by volume of the polymer concrete.

30

Alternatively, the heavy aggregate may be made up of one or more of coloured stones, gravel, limestone, shells, glass or the like material.

Preferably the resin contains a thixotrope to keep the light aggregate in suspension.

- 5 The amount of thixotrope is normally between 0.5% to 1% of the resin weight. Preferably, the thixotrope is fumed silica such as found in Cabosil or Aerosil.

The polymer concrete of the present invention may also include fibrous reinforcement material to increase the structural properties of the polymer concrete mix. The reinforcement material may be glass, aramid, carbon, timber and/or thermoplastic fibres.

Preferably, the polymer concrete includes a fire resistant compound such as aluminium trihydrate.

- 15 The amount of resin in the polymer concrete within a bottom portion of the body is higher when compared to a top portion of the body.

Normally the majority of the sandwich panels are vertically orientated within the body. That is, the panels are aligned so that the panels are substantially perpendicular with respect to the top face and bottom face of the body.

Preferably at least one of the sandwich panels extends substantially the length of the body. More preferably, the majority of the sandwich panels extend for substantially the length of the body.

25

A sandwich panel may be located directly under each rail seat.

The sandwich panel under each respective rail seats may be aligned so that the sandwich panels are substantially parallel with respect to the top face and the bottom face of the body.

30

The structural core material of the sandwich panel is typically made from a polymer or is polymer based. The structural core material may include microspheres made from polymeric materials, such epoxy resin, unsaturated polyester resin, silicone resin, phenolics, polyvinyl alcohol, polyvinyl chloride, polypropylene, and polystyrene or
5 from inorganic materials, such as glass, silica-alumina ceramics or cenospheres (hollow fly ash particles).

Alternatively, structural core material may include a foamed phenolic resin product.

- 10 The skins of the sandwich panels may be made from a polymer reinforced with fibres. The fibres may be made from glass, carbon, Kevlar, thermoplastics or combinations thereof. The polymer may be made of polyester, vinyl ester, phenolic, epoxy, polyurethane, thermoplastics or combination thereof.
- 15 Preferably, the polymer used in the skins is the same as that used in the structural core material. More preferably, the sandwich panel is produced in single manufacturing process. In this way a strong primary bond can be created between the skins and the foam core.
- 20 The sleeper may also include at least one fibre composite reinforcement member. The fibre composite member may have similar amounts of fibres orientated in longitudinal and transverse direction.

The fibre composite reinforcement member may be located either above or below the
25 sandwich panels. Normally there are two fibre composite reinforcement members. One fibre composite reinforcement member may be located above the sandwich panels whilst one fibre composite reinforcement member may be located below the sandwich panels. At least one reinforcement sheet of fibre composite material may be located within the sleeper above said sandwich panels, and at least one reinforcement
30 sheet of fibre composite material located within the sleeper below said sandwich panels.

The fibre composite reinforcement member may be oriented so that it is parallel to the top surface and the bottom surface. That is, the fibre composite reinforcement member may be oriented transversely (or perpendicular) to the sandwich panels.

5

The fibre composite reinforcement member may be produced from any suitable glass, carbon or aramid fibre and/or plastic material. Normally the fibre composite reinforcement member is made of the same materials as used to produce the skin of the sandwich panels. Suitably, the fibre composite reinforcement member is double the thickness of a skin of the sandwich panel. Preferably the fibre composite reinforcement sheets are made of the same material that makes the skins of the sandwich panels. Preferably, each fibre composite reinforcement sheet is made from two skins of a sandwich panel.

15 In another form, the invention resides in a method of producing a railway sleeper formed from castable material, said method including the steps of:

- locating a first amount of polymer concrete in a mould where the bottom of the mould corresponds to the top of the sleeper;
- placing a plurality of sandwich panels in a spaced arrangement within the
- 20 mould; and
- filling the spaces between said panels with further polymer concrete.

The method may further include the step of placing fibre composite reinforcement members within the mould.

25

Preferably in the method said first amount of polymer concrete includes an amount of polymer resin and an amount of filler material where a first proportion of said filler material has a higher specific gravity than the specific gravity of the resin and a second proportion of said filler material has a specific gravity lower than or approximately equal to that the resin; said method including the steps of:

30

- placing the first amount of polymer concrete as a slurry into the mould;

- allowing said higher specific gravity filler material to settle while allowing said lower specific gravity filler material to remain relatively evenly suspended in the resin; and
- allowing the first amount of polymer concrete to cure.

5

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the invention, by way of examples only, will be described with reference to the accompanying drawings in which:

10 Figure 1 shows a perspective view of a railway sleeper according to one embodiment of the invention;

 Figure 2A shows a perspective view of the location of sandwich panels and fibre composite members within the sleeper shown in Figure 1;

 Figure 2B is an end-view enlargement of the circled portion of Figure 2A;

15 Figures 3A to 9A show front cross-sectional views during the steps taken to manufacture a railway sleeper of the invention in a mould;

 Figures 3B to 9B show end cross-sectional views during the steps illustrated in corresponding Figures 3A to 9A;

20 Figure 10 is a perspective view showing attachment of a railway rail to a railway sleeper according to the invention; and

 Figure 11 is a cross-sectional view of a railway rail attached to the sleeper shown in Figure 10.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

25

Figures 1 and 2 show a railway sleeper 10 that can be used for replacement of a timber sleeper. The sleeper 10 is constructed from a body 20, a series of sandwich panels 30 and two sheet-like fibre composite members 40A and 40B.

30 The body 20 is constructed from polymer concrete into which is embedded reinforcements. The body has a top face 21 for placement of a railway rail and a bottom face 22 which in use of the railway sleeper 10 bears onto a bed of ballast,

typically coarse graded rock. The railway sleeper 10 has two rail seats 23, two ends 24 and a middle section 25. A pair of wings 26 extend sideways from the body 20 adjacent each rail seat 23. Each rail seat 23 has a recess 27 with two raised portions 28 extending away from the recess 27. A fastening hole 29 is located adjacent each
5 of the raised portions for engagement with a fastener.

The polymer concrete which forms an upper part of the body 20 is formed with approximately 28% by volume of epoxy resin including a fumed silica that is 0.8% of the weight of the resin, 22% by volume of light aggregate and 50% by volume of
10 heavy aggregate.

The light aggregate is in the form of cenospheres having a specific gravity of approximately 0.7. A cenosphere is a lightweight, inert, hollow sphere made largely of silica and alumina and usually filled with air or inert gas, and typically produced as
15 a byproduct of coal combustion at thermal power plants. The heavy aggregate is formed from crushed basalt having a specific gravity of approximately 2.8 and a particle size of 3-5mm.

The light aggregate has a specific gravity that is slightly less than that of the resin
20 whilst the heavy aggregate has a specific gravity that is larger than that of the resin.

A thixotrope is added to the resin so that the light aggregate will stay in suspension within the resin and hence will be substantially uniformly distributed throughout the polymer concrete. Consequently, the resin together with the light aggregate in
25 suspension becomes a flowable filled resin system in its own right. The amount of the light aggregate suspended in the resin can be varied as required.

The heavy aggregate, which is heavier than the resin, sinks to the bottom of the polymer concrete before it sets and can as such be positioned adjacent a top face of
30 the sleeper especially around the rail seats. By adding the heavier aggregate in specific amounts during the pour, layers or areas of polymer concrete with different

amounts of aggregate and hence different density and structural properties can be obtained throughout the sleeper.

The polymer concrete which forms a lower part of the body 20 is formed with approximately 56% by volume of epoxy resin including a fumed silica that is 0.8% of the weight of the resin, 44% by volume of light aggregate. That is, the polymer concrete that forms a lower part of the body is the same as the polymer concrete that forms an upper part of the body without the heavy aggregate.

10 The sandwich panels 30 are located within the body 20 and provide additional shear strength to the sleeper 10. The sandwich panels take three different forms. The main sandwich panels 30A extend the length of the sleeper 10, are vertically oriented and are substantially rectangular in shape. There are six main sandwich panels 30A shown in Figure 2, but that number can vary as desired. Reinforcement sheets 40A and 40B lay across the top and bottom edges respectively of the main panels 30A and form respective reinforcement members. The main panels 30A and reinforcement sheets 40A and 40B together form the main longitudinal structure 60 of the body 20.

20 Wing sandwich panels 30B are trapezoid in shape and are located within the wings 26 of the sleeper 10. A pair of wing panels 30B is located on each side of the main longitudinal structure adjacent each rail seat 23. These increase the width of the sleeper at each rail seat and provide additional stiffness to the sleeper directly under the relevant rail.

25

The sandwich panels 30A and 30B are vertically orientated and accordingly are substantially perpendicular to the top face 21 and bottom face 22 of the body 20. A rectangular sandwich panel is located horizontally directly underneath each rail seat 23 to form a rail seat bed panel 30C and portion of the top surface 21 of the structure 60. The rail seat bed panel 30C may be deleted in some light duty sleepers.

30

Each sandwich panel 30A, 30B and 30C has a syntactic foam core 32 and two fibre reinforced polymer skins 31. The syntactic foam core 32 in this embodiment is made from phenolic resin with hollow glass microspheres and other liquid fillers such as glycerol and lignosulphonate. It should be appreciated that the materials used to produce the syntactic foam core 32 may be varied to suit the specified need of the railway sleeper. The reinforced polymer skins 31 are made from glass fibre and phenolic resin. However the skins 31 may alternatively be made from other materials depending on the specific needs of the railway sleeper.

Respective fibre composite sheet-like reinforcement members 40A and 40B are located respectively above and below the rectangular main sandwich panels 30A. Each fibre composite reinforcement sheet 40A and 40B is made from two fibre-reinforced polymer skins 41 made from glass fibre and phenolic resin. The skins 41 have the same composition and structure as the skins 31 on the faces of the sandwich panels.

The process of manufacturing the railway sleeper 10 will now be described with reference to the steps shown in Figures 3A and 3B to 9A and 9B. The railway sleeper 10 is produced in an upside down manner.

An amount of polymer concrete 63 is first poured into lower cavities 65 in a mould 50. These cavities 65 correspond to the rail seats 23 on the sleeper. The polymer concrete, which includes the heavy aggregate, is mixed and poured into the cavities. The heavy aggregate settles to the bottom of the mould 50. A rail seat bed panel 30C is then placed in a horizontal orientation in position. That stage is illustrated by Figures 3A and 3B.

More polymer concrete 67 which includes the heavy aggregate is then poured into the mould 50 as shown in Figures 4A and 4B. Once again the heavy aggregate settles to the bottom of the mould.

The upper fibre composite reinforcement sheet 40A is then positioned along substantially the full length of the mould 50 as shown in Figures 5A and 5B.

5 Polymer concrete 69 which does not include the heavy aggregate is then poured into the mould 50 as shown in Figures 6A and 6B.

10 The main sandwich panels 30A, which extend substantially the full length of the mould, are then located within the mould as shown in Figures 7A and 7B. These main panels 30A are spaced from each other and from the walls of the mould and are vertically oriented within the mould 50. As the main panels 30A are positioned within the mould, the polymer concrete 69 which does not include the heavy aggregate is forced between the panels 30A.

15 The wing panels 30B are then added as shown in Figures 8A and 8B. Again, these sandwich panels 30B are vertically orientated. More polymer concrete 71 which does not include the heavy aggregate is then added to fully cover the panels 30A and 30B. The lower fibre composite reinforcement sheet 40B is then located along substantially the full length of the mould as also shown in Figures 8A and 8B.

20 More polymer concrete 69 which does not include the heavy aggregate is then added to cover the lower reinforcement sheet 40B and fill the remainder of the mould. The mould is then screeded and the polymer concrete left to cure as shown in Figures 9A and 9B.

25 When removed from the mould all the sandwich panels 30 and reinforcement sheets 40 are covered by a protective layer of polymer concrete. In Figure 1 the upper portion of the sleeper 12, is shown stippled to indicate the polymer concrete 63 and 67 which contains the heavy aggregate, while the lower portion 14 is shown unshaded to indicate the polymer concrete 69 in which the heavier aggregate is absent.

30

It should be appreciated that, alternatively, to improve wear characteristic, polymer concrete which includes the heavy aggregate may be used between the sandwich

panels 30 and the mould, and also placed on top of the fibre composite reinforcement member located at the top of the mould.

5 The use of the polymer concrete which includes the heavy aggregate provides additional impact and wear resistance to the body 20 of the sleeper 10. By using a polymer concrete in which the heavy aggregate settles to the bottom in the mould the present invention provides greatly improved compressive and wear resistance to the upper portion of the sleeper while also providing improved tensile strength to the lower portion of the sleeper. The process uses gravity alone to provide the
10 segregation of the aggregates.

Once the railway sleeper has cured, holes 29 are drilled through the rail seat and the upper reinforcement sheet under the rail seat. The holes allow standard railway screw fasteners to be used to fasten a rail 5 to the sleeper. Alternatively the holes 29
15 can be drilled on site during installation of the sleepers. Dog spike fasteners can be used instead of screw fasteners.

In order to attach railway rails to the railway sleeper 10, as shown in Figures 10 and 11, a rail fastening screw 6 is located through the predrilled holes 29. The screw 6 is
20 rotated until its wide-collared head 7 engages with both the rail 5 and the raised portion 28 of the rail seat 23. The raised portion 28 of the rail seat better locates against the sloping underside of the screw's collar and assists in preventing bending of the head 7 with respect to the screw's shaft 8. The threaded shaft 8 of the screw 6 is able to engage a rail seat panel 30C the upper reinforcement sheet 40A and the
25 relevant main panels 30A.

It should be appreciated that the sleeper may alternatively have a flat rail seat so that traditional fastening systems that are used on hardwood timber sleepers can be utilised.

30

Whilst the above description includes the preferred embodiments of the invention, it is to be understood that many variations, alterations, modifications and/or additions

may be introduced into the constructions and arrangements of parts previously described without departing from the essential features or the spirit or ambit of the invention.

- 5 It will be also understood that where the word "comprise", and variations such as "comprises" and "comprising", are used in this specification, unless the context requires otherwise such use is intended to imply the inclusion of a stated feature or features but is not to be taken as excluding the presence of other feature or features.
- 10 The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that such prior art forms part of the common general knowledge.

CLAIMS

1. A railway sleeper comprising a body having a top face on which railway rails are located and a bottom face for placement on a ground surface, said body being
5 formed from:
- a polymer concrete comprising an amount of polymer resin and an amount of filler; and
 - a plurality of fibre composite sandwich panels, each sandwich panel having a pair of fibre composite skins with a structural core material located
10 therebetween;
- wherein the fibre composite sandwich panels extend longitudinally within said body.
2. A sleeper according to claim 1 wherein said body is moulded and includes two integrally moulded rail seats.
15
3. A sleeper according to claim 2 wherein each said rail seat includes a recess to accommodate a foot of one of said railway rails.
4. A sleeper according to claim 2 or 3 wherein a said sandwich panel is located
20 directly under each rail seat.
5. A sleeper according to claim 4 wherein each said sandwich panel under its respective rail seat is aligned so it is substantially parallel with respect to said top face and said bottom face of the body.
25
6. A sleeper according to any one of the previous claims wherein the filler comprises a light aggregate with a specific gravity less than that of the resin.
7. A sleeper according to claim 6 wherein the light aggregate has a specific
30 gravity in the range 0.5 to 0.9.

8. A sleeper according to any one of the previous claims wherein the filler comprises a heavy aggregate with a specific gravity greater than that of the resin.
9. A sleeper according to claim 8 wherein:
- 5 – a first portion of said body is formed from a first polymer concrete that includes an insignificant amount of the heavy aggregate, and
 - a second portion of said body is formed from a second polymer concrete that includes a mixture of the heavy aggregate and the light aggregate.
- 10 10. A sleeper according to claim 9 wherein said second portion of the body is an upper portion of the sleeper and said first portion comprises the volume between said sandwich panels.
11. A railway sleeper according to any one of the previous claims wherein the
15 majority of the sandwich panels are orientated vertically within the body.
12. A railway sleeper according to any one of the previous claims wherein at least one of the sandwich panels extends substantially the length of the body.
- 20 13. A railway sleeper according to any one of the previous claims wherein the majority of the sandwich panels extend for substantially the length of the body.
14. A sleeper according to claim 3 wherein a raised portion is located on one or both sides of the recess within the top.
- 25 15. A sleeper according to claim 8 wherein said polymer concrete in said first portion of the body has a resin content in the range 25 to 30% by volume.
- 30 16. A sleeper according to claim 8 or 15 wherein said polymer concrete in the first portion of the body has a resin content in the range 50 to 60% by volume when no heavy aggregate is used.

17. A sleeper according to claim 9 or 10 wherein the light aggregate amounts to 20 to 25% by volume of the polymer concrete which includes heavy aggregate.
18. A sleeper according to claim 9 or 10 wherein the light aggregate amounts to
5 40 to 50% by volume of the polymer concrete in those portions of said polymer concrete where no heavy aggregate is used.
19. A sleeper according to claim 9 or 10 wherein the light aggregate is substantially cenospheres or hollow glass microspheres having a specific gravity of
10 approximately 0.7 and sized in the range 20 to 300 microns.
20. A sleeper according to claim 9 or 10 wherein said heavy aggregate amounts to 40 to 60% by volume of the polymer concrete in those portions of said polymer concrete where said heavy aggregate is used.
- 15 21. A sleeper according to claim 9, 10 or 20 wherein the heavy aggregate is crushed hard rock having a particle size in the range 5 to 7 mm.
22. A sleeper according to claim 9, 10 or 20 wherein said heavy aggregate is
20 sand which amounts to 50 to 60% by volume of the polymer concrete.
23. A sleeper according to any one of the previous claims wherein said polymer resin contains a thixotrope sufficient to keep the light aggregate in suspension.
- 25 24. A sleeper according to claim 24 wherein the thixotrope is fumed silica.
25. A sleeper according to any one of the previous claims wherein the polymer concrete includes fibrous reinforcement material.
- 30 26. A sleeper according to claim 10 wherein the proportion of resin in the polymer concrete of said upper second portion of the body is lower than the proportion in said first portion of the body.

27. A sleeper according to any one of the previous claims wherein said structural core material of the sandwich panels is polymer based.

5 28. A sleeper according to claim 27 wherein said structural core material includes microspheres.

29. A sleeper according to claim 27 wherein said structural core material includes a foamed phenolic resin product.

10

30. A sleeper according to any one of the previous claims wherein the skins of said sandwich panels are made of a polymer reinforced with fibres made from glass, carbon, Kevlar, thermoplastics or combinations thereof.

15 31. A sleeper according to any one of the previous claims also including at least one reinforcement sheet of fibre composite material located within the sleeper above and below said sandwich panels.

32. A sleeper according to claim 31 wherein the fibre composite reinforcement
20 sheets are made of the same material used to produce the skin of the sandwich panels.

33. A sleeper according to claim 32 wherein the fibre composite reinforcement sheets are made from two skins as used for a sandwich panel.

25

34. A method of producing a railway sleeper formed from castable material, said method including the steps of:

- locating a first amount of polymer concrete in a mould where the bottom of the mould corresponds to the top of the sleeper;
- 30 – placing a plurality of sandwich panels in a spaced arrangement within the mould; and
- filling the spaces between said panels with further polymer concrete.

35. A method according to claim 34 including the step of placing fibre composite reinforcement sheets within the mould.

- 5 36. A method according to claim 34 or 35 wherein said first amount of polymer concrete includes an amount of polymer resin and an amount of filler material where a first proportion of said filler material has a higher specific gravity than the specific gravity of the resin and a second proportion of said filler material has a specific gravity lower than or approximately equal to that the resin; said method including the
- 10 steps of:
- placing the first amount of polymer concrete as a slurry into the mould;
 - allowing said higher specific gravity filler material to settle while allowing said lower specific gravity filler material to remain relatively evenly suspended in the resin; and
 - 15 - allowing the first amount of polymer concrete to cure.

1 / 5

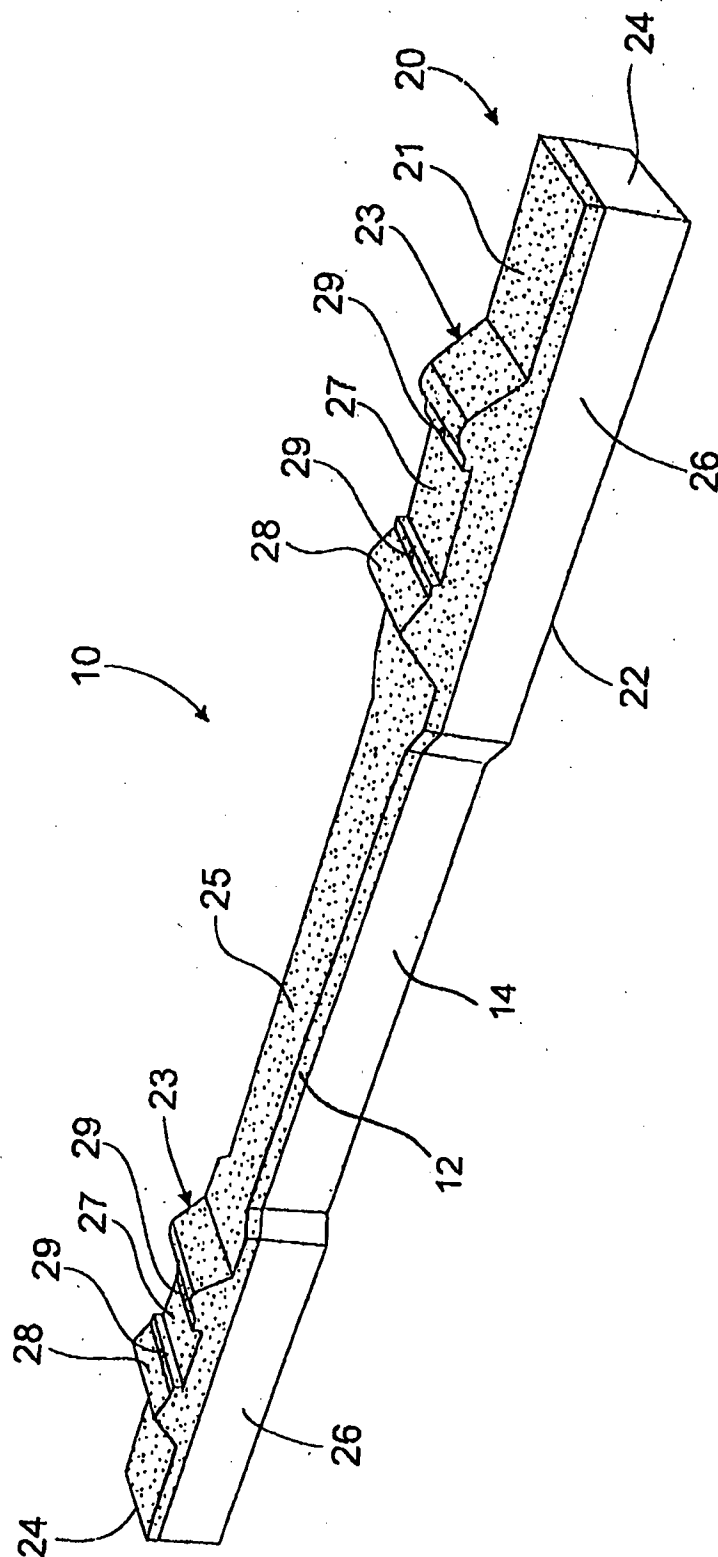
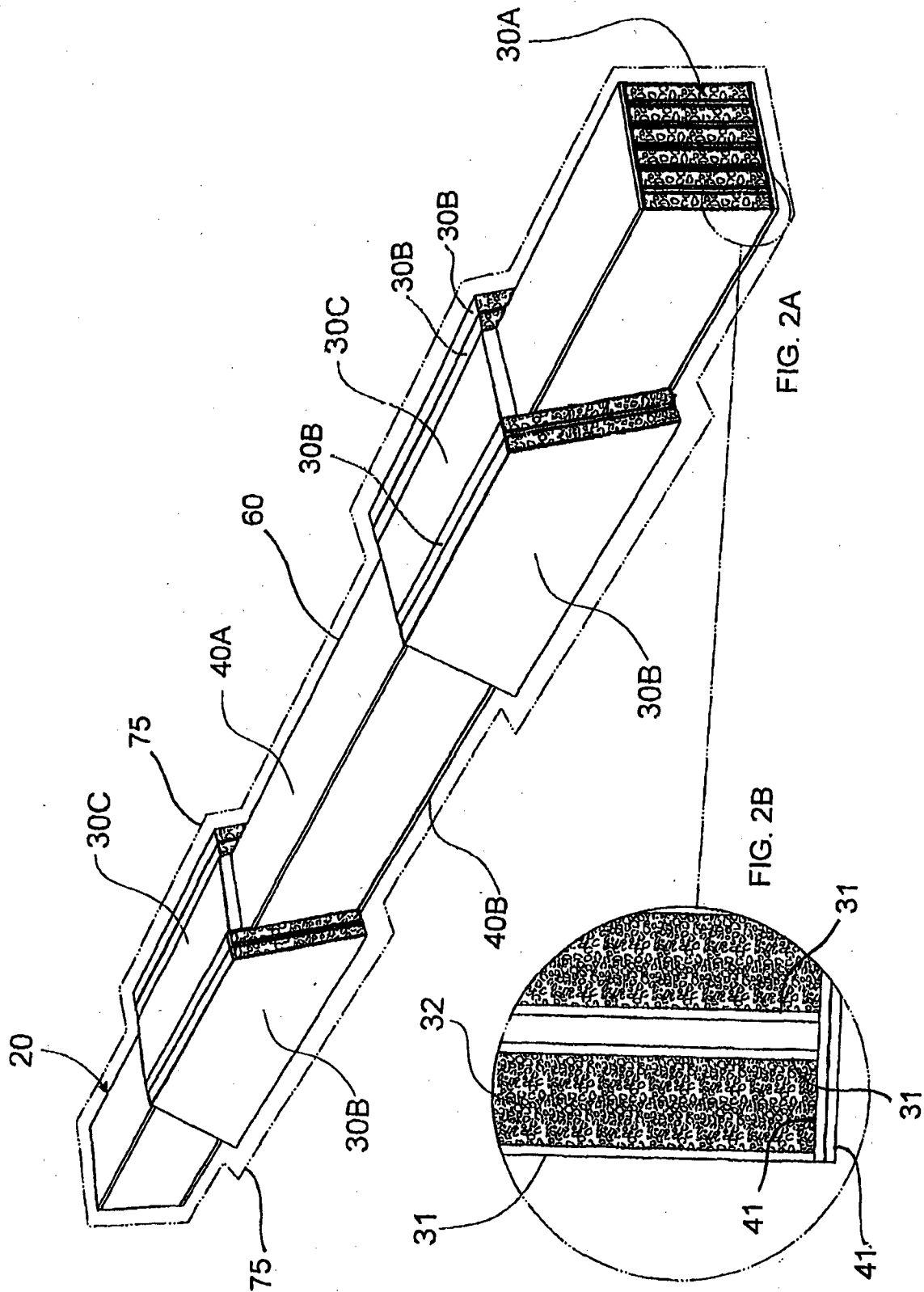
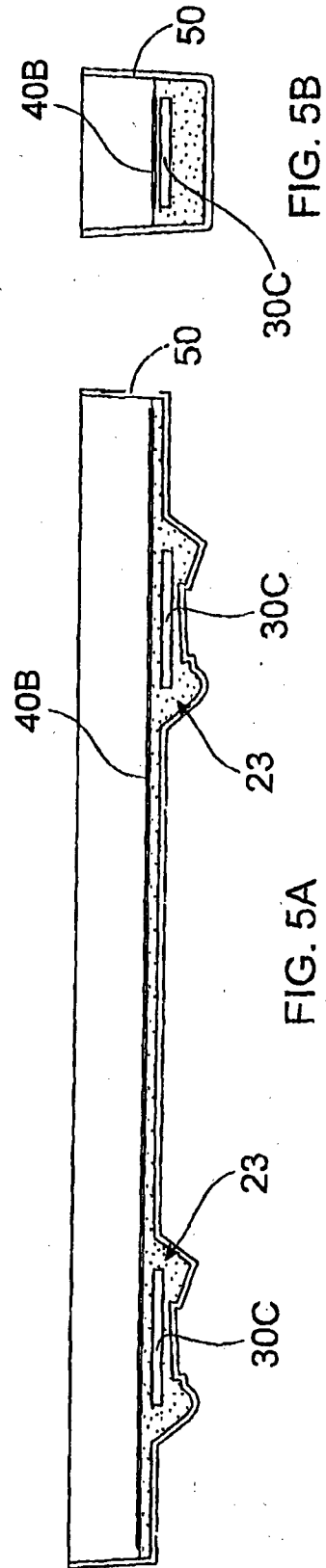
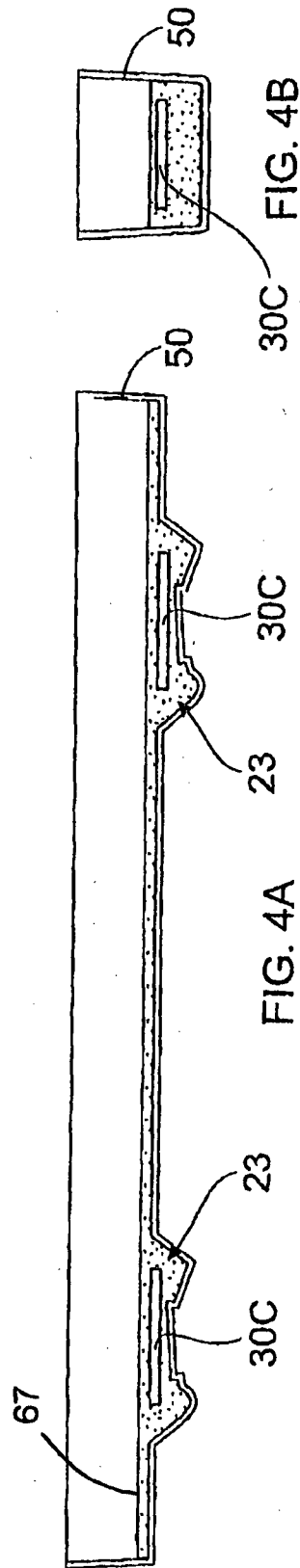
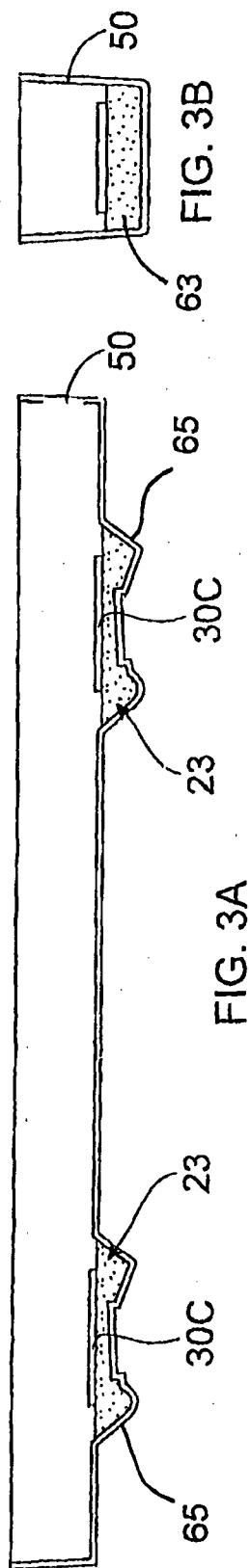


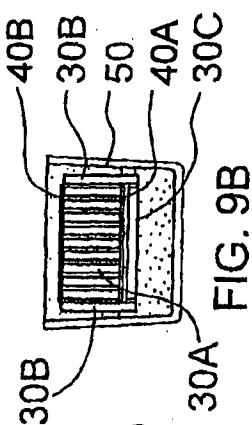
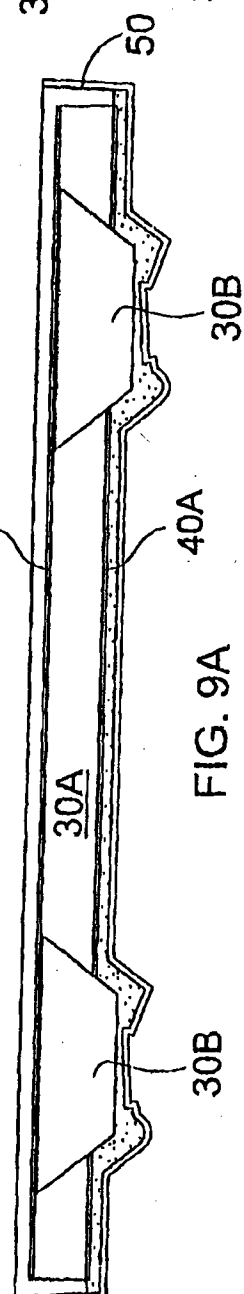
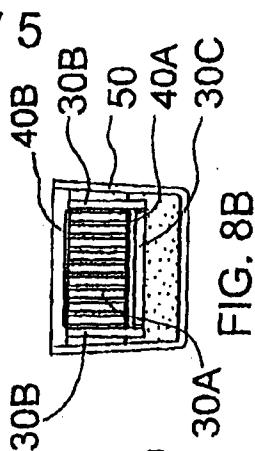
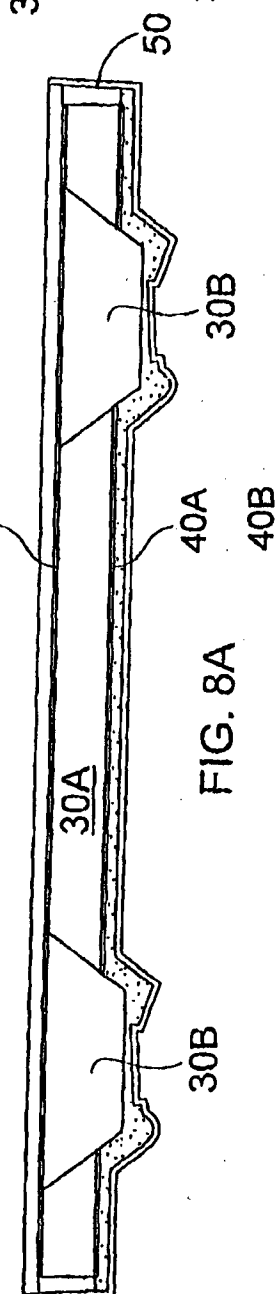
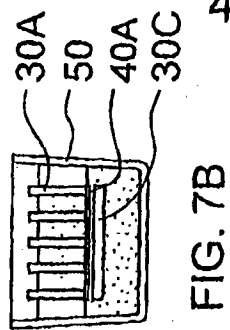
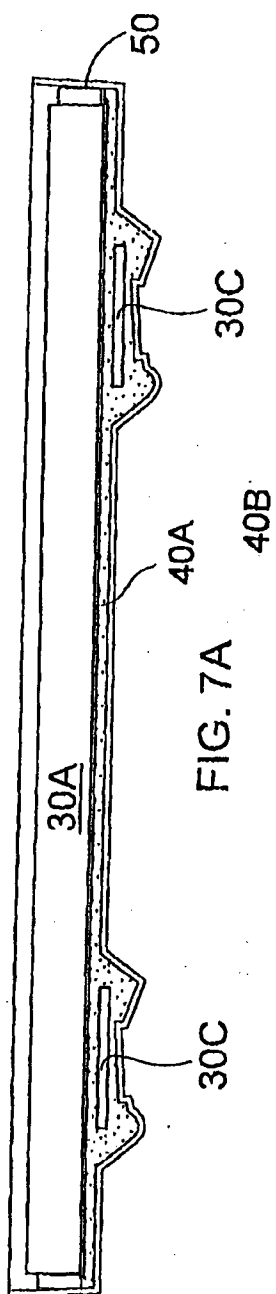
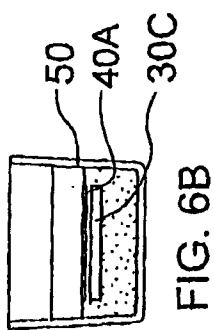
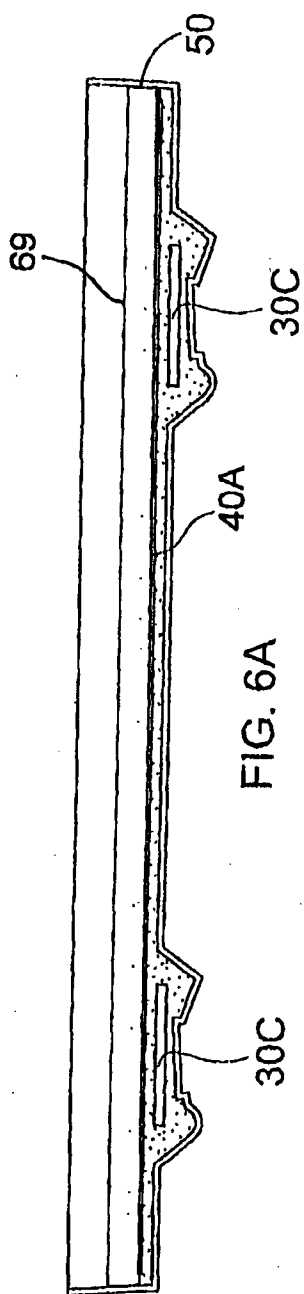
FIG. 1

2 / 5



3 / 5





4 / 5

5 / 5

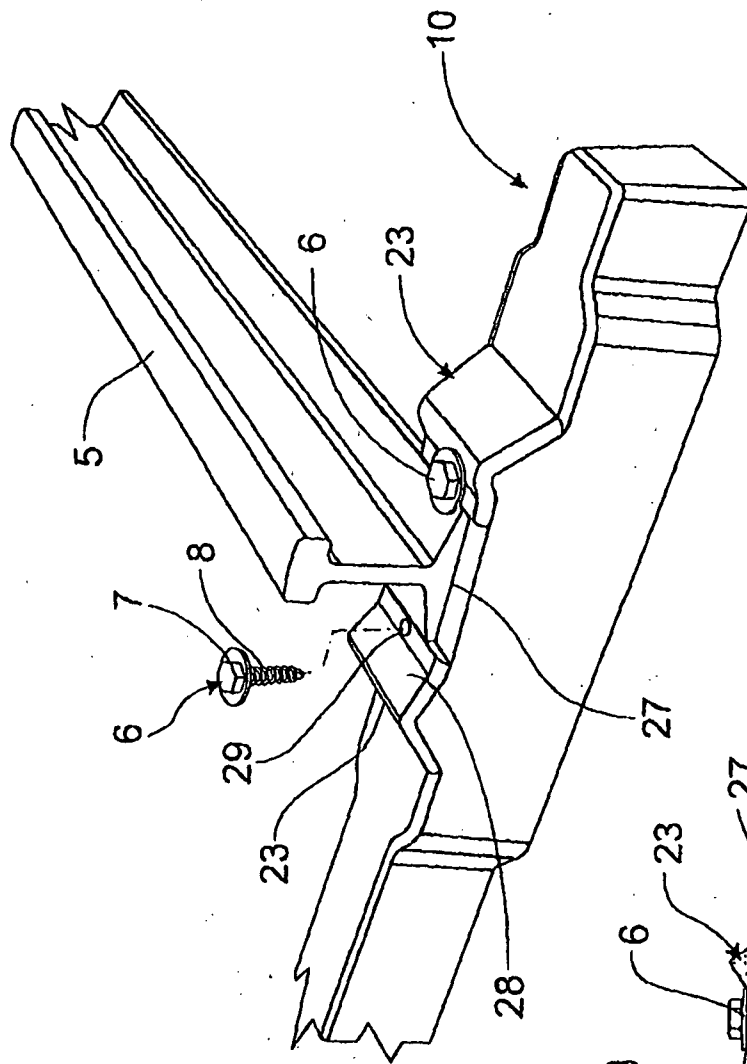


FIG. 10

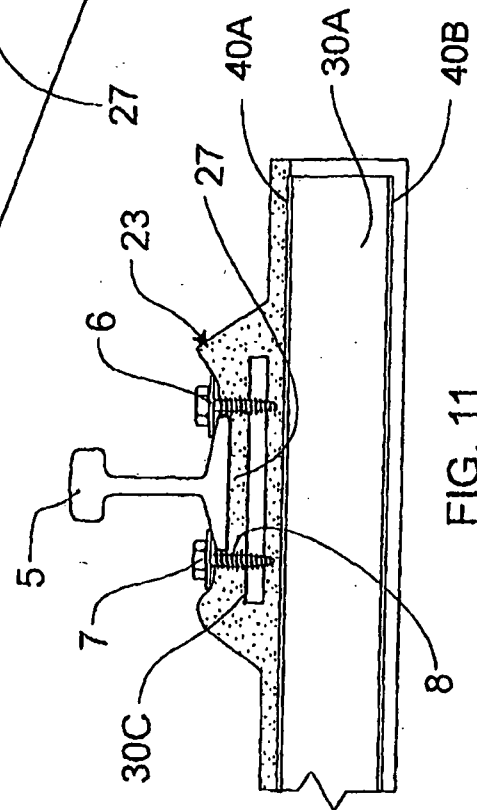


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2013/001492

A. CLASSIFICATION OF SUBJECT MATTER

E01B 3/44 (2006.01) E01B 3/46 (2006.01) B29C 39/10 (2006.01) B29C 39/12 (2006.01) B29D 99/00 (2010.01)
B32B 5/14 (2006.01) B32B 5/16 (2006.01) B32B 5/22 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC: IPC, CPC E01B3/00, E01B3/44/LOW, E01B3/46/LOW, B29C39, B29D31/-, B32B5/-, B29D99/- & Keywords: rail, sleeper, tie, cross tie, polymer, resin, concrete, aggregate, filler, reinforce, layer, panel, mould, embed and like terms.
Google Patent and Internet Search: Keywords sleeper, rail, polymer, reinforcing, plate, foam, microsphere and like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* "A"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
24 February 2014

Date of mailing of the international search report
24 February 2014

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
Email address: pct@ipaustalia.gov.au
Facsimile No.: +61 2 6283 7999

Authorised officer

John Ho
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No. 0262832329

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/AU2013/001492
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/100691 A1 (THE UNIVERSITY OF SOUTHERN QUEENSLAND) 27 October 2005 See figures 1A-8B, page 2 line 19-page 5 line 3 and page 6 line 10-page 9 line 15	34-36
Y	See figures 1A-8B, page 2 line 19-page 5 line 3 and page 6 line 10-page 9 line 15	1-33
Y	JP 2007-276186 A (SEKISUI CHEM CO LTD et al.) 25 October 2007 See figures 11-12 and paragraph 01481	1-5, 11-14, 25, 27-33
Y	WO 2009/059361 A1 (LOC COMPOSITES PTY LTD) 14 May 2009 See figure 1, page 3 lines 6-11, 20-30 and page 7 lines 9-24	1-33
A	US 3355534 A (GROFF) 28 November 1967 See figure 7	2-4 and 14

Form PCT/ISA/210 (fifth sheet) (July 2009)

Supplemental Box

Continuation of: Box III

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1-33 are directed to a railway sleeper comprising a body having a top face for locating railway rails and a bottom face for placement on a ground. The feature of a body being formed from a polymer concrete comprising an amount of polymer resin and an amount of filler, and a plurality of fibre composite sandwich panels; each sandwich panel having a pair of fibre composite skins with a structural core material therebetween and wherein the fibre composite panels extend longitudinally within the body is specific to this group of claims.
- Claims 34-36 are directed to a method of producing a railway sleeper formed from a castable material. The feature of locating a first amount of polymer concrete in a mould where the bottom of the mould corresponds to the top of the sleeper, placing a plurality of sandwich panels in a spaced arrangement within the mould and filling the spaces between the panels with further polymer concrete is specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. The only feature common to all of the claimed inventions and which provides a technical relationship among them is a railway sleeper including a body formed from a polymer concrete, and a plurality of sandwich panels located within the body.

However this feature does not make a contribution over the prior art because it is disclosed in:

D1 - WO 2005/100691 A1 (THE UNIVERSITY OF SOUTHERN QUEENSLAND) 27 October 2005 (see the reference to a sandwich panel in page 4 lines 27-30)

D2 - JP 2007-276186 A (SEKISUI CHEM CO LTD et al.) 25 October 2007 (see figures 11-12 in particular)

Therefore in the light of this document this common feature cannot be a special technical feature. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a posteriori*.

INTERNATIONAL SEARCH REPORT Information on patent family members		International application No. PCT/AU2013/001492	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
WO 2005/100691 A1	27 Oct 2005	None	
JP 2007-276186 A	25 Oct 2007	CN 101050614 B	19 Sep 2012
		HK 1109179 A1	18 Jan 2013
		JP 2007276186 A	25 Oct 2007
		JP 4904073 B2	28 Mar 2012
WO 2009/059361 A1	14 May 2009	None	
US 3355534 A	28 Nov 1967	US 3355534 A	28 Nov 1967
End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001. Form PCT/ISA/210 (Family Annex)(July 2009)			