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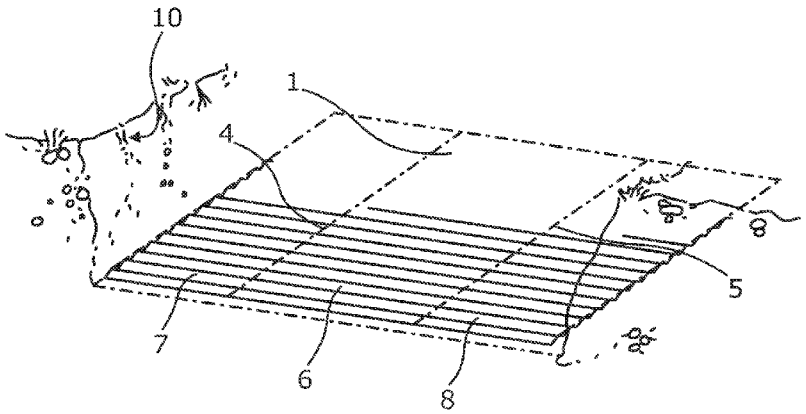

Fig. 4

(57) Abstract: The invention provides a composite product for use as formwork, which acts as a mold defining a cavity in the ground into which concrete is poured. The composite product comprises: a structural panel formed from polymeric material, the panel being rigid, water proof and gas proof; and a bonding layer, the bonding layer having a structure that provides a keying formation capable of keying into concrete cast against said layer. The structural panel has an inner face and an outer face, and the bonding layer extends over most or all of the inner face of the structural panel, such that, in use, the bonding layer is presented on the surface of the formwork that defines the cavity within which concrete is poured and serves to fully bond the formwork to the cast concrete.

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FORMWORK

Field of the Invention

This invention relates to formwork used in building construction and civil engineering projects.

Background of the Invention

Traditional methods used for forming concrete slabs, beams, walls and other concrete structures commonly involve the installation of multiple sheets of plywood, timber faced metal framed panels or large timber table forms. These forms are held in place by shoring, props, scaffolding or similar restraining means.

Some of these formwork components may comprise a finish or layer which is intended to improve the re-use potential of the form, or improve the surface finish of the individual component.

Traditional formwork is usually built on site from timber and plywood or moisture-resistant particleboard. This option therefore offers a high degree of flexibility, and is used extensively. However, it is time-consuming and labour intensive.

There has therefore been a move towards alternative formwork options, which still comprise rigid panels which together act as a mold into which concrete is poured, but which save on construction time and/or labour costs.

JP H 2-167960 describes a precast concrete (PC) formwork which includes a plurality of thin precast concrete sheets having the same planar shape as the outside faces of a pillar/beam and with their side joining faces formed as inclined faces that mutually mate when assembled. These are linked by hinge fittings mounted between said side joining faces, permitting free rotation about the hinge. Once assembled, concrete can be poured into the hollow portion defined by the precast concrete sheets.

CN 202577946 describes a microcellular foam multilayer PVC wood-plastic building board, which has a top surface layer, a core layer and a bottom surface layer. The top

surface layer and bottom surface layer may have a smooth surface or may be formed with an integral raised pattern, having a height of 2mm to 5mm, to assist with the adhesion of subsequent surface painting. The board is formed by extruding the mixed raw materials, including PVC resin powder, foaming agent, and wood powder, for the layers into a mould.

WO 2008/128683 describes a formwork element with a coated film of a latticework. The latticework comprises at least two separate mesh mats, which are surrounded by a film. The mats that are described are steel fabric mats, which are formed by metal rods laid crosswise. The steel mesh gives the formwork element the necessary mechanical strength. The shrink film that wraps the mats forms a joint between each of the individual lattice mats and this joint provided by the shrink wrapping means that the formwork element can be space-saving, being delivered in a flat condition and then folded on site into the desired configuration. The concrete can then be poured into the folded formwork. The shrink film presents a continuous inner surface that, in use, will contact this poured concrete with a substantially planar interface. Separate insulating foam boards may be provided, abutting the mats on their outer faces.

FR2539169 describes a formwork enclosure, made of a synthetic material which is malleable and flexible. The product includes two cheeks connected to a base section and the cheeks can be folded up to form a U shape. The connection between the cheeks and the base section is made by two folded ends, which are reinforced by a reinforcing member incorporated into the material. The inner face of the cheeks, which is intended to be in contact with the concrete, is shaped to be in the form of a wave pattern. This integral wave pattern, which is intended to stiffen the enclosure so that it can withstand the pressure of the concrete during casting, can also be reinforced by metal rods incorporated into the material.

The current preferred alternative to traditional formwork is the use of polypropylene panels as formwork. These have been on the market for over 15 years and are in particular used as formwork for ground beams and for pile caps.

The polypropylene formwork is a prefabricated, permanent system. It can be used as part of gas and water proofing systems. Based on UK pricing, it is similar in material cost to the timber formwork option, but offers savings on both time and labour.

It particularly useful where there is no requirement for waterproofing, e.g. housing or where watertight admixtures are used.

The panels are commonly supplied as pre-creased panels that can then be folded in-situ to create a 'U' shape, which lines the foundation in preparation for the concrete pour. Alternatively, individual panels can be connected together in-situ to create a 'U' shape, which lines the foundation in preparation for the concrete pour. It may also be that there is a pre-creased panel that can then be folded in-situ to create a 'L' shape, and this is connected together in-situ with an individual panels to create a 'U' shape, which lines the foundation in preparation for the concrete pour.

These panels are typically about 8mm thick with a weight of 1400g/square metre. Thinner options, e.g. 4mm thick with a weight of 700g/square metre and 7mm thick with a weight of 1200g/square metre, are also known. The polypropylene panels may have a density of about 0.9 g/cm^3 (ISO1183).

A system of this type is described in European Patent No. 0 866 196.

Problem Solved by the Invention

The present inventor has identified that there is a problem with such panels in that they are smooth and do not bond to the concrete. In addition, the panels are not straightforward to connect with ground slab waterproofing membranes, due to wavering and corners.

If the polypropylene formwork of the currently available type is used where ground settlement is expected then the inventor has identified that there is a problem, in that the formwork panels will fall away with the ground and this could lead to tearing. Therefore the waterproofing is no longer intact.

If the polypropylene formwork was punctured then water would enter the concrete and freely move along the concrete, since the formwork is not bonded to the structural concrete. This tracking of water along the concrete is a problem.

These problems that have been identified provide a new technical teaching to the field of the invention. In particular, they provide a recognition of the fact that although the use of polypropylene panels for formwork has certain advantages, especially in terms of reduced time and labour cost for installation, the installed formwork has a disadvantage in terms of leaving the concrete vulnerable to water because a secure waterproof bond is not formed between the formwork and the concrete.

The prior art did not recognise the importance of having a design of formwork such that a secure waterproof bond is formed between the formwork and the concrete. The prior art did not recognise the importance of having a design of formwork such that tracking of water along the concrete is prevented or reduced.

Therefore it has been appreciated that there is a need for a formwork that is a prefabricated, permanent system but that also provides medium to long term waterproofing for the post cast concrete, even if there is settlement of the surrounding ground.

It may be that, for example the waterproofing is provided over a timeframe of up to or greater than 30 days from the pouring of the concrete, or of up to or greater than 60 days from the pouring of the concrete, or of up to or greater than 90 days from the pouring of the concrete. However, these are exemplary timeframes only and the invention is not limited in this regard.

Summary of the Invention

According to a first aspect of the invention there is provided a composite product for use as formwork, which acts as a mold defining a cavity in the ground into which concrete is poured, the composite product comprising:

- a structural panel formed from polymeric material, the panel being rigid, water proof and gas proof; and
- a bonding layer, the bonding layer having a structure that provides a keying formation capable of keying into concrete cast against said layer;

wherein the structural panel has an inner face and an outer face, and wherein the bonding layer extends over most or all of the inner face of the structural panel, such that, in use, the bonding layer is presented on the surface of the formwork that defines

the cavity within which concrete is poured and serves to fully bond the formwork to the cast concrete.

The skilled person will appreciate that a keying formation is an arrangement that acts to lock together ("key into") with another structural part. Therefore the keying formation must be shaped so as to extend into and lock with concrete that is cast against the bonding layer. The keying formation needs to, at least in part, physically bond into the concrete. In other words, it must embed in the concrete. Thus there is not a planar interface between the keying formation and the concrete but rather part of the formation extends into the concrete and/or concrete is received into part of the formation.

A porous material whereby an array of apertures is provided within a fibre network, such as a mesh structure or a geotextile fleece, is one arrangement that is particularly suitable for achieving this, as the fibre network can extend into and engage with the poured concrete and the apertures can receive concrete. Thus the bonding layer will lock with the concrete as it sets into the apertures. This gives the required "keying in" and means that the bonding layer serves to fully bond the formwork to the cast concrete.

The claimed product is a composite product. Therefore the bonding layer is suitably formed separately from the structural panel but in the product they are provided together as the composite parts of the product. The bonding layer may be attached directly to the structural panel, e.g. by the use of adhesive or other securing means, or by friction welding or moulding the bonding layer to the structural panel. Alternatively, it may be attached indirectly to the structural panel, e.g. by being attached to an intermediate layer that in turn is attached to the structural panel. It may be that the bonding layer is partly provided within the structural panel, e.g. the structural panel may be cast or extruded around part of the bonding layer such that it is secured thereto. Thus the bonding layer may be partially embedded in the structural panel.

The bonding layer being formed separately from the structural panel before being joined with the panel as a composite product is advantageous. In particular, it allows the bonding layer to be formed from a different material to the structural panel and

therefore for the bonding layer to have different physical properties. As noted above, the panel must be rigid, water proof and gas proof. However, the bonding layer does not need to have these characteristics. It may, for example, be desired that the bonding layer is flexible rather than rigid.

It also allows the bonding layer to be formed using a different technique, if desired, and permits shapes of formation to be produced that are more than just protrusions or patterns on an outer surface of the panel.

Therefore by having the bonding layer formed separately it can be made using the most appropriate materials, can be formed to the desired shape, and can be formed using the most appropriate techniques when allowing for its intended function.

The bonding layer preferably has a structure that also serves to interrupt or hinder water tracking along the surface of the concrete cast against said layer. This then has the benefit of localising the effect of any damage to the structural panel. In the event that there is damage to the structural panel, and thus there is a section of that panel that no longer serves as a waterproofing layer, the water only contacts the surface of the concrete in that section; the water does not track along to reach further sections of the concrete surface. Thus any water damage is restricted.

A porous material whereby an array of apertures is provided within a fibre network, such as a mesh structure or a geotextile fleece, is one arrangement that is particularly suitable for achieving this, as the fibre network serves to interrupt or hinder water tracking. The fibres define the apertures and therefore are present around the outside of each aperture; this means that fibres extend in multiple directions. For example, in a polymer mesh where the apertures are quadrilateral in shape, there may be a first set of parallel polymer strands in one direction and a second set of parallel polymer strands in another direction, with these two sets intersecting to define the quadrilateral apertures. Having fibres extend in multiple directions is advantageous in terms of interrupting or hindering water tracking.

In this regard, preferably the bonding layer has a structure that provides a keying formation capable of keying into concrete cast against said layer, wherein the size of the formations is such that when keyed to the concrete a cellular structure is provided.

A porous material whereby an array of apertures is provided within a fibre network, such as a mesh structure or a geotextile fleece, is one arrangement that is particularly suitable for achieving this, as the apertures provide a cellular structure.

The bonding layer is suitably formed from polymeric material; for example it may be a polymeric mesh, or it may be a geotextile fleece formed from polymeric fabric, such as polypropylene or polyester fabric.

As noted above, the structural panel is formed from polymeric material.

Any intermediate layer that is present between the structural panel and the bonding layer may suitably be formed from polymeric material, although other materials could also be contemplated provided they are water proof and gas proof.

In one embodiment, the composite product is substantially formed from polymeric material. For example, the composite product may be 60wt% or more polymeric material, such as 70wt% or more, or 75wt% or more, or 80wt% or more. In one embodiment the composite product may be 90wt% or more polymeric material, e.g. 95wt% or more polymeric material.

The use of polymeric material as the major material from which the composite product is formed is advantageous in terms of ensuring that the product is lightweight, easy to use and easy to cut. Prior art products based on steel or pre-cast concrete did not have these benefits.

In addition, polymeric material does not have a tendency to draw water, as compared to materials such as wood which naturally would draw water and therefore encourage water tracking.

According to a second aspect of the invention there is provided a method for making a structural feature, comprising using one or more composite product according to the first aspect of the invention.

The method may comprise the steps of:

- positioning the one or more composite product in a foundation trench, such that at least the vertical walls of a 'U' shape are defined by the composite product, said 'U' shape being the cross section of a cavity within which concrete will be poured, with the bonding layer being presented on the surface of the formwork that defines said cavity;
- backfilling the trench so as to support the composite product or products;

and

- pouring concrete into the cavity, in liquidised form, and allowing the concrete to set.

The structural feature formed by the method may suitably be a ground beam or a pile cap.

In one embodiment the composite product is a pre-creased product. In that embodiment the composite product is folded along the crease or creases before the backfilling step. It may be that the composite product is folded along the crease or creases before the composite product is placed in the foundation trench or it may be folded after the product is placed in the foundation trench.

A reinforcement cage may be positioned in the cavity before the concrete is poured.

It is possible to make structural features, such as groundbeams, without using a reinforcement cage, however. In this instance, spacers can be positioned in the 'U' shape cavity which are of similar width as the cavity and thus maintain the shape of the vertically extending walls against the pressure of the backfill. The spacers, which might be made from timber, are removed as the concrete is poured in.

According to a third aspect of the invention there is a structural feature, comprising one or more composite product according to the first aspect. This structural feature may be formed by carrying out the method of the second aspect.

In one embodiment the structural feature has a 'U' shape cross section, which can line a foundation trench. Preferably at least the vertical walls of the 'U' shape are defined by the composite product or products.

In one embodiment there are two or more composite products and these are joined together by one or more connectors. Preferably these connectors are waterproof.

In particular, it is preferred that the connectors are sufficiently waterproof to maintain the integrity of the product as a whole, i.e. the plurality of composite products plus the plurality of connectors that connect the products together in the required configuration. It may therefore be that only the parts of the connectors that are exposed once they have been used to connect the products together are waterproof, or it may be that the connectors are fully waterproof.

In one embodiment the structural feature is a ground beam or a pile cap.

Detailed Description of the Invention

The composite product of the invention comprises a structural panel and a bonding layer.

The structural panel is formed from polymeric material. It may be formed from a single polymeric material or from more than one polymeric material, e.g. it may be formed from a blend of polymeric materials or it may be a laminate structure where there are at least two layers made from different polymers.

The structural panel must be able to load bear and must be rigid and the polymeric material must be chosen accordingly. The structural panel should be able to bear the load of a layer of concrete that is 1m thick or more, such as 2m thick or more.

The polymeric material for the structural panel is suitably a thermoplastic polymer, more preferably a hydrocarbon polymer such as an olefin. In other words, the hydrocarbon polymer is preferably formed by polymerising a monomer which is an olefin. The olefin may, for example, be an alpha olefin; preferably an olefin containing from 2 to 6 carbon atoms. Thus the polymeric material may be based on a monomer which is an olefin containing from 2 to 6 carbon atoms. Examples are polyethylene or polypropylene.

A high density polypropylene or polyethylene is particularly suitable. Blends or combinations thereof may be used.

Other thermoplastic polymers which may be used include polyethylene terephthalate, polystyrene, polyvinyl chloride, polyamides, or blends or combinations thereof.

The use of thermoplastic polymeric material can be useful in permitting a rigid, water proof and gas proof panel to be thermoplastically pre-formed in a convenient manner.

In another embodiment, however, the structural panel is formed from polymeric material that is not thermoplastic or comprises a layer of polymeric material that is not thermoplastic.

The polymeric material may be provided in hollow or lightweight form.

The use of polymeric material is advantageous in terms of ensuring that the product is lightweight, easy to use and easy to cut.

The structural panel as formed from polymeric material may also serve to provide an insulating function.

The structural panel as formed from polymeric material may optionally be fluted or corrugated.

A preferred material is polypropylene, especially fluted or corrugated polypropylene, since this exhibits suitable mechanical properties and is extremely cost effective to manufacture. A further advantage is that polypropylene is resistant to attack from a wide range of chemicals and minerals, making the formwork suitable for use in contaminated ground. Modified polypropylenes, which have even better chemical resistance, can be used. These are known in the art.

It is possible to coat the outer face of the structural panel in order to provide enhanced properties, e.g. in terms of chemical resistance, although clearly this increases the cost of manufacture.

The structural panel is suitably 3mm thick or more, such as 4mm thick or more, especially 5mm thick or more. In one embodiment the structural panel is from 5mm to 20mm thick, such as from 6mm to 19mm thick or from 7mm to 18mm thick or from 8mm to 17mm thick or from 9mm to 16mm thick. In a preferred embodiment the structural panel is suitably from 10mm to 15mm thick.

The structural panel can have any suitable length and width, to suit the size of the foundation trench into which the formwork is to be located. The structural panel may, for example, be cut to size.

The structural panel may, for example, be an extruded polymer panel.

The composite product also comprises a bonding layer. The bonding layer has a structure that provides a keying formation capable of keying into concrete cast against said layer. The keying formation needs to, at least in part, physically bond into the concrete.

The thickness of the bonding layer may, in one embodiment, be from 0.01mm to 5mm, such as from 0.05mm to 3mm, e.g. from 0.05mm to 2mm. Preferably it is from 0.05mm to 1.5mm, such as from 0.1mm to 1mm.

In one embodiment the bonding layer is a porous material whereby an array of apertures is provided within a fibre network, such as a mesh structure or a geotextile fleece. The fibre network defines the apertures and provides a raised formation that extends out from the structural panel and can physically bond into the concrete. Significantly, the fibre network also serves to interrupt or hinder water tracking along the surface of the concrete that is cast against the bonding layer. It may suitably be that the bonding layer is a porous material whereby an array of apertures is provided within a polymeric fibre network.

In one embodiment the bonding layer is a geotextile fleece. This may be woven or non-woven (e.g. it may be needle punched or heat bonded). The fibre network is therefore the fabric fibres of the geotextile fleece. These are usually polymeric fibres, e.g. polypropylene or polyester fibres.

In one embodiment the bonding layer is a geotextile fleece made from polypropylene or polyester.

The geotextile fleece bonding layer may be directly attached to the structural panel.

Alternatively, it may be attached indirectly to the structural panel, e.g. by being attached to an intermediate layer that in turn is attached to the structural panel. The intermediate layer may be polymeric; in one embodiment it may be an epoxy resin layer and/or a polyurethane resin layer. It may suitably be that the intermediate layer has adhesive properties.

In another embodiment the bonding layer is a polymeric mesh. The fibre network is therefore the interlaced "threads" of polymer that define the mesh. The polymeric mesh may, for example, be formed by extrusion, expansion or weaving processes.

It may be that the polymeric mesh is made from a thermoplastic polymer, more preferably a hydrocarbon polymer such as an olefin. In other words, the hydrocarbon polymer is preferably formed by polymerising a monomer which is an olefin. The olefin may, for example, be an alpha olefin; preferably an olefin containing from 2 to 6 carbon atoms. Thus the polymeric material may be based on a monomer which is an olefin containing from 2 to 6 carbon atoms. Examples are polyethylene or polypropylene.

A medium density polyethylene is particularly suitable, although high and low density polyethylenes are also suitable.

Other thermoplastic polymers which may be used include polyethylene terephthalate, polystyrene, polyvinyl chloride, polyamides, or combinations thereof.

In another embodiment polymeric mesh is formed from polymeric material that is not thermoplastic.

The use of polymeric material for the bonding layer is advantageous in terms of ensuring that the product is lightweight, easy to use and easy to cut.

The polymeric mesh bonding layer may be directly attached to the structural panel.

Alternatively, it may be attached indirectly to the structural panel, e.g. by being attached to an intermediate layer that in turn is attached to the structural panel. The intermediate layer may be polymeric; in one embodiment it may be an epoxy resin layer and/or a polyurethane resin layer. It may suitably be that the intermediate layer has adhesive properties.

The keying formation of the bonding layer may be provided by a raised formation or rib-like structure. Preferably a plurality of formations are provided, more preferably arranged in a regular pattern.

Conveniently there may be a plurality of straight parallel formations which intersect another plurality of similar straight parallel formations to provide a series of diamonds or squares or other quadrilateral shapes. The intersecting formations provide a structure which will hereafter be referred to as a grid.

In one embodiment the grid is a polymeric mesh.

The bonding layer may be in the form of a sheet having the formations attached thereto. Alternatively, and preferably, the bonding layer is provided solely by the grid i.e. it has no sheet and is directly attached to the structural panel.

The apertures in the grid may be from 1 square mm to 625 square mm; preferably from 5 square mm to 100 square mm. The apertures may be square or diamond shaped although other shapes are suitable.

Preferably the size of the formations provided by the grid is such that when keyed to the concrete a cellular structure is provided. The advantage of this is that water tracking between the membrane and concrete face is prevented or reduced in the event that the membrane is damaged (e.g. a hole is formed) in one place.

A particularly suitable grid is one sold by Netlon Limited for use in soil stabilisation.

The composite product may be formed by any suitable technique, for example extrusion or calendaring.

In one embodiment the composite product may be formed by using adhesive to secure the bonding layer to the structural panel.

In another embodiment the composite product may be formed by friction welding the bonding layer to the structural panel.

In another embodiment the composite product may be formed by moulding the bonding layer to the structural panel.

In another embodiment the composite product may be formed by forming the bonding layer within the structural panel. For example, the structural panel may have an outer border and an inner panel section, and the bonding layer may be formed within the inner panel section. The bonding layer may be partially embedded within the structural panel.

In another embodiment the composite product may be formed by attaching the bonding layer indirectly to the structural panel, e.g. by being attached to an intermediate layer that in turn is attached to the structural panel. The intermediate layer may be polymeric; in one embodiment it may be an epoxy resin layer and/or a polyurethane resin layer.

The composite product may be provided as a flat, individual, panel. The panel does not need to have any pre-creasing. Three such individual products can be connected together in-situ to create a 'U' shape cross section, which lines the foundation trench in preparation for the concrete pour.

Equally, two such products could be used as the vertical components of a 'U' shape cross section. The horizontal component of the 'U' shape at the bottom of the foundation trench may be covered with a waterproof film that has an outer surface with a structure that provides a keying formation capable of keying into concrete cast against said layer (this may be provided by the use of a bonding layer and this may be the same as the bonding layer of the composite product or may be different). It will be

appreciated that the horizontal wall does not require a structural panel to be present because it is only the parts of the formwork that are vertical that are load bearing. It is, however, necessary that waterproofing is provided on that wall and that the waterproofing connects with the vertically oriented composite products such that the 'U' shape is waterproofed.

For example, horizontal component of the 'U' shape at the bottom of the foundation trench may be covered with a non water-tracking water/gasproof membrane as described in GB 2 340 070. This may in particular be a Fosroc ® Proofex Engage product, which is a pre-applied membrane which mechanically bonds to poured concrete. This waterproof membrane system incorporates a cell mesh, bonded to a blended polyethylene / polypropylene membrane, which allows poured concrete to interlock, forming a mechanical bond.

The composite product may be provided as a flat but pre-creased panel that can then be folded in-situ to create a 'U' shape cross section, which lines the foundation trench in preparation for the concrete pour. Such a panel would have two pre-creases.

The composite product may be provided as a flat but pre-creased panel that can then be folded in-situ to create an 'L' shape cross section, which partially lines the foundation trench in preparation for the concrete pour. Such a product would have a single pre-crease. This product can then be used in combination with a flat, individual, composite product that does not need to have any pre-creasing; these two products can be connected together in-situ to create a 'U' shape cross section, which lines the foundation trench in preparation for the concrete pour.

When more than one composite product is used to create the 'U' shape, it will be appreciated that suitable connectors may be used to connect the products together in the required configuration. The connectors may, for example, be 'T' shaped connectors or 'H' shaped connectors or 'L' shaped connectors.

The connectors are suitably waterproof. In particular, it is preferred that the connectors are sufficiently waterproof to maintain the integrity of the product as a whole, i.e. the plurality of composite products plus the plurality of connectors that connect the products together in the required configuration. It may therefore be that

only the parts of the connectors that are exposed once they have been used to connect the products together are waterproof, or it may be that the connectors are fully waterproof.

It may also be that there is a pre-creased panel that can then be folded in-situ to create a 'L' shape, and this is connected together in-situ with an individual panel to create a 'U' shape, which lines the foundation in preparation for the concrete pour.

In the products that are pre-creased, the crease lines may be formed by any suitable technique on the formed structural panel. It may be that the crease lines are formed by using a platen equipped with suitably positioned and adapted blades. The crease lines may be formed on site.

An advantage of such an approach is that the composite product can be flat packed for transportation and storage, and folded into shape along the crease lines on site.

The composite product may, however, equally be provided as a pre-formed panel already having a 'U' shaped cross section, which lines the foundation trench in preparation for the concrete pour.

The composite product may be provided as a pre-formed panel already having an 'L' shape cross section. This is connected together in-situ with an individual panel to create a 'U' shape, which lines the foundation in preparation for the concrete pour.

Preferably the surface of the formwork that defines the cavity within which concrete is poured is configured such that one or more spacers, such as steel rebar spacers, can be connected to the composite product at said surface.

In one embodiment one or more spacers, such as steel rebar spacers, are connected to the composite product at the surface of the formwork that defines the cavity within which concrete is poured. The spacers may, for example, be welded (e.g. hot air gun welded) or glued to the surface.

The invention will be further illustrated in a non-limiting manner by the drawings, in which:

Figure 1 is a plan view of a composite product according to the invention.

Figure 2 is a side view of a composite product according to the invention.

Figure 3 shows the composite product according to the invention being used to form a groundbeam.

Figure 4 shows another composite product according to the invention.

Figure 5 shows another composite product according to the invention being used to form a groundbeam.

The composite product 1 as shown in Figure 1 and Figure 2 is suitable for use as formwork, which acts as a mold defining a cavity in the ground into which concrete is poured. The composite product 1comprises a structural panel 2 formed from polymeric material. This panel 2 is rigid, water proof and gas proof and is from 5mm to 20mm thick. The panel is formed from extruded polymeric material, such as high density polypropylene or polyethylene or a blend or copolymer thereof.

The composite product 1further comprises a bonding layer 3. The bonding layer 3 has a structure that provides a keying formation capable of keying into concrete cast against said layer.

The bonding layer 3 has a structure that also serves to interrupt or hinder water tracking along the surface of the concrete cast against said layer.

In this regard, as can be seen in Figure 1, the bonding layer 3 has a structure that provides a keying formation capable of keying into concrete cast against said layer, wherein the size of the formations is such that when keyed to the concrete a cellular structure is provided.

In the illustrated embodiment the bonding layer 3 comprises a polymeric mesh with a plurality of straight parallel formations which intersect another plurality of similar

straight parallel formations to provide a series of diamonds or squares or other quadrilateral shapes 3a.

As can be seen in Figure 2, the structural panel 2 has an inner face 2a and an outer face 2b. The bonding layer 3 extends over substantially all (or all) of the inner face 2a of the structural panel 2. Thus, in use, the bonding layer 3 is presented on the surface of the formwork that defines the cavity within which concrete is poured and serves to fully bond the formwork to the cast concrete and to interrupt or hinder water tracking along the surface of the cast concrete.

As shown in Figure 1, the composite product 1 of the invention may be provided as a flat, individual, panel. This panel does not need to have any pre-creasing. However, the invention is not limited to this embodiment.

Three such individual products 1 can be connected together in-situ to create a 'U' shape cross section, which lines the foundation trench in preparation for the concrete pour.

They can be connected together by connectors, e.g. waterproof connectors. These may, for example, be 'L' shaped connectors.

In Figure 3 three such composite products 1 form a groundbeam. However, it will be appreciated that is possible to use the present invention to produce other structural features, such as pile caps.

The three composite products 1 are located in a blinded, backfilled trench 10, to create a 'U' shape cross section, which lines the foundation trench in preparation for the concrete pour. A reinforcement cage 11 is disposed within the 'U' shape. Subsequently, concrete is poured into the 'U' shape trench, which, once the concrete has set, remains in place.

It will be appreciated that in an alternate embodiment two such products 1, each of which is a flat individual panel, could be used as the vertical components of the 'U' shape cross section and the horizontal component of the 'U' shape at the bottom of the foundation trench 10 may be covered with a waterproof film 12 that has an outer

surface with a structure that provides a keying formation capable of keying into concrete cast against said layer. This alternate embodiment is shown in Figure 5. Therefore a blinded, backfilled trench 10 has the waterproof film 12 pre-applied to a base layer of blinding concrete 14 present at the bottom of the foundation trench 10. The two composite products 1 are then placed in the trench and connected to the horizontal waterproof film 12 via connectors 13 to form a 'U' shape cross section, which lines the foundation trench in preparation for the concrete pour. A reinforcement cage (not shown) may optionally be disposed within the 'U' shape formed by the vertical composite products 1 and the horizontal waterproof film 12. Subsequently, concrete is poured into the 'U' shape trench, which, once the concrete has set, remains in place.

In Figure 5 the composite products 1 are used to form a groundbeam. However, it will be appreciated that is possible to use the present invention to produce other structural features, such as pile caps

As another alternative, the composite product 1 of the invention may be provided as a flat but pre-creased panel that can then be folded in-situ to create a 'U' shape cross section, which lines the foundation trench in preparation for the concrete pour. This is shown in Figure 4. It can be seen that the product 1 has two pre-creases 4 and 5. The product can therefore be folded along these pre-creases to create a 'U' shape cross section, which lines the foundation trench in preparation for the concrete pour. There is therefore a middle section 6 which provides the horizontal component of the 'U' shape at the bottom of the foundation trench and two side sections 7 and 8 which form the vertical components of the 'U' shape cross section.

Figure 4 shows the product 1 before it is creased.

In use, it may be utilised as follows. Spacers, which might be bars or any other suitable arrangement, are placed in the middle section 6 that presents the horizontal component and then a reinforcement cage 11 (not shown, but as in Figure 3) is lowered onto the middle section 6. The two side sections 7 and 8 are moved into their horizontal alignment by folding along the pre-creases 4 and 5 to produce upright walls, whilst ensuring that side spacers are fitted to the reinforcement cage. Spoil is

then backfilled against the upright walls, thus securing said walls 7 and 8 against the side spacers. Concrete is then poured into the 'U' shape trench.

In an alternate embodiment, the two side sections 7 and 8 are moved into their horizontal alignment by folding along the pre-creases 4 and 5 to produce upright walls before placing the thus-formed 'U' shape product 1 in the trench 10, as in Figure 3. A reinforcement cage 11 is disposed within the 'U' shape. Subsequently, concrete is poured into the 'U' shape trench, which, once the concrete has set, remains in place.

It will be appreciated that the composite product of the invention may also be provided as a pre-formed panel already having a 'U' shaped cross section, which lines the foundation trench in preparation for the concrete pour.

Claims

1. A composite product for use as formwork, which acts as a mold defining a cavity in the ground into which concrete is poured, the composite product comprising:

- a structural panel formed from polymeric material, the panel being rigid, water proof and gas proof; and

- a bonding layer, the bonding layer having a structure that provides a keying formation capable of keying into concrete cast against said layer;

wherein the structural panel has an inner face and an outer face, and wherein the bonding layer extends over most or all of the inner face of the structural panel, such that, in use, the bonding layer is presented on the surface of the formwork that defines the cavity within which concrete is poured and serves to fully bond the formwork to the cast concrete.

2. The composite product of claim 1, wherein the bonding layer has a structure that also serves to interrupt or hinder water tracking along the surface of the concrete cast against said layer.

3. The composite product of claim 2, wherein the bonding layer has a structure that provides a keying formation capable of keying into concrete cast against said layer, wherein the size of the formations is such that when keyed to the concrete a cellular structure is provided.

4. The composite product of any one of claims 1-3, wherein the structural panel is formed from polymeric material which is a thermoplastic polymer.

5. The composite product of claim 4, wherein the structural panel is formed from polymeric material based on a monomer which is an olefin containing from 2 to 6 carbon atoms.

6. The composite product of claim 5, wherein the structural panel is formed from polymeric material which is high density polypropylene or polyethylene or a blend or copolymer thereof.

7. The composite product of any one of claims 1-6, wherein the structural panel is formed from polymeric material that is fluted or corrugated.

8. The composite product of any one of claims 1-7, wherein the structural panel is from 5mm to 20mm thick.

9. The composite product of claim 8, wherein the structural panel is from 10mm to 15mm thick.

10. The composite product of any one of claims 1-9, wherein the bonding layer is a porous material whereby an array of apertures is provided within a fibre network.

11. The composite product of claim 10, wherein the bonding layer is geotextile fleece.

12. The composite product of claim 11 wherein the bonding layer is a geotextile fleece made from polypropylene or polyester.

13. The composite product of claim 10, wherein the bonding layer is a polymeric mesh.

14. The composite product of claim 13, wherein the bonding layer is a polymeric mesh which is formed from polymeric material based on a monomer which is an olefin containing from 2 to 6 carbon atoms.

15. The composite product of claim 13 or claim 14, wherein the bonding layer comprises a polymeric mesh with a plurality of straight parallel formations which intersect another plurality of similar straight parallel formations to provide a series of diamonds or squares or other quadrilateral shapes.

16. The composite product of any one of claims 13 to 15, wherein the bonding layer comprises a polymeric mesh with apertures sized from 5 square mm to 100 square mm.

17. The composite product of any one of claims 1-16, wherein the bonding layer is directly attached to the structural panel.

18. The composite product of any one of claims 1-17, wherein the composite product is 60wt% or more polymeric material.

19. The composite product of claim 18, wherein the composite product is 90wt% or more polymeric material.

20. A method for making a structural feature, comprising using one or more composite product according to any one of claims 1-19.

21. The method of claim 20, wherein the method comprises the steps of:

- positioning the one or more composite product in a foundation trench, such that at least the vertical walls of a 'U' shape are defined by the composite product, said 'U' shape being the cross section of a cavity within which concrete will be poured, with the bonding layer being presented on the surface of the formwork that defines said cavity;
- backfilling the trench so as to support the composite product or products;

and

- pouring concrete into the cavity, in liquidised form, and allowing the concrete to set.

22. The method of claim 21 wherein the composite product is a pre-creased product and the composite product is folded along the crease or creases before the backfilling step.

23. The method of any one of claims 20-22 wherein the structural feature formed by the method is a ground beam or a pile cap.

24. A structural feature, comprising one or more composite product according to any one of claims 1-19.

25. The structural feature of claim 24, wherein the structural feature has a 'U' shape cross section, which can line a foundation trench.

26. The structural feature of claim 25, wherein at least the vertical walls of the 'U' shape are defined by the composite product or products.

27. The structural feature of any one of claims 24-26, wherein there are two or more composite products and these are joined together by one or more connectors.

28. The structural feature of claim 27 wherein the connectors are waterproof.

29. The structural feature of any one of claims 24-28, wherein the structural feature is a ground beam or a pile cap.

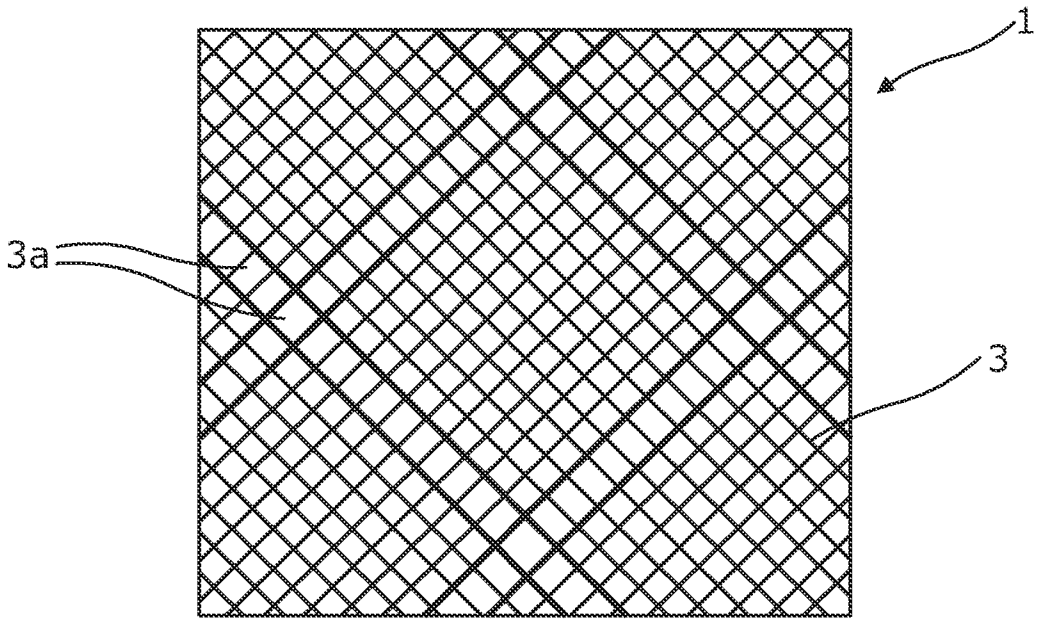

Fig. 1

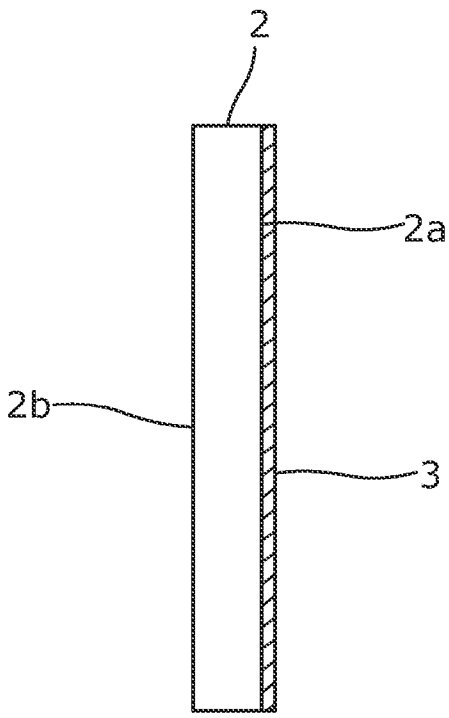

Fig. 2

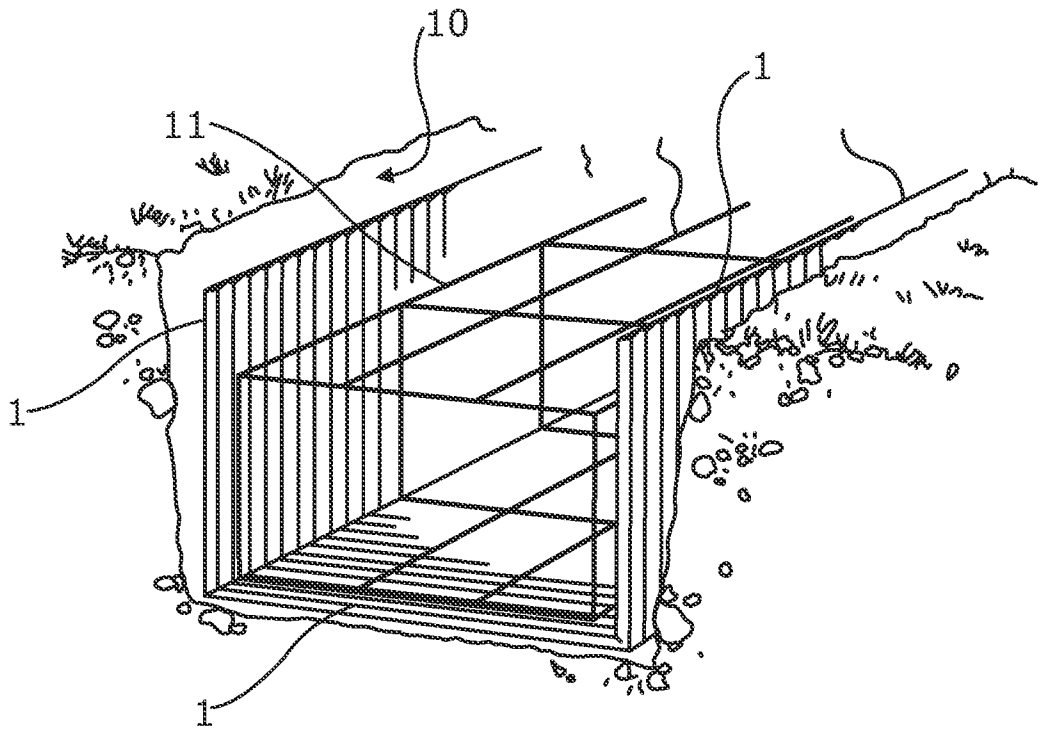

Fig. 3

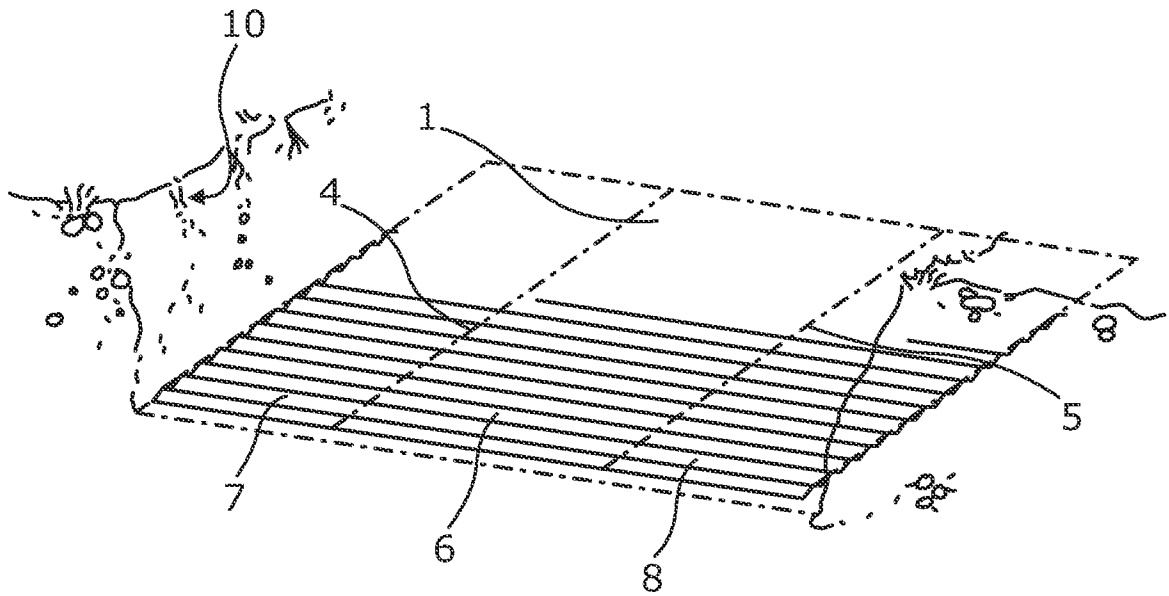

Fig. 4

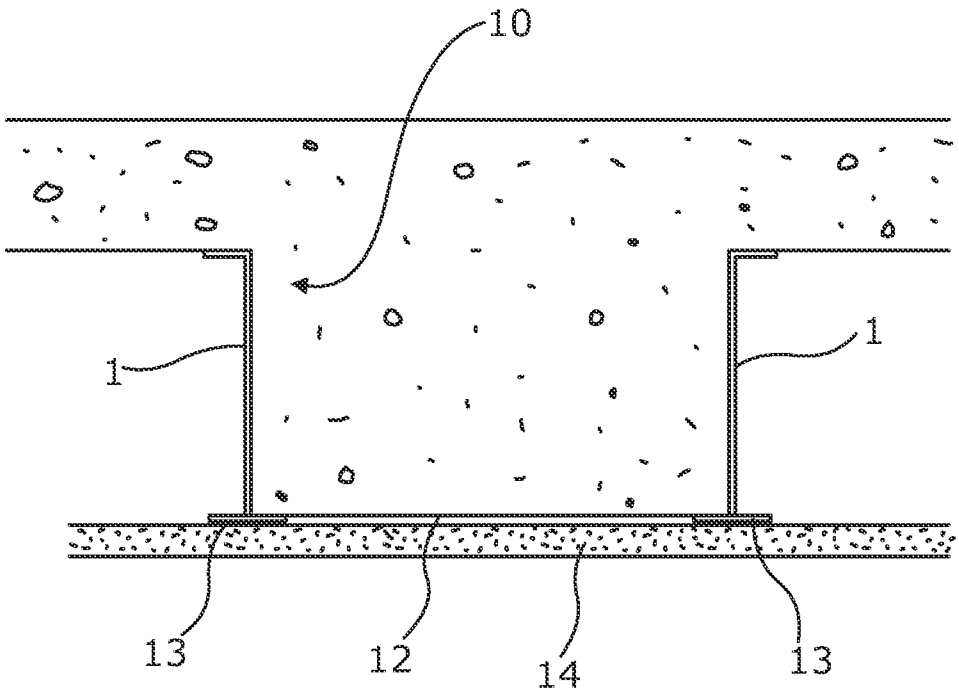

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2016/051345

A. CLASSIFICATION OF SUBJECT MATTER
INV. E02D27/02 E02D31/02
ADD.

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)
E02D E04G E04C B28B B32B

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2007/125042 A1 (HUGHES JOHN [US] ET AL) 7 June 2007 (2007-06-07) the whole document	1-29
A	FR 2 539 169 A1 (DELMAS GEORGES [FR]) 13 July 1984 (1984-07-13) the whole document	1-29
A	GB 2 340 070 A (FOSROC INTERNATIONAL LTD [GB]) 16 February 2000 (2000-02-16) the whole document	1,20,24
A	EP 0 866 196 A1 (WINTER WILLIAM [GB]) 23 September 1998 (1998-09-23) the whole document	1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
1 August 2016	24/08/2016

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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