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Remarks:
Claims 16- 38 are deemed to be abandoned due to non-payment of the claims fees (Rule 45(3) EPC).

(54) A BRACKET, A CONNENCTION, A METHOD OF FORMING A BRACKET AND A METHOD OF FORMING A CONNECTION

(57) The present invention relates to a bracket, a blank for forming a bracket, a connection, a method of forming the connection and a method of forming the bracket. In particular, the bracket is for use supporting a curtain wall. The bracket joins a first construction element to a second construction element, with the bracket having a first proximal end and a second distal end. The bracket comprises a first flange and a second flange, wherein the first flange and the second flange meet at a common line defining a longitudinal axis x, the second distal end of the bracket being distal to the first proximal end of the bracket along the longitudinal axis x of the common line. The first flange comprises a first connecting portion arranged at or towards the first proximal end of the bracket, the first connecting portion comprising a first aperture configured to receive, in use, a shank of a fastener. The second flange comprises a second connecting portion arranged at or towards the second distal end of the bracket, the second connecting portion comprising a plurality of elongate second apertures each configured to receive, in use, a shank of a fastener. The first flange further comprises at least one first tapering portion in which the first flange tapers in a direction generally towards second distal end of the bracket, and/or the second flange further comprises at least one second tapering portion in which the second flange tapers in a direction generally towards the first proximal end of the bracket.

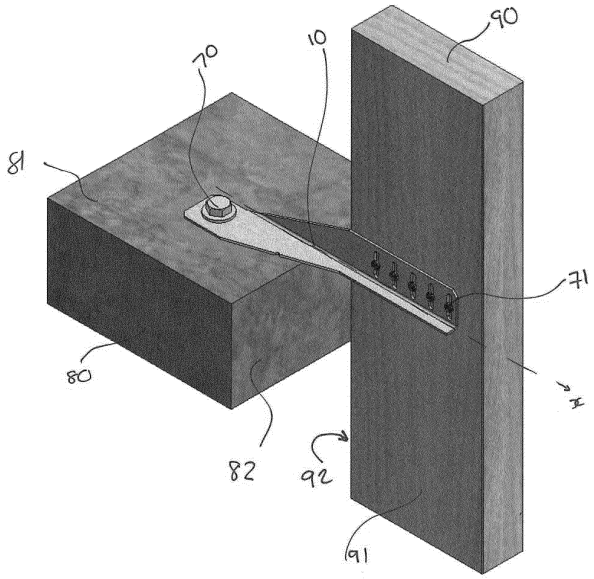

Figure 2

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Description

[0001] The present invention relates to a bracket, a connection, a method of forming the connection and a method of forming the bracket. In particular, the bracket is for use supporting a curtain wall.

[0002] More and more buildings are constructed with timber stud wall systems connected to primary concrete structures in order to achieve reduced environmental concerns, on-site installation time savings, and high thermal insulation performance. For a variety of reasons, it is often advantageous to construct these wall systems with connectors that permit a degree of relative movement between the framing members. The exterior walls and frame are usually made from different materials than the primary structure and thus may have a different behaviour in response to temperature and load variations. A degree of freedom of movement can then reduce stress and prevent fracture of connected parts. Also curtain walls are not designed to support vertical loads and must therefore be isolated from deflection of the primary load-bearing support structure of the building due to changes in live or dead loads carried by that structure.

[0003] A variety of brackets, slides or clips that permit relative movement between primary load bearing structure and timber curtain walls have been made, however there is a need to optimise the use of material in the clips and the loads achieved by the clips while having a gap between the primary load-bearing structure and the vertical members of the curtain wall.

[0004] Most existing timber curtain walls are secured by angle brackets having one flange fixed to the face of vertical member (the stud) in contact with the primary load bearing structure and one face fixed to a horizontal member of the primary load bearing structure, for example a floor. This solution has limited capacity for transmitting horizontal loads as the load direction is perpendicular to the bending line of the bracket and loading may therefore tend to unfold /open out the bracket.

[0005] If elongate holes are used for fasteners fixed on the stud, then additional flanges are needed stiffen the bracket to limit the deflection, otherwise the bracket deflection is accentuated by the fact that the fastener is free to move in slots while the connector is submitted to horizontal loads. When stiffened using such additional flanges, there is also a need to allow the fasteners to slide along the elongated holes without causing the vertical deflection and bending of the connector because of the friction between the fasteners and the connector. Thus having a strong connector that allows vertical deflection by fixing on the face of timber studs leads to a solution that is very expensive to produce.

[0006] The performance of known solutions may be further reduced when there is a gap between the primary structure and the curtain wall frame.

[0007] The construction of timber curtain walls presents specific issues which relate to the use of timber, as opposed to other curtain wall materials, for example steel. Connectors designed for steel studs may not be optimised or suitable for use with timber curtain walls.

[0008] US5467566 describes a curtain wall connecting arrangement for coupling a curtain wall stud and building floor structure, comprising: an elongated clip having two ends with an attachment portion at one end which is plate-like in shape and two oppositely, offset depending ears at the other end, each ear having an elongated slot therein disposed substantially perpendicular to the attachment portion; and spacer means and threaded members, said threaded members securing the spacer means and said two offset depending ears in slideable engagement with the curtain wall stud.

[0009] On timber, the use of spacers is not necessary for leaving the vertical deflection free. Indeed fasteners used on timber have smaller head diameter compared to self-tapping hexagonal head screws and apply less pressure, so there is less friction between the fastener head and the clip. Then the use of spacer is dismissed in the present invention for economic reasons. On the contrary, in steel to steel assembly, fasteners generally have ribs under the head to avoid self-untightening, and these ribs increase the friction between fastener and steel surface. Fasteners such as anchor nails or connector screws do not have such feature.

[0010] US20030033765 describes an apparatus for securing a curtain wall assembly to a building comprising: a support member for supporting at least a portion of said curtain wall assembly from said building, said support member comprising a first flange substantially in a first plane and a second flange substantially in a second plane that is generally perpendicular to said first flange and wherein said first flange also comprises a first fastener slot capable of allowing relative motion in at least one direction between a first fastener and said first flange, wherein said second flange comprises a second fastener opening capable of allowing relative motion in at least one direction between said second fastener and said second flange; and fasteners for connecting said support member to said building and for connecting said support member to at least a portion said curtain wall assembly.

[0011] The aim of the L-shape clip disclosed in US Pat. No. 6,591,562 is that it can be shop assembled with a possible change of clip orientation on site. Then horizontal motion is allowed to adjust the wall position while the connector is already attached to the primary structure. Then the two horizontal degree of freedom of movement are blocked by tightening the fasteners. This system is only possible if only one connector is used. But usual timber stud sizes is 45x145, and the maximum bolt diameter that can be used is 18 mm. The performance of such a bolt is not enough for the intended use (4.5 kN according to EN1995). The invention here implies several smaller fasteners instead and does not allowed a change of orientation once the connector is fastened to the stud. Also horizontal motion is not allowed once the

connector is fastened to the primary structure.

[0012] The present invention addresses the above problems experienced in the art.

[0013] According to a first aspect, the present invention provides a bracket for joining a first construction element to a second construction element, the bracket having a first proximal end and a second distal end, wherein the bracket comprises:

a first flange; and
a second flange; wherein
the first flange and the second flange meet at a common line defining a longitudinal axis x, the second distal end of the bracket being distal to the first proximal end of the bracket along the longitudinal axis x of the common line;
the first flange comprises a first connecting portion arranged at or towards the first proximal end of the bracket, the first connecting portion comprising a first aperture configured to receive, in use, a shank of a fastener;
the second flange comprises a second connecting portion arranged at or towards the second distal end of the bracket, the second connecting portion comprising a plurality of elongate second apertures each configured to receive, in use, a shank of a fastener; and wherein
the first flange further comprises at least one first tapering portion in which the first flange tapers in a direction generally towards second distal end of the bracket; and/or
the second flange further comprises at least one second tapering portion in which the second flange tapers in a direction generally towards the first proximal end of the bracket.

[0014] The connector, blank, connection or method according to the present invention may comprise any one or more of the following features, singly or in any combination, described below and/or as set forth in the appended claims.

[0015] The present invention seeks to achieve maximum possible load capacity from the minimum amount of material in the bracket, thereby realizing substantial savings, in cost as well as material, over the prior art in timber curtain wall construction. The bracket is attached to the flank of the stud to address the issues relating to the use of angle brackets as described above.

[0016] The provision of a tapered flange or flanges limits stress concentrations in the bracket by avoiding the number of sharp angled corners in the bracket, thereby increasing the load capacity while limiting the material used in the bracket.

[0017] Furthermore the progressive/tapered flanges of the present invention reduce the waste of material in the manufacturing process. Indeed the shape of the bracket is such that the opposed edges, before the clip is folded, are generally parallel with the same length in order to form a tangram. The ratio of waste material over used material of the raw steel plate from which the bracket is stamped out is then much lower than in some known brackets.

[0018] In US Pat. No. 5,467,566, a curtain wall slide clip is disclosed, which has two opposed ears with elongated holes that are intended to be fixed to the stud flank, and a flat part that is fixed to primary structure. This invention includes a secondary part between the fastener and the clip ears for slideably securing the ears to the curtain wall framing structure. This secondary part can be a washer, a ring, or any other kind of spacer. The remaining friction between the fastener head and the clip is small but would still cause the bending of the flat part of the clip described in US Pat. No. 5,467,566. In contrast, the present invention includes a progressive flange that prevents the connector from bending due to this friction effect.

[0019] The provision of a tapered flange or flanges avoids protrusion of the bracket through a screed layer which may be cast after installation of the connector, particularly on the floor element.

[0020] The tapering of the flanges may limit thermal transfer through the bracket (and so may limit thermal bridging across the bracket) and may limit the interference of the bracket with any insulation layer arranged between the studs or between the construction members.

[0021] Preferred embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a schematic perspective view of a bracket according to a first aspect of the present invention;
Figure 2 is a schematic perspective view of a connection between two structural elements using the bracket of Figure 1;
Figure 3 is a schematic side view of the connection of Figure 2;
Figure 4 is a schematic perspective view of a bracket according to a further aspect of the present invention;
Figure 5 is a schematic perspective view of a bracket according to a further aspect of the present invention;
Figure 6 is a schematic perspective view of a bracket according to a further aspect of the present invention;
Figure 7 is a schematic illustration of a blank after folding, and a number of blanks marked out for cutting from a sheet of sheet material; and
Figure 8 is a schematic illustration of a comparable prior art bracket after folding, and a number of blanks marked out for cutting from a sheet of sheet material showing the difference in size and material needed when compared

to that of the present invention as illustrated in Figure 7.

[0022] In a first aspect, the present invention provides a bracket 10 for joining a first construction element to a second construction element, as shown in Figure 1. The bracket 10 comprises first and second integrally formed flanges 20, 30 which meet at a common bending line 40. A longitudinal axis x is defined along the common line 40. The bracket 10 has a first, proximal end 50 and a second, distal end 60, the second, distal end of the bracket 60 being distal to the first proximal end 50 of the bracket along the longitudinal axis x of the common line 40. Each of the two flanges 20, 30 is substantially planar, and the first flange is arranged at right angle to the second flange.

[0023] The first flange defines the length of the bracket relative to the longitudinal axis x of the common line 40. It comprises, in order along the longitudinal axis x, a first connecting portion 21, a tapering portion 22 and a reinforcing portion 23.

[0024] The first connecting portion 21 extends from the first proximal end 50 of the bracket 10. It comprises a fastener aperture 24 configured to receive, in use, a shank of a fastener 70 for attaching the first flange 20 to a structural member, for example a concrete floor structure 80. The first aperture 24 is configured to substantially prevent lateral movement of the shank of the fastener in the aperture in use. The first connecting portion 21 defines the widest part of the first flange 20 in a direction generally perpendicular to the longitudinal axis x. The outer edge of the first connecting portion is substantially parallel to the longitudinal axis x of the common line 40. The outer edge is to be understood as the edge of the flange forming the far side of the flange to the common line.

[0025] In the tapering portion 22 in which the width of the flange, as measured perpendicular to the axis x, reduces linearly such that the flange tapers in a direction generally towards the second end 60 of the bracket. An outer tapering edge 25 of the first tapering portion 22 is arranged distal to the common line 40 and is at an acute angle $\alpha 1$ to the longitudinal axis x in the plane of the first flange. The outer tapering edge 25 is linear.

[0026] The first reinforcing portion 23 is arranged between the first tapering portion 22 and the second distal end 60. Its outer edge is substantially parallel to the longitudinal axis x of the common line 40. Its width in a direction substantially perpendicular to the longitudinal axis x is less than that of the connecting portion 21. The first reinforcing portion 23 extends to the second distal end 60 of the bracket.

[0027] The second flange 30 comprises, in order along the longitudinal axis x a second tapering portion 32 and a second connecting portion 31. The second flange 30 extends from a point on the common line 40 approximately adjacent to the proximal end of the first tapering portion to the second distal end 60 of the bracket 10. The second flange 30 therefore extends along a majority, but not the entirety, of the length of the bracket 10.

[0028] The second connecting portion 31 is at the second distal end 60 of the bracket 10. It comprises a plurality of elongate second apertures 34 each configured to receive, in use, a shank of a fastener for attaching to a second structural member, for example timber curtain wall stud 90. The long axis of each of the elongate second apertures 34 (i.e. the axis arranged in the elongate direction) is arranged generally perpendicular to the longitudinal axis x. The long axes of the plurality of elongate apertures 34 are therefore generally parallel to each other. The elongate apertures 34 each extend along a majority of the width of the second connecting portion 31 in the direction generally perpendicular to the longitudinal axis x. The second apertures 34 are configured to slidingly receive a shank of a fastener 71 such that the shank is moveable along the elongate length of the aperture 34 in use, i.e. such that the shank of the fastener 71 moves laterally relative to the elongate axis of the shank.

[0029] The second connecting portion 31 defines the widest part of the second flange 30 in the direction generally perpendicular to the longitudinal axis x. The outer edge of the second connecting portion 31 is substantially parallel to the longitudinal axis x of the common line 40.

[0030] In the tapering portion 32 in which the width of the flange, as measured perpendicular to the axis x, reduces linearly such that the flange tapers in a direction generally towards the first proximal end 50 of the bracket. An outer tapering edge 35 of the second tapering portion 32 is arranged distal to the common line 40 and is at an acute angle $\alpha 2$ to the longitudinal axis x in the plane of the second flange. The outer tapering edge 25 is linear. The angle $\alpha 1$ is equal to angle $\alpha 2$.

[0031] The bracket 10 therefore comprises, in order along the longitudinal axis x of the common line 40, the first connecting portion 21; the first and second tapering portions 22, 32 extending along a shared portion of the longitudinal axis x of the common line 40; and the second connecting portion 31 and reinforcing portion 23 extending along a shared portion of the longitudinal axis x of the common line 40.

[0032] Each of Figures 4 to 6 illustrates a bracket according to further embodiments of the present invention. In the following, only features which differ from those of the first embodiment are described. These embodiments are otherwise as described above.

[0033] In the embodiment shown in Figure 4, the first flange 120 does not extend the full length of the bracket 110 relative to the longitudinal axis x of the common line 40. It comprises, in order along the longitudinal axis x, a first connecting portion 121 and a tapering portion 122. The first flange 120 extends from the first end 50 to a point on the common line 40 adjacent to an intermediate part of the second connecting portion 130. The first flange 120 therefore

extends along a majority, but not the entirety, of the length of the bracket 10.

[0034] The second flange 130 extends from a point on the common line 40 adjacent to an intermediate part of the first connecting portion 130 to the second, distal end 60 of the bracket 110. The second flange 30 therefore extends along a majority, but not the entirety, of the length of the bracket 10.

[0035] The bracket 110 therefore comprises, in order along the longitudinal axis x of the common line 40, an end part the first connecting portion 121, a part of the first connecting portion and a part of the second tapering portion 132 extending along a shared portion of the common line 40, a part of the first tapering portion and a part of the second tapering portion extending along a shared portion of the common line 40; a part of the first tapering portion 122 and a part of the second connecting portion 131 extending along a shared portion of the common line 40; and an end part of the second connecting portion 131.

[0036] Additional fastener holes 73 are provided in the second flange 30. The second connecting portion can be tapered at the bottom edge to improve tessellation of the blank form and reduce the amount of material used.

[0037] The first flange 220 of the embodiment shown in Figure 5 is generally as described in the first embodiment above (shown in Figure 1) except that the the first connecting portion 221 extends along a greater proportion of the length of the bracket 210.

[0038] The second flange 230 comprises, in order along the longitudinal axis x, a second tapering portion 232 and a second connecting portion 231. The second flange 130 extends from a point on the common line 40 adjacent to an intermediate part of the first connecting portion 230 to the second, distal end 60 of the bracket 210. The second flange 230 therefore extends along a majority, but not the entirety, of the length of the bracket 210.

[0039] The second connecting portion 231 comprises a plurality of elongate second apertures 234. As in the first embodiment, the long axis of each of the elongate second apertures 34 (i.e. the axis arranged in the elongate direction) is arranged generally perpendicular to the longitudinal axis x. The plurality of elongate second apertures 234 are arranged in an alternating pattern such that they form two rows, with one row arranged proximal to the common line 40 and one row distal to the common line.

[0040] The elongate apertures 34 each extend along a portion of the width of the second connecting portion 31 in the direction generally perpendicular to the longitudinal axis x. The spacing of the two rows is arranged such that they are partially overlapping.

[0041] Figure 6 shows an embodiment having the flange structure of the embodiment shown in Figure 4, but including alternating elongate apertures 334 as in the embodiment of Figure 5.

[0042] The present invention further provides a connection as shown in Figures 2 and 3, comprising a bracket 10 according to the present invention, and first and second structural members in the form of a concrete floor member 80 and a timber curtain wall stud 90.

[0043] The floor member 80 has a generally vertical end face 82 and a generally horizontal upper (or bottom) face 81. The first connecting portion 21 of the first flange 20 is arranged on the upper face 81 and an anchor bolt is arranged in the fastener aperture 23. This attaches the first flange 20 to the floor member 80 such that relative movement in any direction between these components is restricted in all directions.

[0044] The timber curtain wall stud 90 has a generally vertical end face 92 arranged parallel to the generally vertical end face 82 of the floor member. The end face 82 of floor member and the end face 92 of the timber curtain wall stud 90 are spaced apart relative to the longitudinal axis x. The timber wall stud 90 further comprises a generally vertical lateral face 91 arranged generally perpendicular to the end face 92. The second flange 30 is in planar contact with the lateral face 91. A plurality of fasteners are arranged in the elongate apertures 34 (one fastener in each aperture). The fasteners 71 are slidingly received in the elongate second apertures 34, the apertures being configured such that the fastener is slidable along the elongate length of the aperture. Relative vertical movement between the timber wall stud 90 and the second flange 30 of the bracket is thereby accommodated.

[0045] The connection of the present invention may be formed by providing a bracket according to the invention, and fastening the first and second flanges 20, 30 to the first construction element and second construction element respectively. The first construction element is fastened to the first flange 20 using an anchor or other fastener 70 such that relative movement between the first flange and the first construction element is substantially prevented. The second flange 30 is fastened to the second construction element such that relative movement of the second flange 30 and the second construction element is accommodated by sliding of one or more fastener shanks received in the or each elongate second aperture along the elongate length of the aperture.

[0046] The vertical position of the second construction element may be adjusted such that a load associated with the mass of the second construction element is substantially supported by a further construction element arranged below the second construction element.

[0047] The present invention also provides a blank for forming a bracket as described herein. The blank is preferably formed from a sheet material, most preferably a metal such as stainless steel. The blank comprises a first element configured to form, in use, the first flange of the bracket; a second element configured to form, in use, the second flange of the bracket; and an axis configured to form, in use, a common line arranged between the first and second flanges of

the bracket. The blank may be folded along the axis to form the bracket. Before folding, the outer edges of the tapering sections of the first and second elements may be generally parallel to each other. This is illustrated schematically in Figure 7 (and can be contrasted with a prior art bracket as shown in Figure 8).

[0048] A plurality of blanks may be cut, stamped or otherwise formed from a single sheet of material. Preferably, the plurality of blanks may be tessellated to minimise waste material between the blanks.

[0049] The present invention further provides a method of forming a bracket according to the present invention comprising the steps of providing a blank as described above and bending the blank along the common line such that the first flange is angled relative to the second flange.

[0050] Whilst preferred embodiments of the present invention have been described above and illustrated in the drawings, these are by way of example only and non-limiting. It will be appreciated by those skilled in the art that many alternatives are possible within the ambit of the invention. For example, the bracket, connection or method may, alternatively or in addition, comprise one or more of the following features singly or in any combination:

The bracket is preferably formed from sheet metal, most preferably from a sheet of galvanised steel. In any embodiment, the bracket may alternatively, or in addition, comprise other materials, such as a stainless steel, hot rolled leg angle, a plastic or a composite.

[0051] In the illustrated connection, the bracket is used to connect a timber curtain wall stud to a concrete floor structure. The skilled person will understand this bracket could be used to connect alternative construction members, for example other curtain wall elements, curtain wall elements formed from other materials, or other floor elements, joists or plinths.

[0052] As described above, in the tapering portions the width of the bracket perpendicular to the longitudinal axis x gradually lessens in a direction generally towards one end of the bracket. In the illustrated embodiments, the tapering is a linear reduction in width. The skilled person will understand that the term "taper" may include alternative forms of progressive reduction of the width of the flange. For example, the outer edges of the tapering portions may alternatively be curved, stepped or otherwise progressively reduced. The tapering section may taper to a point or to a blunt edge. The vanishing point of the taper is not necessarily intended to be the end point of the bracket.

[0053] In any embodiment, the tapering shape may extend along one or both connecting portions such that the connecting portion and tapering portion taper continuously, or with a change in gradient. The outer edge of the connecting portion may alternatively, or in addition, be otherwise stepped or curved.

[0054] Preferably, angle $\alpha 1$ is equal to angle $\alpha 2$ such that, if the bracket is formed from a single blank, before bending of the blank along the common bending line to form the bracket, the outer edges of the tapering portions are parallel. This may allow for improved tessellation of the blanks in the sheet material from the blank is cut, reducing material waste.

[0055] The angle α of the tapering edges may be increased or decreased compared to that shown, for example to accommodate the different spacing between the construction members.

[0056] In use, the tapering portions effectively distribute loads on the flanges, avoiding stress concentrations and increasing the overall strength of the bracket while minimising the amount of material used.

[0057] The length of the connecting portions, tapering portions and reinforcing portions (by present) may vary such that their start and end points may be at different points along the length bracket relative to the longitudinal axis x than those illustrated. The first and second tapering portions extend along at least a shared length of a longitudinal axis x. For example, the narrow end of the taper of the first flange may be arranged at the same distance along the longitudinal axis x from the first end as the wide end of the tapering portion of the other flange. Alternatively, the tapering portions may begin and/or end adjacent to the connecting portions of the other flange.

[0058] In any embodiment, the first aperture 24 is preferably configured to substantially prevent lateral movement of the shank of the fastener received in the aperture in use. In the illustrated embodiment, the fastener received in aperture 24 is an anchor bolt, however the skilled person will understand that any other suitable type of fastener, for example a screw, nail or alternative type of bolt may be used.

[0059] In the illustrated embodiments, the second flange comprises a plurality of elongate apertures configured to slidingly receive the shank of a fastener in use. The number of elongate apertures may differ to that shown provided that one or more elongate apertures is provided in the second flange. The apertures may be arranged differently to those shown. For example, the apertures may be arranged in any number of rows or in an irregular configuration. The provision of the elongate apertures allows for the height of the curtain wall to be adjusted relative to the floor after installation. The elongate of apertures also allow the weight of the curtain wall to be borne by the structure below (for example, the ground, a foundation or other structural element).

[0060] In use, one or more of the elongate apertures receives a shank of a fastener. The aperture configured to slidingly receive the shank of the fastener such that the shank is moveable along the elongate length of the aperture in use (i.e. moveable laterally relative to long axis of the shank of the fastener). In the illustrated embodiments, the fasteners provided are screws. The skilled person will understand that other fasteners, for example nails or bolts, may be used.

[0061] The size of the fastener is to be selected relative to the size of the aperture such that relative movement between the first construction element and the second bracket parallel to the longitudinal axis x is restricted, and preferably prevented.

[0062] The skilled person will understand that it is not necessary in all applications to provide a fastener in each of the elongate apertures 34. The provision of a plurality of elongate apertures may allow multiple fasteners to be used in order to increase the load capacity of the connection, and/or to resist rotation. In addition, the provision of a plurality of elongate apertures arranged in a spaced configuration relative to the longitudinal axis X that allows for a range of sizes of gap between the first construction element and the second construction element. The elongate apertures ideally have an aspect ratio of at least 1:2. Preferably, the size of the elongate apertures is between 3mm x 6mm and 20mm x 400mm. The provision of at least two elongate apertures in which fasteners are received improves the resistance of the connection to torsion or rotational loads.

[0063] The first and second tapering portions may extend along a common length of the longitudinal axis x, meaning that they extend from a point on their respective flanges at a distance x1 along the bracket from the first end, measured parallel to the longitudinal axis, to a distance x2 along the bracket from the first end, measured parallel to the longitudinal axis. Distance x1 may be the length of the first connecting portion and/or the second connecting portion may extend from distance x2 to the second end of the bracket.

[0064] In the illustrated embodiments, the common line 40 is a common bending line, formed by bending/folding a single blank cut out from a sheet of metal. In any embodiment, the common line may be a common joining line, the first and second flanges (or portions thereof) being formed separately and welded, adhered or otherwise joined to each other to form the bracket. Alternatively, hot-rolled leg angle may be used which provides already the common line between respective flanges of the leg angle.

[0065] Preferably, the bracket may be configured such that the blank can be bent in either direction relative to the first flange such that the same blank can be used to form a left hand or a right hand bracket.

[0066] In the first embodiment, the first flange defines the length of the bracket relative to the longitudinal axis x of the common line 40. In alternative embodiments, the first end of the bracket may be defined by the first flange and the second end of the bracket may be defined by the second flange, wherein each flange extends along only a portion of the length of the bracket. In yet further embodiments, both flanges may extend the full length of the bracket.

[0067] The first and/or second flanges are preferably substantially planar. One or both flanges may comprise non-planar features such as embossments. For example, embossments may be provided on one or both tapering portions.

[0068] In any embodiment, the first connecting portion is arranged at or towards the first proximal end of the bracket and the second connecting portion is arranged at or towards the second distal end of the bracket. Preferably, the connecting portion may comprise the maximum width of one or both flanges as measured perpendicular to the longitudinal axis x.

[0069] One or more reinforcing portions may be present in one or both flanges. The reinforcing portion may comprise an outer edge having a linear, tapered, stepped or curved shape. Preferably, the outer edge of the reinforcing portion may be generally parallel to the longitudinal axis x. The reinforcing portion may have a width smaller than that of the connecting portion. More preferably the reinforcing portion may comprise the narrowest part of flange.

[0070] A reinforcing portion may extend from the first tapering portion to the second distal end of the bracket. Alternatively, or in addition, reinforcing portion may extend from the second tapering portion to the first proximal end of the bracket.

[0071] In the absence of a reinforcing portion, the first tapering portion may extend from the connecting portion to the second, distal end of the bracket. In the absence of a reinforcing portion, the second tapering portion may extend from the second connecting portion to the first, proximal end of the bracket. Alternatively, one or both tapering portions may terminate adjacent to the connecting portion of the other flange.

[0072] The provision of narrow reinforcing portions, or the omission of reinforcing portions such that one or more flanges stops short of the end of the bracket may avoid or limit the protrusion of the material of the bracket into an additional concrete screed or other material which may be poured onto or applied to the floor. The reduction of material in the flanges also limits thermal bridging across the bracket.

[0073] In a connection formed according to the present invention, the attachment of the bracket to the lateral face of the second construction element, as opposed to the end face of the stud, is to allow for a gap between the two construction elements. Such a gap allows for insulation to be placed between the construction elements.

[0074] In alternative embodiments, there may be no gap between the construction elements, such that the end faces of the two construction elements abut each other.

[0075] The skilled person will understand that a bracket according to the present invention may be used with alternative configurations of construction members. For example, the bracket may be connected to two parallel construction element faces, if required.

[0076] The bracket is preferably a right angle bracket. Alternatively, the bracket may be formed at another angle, for example any angle between 90 to 180 degrees.

[0077] The first flange and/or second flange may include additional fastener apertures 73, preferably in the connecting portion of the flange. The additional fastener apertures 73 may receive fasteners in use to fix the relative positions of the second flange and the second construction element.

[0078] The skilled person will understand that the terms "upper", "lower" etc. as used in this description relate to the orientation of the connection shown in the Figures and should not be considered limiting. The skilled person will understand that the connected may also be used in alternative orientations.

[0079] In use, the first flange is fastened to the first construction member such that there is no relative movement between them. The fasteners received in the elongate apertures attach the second flange to the second construction member but are slidingly received in the apertures such that relative movement between the second construction member and the second flange is permitted parallel to the long axis of the elongate apertures, as indicated by the arrows in Figure 3. This connection safely allows vertical deflection of the second construction element relative to the first construction element, while transmitting horizontal loads (e.g. load parallel to the longitudinal axis x) to be transmitted through the bracket. In a curtain wall structure, this allows vertical deflection of the curtain wall structure while retaining the curtain wall to the floor in the horizontal direction. The weight of the curtain wall can therefore be supported by a lower floor or lower construction element, while horizontal loads such as wind loading are transmitted to the first construction element (the floor).

[0080] By shaping the bracket in as described herein, the present invention aims to avoid stress concentrations, improve load distribution, improve resistance to lateral and rotational loads on the structure or joint and reduce thermal bridging while optimising material use.

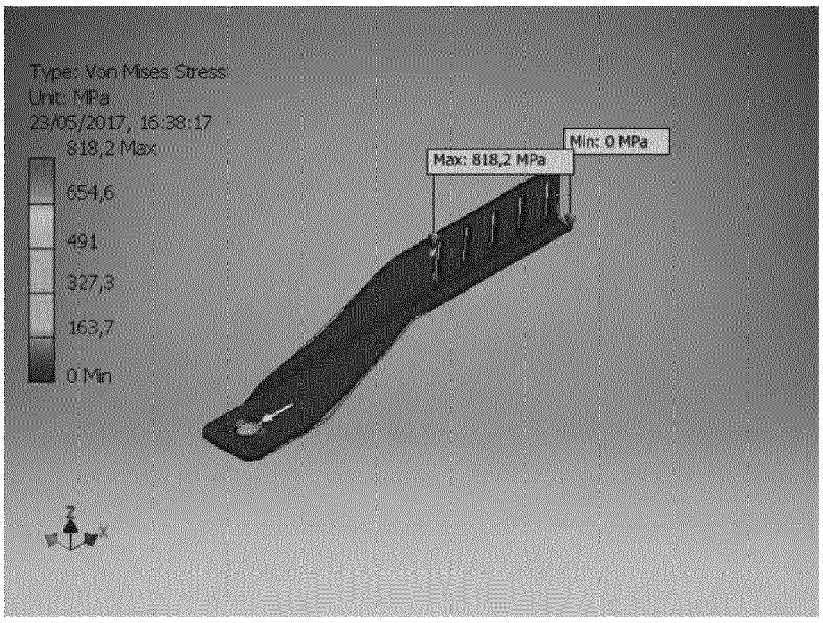
[0081] Brackets according to the present invention were modelled and Finite Element Analysis carried out to compare the performance of a bracket according to the present invention (labelled "CCW") with a bracket as described in US5467566.

[0082] The same material and overall geometry was used for the CCW and the prior art bracket, including the steel thickness (t), overall length (L) and width (w) of the flange in contact with the first structural member (a concrete floor), and the gap (g) between the first and second structural members.

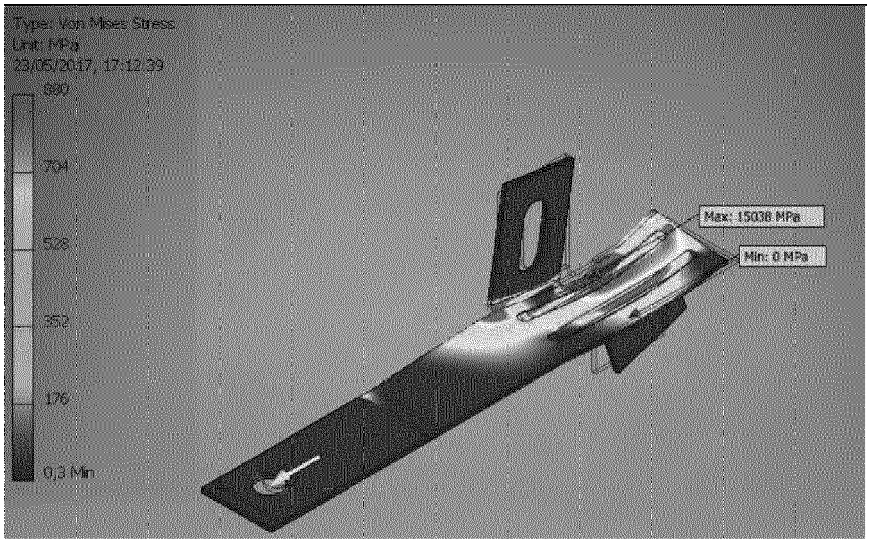
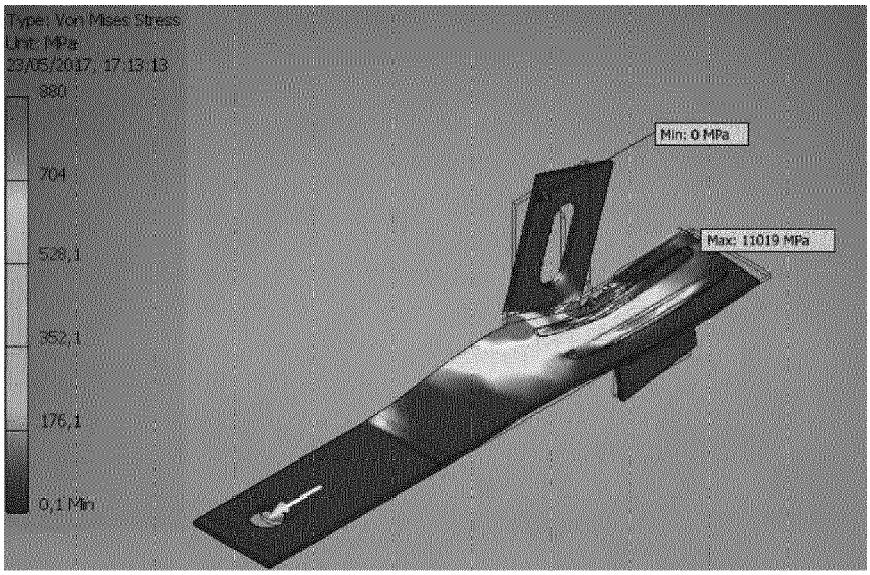
[0083] The loading applied in the model was based on the intended use of the bracket according to the present invention. It has been shown by testing that the worst case loading scenario for the CCW bracket occurs with fasteners are arranged in the upper end of the elongate slots (i.e. distal to the first flange). This configuration was therefore used for the model. For the prior art bracket, as worst case loading conditions were unknown, the bracket was modelled in two configurations, firstly with a fastener at the top of each slot, and secondly with a fastener at the bottom of each slot.

[0084] In the following stress illustrations, the same colour scale is used for both brackets. Both stress and deflection were monitored in the analysis.

Table 1 - Von Mises stress criteria under tension

Bracket	**Maximum value (MPa)**	**Illustration**
CCW	818	

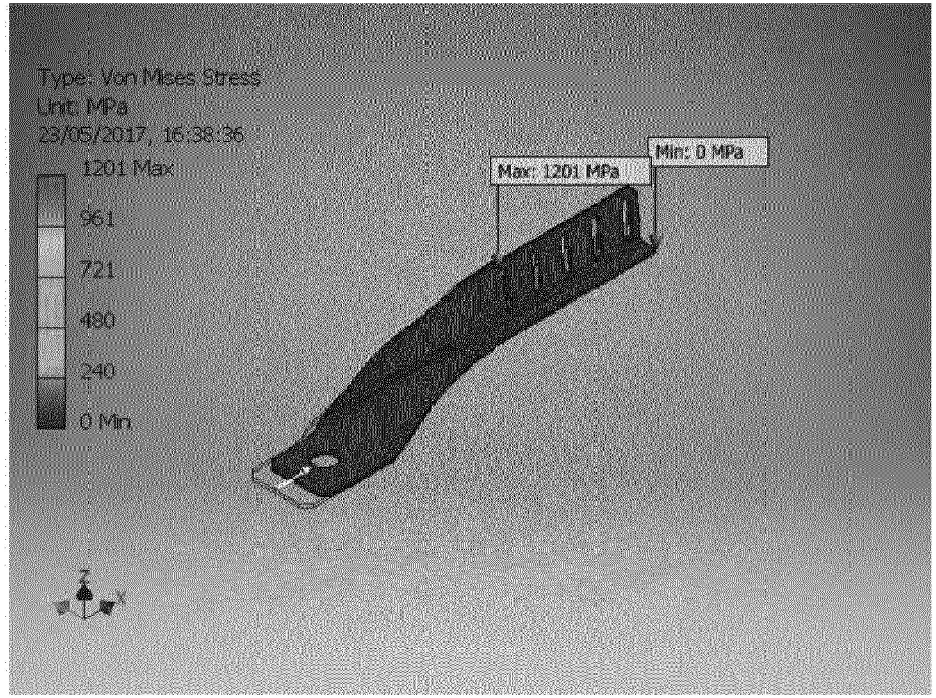
(continued)

Bracket	Maximum value (MPa)	Illustration
US5467566 - first fastener position	15038	
US5467566 - second fastener position	11019	

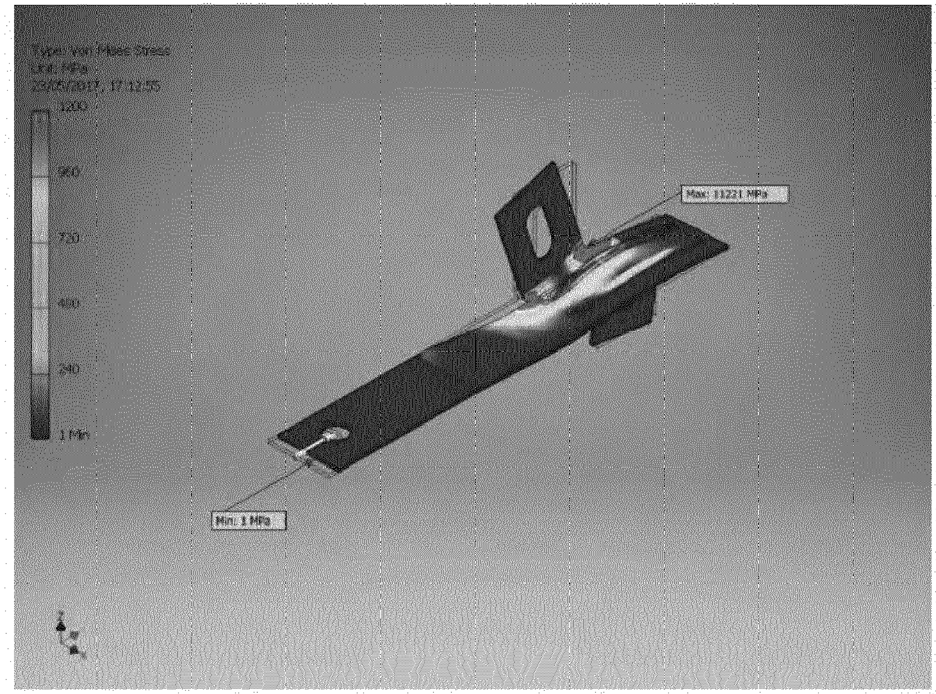
[0085] Under tension, the maximum stress in the bracket as described in US5467566 is 18 times higher than that in the CCW bracket. Stress concentrations can be seen in the prior art bracket between the upper and lower vertical flanges. In the bracket according to the present invention, no stress concentrations are observed.

[0086] In addition, it is noted that the elongate apertures of the CCW bracket remain parallel under loading, whereas the slots on the prior art bracket are deflected such that they are no longer parallel.

Table 2 - Von Mises stress criteria under compression

Bracket	Maximum value (MPa)	Illustration
CCW	1201	

(continued)

Bracket	Maximum value (MPa)	Illustration
US5467566 - second fastener position	11221	

[0087] Under compression, the maximum stress in the bracket as described in US5467566 is 9 times higher than in CCW. There is a high stress concentration on each corner between the upper and lower vertical flanges and the horizontal flange. The horizontal flange has a low buckling strength compared to the profile on the same area on the bracket according to the present invention. The resulting axial displacement is higher in the prior art bracket (3.6 mm) than in the CCW bracket (0.07 mm).

[0088] Additional analyses were performed to assess the influence of changing the main geometric parameters listed above, and of changing the length of the embossments (E_l) of the bracket as described in US5467566. The results of these analyses are summarised in the following comparison table, which also includes the results of the initial analysis for comparison.

Table 3 - Overall Comparison

Analysis	Parameters (same on both)				EI	embossment qtty on USPAT5467566	Max Von Mises stress (Mpa)						Vertical deflection under 25N vertical (mm)		
							tension			compression					
	t	w	L	g			CCW	USPAT5467566	ratio	CCW	USPAT5467566	ratio	CCW	USPAT5467566	ratio
Initial	2	40	260	50	82	2	818	11019	1347%	1201	11221	934%	0,07	4,28	6114%
increasing EI only	2	40	260	50	173	2	818	9633	1178%	1201	9726	810%	0,07	1,67	2379%
increasing t, w, embossment depth and reducing L	3	60	240	50	173	3	473	3209	678%	584	3218	551%	0,01	0,17	1697%
reducing g	2	40	260	0	173	2	795	8178	1029%	783	8201	1047%	0,01	0,46	4594%

[0089] It will be appreciated from these results that the present invention provides improved performance under tension and compression.

[0090] Each feature disclosed in this specification (including the accompanying claims and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features. In addition, all of the features disclosed in this specification (including the accompanying claims and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive. Accordingly, while many different embodiments of the present invention have been described above, any one or more or all of the features described, illustrated and/or claimed in the appended claims may be used in isolation or in various combinations in any embodiment. As such, any one or more feature may be removed, substituted and/or added to any of the feature combinations described, illustrated and/or claimed. For the avoidance of doubt, any one or more of the features of any embodiment may be combined and/or used separately in a different embodiment with any other feature or features from any of the embodiments, as set forth in the appended claims.

[0091] The following clauses describe further preferred aspects of the present invention:

1. A bracket for joining a first construction element to a second construction element, the bracket having a first proximal end and a second distal end, wherein the bracket comprises:

a first flange; and
a second flange; wherein
the first flange and the second flange meet at a common line defining a longitudinal axis x, the second distal end of the bracket being distal to the first proximal end of the bracket along the longitudinal axis x of the common line;
the first flange comprises a first connecting portion arranged at or towards the first proximal end of the bracket, the first connecting portion comprising a first aperture configured to receive, in use, a shank of a fastener;
the second flange comprises a second connecting portion arranged at or towards the second distal end of the bracket, the second connecting portion comprising a plurality of elongate second apertures each configured to receive, in use, a shank of a fastener; and wherein
the first flange further comprises at least one first tapering portion in which the first flange tapers in a direction generally towards second distal end of the bracket; and/or
the second flange further comprises at least one second tapering portion in which the second flange tapers in a direction generally towards the first proximal end of the bracket.

2. A bracket as set forth in clause 1 wherein the second apertures are elongate in a direction generally perpendicular to the longitudinal axis x of the common line.

3. A bracket as set forth in any preceding clause wherein each second aperture is configured to slidingly receive a shank of a fastener such that the shank is moveable along the elongate length of the aperture in use.

4. A bracket as set forth in any preceding clause wherein;

the first tapering portion is arranged adjacent to the first connecting portion; and/or
the second tapering portion is arranged adjacent to the second connecting portion.

5. A bracket as set forth in any preceding clause wherein the first and second tapering portions extend along at least a shared portion of the longitudinal axis x of the common line.

6. A bracket as set forth in any preceding clause wherein the bracket comprises, in order along the longitudinal axis x of the common line;

the first connecting portion;
the first and second tapering portions extending along at least a shared portion of the longitudinal axis x of the common line; and
the second connecting portion.

7. A bracket as set forth in any preceding clause wherein;

the first tapering portion comprises a first tapering edge distal to the common line, the first tapering edge being arranged at an acute angle $\alpha 1$ to the longitudinal axis x in the plane of the first flange; and
the second tapering portion comprises a second tapering edge distal to the common line, the second tapering edge being arranged at an acute angle $\alpha 2$ to the longitudinal axis x in the plane of the second flange; and
angle $\alpha 1$ is equal to angle $\alpha 2$.

8. A bracket as set forth in any preceding clause wherein;

the first flange further comprises a first reinforcing portion arranged between the first tapering portion and the second distal end; and/or
the second flange further comprises a second reinforcing portion arranged between the second tapering portion and the first proximal end.

9. A bracket as set forth in any preceding clause wherein:

the first flange has a width w1 perpendicular to the longitudinal axis x;
the second flange has a width w2 perpendicular to the longitudinal axis x;
the first tapering portion tapers towards the second distal end of the bracket by a progressive reduction of the width w1 of first flange in a direction generally towards the second distal end of the bracket; and
the second tapering portion tapers towards the first proximal end of the bracket by a progressive reduction of the width w2 of the second flange in a direction generally towards the first proximal end of the bracket.

10. A bracket as set forth in clause 8 wherein the progressive reduction of the width w1 and/or w2 is linear.

11. A bracket as set forth in any preceding clause wherein the first aperture is configured to substantially prevent lateral movement of the shank in the aperture in use.

12. A bracket as set forth in any preceding clause wherein the second flange comprises a plurality of elongate second apertures.

13. A bracket as set forth in clause 12 wherein each of the plurality of elongate second apertures is arranged generally parallel to the other or others of the plurality of elongate second apertures.

14. A bracket as set forth in any preceding clause wherein the first flange extends along all of the length of the bracket relative to the longitudinal axis x of the common line.

15. A bracket as set forth in any preceding clause wherein the second flange extends partially along the length of the bracket relative to the longitudinal axis x of the common line, and preferably along a majority of the length of the bracket relative to the longitudinal axis x of the common line.

16. A bracket as set forth in any preceding clause wherein the bracket is formed from sheet metal.

17. A bracket as set forth in any preceding clause wherein the first flange and the second flange are integrally formed.

18. A bracket as set forth in any preceding clause wherein the common line is a common bending line.

19. A bracket as set forth in any preceding clause wherein the first flange and/or the second flange is substantially planar.

20. A bracket as set forth in any preceding clause for attaching a curtain wall element to a floor.

21. A bracket as set forth in any preceding clause wherein

an outer edge of the first connecting portion is substantially parallel to the longitudinal axis x of the common line; and/or
an outer edge of the second connecting portion is substantially parallel to the longitudinal axis x of the common line.

22. A bracket as set forth in any preceding clause wherein the first flange is arranged at an angle approximately 90 degrees relative to the second flange.

23. A blank for forming a bracket as set forth in any preceding clause, the blank comprising;

a first element configured to form, in use, the first flange of the bracket;
a second element configured to form, in use, the second flange of the bracket; and
an axis configured to form, in use, a common line arranged between the first and second flanges of the bracket.

24. A blank as set forth in clause 23 wherein the blank if formed from sheet material, wherein the sheet material is preferably sheet metal.

25. A blank as set forth in clause 23 or clause 24 wherein the outer edges of the first tapering portion and the second tapering portion are substantially parallel.

26. A method of forming a bracket as set forth in any of the preceding clauses 1 to 22 comprising the steps of;

providing a blank according to any of the preceding clauses 23 to 25; and
bending the blank along the common line such that the first flange is angled relative to the second flange.

27. A connection comprising;

a bracket as set forth in any of the preceding clauses 1 to 22;
a first construction element; and
a second construction element.

28. A connection as set forth in clause 27 wherein one of the first construction element and the second construction element is a curtain wall element.

29. A connection as set forth in any of the preceding clauses 27 to 28 wherein one of the first construction element and the second construction element is floor, a floor component, a joist

30. A connection as set forth in any of the preceding clauses 27 to 29 wherein one of the first construction element and the second construction element is substantially horizontal and the other of the first construction element and the second construction element is substantially vertical.

31. A connection as set forth in any of the preceding clauses 27 to 30 wherein;

the first construction member comprises a first end face and a first connection face, the first connection face being substantially perpendicular to the first end face;
the second construction member comprises a second end face and a second connection face, the second connection face being substantially perpendicular to the second end face;
the first end face is arranged substantially parallel to the first end face such that the plane of the first connection face is substantially perpendicular to the plane of the second end face;
the first flange is fastened to the first connection face; and
the second flange is fastened to the second connection face.

32. A connection as set forth in clause 31 wherein the first end face is arranged in a spaced configuration to the second end face.

33. A connection as set forth in any of the preceding clauses 27 to 32 wherein the elongate second apertures are arranged substantially vertically.

34. A connection as set forth in any of the preceding clauses 27 to 33 wherein first construction element and second construction element are arranged in a spaced configuration along the longitudinal axis x.

35. A connection as set forth in any of the preceding clauses 27 to 34 further comprising a fastener received in the fastener for fastening the first flange to the first construction member.

36. A connection as set forth in any of the preceding clauses 27 to 35 further comprising a shank of a fastener slidably received in at least one of the at least one elongate second apertures, the aperture being configured such that the fastener is slidable along the elongate length of the apertures.

37. A method of forming a connection as set forth in any of the preceding clauses 27 to 36 comprising the steps of:

providing a bracket as set forth in any of the preceding clauses 1 to 22;
fastening the first flange to the first construction element such that relative movement between the first flange and the first construction element is substantially prevented;
fastening the second flange to the second construction element such that relative movement of the second flange to the second construction element is accommodated by sliding of one or more fastener shanks received in the or each elongate second aperture along the elongate length of the aperture.

38. A method as set forth in clause 37 further comprising the steps of:
adjusting the position of the second construction element such that a load associated with the mass of the second construction element is substantially supported by a further construction element arranged below the second construction element.

Claims

1. A bracket for joining a first construction element to a second construction element, the bracket having a first proximal end and a second distal end, wherein the bracket comprises:

a first flange; and
a second flange; wherein
the first flange and the second flange meet at a common line defining a longitudinal axis x, the second distal end of the bracket being distal to the first proximal end of the bracket along the longitudinal axis x of the common line;
the first flange comprises a first connecting portion arranged at or towards the first proximal end of the bracket, the first connecting portion comprising a first aperture configured to receive, in use, a shank of a fastener;
the second flange comprises a second connecting portion arranged at or towards the second distal end of the bracket, the second connecting portion comprising a plurality of elongate second apertures each configured to receive, in use, a shank of a fastener; and wherein
the first flange further comprises at least one first tapering portion in which the first flange tapers in a direction generally towards second distal end of the bracket; and/or
the second flange further comprises at least one second tapering portion in which the second flange tapers in a direction generally towards the first proximal end of the bracket.

2. A bracket as claimed in claim 1 wherein the second apertures are elongate in a direction generally perpendicular to the longitudinal axis x of the common line.

3. A bracket as claimed in any preceding claim wherein each second aperture is configured to slidingly receive a shank of a fastener such that the shank is moveable along the elongate length of the aperture in use.

4. A bracket as claimed in any preceding claim wherein;

the first tapering portion is arranged adjacent to the first connecting portion; and/or
the second tapering portion is arranged adjacent to the second connecting portion.

5. A bracket as claimed in any preceding claim wherein the first and second tapering portions extend along at least a shared portion of the longitudinal axis x of the common line.

6. A bracket as claimed in any preceding claim wherein the bracket comprises, in order along the longitudinal axis x of the common line;

the first connecting portion;
the first and second tapering portions extending along at least a shared portion of the longitudinal axis x of the

common line; and
the second connecting portion.

7. A bracket as claimed in any preceding claim wherein;

the first tapering portion comprises a first tapering edge distal to the common line, the first tapering edge being arranged at an acute angle $\alpha 1$ to the longitudinal axis x in the plane of the first flange; and
the second tapering portion comprises a second tapering edge distal to the common line, the second tapering edge being arranged at an acute angle $\alpha 2$ to the longitudinal axis x in the plane of the second flange; and
angle $\alpha 1$ is equal to angle $\alpha 2$.

8. A bracket as claimed in any preceding claim wherein;

the first flange further comprises a first reinforcing portion arranged between the first tapering portion and the second distal end; and/or
the second flange further comprises a second reinforcing portion arranged between the second tapering portion and the first proximal end.

9. A bracket as claimed in any preceding claim wherein:

the first flange has a width w1 perpendicular to the longitudinal axis x;
the second flange has a width w2 perpendicular to the longitudinal axis x;
the first tapering portion tapers towards the second distal end of the bracket by a progressive reduction of the width w1 of first flange in a direction generally towards the second distal end of the bracket; and
the second tapering portion tapers towards the first proximal end of the bracket by a progressive reduction of the width w2 of the second flange in a direction generally towards the first proximal end of the bracket.

10. A bracket as claimed in claim 8 wherein the progressive reduction of the width w1 and/or w2 is linear.

11. A bracket as claimed in any preceding claim wherein the first aperture is configured to substantially prevent lateral movement of the shank in the aperture in use.

12. A bracket as claimed in any preceding claim wherein the second flange comprises a plurality of elongate second apertures.

13. A bracket as claimed in claim 12 wherein each of the plurality of elongate second apertures is arranged generally parallel to the other or others of the plurality of elongate second apertures.

14. A bracket as claimed in any preceding claim wherein the first flange extends along all of the length of the bracket relative to the longitudinal axis x of the common line.

15. A bracket as claimed in any preceding claim wherein the second flange extends partially along the length of the bracket relative to the longitudinal axis x of the common line, and preferably along a majority of the length of the bracket relative to the longitudinal axis x of the common line.

16. A bracket as claimed in any preceding claim wherein the bracket is formed from sheet metal.

17. A bracket as claimed in any preceding claim wherein the first flange and the second flange are integrally formed.

18. A bracket as claimed in any preceding claim wherein the common line is a common bending line.

19. A bracket as claimed in any preceding claim wherein the first flange and/or the second flange is substantially planar.

20. A bracket as claimed in any preceding claim for attaching a curtain wall element to a floor.

21. A bracket as claimed in any preceding claim wherein

an outer edge of the first connecting portion is substantially parallel to the longitudinal axis x of the common

line; and/or
an outer edge of the second connecting portion is substantially parallel to the longitudinal axis x of the common line.

22. A bracket as claimed in any preceding claim wherein the first flange is arranged at an angle approximately 90 degrees relative to the second flange.

23. A blank for forming a bracket as claimed in any preceding claim, the blank comprising;

a first element configured to form, in use, the first flange of the bracket;
a second element configured to form, in use, the second flange of the bracket; and
an axis configured to form, in use, a common line arranged between the first and second flanges of the bracket.

24. A blank as claimed in any of claims 23 wherein the blank if formed from sheet material, wherein the sheet material is preferably sheet metal.

25. A blank as claimed in claim 23 or claim 24 wherein the outer edges of the first tapering portion and the second tapering portion are substantially parallel.

26. A method of forming a bracket according to any of claims 1 to 22 comprising the steps of;

providing a blank according to any of claims 23 to 25; and
bending the blank along the common line such that the first flange is angled relative to the second flange.

27. A connection comprising;

a bracket as claimed in any of claims 1 to 22;
a first construction element; and
a second construction element.

28. A connection as claimed in claim 27 wherein one of the first construction element and the second construction element is a curtain wall element.

29. A connection as claimed in any of claims 27 to 28 wherein one of the first construction element and the second construction element is floor, a floor component, a joist

30. A connection as claimed in any of claims 27 to 29 wherein one of the first construction element and the second construction element is substantially horizontal and the other of the first construction element and the second construction element is substantially vertical.

31. A connection as claimed in any of claims 27 to 30 wherein;

the first construction member comprises a first end face and a first connection face, the first connection face being substantially perpendicular to the first end face;
the second construction member comprises a second end face and a second connection face, the second connection face being substantially perpendicular to the second end face;
the first end face is arranged substantially parallel to the first end face such that the plane of the first connection face is substantially perpendicular to the plane of the second end face;
the first flange is fastened to the first connection face; and
the second flange is fastened to the second connection face.

32. A connection as claimed in claim 31 wherein the first end face is arranged in a spaced configuration to the second end face.

33. A connection as claimed in any of claims 27 to 32 wherein the elongate second apertures are arranged substantially vertically.

34. A connection as claimed in any of claims 27 to 33 wherein first construction element and second construction element

are arranged in a spaced configuration along the longitudinal axis x.

35. A connection as claimed in any of claims 27 to 34 further comprising a fastener received in the fastener for fastening the first flange to the first construction member.

36. A connection as claimed in any of claims 27 to 35 further comprising a shank of a fastener slidably received in at least one of the at least one elongate second apertures, the aperture being configured such that the fastener is slidable along the elongate length of the apertures.

37. A method of forming a connection as claimed in any of claims 27 to 36 comprising the steps of:

providing a bracket as claimed in any of claims 1 to 22;
fastening the first flange to the first construction element such that relative movement between the first flange and the first construction element is substantially prevented;
fastening the second flange to the second construction element such that relative movement of the second flange to the second construction element is accommodated by sliding of one or more fastener shanks received in the or each elongate second aperture along the elongate length of the aperture.

38. A method as claimed in claim 37 further comprising the steps of:
adjusting the position of the second construction element such that a load associated with the mass of the second construction element is substantially supported by a further construction element arranged below the second construction element.

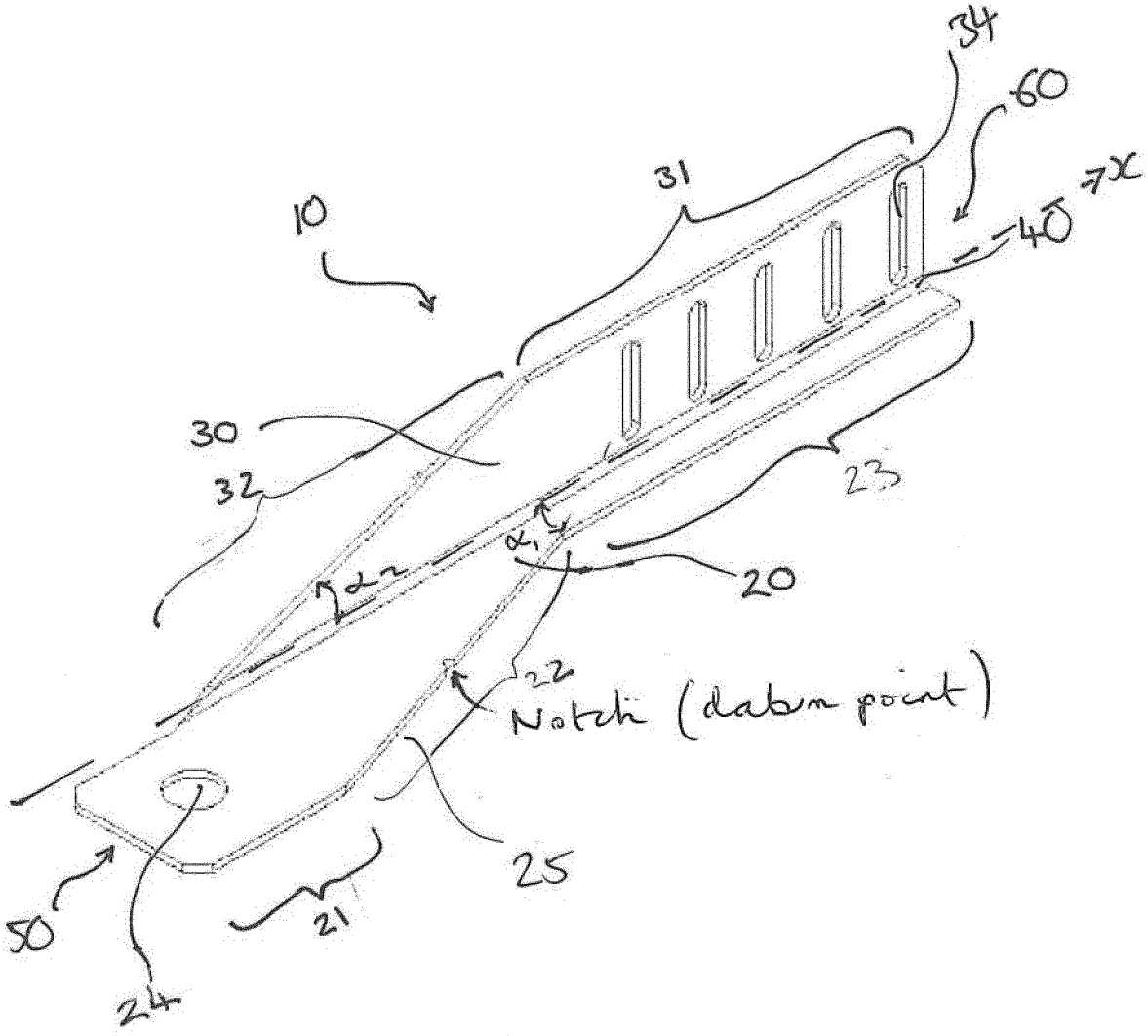


Figure 1

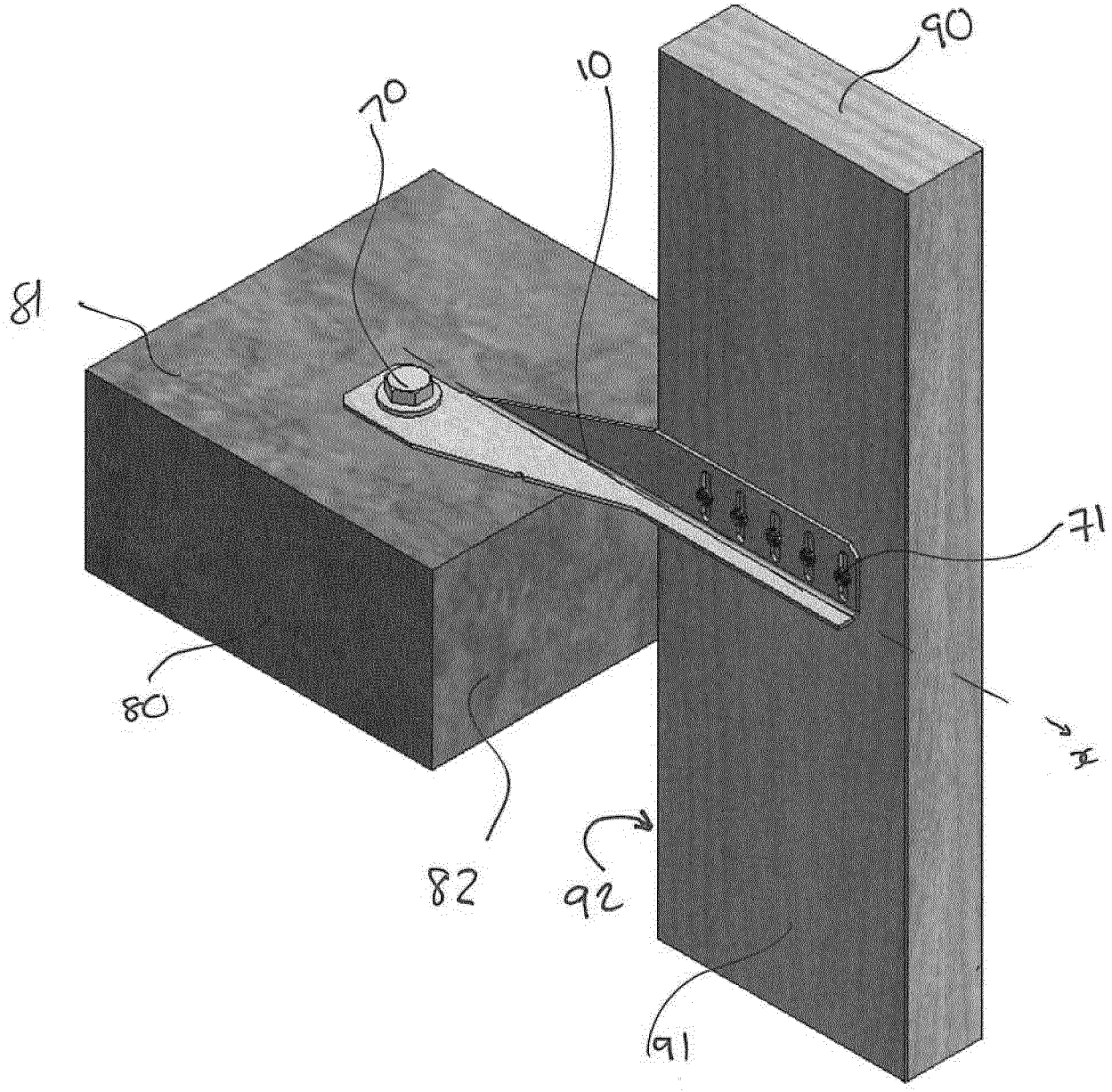


Figure 2

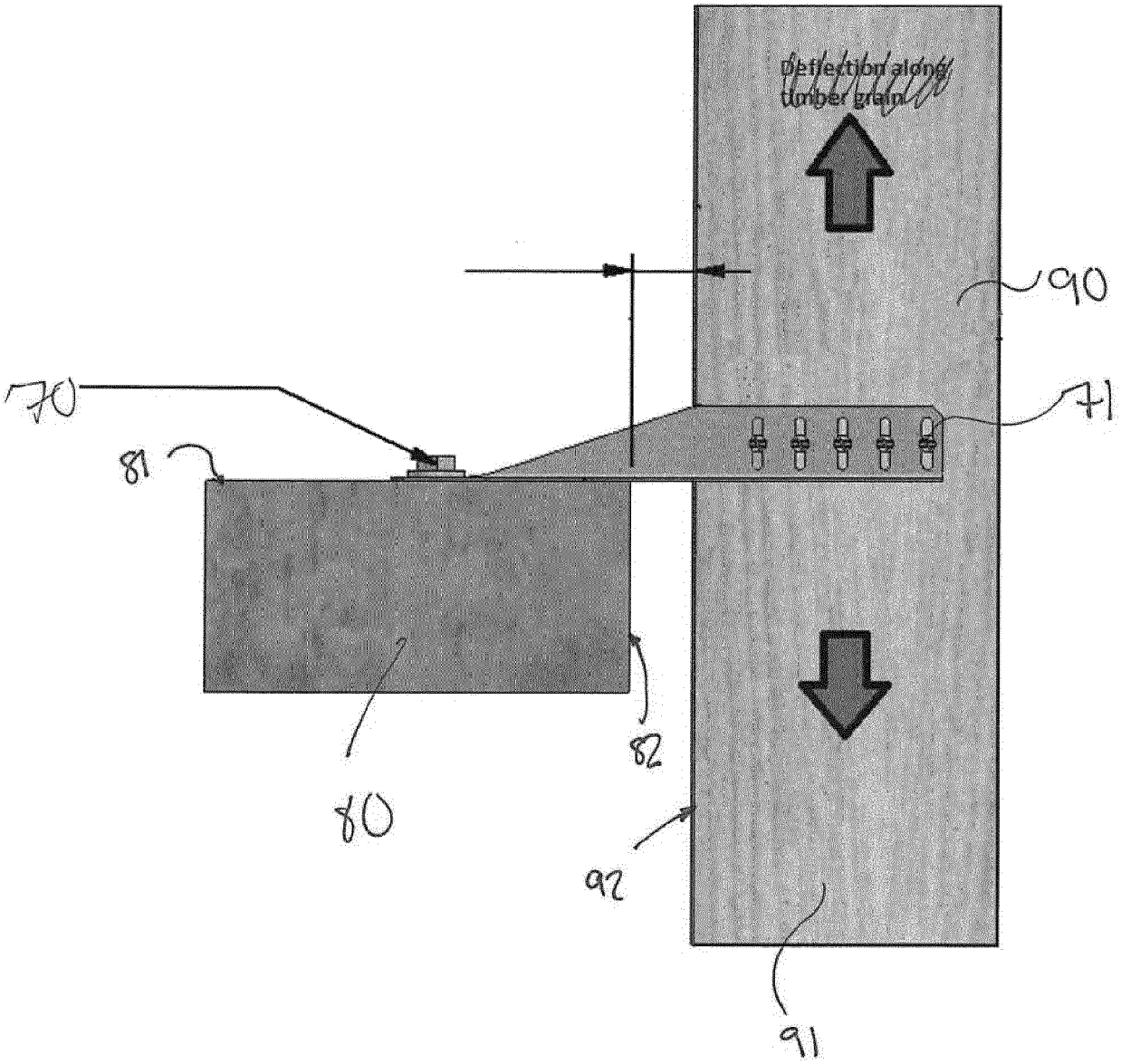


Figure 3

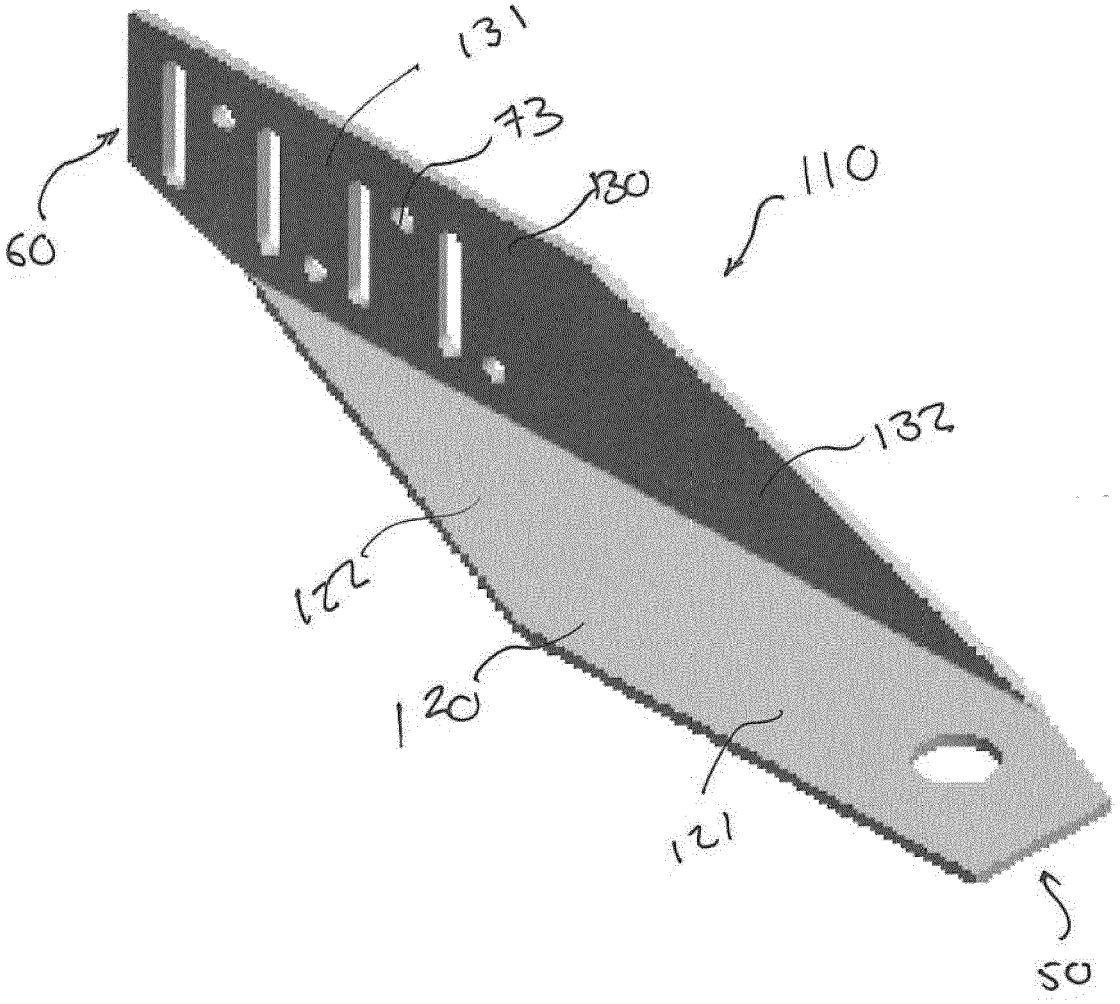


Figure 4

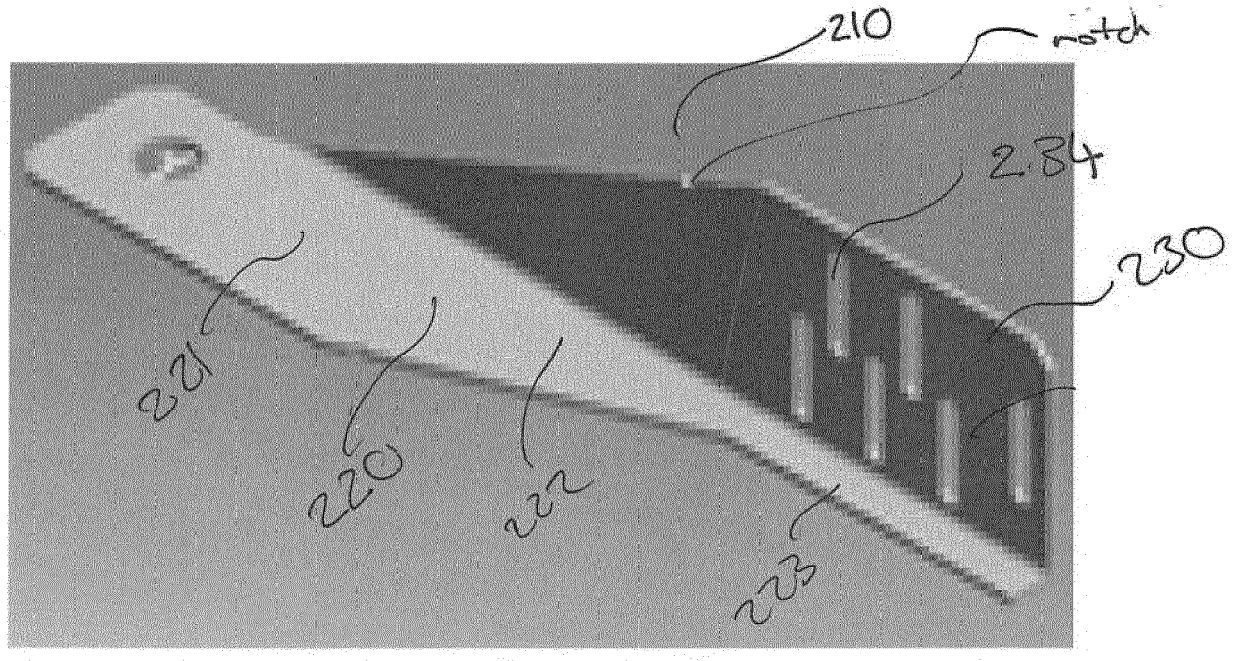


Figure 5

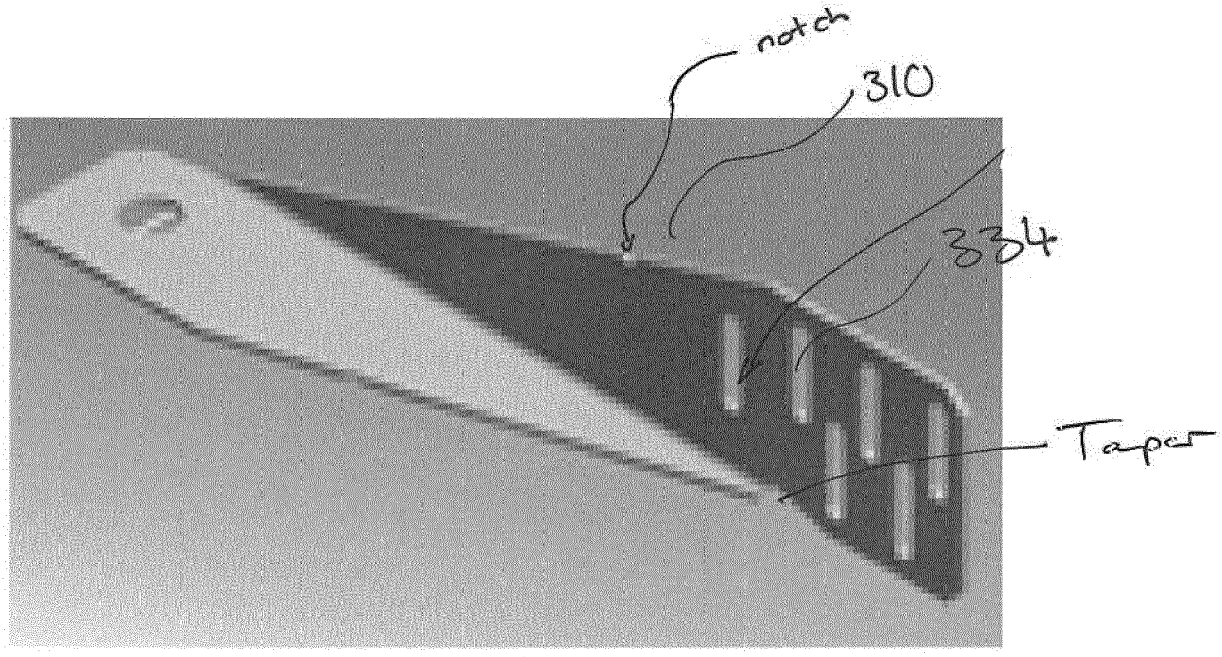


Figure 6

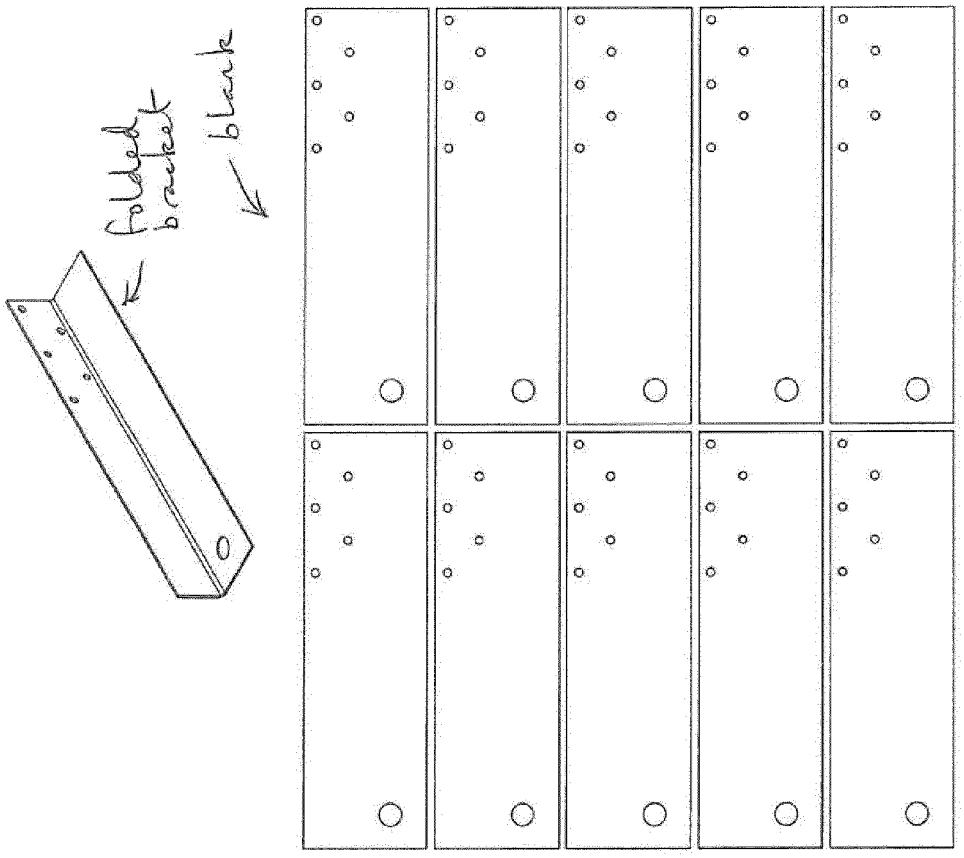


FIGURE 8

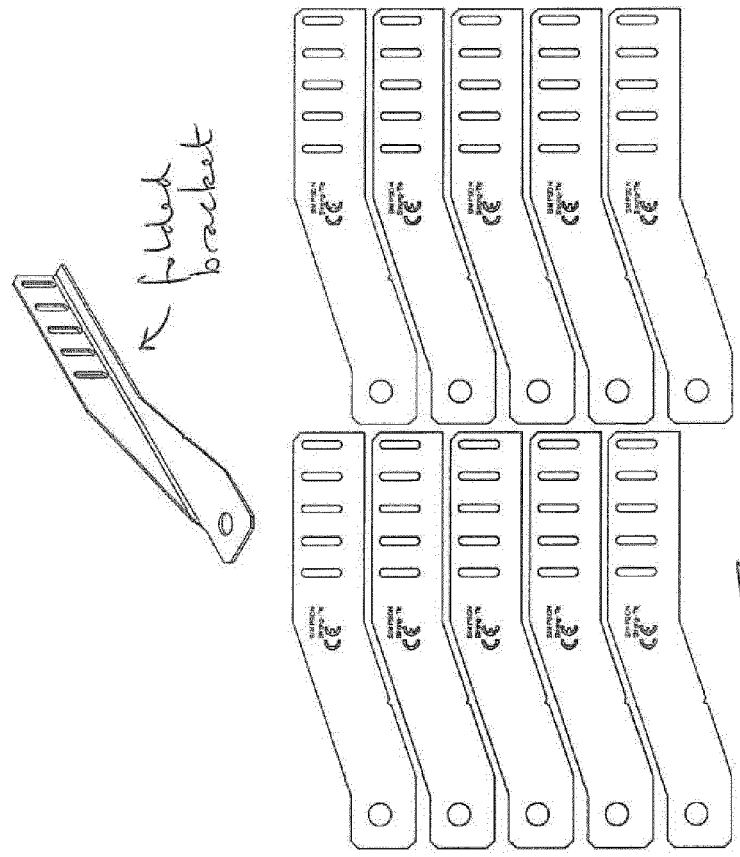


FIGURE 7

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 19 15 4914

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 595 031 A (COMMINS ALFRED D [US]) 21 January 1997 (1997-01-21) * column 7, line 7 - line 53; figures 1,2 *	1-15	INV. E04B1/26 E04B2/88
X	US 4 525 972 A (PALACIO JOAQUIN J [US] ET AL) 2 July 1985 (1985-07-02) * column 5, line 43 - column 6, line 38; figure 2 *	1,2,4-15	

TECHNICAL FIELDS SEARCHED (IPC)

E04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	31 October 2019	Melhem, Charbel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 15 4914

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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31-10-2019

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