(12) UK Patent Application (19) GB (11) 2529068 (13) A

(43) Date of A Publication 10.02.2016

(21) Application No: 1513788.8

(22) Date of Filing: 04.08.2015

(30) Priority Data:
(31) 1413890 (32) 05.08.2014 (33) GB

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(51) INT CL:
E04B 1/41 (2006.01) ***E04B 2/30*** (2006.01)
E04B 2/44 (2006.01)

(56) Documents Cited:
GB 2494135 A **US 20050016095 A1**
AU2008201591

(58) Field of Search:
INT CL **B29C, E04B**
Other: **WPI, EPODOC, TXTE**

(54) Title of the Invention: **Functional wall tie**
Abstract Title: **Wall tie**

(57) A wall tie or bracket 1 comprising a fibre reinforced polymer elongate body 3. At least one end of the body has an overmoulded end portion 5. The end portion may be formed from polyamide or polypropylene. The end portion may comprise a retention portion and/or a fixing. The body may be provided with surface features such as ribs, threads or sand in order to enhance the bond with the end portion. Also claimed is a drip clip for affixing an elongate wall tie rod to inhibit passage of water and condensation across a cavity, the clip comprising a helical rod of 0.75 to 2.5 turns.

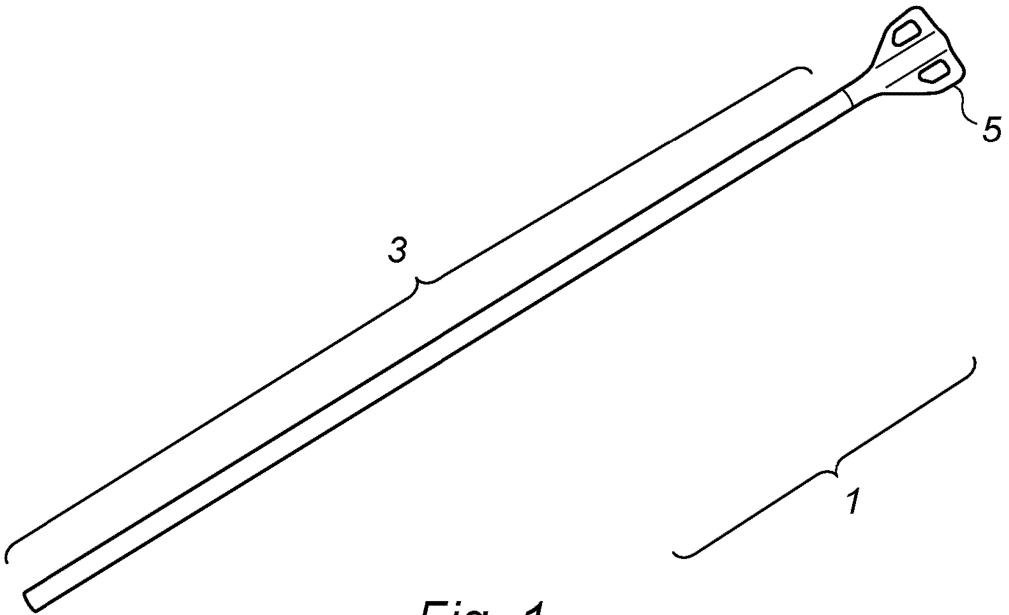

Fig. 1

GB 2529068 A

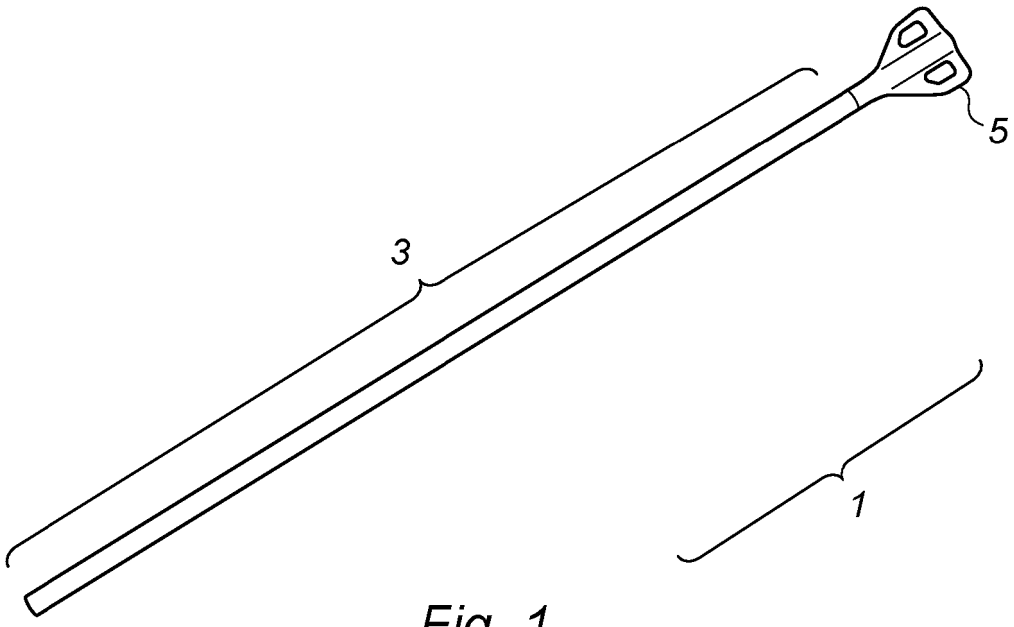

Fig. 1

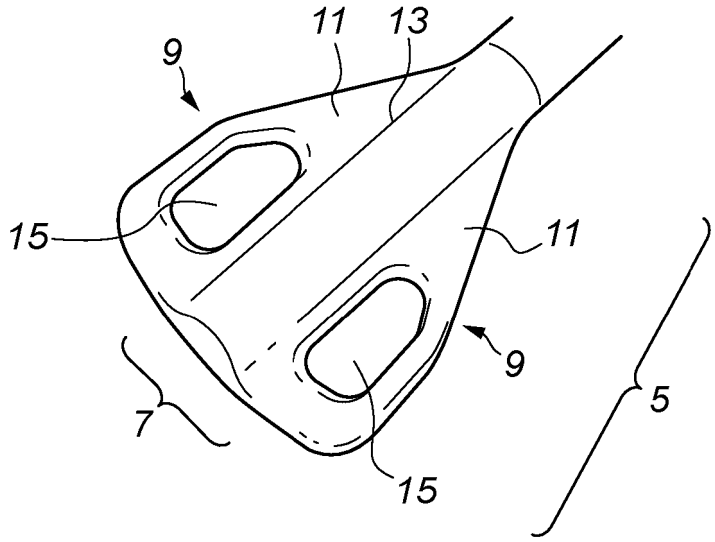

Fig. 2

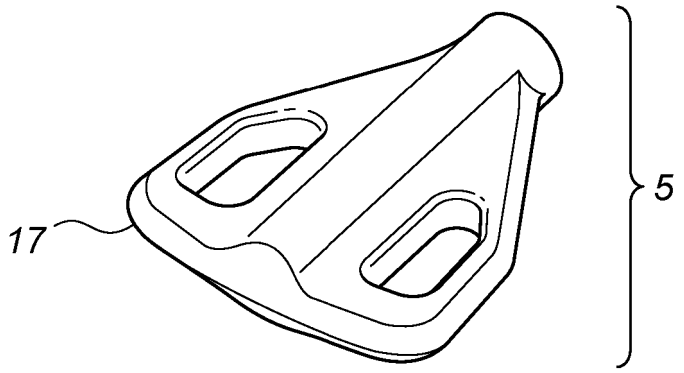

Fig. 3

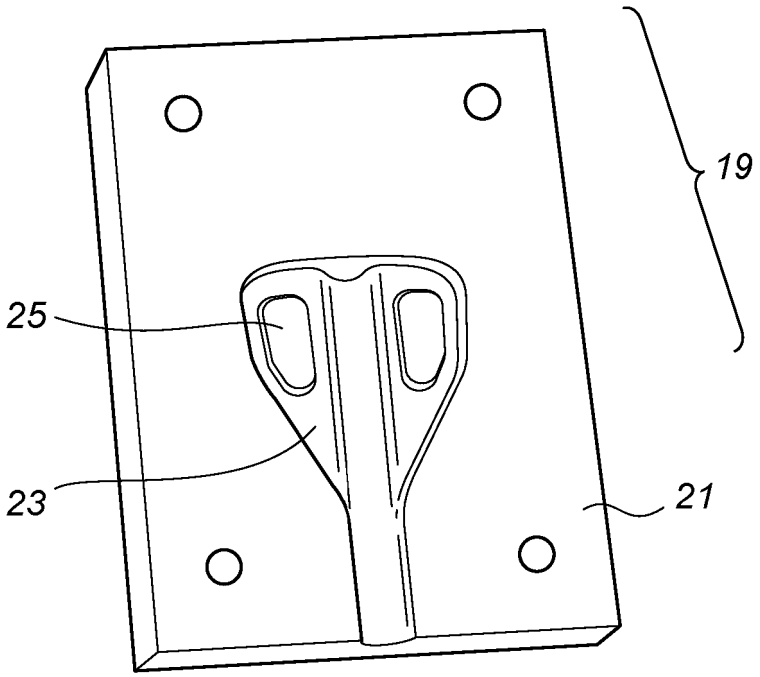

Fig. 4

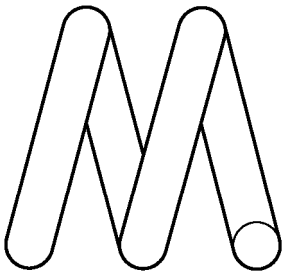

Fig. 5a

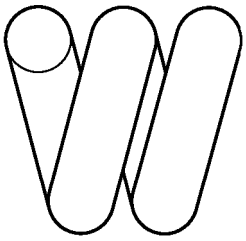

Fig. 5b

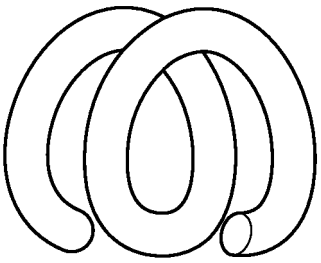

Fig. 5c

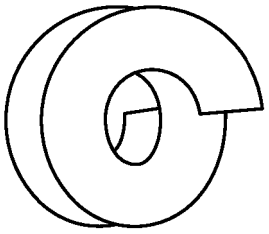

Fig. 5d

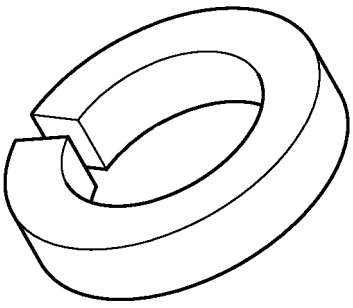

Fig. 6a

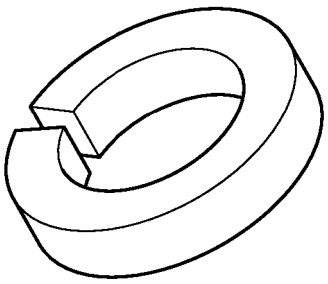

Fig. 6b

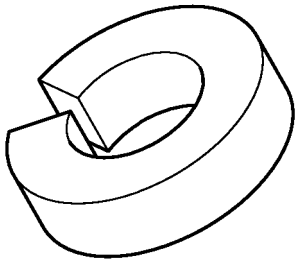

Fig. 6c

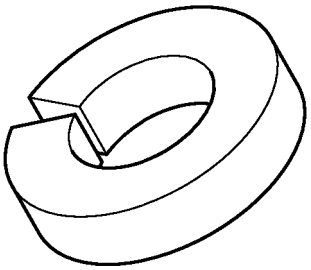

Fig. 6d

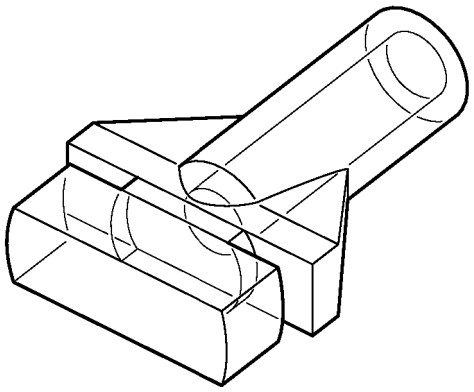

Fig. 7

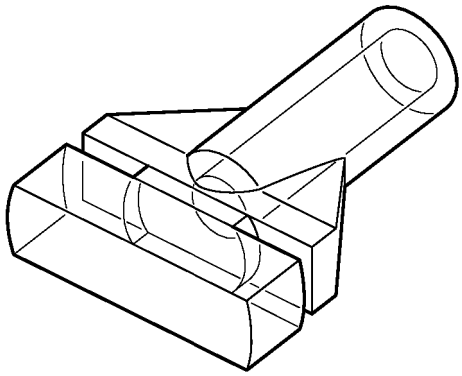

Fig. 8

Functional wall-tie

FIELD OF THE INVENTION

This invention pertains generally to the field of structural wall ties for tying two or more structural skins, e.g. in the construction industry. More particularly, the invention relates to a wall tie, components for a wall tie and methods of manufacturing a wall tie.

BACKGROUND OF THE INVENTION

In building construction, a common practice is to construct building having two skins, especially in brick or concrete block cavity wall construction, but also in buildings having reinforced concrete or steel frame structures which may have an outer or inner skin.

It is typically necessary in order to produce structures with the desired structural integrity to tie the walls to one another, usually using wall ties.

The conventional solution is a wall tie, such as a steel wall tie. In the case of dual skin cavity wall brick or concrete block construction, a steel wall tie is typically adapted to be secured during building in the mortar between the bricks or blocks and extend beyond the cavity. If there is a skin, such as a wooden skin or steel skin tied to a brick/block skin, one end of the tie may be adapted for securing to the wooden or steel skin, whilst the other end is adapted for securing in the mortar between the bricks/blocks. Failure of wall ties can lead to loss of structural integrity in the building, bulging walls and failure of the building ultimately. Failure is most likely in the event of corrosion of the wall ties, poor fixing of the wall ties to one or other skin, failure of the wall tie due to weakness in its fabric or loss of integrity in the event of fire.

One problem associated with steel wall ties has been corrosion, which has led to a significantly shorter lifetime in wall ties than had been expected, although this has been partially addressed by the use of more expensive and energy demanding stainless steel. Another problem with conventional steel wall ties is their high thermal conductivity, which leads to loss of heat from the

home and reduced benefit of insulation provided by the cavity wall arrangement. By virtue of their high thermal conductivity, such steel wall ties are a focus for condensation, which may increase the tendency to corrode and may lead to dampness at associated points in one or other skin. Where, cavity wall insulation is provided, condensation can lead to dampness in the insulation material close to the ties and associated problems, such as damp spots and/or cold spots on internal walls.

There is a need for improved wall ties and brackets that have reduced thermal conductivity combined with structural and functional qualities.

The present inventor has invented a new and improved wall tie.

PROBLEM TO BE SOLVED BY THE INVENTION

There is a need for improvements in wall ties for tying structural skins such as brick courses in cavity wall systems.

It is an object of this invention to provide a wall tie that demonstrates good thermal performance, is relatively low cost to manufacture and can demonstrate desirable functional characteristics.

SUMMARY OF THE INVENTION

In accordance with a first aspect of the invention, there is provided functional wall tie or bracket comprising a fibre-reinforced polymer elongate body member having overmoulded on at least one end thereof a functional end portion.

In a second aspect of the invention, there is provided a method of manufacturing a functional wall tie or bracket, the method comprising providing a fibre-reinforced polymer elongate body member and overmoulding on at least one end therof a functional end portion.

In a third aspect of the invention, there is provided a mould tool for providing an overmould according to the preferred method of the invention mentioned above, the mould tool configured to receive an elongate body member and shaped to receive an injection of a mould material for forming a retention end portion about an end of the elongate body member.

In a fourth aspect of the invention, there is provided drip clip for affixing to an elongate wall tie rod to inhibit passage of condensation and water across a cavity, the drip clip comprising a helical rod of 0.75 to 2.5 turns.

In a fifth aspect of the invention, there is provided a method of forming a drip clip, comprising providing an injection mould tool for another product having a sprue passage of shape and configuration of the drip clip defined above.

In a sixth aspect of the invention, there is provided a drip clip comprising a partial annulus (preferably of greater than 270 degrees completion) or a spiral (preferably of from 270 to 400 degrees).

ADVANTAGES OF THE INVENTION

The wall tie of the invention enables functional end portions to be provided for low thermal conductivity wall ties and brackets such as those formed by elongate polymer reinforced fibre rod member whilst maintaining a strong robust bond between the more robust bond between the functional end and the rod member.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 is a plan view of a wall tie according to one embodiment of the invention;

Figure 2 is a plan view of a retention end portion of a wall tie of Figure 1;

Figure 3 is a diagrammatic representation in perspective view of a retention end portion of a wall tie according to one embodiment of the invention;

Figure 4 is a plan view of one half of a mould tool according to another aspect of the invention

Figure 5 a to d are representations of helical (a to c) and spiral (d) drip clips according to another aspect of the invention.

Figure 6 a to d are representations of spiral drip clips according to another aspect of the invention;

Figures 7 and 8 are graphical representations in perspective view of functional end portions according to one aspect of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The invention provides for an improved bracket or wall tie for tying skins of a building structure one or both of which are typically structural skins. The wall tie comprises an elongate body portion/member (terms to be used interchangeably) having overmoulded on at least one end, and optionally on each end, thereof a functional end portion.

Preferably, the elongate body portion comprises, and more preferably is formed of and consists essentially of a fibre reinforced polymer (FRP) material. Hereinafter, the features of the invention should be read as having, preferably, an elongate body portion of fibre-reinforced polymer.

Preferably the elongate body portion is an elongate rod. Preferably, the rod has a diameter of up to 20 mm, more preferably up to 15 mm, e.g. 3 to 12 mm and more preferably 5 to 10 mm.

The elongate body portion may be of any suitable length and is preferably 200 to 600 mm in length.

The functional end portion may be any suitable end portion which has a function, such as a retention function (e.g. a laterally flared retention end portion) for improving retention of a wall tie in mortar of a building course or a fixing element for affixing a wall tie to a timber frame (e.g. comprising a L-form end with fixing holes) or for affixing a wall tie to a channel bracket (e.g. a channel tie configured to be received in a steel or composite channel embedded in masonry or affixed to timber) or as a bracket. The functional end portion may provide a junction portion which is in or capable of operable communication with a peripheral functional component. For example the junction portion may provide a socket for a ball and socket arrangement with a peripheral fixing component.

The functional end portion preferably has a joint end being the end of the functional end portion toward the main body portion (elongate body

portion/member) and a peripheral end, being the end of the functional end portion away from the body portion.

The functional end portion may optionally be defined as the entirety of the component which is formed on an end of the elongate body portion.

In a preferred embodiment, the functional end portion comprises a principal portion, which is typically medially located in the functional end portion. The principal portion houses or covers a peripheral end portion of the elongate body member. Thus, the elongate body member preferably extends into the functional end portion. Thereby, a peripheral end of the elongate body member is, within the functional end portion, thereby increasing the strength and rigidity of the joint between the elongate body portion and functional end portion. Preferably, the elongate body portion extends into the functional end portion at least 20% of the length of the functional end portion, more preferably at least 30%, still more preferably at least 50%, still more preferably at least 60%, yet more preferably at least 75% and most preferably at least 80%. Thus the functional end portion does not have a point of significant stress at a joint with the elongate body portion and is not likely to break off.

Preferably, the principal portion is generally tubular (or at least defines a generally tubular cavity) for receiving or covering a generally rod-shaped elongate body portion.

In one example of a functional wall tie of the invention, the functional end portion is a retention end portion which may be laterally flared. According to this embodiment, the retention end portion may be configured for disposal between rows of building elements, such as bricks in a course which are held by mortar in order to increase the retention of the wall tie, particularly under tension. The retention end portion is configured to be embedded in the mortar during the laying of the course. By laterally flared, it is meant that the retention end portion extends laterally (in a direction generally orthogonal to a longitudinal direction that may be defined by the elongate body portion). Hereinafter the dimension in the lateral direction may be referred to as width, whilst a further dimension orthogonal to both lateral (width) and longitudinal (length) directions

may be referred to as depth. Preferably the retention end portion has a relatively low depth profile.

The retention end portion preferably has a joint end being the end of the retention end portion toward the main body portion and a peripheral end, being the end of the retention end portion away from the body portion. The lateral end portion preferably flares laterally outwards in a direction from the joint end to the peripheral end. Thereby, when in position in a brick course, embedded in mortar, for example, the retention end is somewhat resistant to being removed from the cured mortar as pulling on the all tie will simply increase the resistive force of its removal. Preferably, the retention end portion is flared laterally in two laterally opposing directions (e.g. either side of the longitudinal axis defined by the elongate body portion) so as to form a pair of laterally opposing fins (which define a wedge-like shape).

The retention end portion may be defined as the entirety of the component which is formed on an end of the elongate body portion. A laterally flared retention end portion may be defined as that portion of the retention end portion peripheral to the start point of the lateral flare (relative to the width of the elongate body portion). Where a retention end portion is referred to herein, especially with regard to relative quantities/lengths, the flared retention end portion is contemplated as an alternative.

The retention end portion preferably comprises a lateral extension or laterally extending fin which provide the lateral extension of the end portion, more preferably two opposing lateral extensions or fins. In a preferred embodiment, the retention end portion comprises a principal portion, which is typically medially located in the retention end portion, having a lateral extension or fin (which terms will be used interchangeably hereinafter) extending laterally therefrom and preferably two lateral extensions or fins, one extending from each side of the principal portion.

The principal portion, according to a preferred embodiment, houses or covers a peripheral end portion of the elongate body portion. Thus, the elongate body portion preferably extends into the retention end portion. Thereby, a

peripheral end of the elongate body portion is, within the retention end portion, embedded in the mortar in a course, in use, thereby increasing the strength and rigidity of the joint between the elongate body portion and retention end portion.

Preferably, the principal portion is generally tubular for receiving or covering a generally rod-shaped elongate body portion.

Preferably, the lateral extensions or fins project or extend laterally outwardly from the principal portion, preferably either side of the principal portion.

The or each lateral extension or fin is preferably substantially planar, optionally having one or more holes formed therein or notches or irregularities formed about the edge of the lateral extension in order to enhance mortar bond about the retention end portion. In one embodiment, each of two such fins has hole formed within it, the hole forming over at least 25% of the area of the fin, preferably at least 40% and for example from 40-70% of the area of the fin.

The edge of the retention end portion, defining the lateral extension or flare, may define a flare angle, being the angle of the flare to the longitudinal direction (from body to periphery of the body portion). Due to the shape of the retention end portion, there may be more than one flare angle defined by the lateral extensions. Thus there may be more than one flare angle. For example, there may be a primary flare angle, which may be defined as the angle of the edge of a fin or lateral extension responsible for the greatest degree of lateral extent. There may be a maximum flare angle, which may be the flare angle which is the greatest. There may also be a corrected average flare angle being the average of the flare angles corrected according to the length of the edge at that angle. There may also be the generalized flare angle, being the angle calculated if drawing a straight line from the initial flare point to the most laterally extended point.

Angles are defined, unless otherwise stated, relative to the longitudinal direction of the elongate body portion in the peripheral end direction.

Optionally, a maximum flare angle of up to 170° is provided, e.g. up to 135°, or up to 120° (and in any case greater than 90°), preferably in short

lengths (e.g. 5 mm or less, preferably 2 mm or less or 1 mm or less) in order to form a one or more teeth, in order to improve retention in the mortar, when in use.

Optionally, the retention end portion has a generalized flare angle of up to 60°, preferably up to 45°, more preferably up to 30° and in any case preferably at least 10°, more preferably at least 15° and ideally at least 20°.

Preferably, the primary flare angle is up to 135°, more preferably up to 90°, still more preferably up to 60°. Preferably the primary flare angle is at least 10°, more preferably at least 15°. Still more preferably, the primary flare angle is from 20 to 50° and most preferably about 25 to 45°. A flare angle at or around 30° is considered optimal.

Preferably, no edges of the flared portions of the retentive end portions define an angle with respect to adjacent edges of 90° or less.

Preferably, the depth of the fins or lateral extensions is up to 15mm, preferably 10mm or less, still more preferably less than 7 mm and most preferably from 2 to 5 mm and ideally 4 or about 4 mm. The edges may be sharp, shear edges or may be rounded or chamfered, e.g. to a mid-point (e.g. at an angle of up to 45° or up to 30° to the shear edge).

In a preferred embodiment in which a peripheral end of the elongate body portion is covered by the retention end portion (or any functional portion intended to be disposed in mortar between courses of bricks or blocks), a principal portion preferably has a depth of up to 5 mm more than the depth of the peripheral end, preferably up to 2 mm and preferably up to 1 mm greater. In an embodiment, for example, where the elongate body portion and peripheral end thereof have a depth of 7 mm, the depth of the principal portion may preferably be 8 mm. Preferably the fins have a depth of less than the principal portion.

Preferably, the length of the retention end portion is up to 50 mm, preferably up to 45 mm, more preferably at least 10 mm, yet more preferably at least 20 mm, still more preferably 25 to 40 mm, still more preferably at least 30 mm and most preferably about 32 to 37 mm, e.g., about 35 mm.

Preferably the width (maximum lateral extent) of the retention end portion is greater than the width of any peripheral end of the elongate body portion

(and preferably greater than the width of the elongate body portion generally). Preferably, the maximum width of the retention end portion is at least 15 mm, more preferably at least 20 mm, preferably up to 100 mm, more preferably up to 50 mm, still more preferably at least 25 mm and more preferably up to 45 mm and most preferably up to about 35 mm (e.g. 28 to 32 mm).

Preferably the shorter of the length or width of the retention end portion (and more particularly the flared retention end portion) is at least 50% of the longer of the length or width of the retention end portion, more preferably at least 60%, still more preferably at least 75% and ideally at least 80%.

In one embodiment, the retention end portion is 2 to 4 times the width of the elongate body portion on which it is formed.

The functional end portion may be any suitable size depending on its purpose (e.g. L-form end with fixing holes or a channel tie end). Preferably, the length, extending from the junction end to the peripheral end of the functional end portion is up to 100 mm (especially for channel ties or L-form ends, where the peripheral leg of the L is included in the length), more typically up to 50 mm, preferably at least 10 mm, more preferably at least 20 mm, still more preferably at least 25 mm.

The width (maximum lateral extent) of the functional end portion may be any suitable width according to the particular function, but is typically greater than the width of any peripheral end of the elongate body portion (and preferably greater than the width of the elongate body portion generally) and normally at least double the width. Optionally, the maximum width of the retention end portion is at least 15 mm, more preferably at least 20 mm, optionally up to 100 mm, such as up to 50 mm.

The functional end portion of the wall tie of the invention may be formed of any suitable injection mouldable material, but is preferably a material which is capable of forming a good bond with the elongate body portion. More preferably, the retention end portion is formed of a low thermal conductivity material.

Preferably, in accordance with the present invention, the functional end portion is formed by overmoulding onto a peripheral end (or each peripheral end) of an elongate body member (for forming the elongate body portion) by placing an elongate body member in a suitable mould and injection moulding a mould material which is set or cured to form the functional end portion.

The mould material may be any suitable material capable of overmoulding onto an elongate rod and, in particular, onto a fibre-reinforced polymer rod. Preferably, the mould material comprises an injection mouldable polymer or polymer-forming monomer (or monomer blend) composition for forming a polymer such as a polypropylene, a poly amide, a poly amide-imide, a poly imide, a poly ether ether ketone (PEEK), a polycarbonate, a polypthalamide, a polyphenyl sulfide or a blend thereof. Preferably, the mould material comprises a poly amide (e.g. a Zytel™ polymer available from DuPont such as 101L BKB080 or HTN52G45HSL BK083) or a polypropylene. Preferably, the mould material comprises a filler. More preferably, the mould material is fibre reinforced (e.g. basalt fibre, glass fibre, carbon fibre or any other fibre referred to here, or a mixture thereof) and preferably glass or basalt fibre reinforced and most preferably glass fibre reinforced. Preferably a reinforcing glass fibre has a fibre length of 1 mm to 10mm.

Preferably, the glass (or other fibre) reinforcement is provided in an amount in the range of from 10% to 60% by weight, more preferably at least 25% and preferably up to about 50%. In one, preferred, embodiment, the glass (or other) fibre reinforcement is provided in an amount of from 25% to 35% by weight, preferably about 30%. In another embodiment, the glass (or other) fibre reinforcement is provide in an amount of from 40% to 50% by weight

Optionally, the mould material further comprises a filler, such as nanoclay or aluminium tri-hydrate (in an amount of up to 20% by weight, e.g. 5 to 10% by weight).

Optionally the functional end portion is provided with an outer coating of, for example, Kevlar or a resin loaded with an intumescent clay. Optionally the outer coat comprises a granular material such as a silica based

material, e.g. sand, or is provided with surface features such as undulations, protrusions or ribs (particularly where the functional end is to be used as a retention end in mortar).

Optionally the elongate body member is provided with surface features to enhance the bond between it and the overmoulded functional end portion, such as notches or cuts, one or more holes in the elongate body member (e.g. at the peripheral end thereof) or a sand surface (which is preferred). A yet further surface feature may be provided by an overwound threaded surface (in resin). Indeed, the surface features may comprise any protrusions, undulations or surface irregularities extending from the body member of the wall-tie. The surface features may be ribs, such as annular ribs, or helical ridges or threads formed on the body member of the wall tie. Optionally, the surface features are provided by a helical thread formed on the body member of the wall tie. A thread is preferably provided by a length of a fibre thread (e.g. cotton) set in a resin (e.g. epoxy resin) on the surface of the body member. Optionally, the surface features, especially where for example the surface features are ribs or threads, they extend outwardly from the body member of the wall-tie by up to 0.25 mm (or up to 0.1 mm).

Such surface features on the body member may be provided along the entire length thereof, or may be limited to one or both peripheral ends of the body member (which are to be housed within the functional end portion). Accordingly, the surface features may be provided on a peripheral end for a length of up to 100 mm and preferably at least 20 mm, preferably at least 30 mm an optionally from 40 to 80 mm from the peripheral end of the body member.

One overmoulded end may be provide or, when two overmoulded ends are provided, overmoulding may be achieved as a single piece as a single unit over an elongate body member (e.g. both ends moulded simultaneously) or one end at a time (in a multi-step process).

Optionally, a small steel insert may be provided in the overmoulded functional end portion to aid detection with a metal detector.

The elongate body portion/member may be any suitable form, but is preferably an elongate rod, which may have a helicial groove, annular grooves or

projections or any other surface undulation or formation. Preferably the elongate rod is formed of fibre reinforced polymer. Preferably, the elongate rod is formed by pultrusion. Hereinafter, the body portion is discussed in terms of an elongate rod, but the further features described, where the context allows, are intended to apply also to elongate body members generally.

The wall tie may be of any desired length in order, typically, to bridge a cavity and form a tie between two skins. Preferably, the wall tie is up to 1 m in length, more preferably up to 750 mm and optionally up to 600 mm. Preferably the wall tie is at least 100 mm in length and preferably at least 200 mm.

The body portion preferably comprises at least 50 % of the length of the wall tie, more preferably, at least 60%, yet more preferably at least 75% and still more preferably at least 85%, such as in the range of 70% to 90%, preferably 85% to 90%. In any case it is preferred that each functional end portion comprises less than 25% of the length of the wall tie. The length of the or each functional end portion, is preferably minimized to minimize thermal bridging and materials. Preferably, the body portion comprises in situ at least 50% of the separation of the first and second skins (i.e. in the horizontal plane across the cavity), more preferably at least 60%, still more preferably at least 75% and most preferably at least 90%.

Preferably the body portion is formed of a fibre reinforced polymer (FRP).

The FRP is preferably formed of a fibre dispersed in a cured polymer resin. Any suitable fibre or fibres may be used in the manufacture of the fibre-reinforced polymer. Examples of fibres that may be used in the FRP or polymer-based material in accordance with the present invention may be synthetic and/or natural fibres and may include any one or a combination of: glass fibres; carbon fibres; boron fibres; Kevlar™ fibres; mineral fibres; basalt fibre; metal strands such as aluminium, copper or steel; polymer fibres such as polyester, polyethylene or aramids; or natural fibres such as cotton, jute, hemp or flax. Preferably the fibres are selected from fibres having low thermal conductivity. Thus, preferably, the fibres are selected from glass fibres, polymer fibres and

basalt fibres, more preferably glass fibres and basalt fibres and most preferably basalt fibres.

Optionally, more than one fibre material can be used in combination in the fibre-reinforced polymer in forming the wall-tie of the invention. Such constitution of combinations of fibre materials may vary longitudinally along the length of the wall-tie, for example, or radially from core to surface, or the combination may comprise a random distribution of constituent fibres. Suitable such combinations of fibre materials might be, for example, any two or more of glass fibres, polymer fibres, carbon fibres and basalt fibres in combination, such as glass and basalt fibres or basalt and carbon fibres in combination.

Particularly suitable fiber-reinforced polymers for the wall-tie of the invention include glass fiber-reinforced polymers or basalt fiber-reinforced polymer.

The fibres may be orientated in any suitable arrangement, e.g. random, partially aligned or aligned. Preferably, at least a portion (e.g. a core) of the body portion of the wall-tie of the invention is formed of fibre-reinforced polymer having partially aligned and preferably aligned fibres. Preferably, the body portion comprises a core fibre-reinforced polymer material having longitudinally aligned fibres, typically of basalt fibre, being fibres aligned longitudinally with the body portion of the wall tie.

The body portion may be formed of a core of fibre-reinforced polymer, preferably basalt fibre and preferably longitudinally aligned fibres. Optionally, the body portion may comprise more than one layer of fibre reinforced polymer material. For example, the body portion may comprise of a longitindal core of fibre-reinforced polymer and one or more layers of fibre-reinforced polymer formed thereon. Longitudinal alignment of fibres enables the body portion to have the tensile strength in the longitudinal direction that is the main requirement of a wall-tie. In one embodiment, the body portion comprises a core of FRP having randomly orientated fibres and an outer layer of FRP having longitudinally aligned fibres and, optionally further layers therebetween or

thereon. In another embodiment, the body portion comprises a core of FRP having longitudinally aligned polymer and at least one layer of FRP thereon which may comprise a layer of randomly orientated fibre-reinforced polymer, a layer of FRP having lateral fibres and a layer of FRP having longitudinal fibres. An outer layer may be provided by providing a mat of randomly orientated fibres. A fibre-reinforced polymer may have lateral fibres or laterally orientated fibres provided by a helical wind of fibre rovings about a longitudinally aligned core. There may be multiple layers comprising successive layers of longitudinal and random and/or lateral fibres. Lateral and randomly orientated fibres provide additional strength in other dimensions (other than the key longitudinal direction). In a preferred embodiment of the present invention, the body portion comprises at least one layer (e.g. the core) of longitudinally aligned fibre-reinforced polymer and radially outward therefrom at least one layer of laterally aligned fibre-reinforced polymer, which preferably a helically wound layer of fibre rovings. A helical wind of fibres about a longitudinally aligned fibre-reinforced polymer provides significant longitudinal tensile strength combined with further enhanced fire-resistance and other dimensional strength (e.g. torsional and shear strength).

In these multi-layer embodiments, the fibre may be the same or different in each or any layer, but is preferably basalt fibre.

By longitudinal fibres, it is meant fibres which are tending to be orientated in the direction of pultrusion or co-axial with the mandrel. Any fibre which is at an angle of less than 45 degrees to the direction of pultrusion is a longitudinal fibre, although preferably they are less than 15 degrees and more preferably less than 10 degrees deviated from the direction of pultrusion and most preferably substantially in the direction of pultrusion, i.e. most preferably they are substantially axial in orientation.

By laterally orientated fibres, it is meant that the fibres are offset from the median or the direction of pultrusion (e.g. the axis of a mandrel) generally at an angle of 45 degrees or more. More preferably, the laterally orientated fibres are offset from the axial direction by at least 60 degrees and still more preferably at least 75 degrees. In preferred embodiments of the invention,

the lateral orientated fibres are arranged as wound fibres having an angle offset from the transverse direction by up to 15 degrees, optionally up to 30 degrees and possibly up to 45 degrees. More preferably, the wound fibres are offset from the transverse by up to and including 10 degrees and most preferably at least fibre rovings on the relatively wide side of the profile are orientated in the range 1 to 5 degrees from the transverse direction.

The fibre-reinforced body portion of an embodiment of the invention may be manufactured by any suitable means, such as pultrusion, injection moulding, resin transfer moulding, vacuum bag and press moulding, press moulding, compression moulding, filament winding, but preferably, the body portion is manufactured by pultrusion and/or filament winding.

Any suitable resin may be used. Optionally the resins may be thermosetting or thermoplastic, but thermosetting resins are strongly preferred. Actinic-radiation curing resins may alternatively be used.

Preferably the resin is selected from one or more of epoxy resins, vinyl ester resins, bis phenoly epoxy vinyl ester resins, polyester resins, polyurethane resins or phenolic resins. More preferably, especially for use in pultrusion manufacture, the resin is vinyl ester, epoxy or polyester resin, more preferably vinyl ester or epoxy and still more preferably epoxy resin.

Certain additives may optionally be included in the resin formulation to enhance performance, such as Intumescent™ to improve fire resistance (which is incorporated by dissolving or dispersing in the resin) and/or nano clay particles (to enhance fire resistance and increase strength) and/or aluminium tri-hydrate.

The fibre-reinforced polymer used comprising the body portion, which is preferably a pultruded profile, preferably has a fibre content of greater than or equal to 50% by weight of the fibre-reinforced polymer body portion and preferably up to 80% by weight, for example in the range 50 to 75%, more preferably in the range 55 to 70%, e.g. in the range 60 to 65%.

Optionally, the body portion may be provided with an outer coat for enhancing the fire resistance of the wall tie. The outer coat may be any suitable

material, such as a Kevlar™ coating or other heat resistant material. Preferably, the outer coat comprises a granular, preferably of variable size grains, material such as a silica-based material, e.g. sand, preferably adhered to the outer surface with a suitable heat-resistant resin and/or other surface features as discussed above.

In a particularly preferred embodiment, the wall tie of the invention comprises an elongate rod-shaped body portion of pultruded fibre reinforced polymer of 60 to 80% by weight loading of glass or basalt fibre roving having overmoulded on at least one end thereof a retention end portion of poly amide, which is preferably glass reinforced.

In another aspect, there is provided a drip clip for affixing to a elongate wall tie rod to inhibit passage of condensation and water across a cavity, the drip clip preferably comprising a helical rod of 0.75 to 2.5 turns, preferably from 1 to 2 or optionally 1 to 1.5 or 1.5 to 2 (preferably less than 2) turns. Thus, the clip, typically of a pliable plastic material may be clipped over an elongate rod (without having to slip on from the end) of various diameters preferably up to 1.5 times the internal diameter of the helical wind of the drip clip.

Preferably, the drip clip is formed of an injection moulded plastic. It may, for example, be formed of any of the polymer materials, or fibre reinforced polymer materials defined hereinbefore.

Preferably a drip clip has a resting internal helical diameter of from 4 to 8 mm.

In a preferred embodiment, the drip clip comprises the detached sprue of another injection moulded product.

Preferably, the drip clip is formed of polyamide.

The method of forming a drip clip comprises providing an injection mould tool for another product having a sprue passage of shape and configuration of the drip clip defined above.

The invention will now be described in more detail, without limitation, with reference to the accompanying Figures.

In Figure 1, a wall tie 1 comprises an elongate FRP rod providing an elongate body portion 3 and on one end thereof a retention end portion 5 of overmoulded poly amide or a polypropylene. The retention end portion 5, as shown in Figure 2, comprises a principal portion 7 which covers a peripheral end of the rod 3 and two laterally extending fins 9 defining lateral flares 11 having a flare angle of approximately 30° (13). A substantial hole 15 is formed in each of the fins 9 to improve retention with the mortar when *in situ*.

In Figure 3, it can be seen that the edge 17 of the retention end portion 5 is chamfered. The depth of the fins 9 is clearly less than the depth of the principal portion.

In Figure 4, one half of a mould 19 is shown, which shows the channel for receiving the peripheral end of the body member 3, the fin-forming feature 23 and the hole forming feature 25.

In Figures 5a to 5c a helical drip clip is provide of constant diameter, a turn angle of 30 to 45 degrees preferably and approximately 1 and three quarter turns. The number of turns and flexibility enabling the clip to be fitted to a mould of varying sizes. In a preferred embodiment, the helical drip clip is formed from the sprue of an injection moulding process, typically the overmoulding process for forming a wall tie or bracket of the first aspect of the present invention.

In Figures 5d and 6, spiral drip clips are shown in various sizes which are of flexible injection moulded polymer which is capable of being fitted onto a rod.

Figures 7 and 8 illustrate channel tie components as functional ends having a cavity for receiving the rod (or covering the rod in the case of overmoulding) and a peripheral engagement portion for engaging with a channel of a channel tie system.

Example

Two ties, one an elongate basalt fibre reinforced polymer rod, the second an identical rod provided with an overmoulded retention end portion of poly amide (without glass fibre reinforcement) in accordance with one embodiment of the present invention were built into lime mortar and tested to BS EN 846-5:2012.

The ties were respectively 450 mm and 430 mm long and 7mm in diameter. The ties were tested in tension over a cavity width of 300 mm and in compression over 315 mm.

The test

The masonry units from which the couplets were made were masonry units complying with BS EN 771-1:2011. The units contained three perforations and were extruded. The ties were placed in the centre of the unit perpendicular to the longer cavity face. The embedment length was 75 mm in tension therefore the length of mortar beyond the tie embedment length was27.5 mm. The embedment length was 67.5 mm in compression therefore the length of mortar beyond the tie embedment length was 35 mm

The compressive strength of the masonry units, tested in accordance with BS EN 772-1:2000 was 39.5 N/mm2.

The mortar was a pre-mixed dry mortar consisting of natural hydraulic lime (NHL), high calcium lime (CL 90) and specially graded sand and aggregates. The mix proportions were 1:2¼ (lime: sand by volume)

The compressive strength in accordance with BS EN 1015-11 was:

0.5 N/mm2 at 28 days

1.0 N/mm2 at 56 days and

1.7 N/mm2 at 90 days

The flow value measured in accordance with BS 4551:2005 was 117%.

The air content measured in accordance with BS EN 1015-7:1999 was 6.2%.

Prior to laying, the units were conditioned at ambient temperature and humidity in the laboratory for at least 24 hours.

The time allowed from construction to testing was as follows:

10 couplets tested at 28 days following construction

10 couplets tested at 56 days following construction

20 couplets tested at 90 days following construction

The design embedment length of the tie was 75 mm in tension and 67.5 mm in compression.

The pre-compression applied to the specimens was 0.1 N/mm2.

The load capacity and the loads to cause 1 mm deflection to the nearest 10 N for each specimen tested in tension and compression are given as are the displacements at one third of the mean load capacity.

First tie (comparison)

Results:

Testing at 28 days

The mean load capacity in tension is 1470 N.

The lowest individual load capacity in tension is 960 N.

The mean displacement at one third of the mean load capacity in tension is 0.14 mm

The mean load capacity in compression is 1280 N.

The lowest individual load capacity in compression is 1250 N.

The mean displacement at one third of the mean load capacity in compression is 0.11 mm.

Testing at 56 days

The mean load capacity in tension is 2410 N.

The lowest individual load capacity in tension is 1750 N.

The mean displacement at one third of the mean load capacity in tension is 0.37 mm.

The mean load capacity in compression is 1310 N.

The lowest individual load capacity in compression is 1240 N.

The mean displacement at one third of the mean load capacity in compression is 0.11 mm.

Testing at 90 days

The mean load capacity in tension is 2790 N.

The lowest individual load capacity in tension is 1830 N.

The mean displacement at one third of the mean load capacity in tension is 0.30 mm

The mean load capacity in compression is 1450 N.

The lowest individual load capacity in compression is 1230 N.

The mean displacement at one third of the mean load capacity in compression is 0.12 mm.

Second tie (invention)

Results:

Testing at 28 days

The mean load capacity in tension is 1730 N.

The lowest individual load capacity in tension is 1260 N.

The mean displacement at one third of the mean load capacity in tension is 0.22 mm

The mean load capacity in compression is 1350 N.

The lowest individual load capacity in compression is 1270 N.

The mean displacement at one third of the mean load capacity in compression is 0.14 mm

Testing at 56 days

The mean load capacity in tension is 2760 N.

The lowest individual load capacity in tension is 2440 N.

The mean displacement at one third of the mean load capacity in tension is 0.30 mm.

The mean load capacity in compression is 1430 N.

The lowest individual load capacity in compression is 1340 N.

The mean displacement at one third of the mean load capacity in compression is 0.18 mm

Testing at 90 days

The mean load capacity in tension is 3360 N.

The lowest individual load capacity in tension is 2950 N.

The mean displacement at one third of the mean load capacity in tension is 0.54 mm

The mean load capacity in compression is 1360 N.

The lowest individual load capacity in compression is 1300 N.

The mean displacement at one third of the mean load capacity in compression is 0.18 mm.

As can be seen, the tie of the invention demonstrated a considerable improvement in performance compared with the elongate rod. In particular, it offers an improved tie for weaker mortars such as lime mortars. In all cases, failure occurred as a result of failure of the mortar – there were no instances of the retention end portion separating from the elongate body portion.

The invention has been described with reference to a preferred embodiment. However, it will be appreciated that variations and modifications can be effected by a person of ordinary skill in the art without departing from the scope of the invention.

CLAIMS:

1. A functional wall tie or bracket comprising a fibre-reinforced polymer elongate body member having overmoulded on at least one end thereof a functional end portion.

2. A wall tie or bracket as claimed in claim 1, wherein the functional end portion is formed of a poly amide or a polypropylene.

3. A wall tie or bracket as claimed in claim 2, which is fibre reinforced.

4. A wall tie or bracket as claimed in claim 2 or claim 3, which is reinforced with glass fibre in an amount of 20 to 40% by weight.

5. A functional wall tie or bracket as claimed in any one of the preceding claims, wherein the functional end portion comprises a retention end portion and/or a fixing.

6. A functional wall tie or bracket as claimed in any one of the preceding claims, wherein the functional end portion comprises a junction means for or in operable communication with a peripheral functional component.

7. A functional wall tie or bracket as claimed in any one of the preceding claims, wherein at least a portion of the elongate body member is provided with surface features to enhance the bond between the elongate body member and the overmoulded functional end portion.

8. A functional wall tie or bracket as claimed in claim 7, wherein the surface features are selected from one or more of ribs, threads and sand.

9. A functional wall tie or bracket as claimed in claim 7 or claim 8, wherein the surface features extend outwardly from the surface of the elongate body member by up to 0.25 mm.

10. A method of manufacturing a functional wall tie or bracket as defined in any one of claims 1 to 9, the method comprising providing a fibre-reinforced polymer elongate body member and overmoulding on at least one end therof a functional end portion.

11. A mould tool for providing an overmould on an elongate body member to form a functional wall tie as defined in any one of claims 1 to 9, the mould tool configured to receive an elongate body member and shaped to receive an injection of a mould material for forming a functioanl end portion about an end of the elongate body member.

12. A drip clip for affixing to an elongate wall tie rod to inhibit passage of condensation and water across a cavity, the drip clip comprising a helical rod of 0.75 to 2.5 turns.

13. A drip clip as claimed in claim 12 of from 1 to 2 or optionally 1 to 1.5 or 1.5 to 2 (preferably less than 2) turns.

14. A drip clip as claimed in claim 12 or claim 13 formed of an injection moulded plastic.

15. A drip clip as claimed in claim 12, 13 or 14 having a resting internal helical diameter of from 4 to 8 mm.

16. A drip clip as claimed in any one of claims 12 to 15 comprising the detached sprue of another injection moulded product.

17. A drip clip as claimed in any one of claims 12 to 16 formed of a poly amide.

18. A method of forming a drip clip, comprising providing an injection mould tool for another product having a sprue passage of shape and configuration of the drip clip defined in any one of claims 12 to 17.

19. A functional wall tie or mould therefore as hereinbefore described with reference to the drawings.

Intellectual Property Office

Application No:	GB1513788.8	**Examiner:**	Mr William Crowe
Claims searched:	1-11	**Date of search:**	21 August 2015

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-11	US2005/016095 A1 (COMPOSITE TECHNOLOGIES CORP) See Figures and paragraph [0027], noting body portion 12 and overmoulded end portions 14a/b and 16a/b.
X	1-5 and 7-11	AU2008201591 A1 (NOVAPLAS PTY LTD) See Figure 2 and page 6, lines 17-29 especially, noting elongate body 12 and end portion 34 covered with moulded material.
A	-	GB2494135 A (MAGMATECH LTD) See Figures and page 10, line 29 - page 11, line 2, noting fibre reinforced body 303 and moulded end portion 105.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[X] :

Worldwide search of patent documents classified in the following areas of the IPC

B29C; E04B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, TXTE

International Classification:

Subclass	Subgroup	Valid From
E04B	0001/41	01/01/2006
E04B	0002/30	01/01/2006
E04B	0002/44	01/01/2006