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THERMAL AND/OR SOUND INSULATION  
CHARACTERISTICS FOR BUILDING  
CONSTRUCTION****Publication Classification**(51) **Int. Cl.**  
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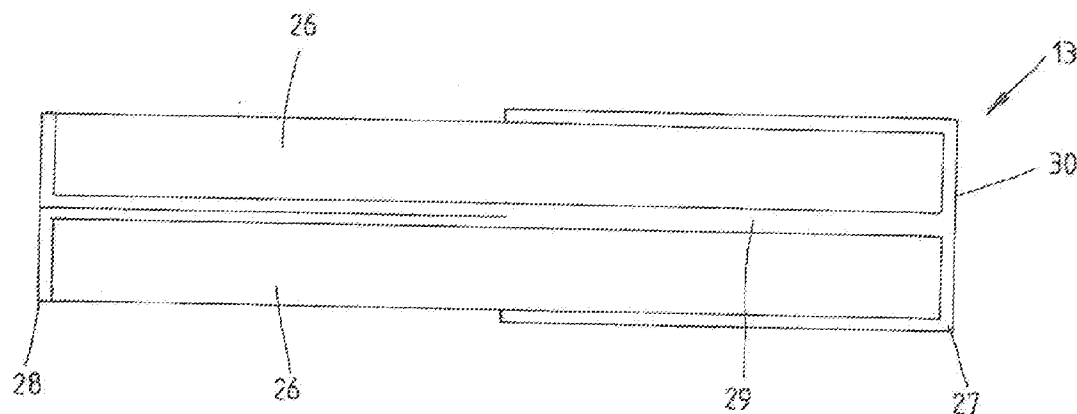
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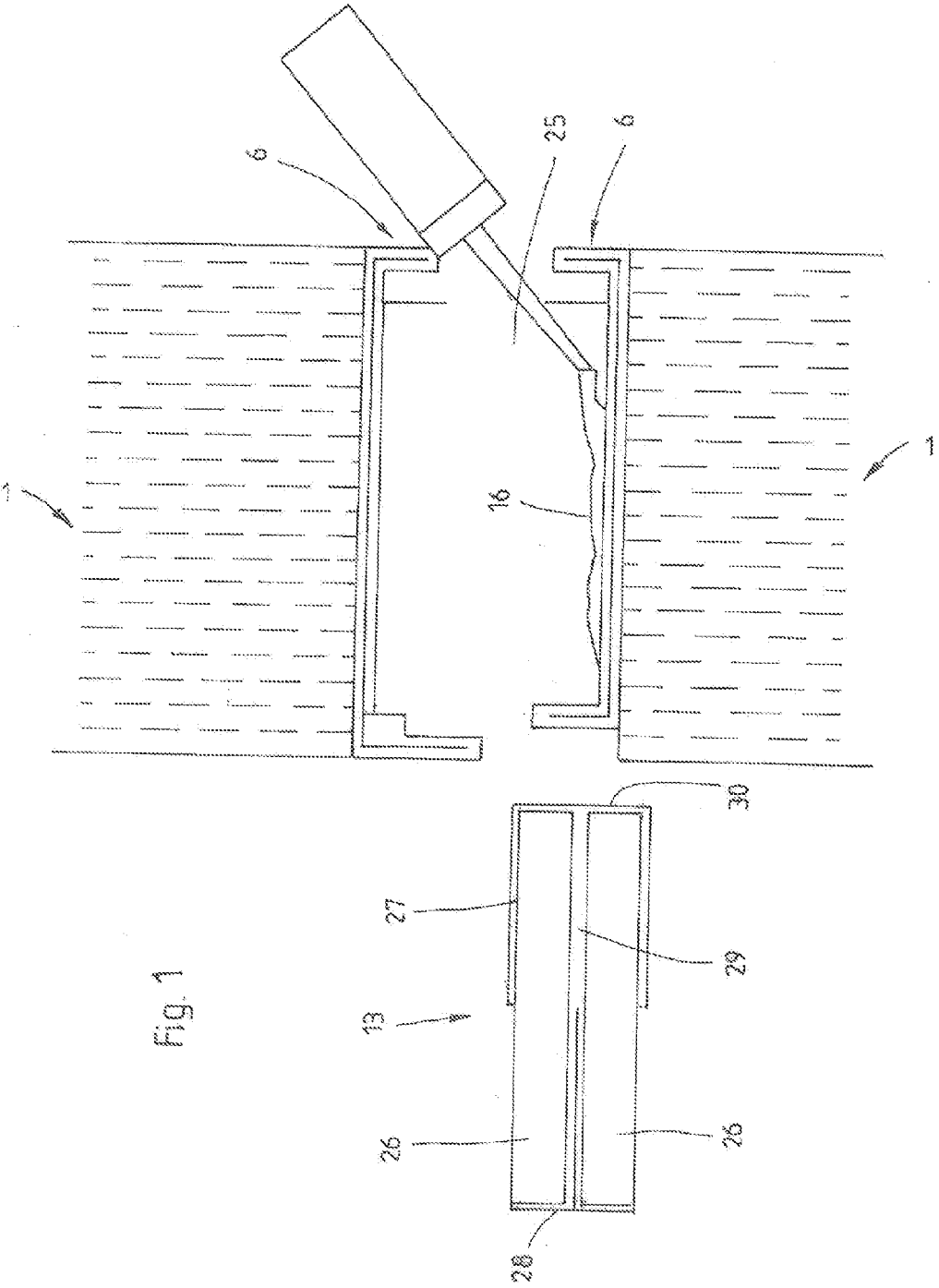
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(57) **ABSTRACT**

The invention relates to a composite structural member with thermal and/or sound insulation characteristics for a building, comprising an insulating board shaped as web part and at least one protective element whereby the web part has two opposing abutting faces and two main surfaces being arranged rectangular to the abutting faces, whereby the board is made of mineral fibres and a binder and whereby the at least one protective element is substantially U-shaped in cross section, having two legs erecting parallel to each other and being connected to the web part, whereby abutting faces of at least one web parts are covered by protective elements, which in combination with said web part take up loads parallel and/or rectangular to the main surfaces of the web part and which are not in direct contact to each other.





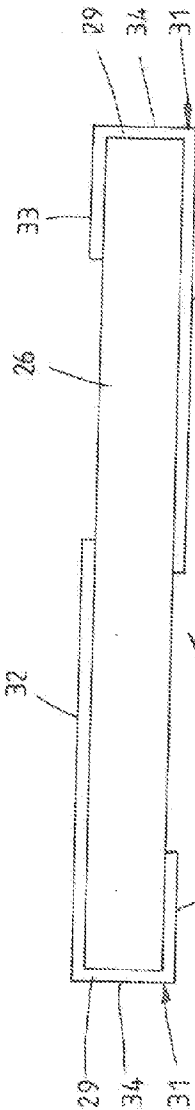


Fig. 3

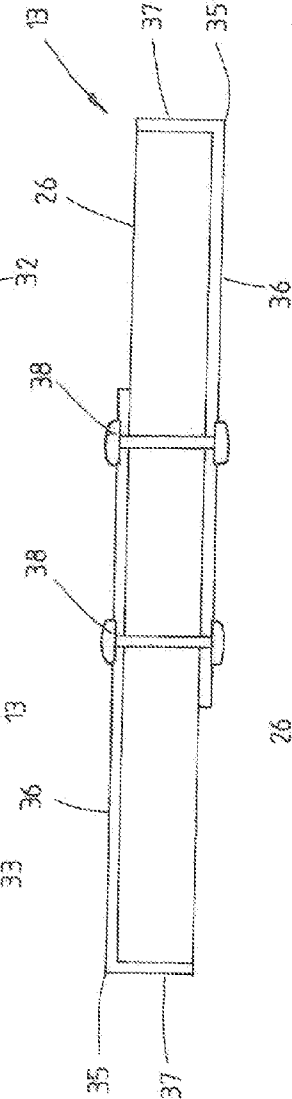


Fig. 4

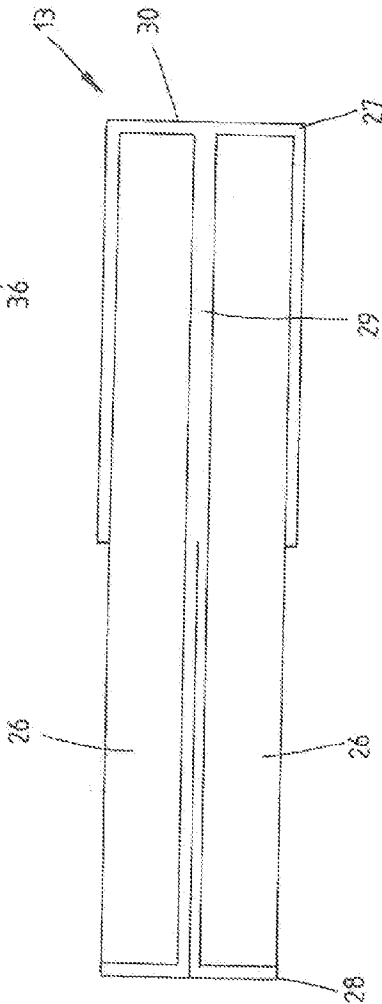


Fig. 2

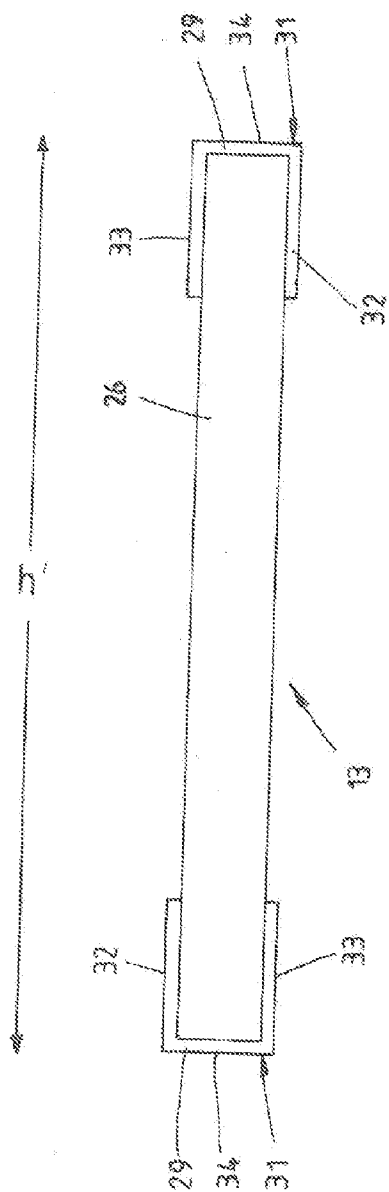


Fig. 5

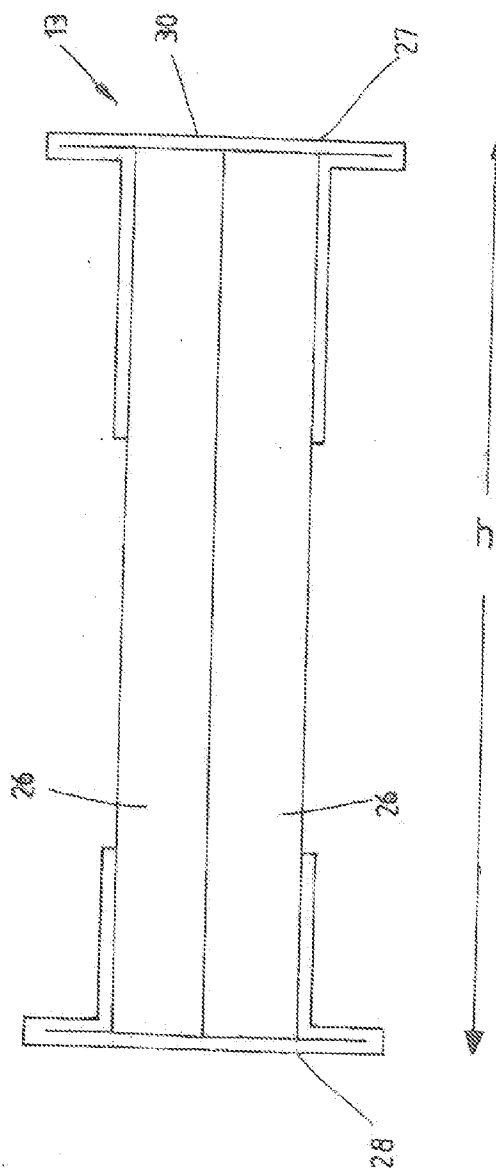


Fig. 6

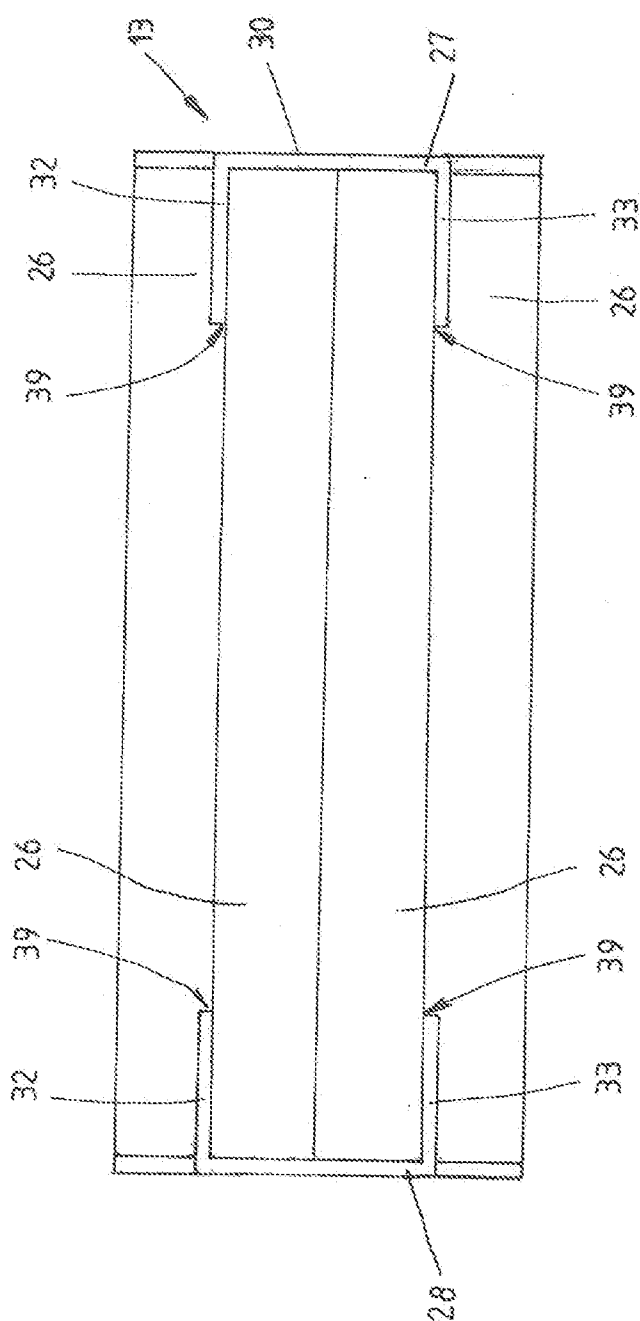


Fig. 7

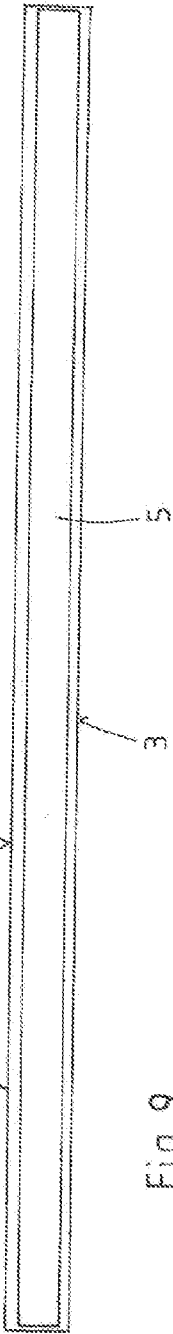
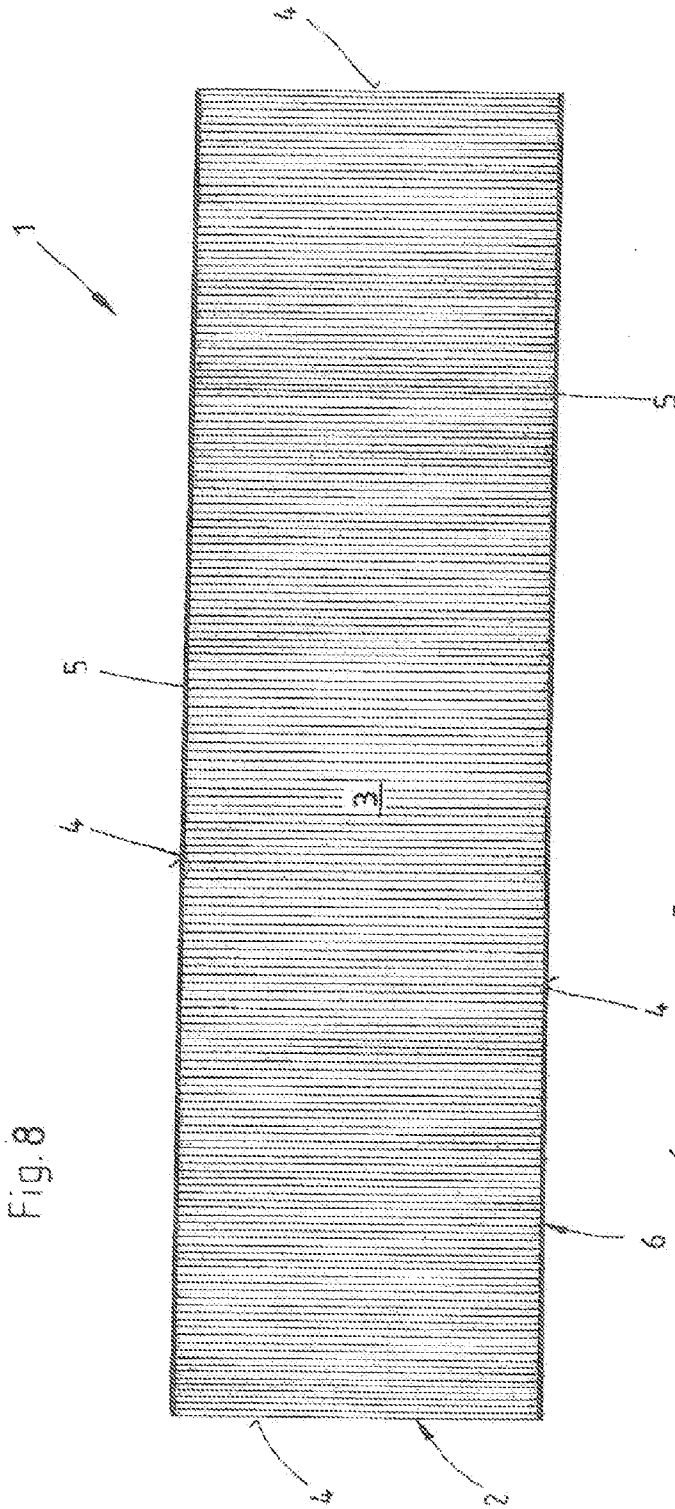


Fig. 10

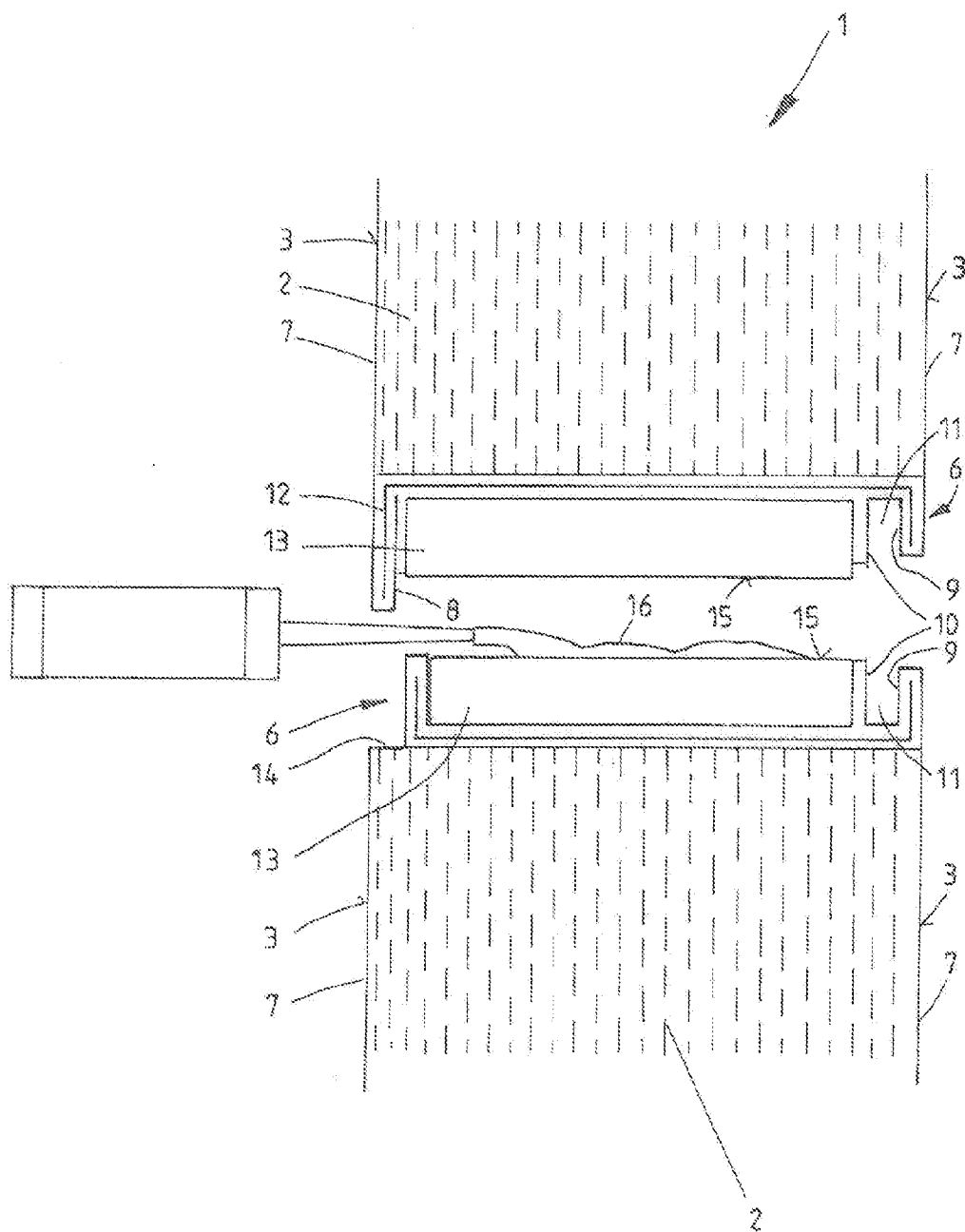
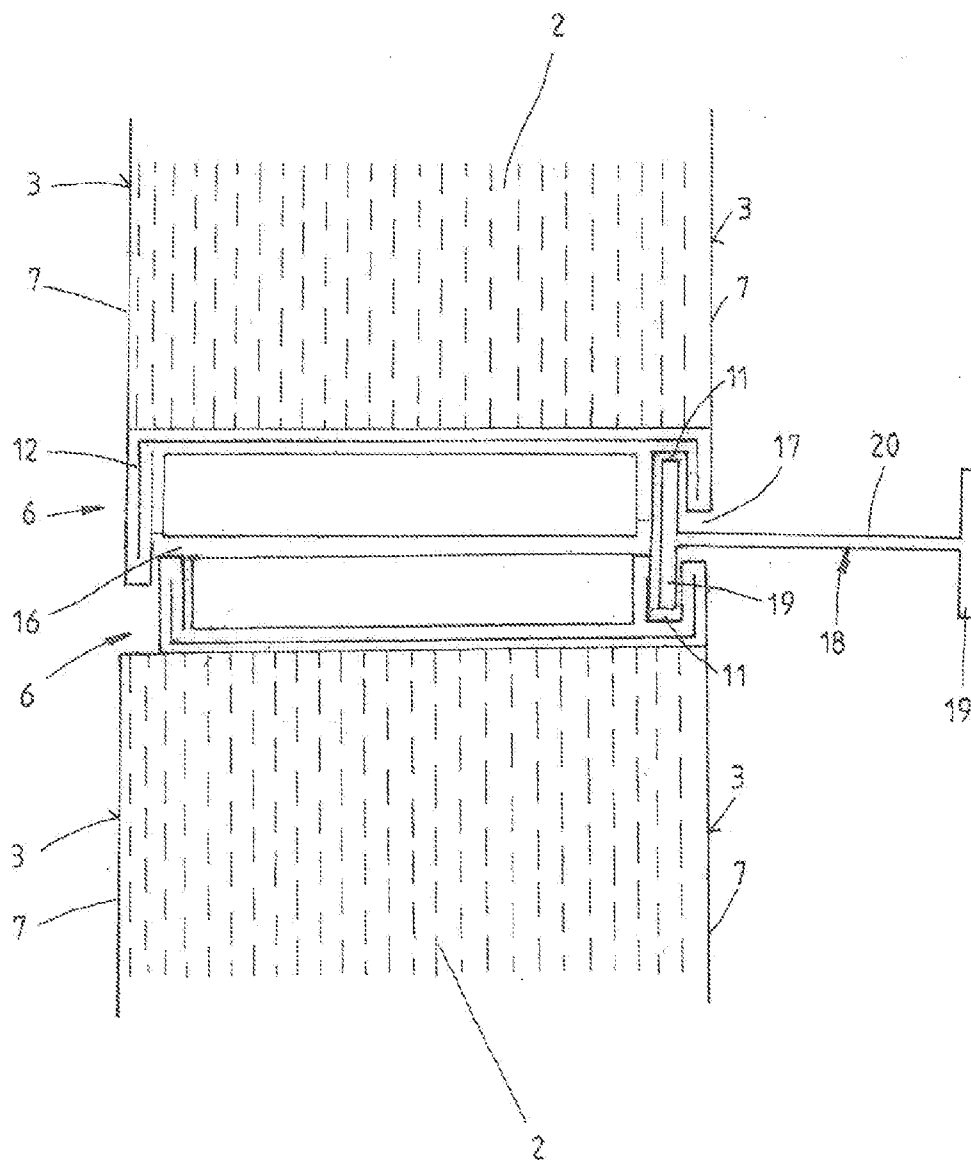


Fig. 11



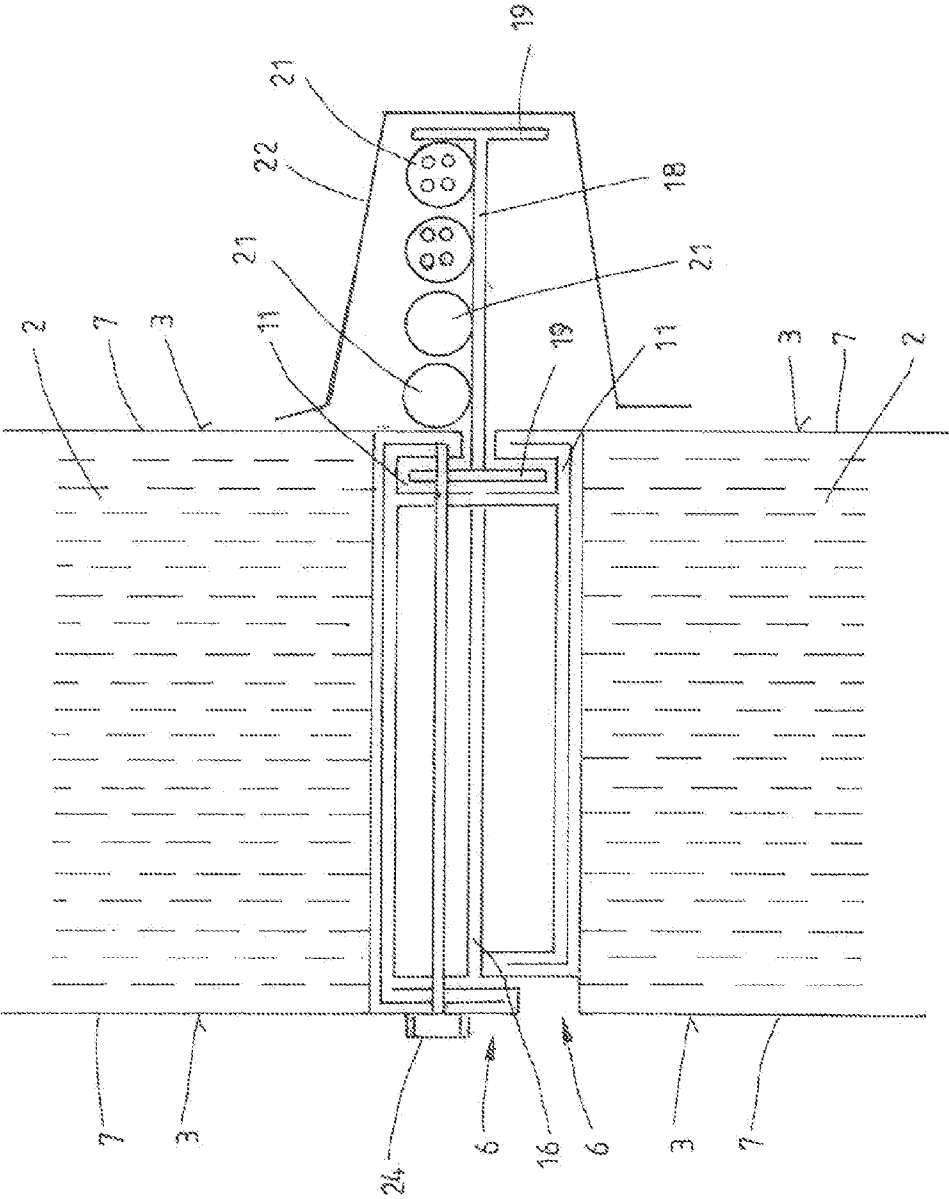
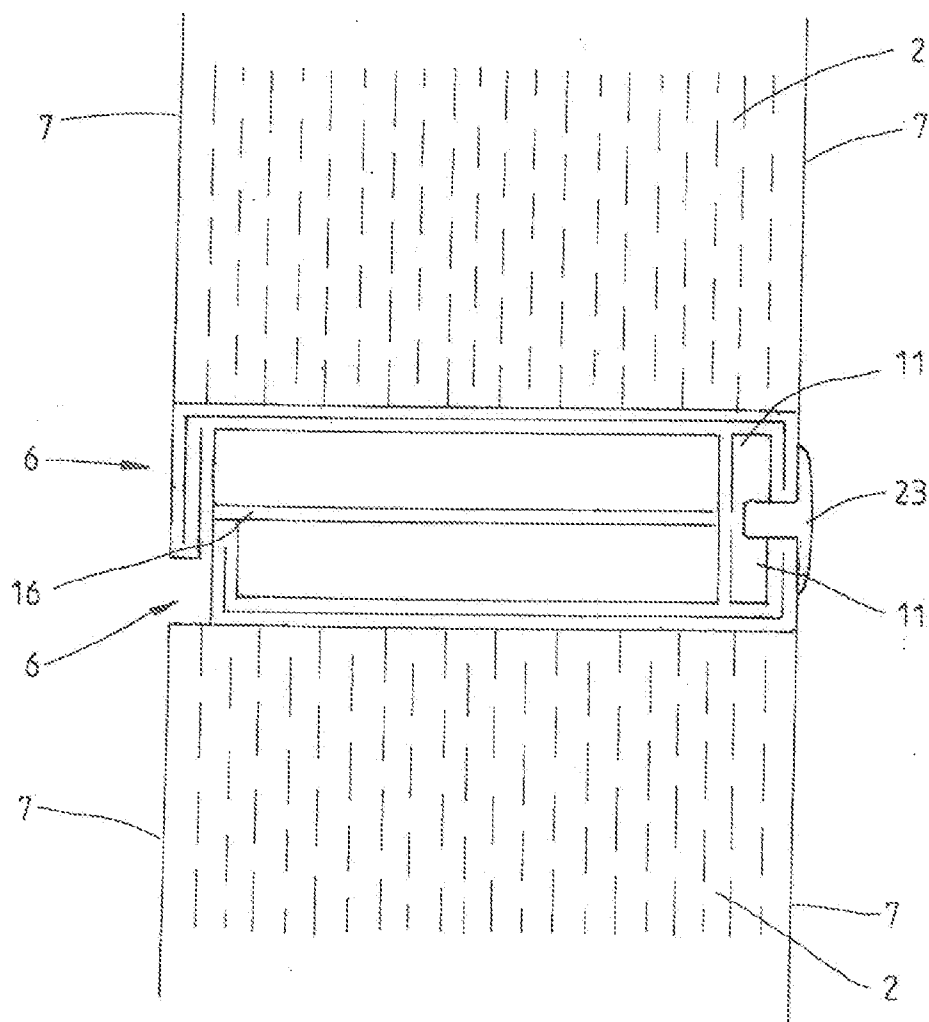
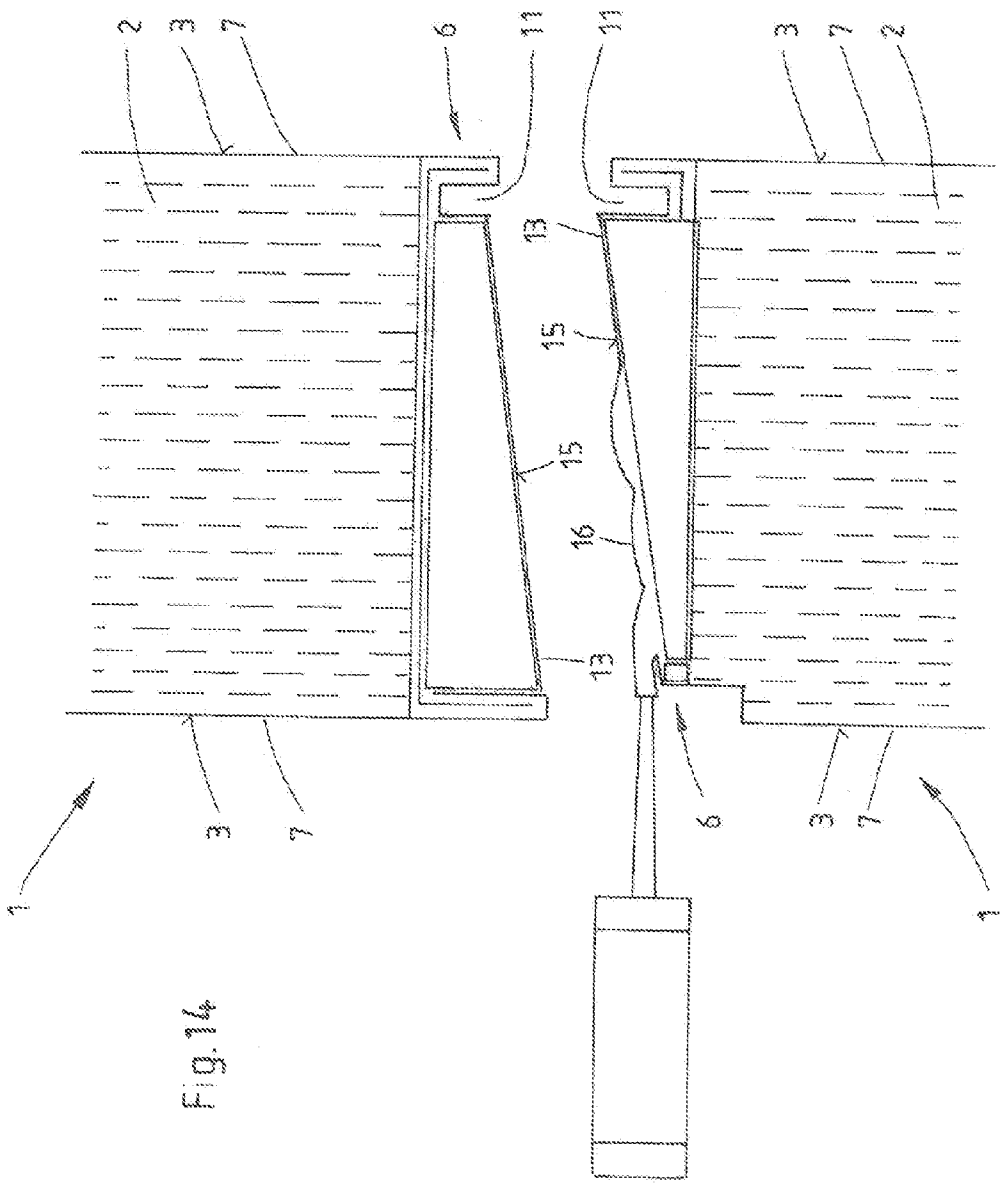


Fig. 12

Fig. 13





# COMPOSITE STRUCTURAL MEMBER WITH THERMAL AND/OR SOUND INSULATION CHARACTERISTICS FOR BUILDING CONSTRUCTION

**[0001]** The invention relates to a composite structural member with thermal and/or sound insulation characteristics for building construction comprising an insulating board shaped web part and at least one protective element, whereby the web part has two opposing abutting faces and two main surfaces being arranged rectangular to the abutting faces.

**[0002]** The present invention sets out to provide composite structural members such as columns, studs, beams, bracings, joists, rafters, purlins, trusses, mounts, and supports, as used in frames, walls, roofs, floors, doors, windows, and other building structures and substructures. They may be designed or utilized for load-bearing and load distribution or stabilizing functions as well as for secondary members or even simple, non-load-bearing substructures.

**[0003]** Generally structural members as well as composite structural members are well known.

**[0004]** Typical structural members within building construction are e.g. steel products in the form of hot rolled long products (often referred to as “sections” or “profiles”). They are often used for the main frame members (columns, beams, bracings). Said hot rolled products mainly appear as e.g. I, H and channel sections, Angles or hollow sections. Nowadays these sections often undergo various transformations through cutting, welding, bending etc., in order to obtain very different shapes and improved performance. In this way, e.g. cellular beams can be fabricated from I or H sections by cutting and welding.

**[0005]** Besides those hot rolled long products, cold formed long products formed from thin sheet steel are widely used as secondary members, e.g. for cladding (rails) and roofs (purlins). Typical shapes are C, U or Z sections.

**[0006]** Steel offers exceptional qualities in terms of mechanical resistance but typically provides undesirable thermal characteristics.

**[0007]** Traditionally wood has been used to a large extent in some variations and in various types of different structures. However, wood has increased in price and quality structural lumber has decreased in availability. Moreover, strength and safety requirements within the building regulations have increased during the years and therefore the use of wood is somewhat limited, in particular in respect to e.g. multi-storey structures.

**[0008]** Furthermore, during the past decade composite structural members have been developed in order to overcome some of the before mentioned drawbacks. Those members often employ a wooden web with wooden flanges on both edges of the web, or combinations of web parts from laminated wood/plywood or wood-based products, like e.g. OSB boards with wooden or wood based flanges. Such kind of wooden composite structural members which may often have the form of an I-beam are e.g. known as TJI-beam, commercially available from US based company TrusJoist. In order to increase the strength of those wooden composite members attempts have been made to include reinforcements. By way of example reference is made to U.S. Pat. No. 5,974,760A and U.S. Pat. No. 6,173,550B1.

**[0009]** Besides that, also composite structural members comprising various wooden or alternative materials for the web parts combined with metal flanges are known in the art. E.g. U.S. Pat. No. 6,301,857 B1 describes a rigid element as

composite structural member comprising an elongated metal flange having a pair of parallel side walls joined at one end by a transverses base wall to form a web receiving pocket. The web is made from wood such as plywood and is elongate and has parallel wide sides and parallel narrow edges. Metal flanges are fixed to both opposite edges, whereby raised teeth of the metal flanges are penetrating into the web. This well known rigid element may have a high load bearing potential but is not easy to produce and does not have good insulation properties as the teeth penetrated into the web and may get into contact to each building up thermal bridges.

**[0010]** U.S. Pat. No. 6,161,361 describes a composite structural member having a pair of spaced apart longitudinally extending flanges and a plurality of thermally insulative conductive web connectors intermittently disposed between the flanges, the web connectors having a pair of opposing ends, each end being attached to a respective flange, wherein at least two of the web connectors are longitudinally spaced apart from each other, thereby forming at least one open cavity defined by at least some portion of the flanges and the at least two web connectors, whereby the web connectors and the open cavity minimize thermal conductance between the flanges. Therefore this prior art improves the insulation properties by reducing the material of the web and building up the cavity. Reducing the material of the web means to reduce the stability, especially the load bearing properties of the composite structural member. To receive a sufficient stability needs the use of very stiff materials which may according to the description be of the prior art plastic, especially recycled plastic.

**[0011]** A common drawback of all the above mentioned prior art structural members is their limited respectively undesirable thermal characteristics and their poor behavior in the event of a fire.

**[0012]** It is therefore an object of the present invention to provide a composite structural member, in the following also referred to as rigid element, which is easy to handle, easy to produce, which has excellent insulation and stability properties and which significantly improves the resistance to fire compared to prior art structural members.

**[0013]** According to the invention this object is achieved with a composite structural member having a board shaped web part, in the following also referred to as the board, made of mineral fibres, a binder and optional an additive, e.g. aerogel, and at least one elongate flange or protective element, whereby the at least one protective element is substantially U-shaped in cross section. The at least one protective element having two legs erecting parallel to each other and being connected to the board and whereby both abutting faces of the board are covered by protective elements, which in combination with the board take up loads parallel and/or rectangular to the main surfaces of the board and which are not in direct contact to each other.

**[0014]** Such a composite structural member can be used for thermal and/or sound insulation of a building façade and has increased thermal and/or sound insulation properties and is increased with respect to its stability properties due to the combination of an insulating material with at least one protective element, thereby completely avoiding thermal bridges. The protective elements protect the board against high loads, and with respect to the design of the protective elements a lot of loads, such as compression force and bending forces are transmitted by the protective elements in connection with the board.

[0015] Because of the combination of all features of the composite structural member according to the invention such composite structural member can for example be used with building elements of big lengths up to more than 12 meters. Such composite structural member can be handled easily because of the relatively low weight of the rigid element mainly made of mineral fibres.

[0016] Building elements according to the prior art always need profiled steel supports between the building beams which have a distance of about 3 to 6 meters. These steel supports have the function to take up loads from the building elements and transfer them into the building construction. A composite structural member according to the invention has the advantage that it can take up all loads directly and transfer the loads for example to building beams.

[0017] According to a further feature of the invention the composite structural member preferably can be fixed in a clamp fit way between legs of an integrated joint element. Preferably the composite structural member can be fixed to the insulating element and/or the integrated joint elements at least by gluing. Gluing the composite structural member to the insulating element and/or the integrated joint elements avoids fastening elements like screws, rivets or the like. Therefore, thermal bridges can be avoided easily.

[0018] According to a further feature of the invention a tensile element stiffens the composite structural member in a contact zone to the insulating element. Preferably the composite structural member has a fibre orientation directed between the protective elements. The fibre orientation has on the one hand an effect on the stiffness of the composite structural member and on the other hand an effect on the insulation properties of the composite structural member. The fibre orientation as described before increases the insulation properties of the composite structural member.

[0019] According to a further embodiment of the invention the composite structural member has two main surfaces of which one main surface is directed to the lateral surface of the insulating element, whereby the two main surfaces of the composite structural member are diverging to each other. This embodiment has the advantage to build up increased water tightness. Preferably the composite structural member has a main surface being capable to be connected with an adhesive.

[0020] To reach a higher stiffness of the composite structural member the composite structural member according to the invention comprises at least one board of mineral fibres and two protective elements, each being fixed to and covering at least partly one main surface and one lateral surface of the board whereby the protective elements are not in direct contact to each other. The composite structural member has an increased stiffness and does not build up a thermal bridge between the outer surfaces of the building element because of the missing contact between the two protective elements which may be made from metal.

[0021] Preferably the two protective elements are overlapping each other on opposed main surfaces of the board. According to a further feature of the invention the protective elements are L-, U- or T-shaped in cross section and made of sheet metal, e.g. steel or aluminium with a thickness of 0.5 to 3.0 mm. Thereby an effective section modulus can be achieved. Alternatively such elements might nowadays also be made of fibre reinforced resin providing comparable strength properties.

[0022] According to a further feature of this embodiment two protective elements are connected to each other by con-

necting means like rivets, screws or the like which run perpendicular to the main surfaces of the boards. Finally, two boards are connected by at least one clamp like protective element which fixes the two boards to each other.

[0023] Preferably the board is build up by at least two layers which are connected by at least one clamp like protective element. The layers can be glued together.

[0024] A composite structural member according to the invention has preferably protective elements being made from sheet metal. According to a further feature of the invention at least one leg of the protective element is inserted into one slit of the board, being arranged in one abutting face of the board.

[0025] Finally the composite structural member according to the invention has at least one protective element having a width being larger than the width of the abutting face of the board.

[0026] Furthermore the invention relates to a building having at least two building elements with a composite structural member as said before and being arranged between the building elements, each building element comprising an insulating element made of mineral fibres, comprising two large surfaces extending substantially parallel and with a distance to each other and four lateral surfaces extending substantially at right angles to the large surfaces, and a frame made of sheet metal and being arranged at least at two lateral surfaces being arranged at opposite sides of the insulating element. According to the invention the frame has integrated joint elements being formed correspondingly to each other and load bearing and wherein at least one integrated joint element comprises the rigid element having thermal and/or sound insulation characteristics and being made of mineral fibres and a binder whereby the corresponding integrated joint elements of the building elements are connected to each other in a form fitted way and by an adhesive being provided between the rigid element and the building elements facing to each other.

[0027] According to a further feature of the invention the adhesive between the composite structural member and the building elements is non-combustible.

[0028] Furthermore, the composite structural members are preferably connected to the insulating element and/or the integrated joint elements by an adhesive, preferably with an incorporated vapor barrier and/or a tensile element, for example a fibrous web.

[0029] Finally, each integrated joint element has at least two legs extending parallel to each other and being made from the sheet metal of the frame, which is connected to the insulating element, especially to the main surfaces of the insulating element and in that each leg is formed by bending a free end of the sheet metal.

[0030] The building element can be developed in the inventive way by incorporating one or all features which are already described above with reference to the composite structural member.

[0031] The invention will be described in the following by way of example and with reference to the drawing in which

[0032] FIG. 1 shows an embodiment of two building elements with a composite structural member to be incorporated between the two building elements;

[0033] FIG. 2 shows the composite structural member according to FIG. 1;

[0034] FIG. 3 shows a second embodiment of a composite structural member according to FIG. 1

[0035] FIG. 4 shows a third embodiment of a composite structural member according to FIG. 1

[0036] FIG. 5 shows a fourth embodiment of a composite structural member;

[0037] FIG. 6 shows a fifth embodiment of a composite structural member;

[0038] FIG. 7 shows a sixth embodiment of a composite structural member

[0039] FIG. 8 shows a building element for thermal and/or sound insulation in top view;

[0040] FIG. 9 shows the building element according to FIG. 8 in side view;

[0041] FIG. 10 shows two building elements according to FIGS. 8 and 9 in a side view perpendicular to the side view of FIG. 9;

[0042] FIG. 11 shows the two building elements according to FIG. 10 with additional equipment;

[0043] FIG. 12 shows the two building elements according to FIGS. 10 and 11 with additional equipment;

[0044] FIG. 13 shows the two building elements according to FIG. 10 with additional equipment;

[0045] FIG. 14 shows a further embodiment of two building elements according to FIGS. 8 and 9 in a side view perpendicular to the side view of FIG. 9.

[0046] An embodiment of the invention is shown in FIGS. 1 to 7. FIG. 1 shows two building elements 1 and it can be seen that one singular composite structural member 13 is used to be inserted into a cavity 25 built up by two load bearing joint elements 6 of two building elements 1 being arranged neighbored to each other. The composite structural member 13 comprises two board shaped web parts (26) of mineral fibres, aerogel particles and a binder as will be described in the following. Said boards (26) consist of components fibres, aerogel particles and at least one binder, whereby 20 to 40 wt % mineral wool fibres, 45 to 70 wt % aerogel particles and 8 to 12 wt % binder are pressed and cured to a board having a density of 150 kg/m<sup>3</sup> to 200 kg/m<sup>3</sup>, preferably of at least 180 kg/m<sup>3</sup>. Such a composite structural member can have a thermal conductivity  $\lambda$  of less than 0.022 W/(mK). As aerogel particles, hydrophobic aerogel particles and up to 10 wt % binder are mixed and shaped to a board which is finally cured. Such a board contains 50 to 70 wt % aerogel particles and up to 30 wt % mineral fibres. The boards 26 are connected to each other by two protective elements 27, 28 of different shape.

[0047] The protective element 27 is made of sheet metal and U-shaped in cross section. Therefore, the protective element 27 has two legs erecting parallel to each other and connected to each other by a web being oriented rectangular to the legs. The distance between the two legs of the protective element 27 is equal to the thickness of the two boards 26 which are glued together by an adhesive 29. Furthermore, the adhesive 29 is provided between the main surfaces and the legs of the protective element 27 as well as between the lateral surfaces of the boards 26 and the web 30 of the protective element 27.

[0048] The second protective element 28 is made of sheet metal and is T-shaped in cross section. The second protective element 28 is arranged at the boards 26 opposite to the protective element 27 whereby the two lateral surfaces of the boards 26 are totally covered by a first leg of the protective element 28 and whereas the second leg of the protective element 28 spans between the two boards 26.

[0049] The two protective elements 27, 28 are not in contact with each other so that the composite structural member 13 according to FIG. 1 does not constitute a thermal bridge between the two outer sides of the building elements 1.

[0050] According to FIG. 1 the composite structural member 13 is inserted into a cavity 25 and fixed by an adhesive 16 to the load bearing joint elements 6 whereby the adhesive 16 is arranged at least on the big surfaces of the load bearing joint elements 6 before the composite structural member 13 is inserted into a load bearing joint element 6 of one building element and a second building element 1 is put on top of the building element 1 already containing the composite structural member 13.

[0051] The invention is not limited with respect to the embodiment according to FIG. 1 to the construction of the composite structural member 13 as shown in FIGS. 1 and 2. There might be some more possibilities to construct a composite structural member 13 which fulfills all characteristics of the rigid element 13 as shown in FIGS. 1 and 2 and which is in particular useful for application within a joint cavity 25; those embodiments specifically focusing on the thermal and fire properties of said composite structural member 13.

[0052] For example FIGS. 3 and 4 show further embodiments of a composite structural member 13 which will be described hereafter in more detail.

[0053] The composite structural member 13 according to FIG. 3 consists of one board 26 and protection elements 31 being U-shaped in cross section and therefore having two legs 32, 33 and a connecting web 34. The legs 32 are longer than the legs 33. The web 34 is connected to abutting surfaces of the board 26. Between the protective elements 31 and the board 26 an adhesive is arranged. It can be seen from FIG. 3 that the longer legs 32 of the two protective elements 31 are connected to opposite main surfaces of the board 26. The length of the two legs 32 of the protective elements 31 is slightly bigger than half of the width of the protective element 23.

[0054] A further embodiment of the rigid element 13 is shown in FIG. 4. This embodiment of the composite structural member 13 consists of the board 26 and two protective elements which are L-shaped in cross section and having therefore a longer leg 36 and a shorter leg 37 being oriented perpendicular to each other.

[0055] The longer legs 36 of the protective elements 35 cover the main surfaces of the composite structural member 13. The length of the longer legs is shorter than the width of the board 26 but longer than half of the width of the board 26 so that both legs 36 of the two protective elements 35 can be easily connected by screws 38 made of synthetic material. Instead of screws 38 rivets can be used.

[0056] Yet another embodiment of the composite structural member 13 is shown in FIG. 5. Such embodiment in particular aims at providing additional strength properties in order to furnish a structural member which is designed for load-bearing or load distribution or stabilizing purposes. The composite structural member 13 consists of a board 26 with at least one, preferably two protective elements 31 being arranged at opposing ends of the board 26. Each protective element 31, made of sheet metal covers an abutting surface of the board 26 and has two legs 32, 33 being in contact with one of the large surfaces of the board 26 being arranged perpendicular to the abutting surfaces of the board 26. The protective elements 31 are substantially U-shaped in cross section. In order to further increase the strength properties of such composite structural

member 13 said protective elements 31 may additionally comprise reinforcing creases. A layer of an adhesive 29 is arranged between the protective elements 31 and the board to fix the protective elements 31 to the board 26.

[0057] The legs 32, 33 of the protective elements can have equal lengths. With respect to the length of the board 26 the length of the legs 32, 33 can vary in a range so that the legs 32, 33 of both protection elements 31 being arranged on one large surface of the board 26 cover nearly the whole large surface of the board 26 without getting into contact to each other. The length of the legs 32, 33 of one protection element 31 can be equal or different to each other.

[0058] Furthermore the board 26 can have two layers which two layers of the board 26 are connected by at least one clamp like protective element 31. Nevertheless the layers of the board 26 can be glued together by a non combustible adhesive.

[0059] The board 26 according to FIG. 5 can be produced in the usual way in that mineral fibres are mixed with a binder and collected on for example a conveyor belt with which a web made of mineral fibres and binder is transported to a hardening device. Before and/or after the hardening device the web can be treated mechanically, for example compressed and/or cut into pieces. Such a web can be transformed to boards having a density between  $150 \text{ kg/m}^3$  to  $400 \text{ kg/m}^3$ , especially  $250 \text{ kg/m}^3$ . However, it is important to note that such board shaped web parts 26 can also be produced in a manner as will be described in the following with reference to FIG. 6 resulting in an advanced fibre homogeneity.

[0060] Tests have proven that such boards 26 according to FIG. 5 with a density of about  $250 \text{ kg/m}^3$  resist compression forces across their height 'h' up to approx. 500 kPa measured according to EN 826. A corresponding composite structural member 13 with a dimension of 80 mm (width) $\times$ 200 mm (height 'h') comprising a U-shaped protective element 31 arranged on one end of the board 26 with a width of the web 34 of 80 mm and the length of the adjacent legs 32, 33 of 30 mm has moreover been tested for its load-bearing capacity. With a thickness of the sheet metal, i.e. the steel material of the protective element 31 being 1.0 mm a beam element according to the description above will provide a load capacity of around 250 kg/m beam and is therefore in particular suitable to be used for substructures of facades or other types of building structures where load bearing or distributing capabilities are required.

[0061] The features described with respect to the composite structural member 13 according to FIGS. 1 to 5 can also be features of the embodiment according to FIG. 6 and to the embodiment according to FIG. 7 as it will be described in the following. However, FIG. 6 shows a special embodiment of a load-bearing composite structural member 13 consisting of two boards 26 which are glued together in the area of their large surfaces and which are clamped together by two protective elements 27, 28 having a web 30. The web 30 has a width being larger than the width of the abutting surfaces of the boards 26. Each protective element 27, 28 is made from one sheet metal being bend four times so that free ends of the sheet metal are arranged parallel to each and are in contact with the outer of the main surfaces of the boards 26; hence forming an I-section which provides extraordinary strength properties and which due to the mineral fibre web part has excellent thermal and fire properties.

[0062] The load-bearing composite structural member 13 shown in FIG. 6 consists of a web having a density of 500

$\text{kg/m}^3$  being composed of two layers each having a thickness of 14 mm and two flanges being fastened to the web with for examples blind rivets and glue. The flanges and the web are I-shaped in cross section. The flanges being the protective elements 27, 28 are made of steel. The flanges have a thickness of 2 mm and widths of 80 mm. The web 30 of the flanges, namely the protective elements 27, 28 has a thickness of 1 mm. The total height (h) of the composite structural member 13 is 150 mm.

[0063] This load-bearing composite structural member 13 having a shape like an I-profile can be used as a column and/or a beam. When tested as a column this load-bearing composite structural member 13 having e.g. a length of approx. 2700 mm provided a bearing capacity of respectively 76 kN and 81 kN.

[0064] Moreover, the load-bearing composite structural member 13 according to FIG. 6 has been tested as a beam with a span of 2.1 m and loaded with two single forces in the thirds point, i.e. with a resulting moment M of  $0.7 \times P$ . The indicated load has been  $2 \times P$ . The failure load has been respectively 15.2 kN and 19.5 kN and the resulting moment M has been respectively 5.3 kNm and 6.8 kNm. The deflection at failure was measured to 12 and 16 mm in the middle. The load-bearing composite structural member 13 described before has therefore two layers each having a thickness of 14 mm and a width of 146 mm and a length of approx. 2700 mm. The two layers are glued together with PU-glue. The two flanges have an inward folding and can thus be fitted to the two layers and are glued to the layers with PU-glue to constitute a column-like load-bearing composite structural member 13.

[0065] Such characteristics can be achieved by using a board shaped web part 26 having a density of about 400 up to  $600 \text{ kg/m}^3$ , especially  $500 \text{ kg/m}^3$ .

[0066] The before described webs can be made of mineral fibres in an amount of 90 to 99 wt-% of the total weight of starting materials in the form of a collected web and a binding agent in an amount of 1 to 10 wt-% of the total weight of starting materials, whereby the collected web of mineral fibres is subjected to a disentanglement process, whereby the mineral fibres are suspended in a primary airflow, whereby the mineral fibres are mixed with the binding agent before, during or after the disentanglement process to form a mixture of mineral fibres and binding agent and whereby the mixture of mineral fibres and binding agent is pressed and cured to provide a consolidated composite with a bulk density of  $400 \text{ kg/m}^3$  to  $600 \text{ kg/m}^3$ , especially of  $500 \text{ kg/m}^3$ . The percentages mentioned are based on dry weight of starting materials. A suitable method is e.g. disclosed and described in more detail in WO2011/012712 by the applicant.

[0067] Such webs can be produced in a versatile and cost-efficient method. By adjusting the density to which the web is pressed, a variety of different webs can be made tailor-made for specific purposes. Therefore, these webs have a variety of uses, predominantly as building elements. In particular the webs can be in the form of panels. In general, the webs are used in applications where mechanical stability and insulating properties are important. Preferably, the thickness of the web is from 4 to 25 mm depending on the intended use. The precise quantity of mineral fibres is chosen so as to maintain appropriate fire resistance properties and appropriate thermal and/or acoustic insulation value and limiting cost, whilst maintaining an appropriate level of cohesion, depending on the appropriate application. A high quantity of fibres increases the fire resistance of the element, increases its

acoustic and thermal insulation properties and limits cost, but decreases the cohesion in the element. This means that the lower limit of 90 wt-% results in an element having good cohesion and strength, and only adequate insulation properties and fire resistance, which may be advantages for some composites, where insulation properties and fire resistance are less important. If insulation properties and fire resistance are particularly important the amount of fibres can be increased to the upper limit of 99 wt-%, but this will result in only adequate cohesion properties. For a majority of applications a suitable composition will include a fibre amount of from 90 to 97 wt-% or from 91 to 95 wt-%. Most usually, a suitable quantity of fibres will be from 92 to 94 wt-%.

**[0068]** The amount of binder is also chosen on the basis of desired cohesion, strength and cost plus properties such as reaction to fire and thermal insulation value. The low limit of 1 wt-% results in a web with a lower strength and cohesion, which is however adequate for some applications and has the benefit of relatively low cost and potential for good thermal and acoustic insulation properties. In applications where a high mechanical strength is needed, a high amount of binder should be used, such as up to the upper limit of 10 wt-%, but this will increase the cost for the resulting product and further the reaction to fire will often be less favorable, depending on the choice of binder. For a majority of applications, a suitable web will include a binder amount from 3 to 10 wt-% or from 5 to 9 wt-%, most usually as suitable quantity of binder will be from 6 to 8 wt-%.

**[0069]** The mineral fibre used for such a web could be any mineral fibres, including glass fibres, ceramic fibres or stone fibres but preferably stone fibres are used. Stone wool fibres generally have a content of iron oxide of at least 3% and alkaline earth metals (calcium oxide and magnesium oxide) from 10 to 40%, along with the other usual oxide constituency of mineral wool. These are silica; alumina; alkali-metals (sodium oxide and potassium oxide) which are usually present in low amounts; and can also include titania and other minor oxides. A fibre diameter is often in the range of 3 to 20 microns, in particular 5 to 10 microns, as conventional. The before described composite structural member 13 according to FIG. 6 can be used instead of a bar 20 as it is shown and will be described in respect to FIG. 11.

**[0070]** Finally FIG. 7 shows an embodiment of the composite structural member 13 consisting of four boards 26 being glued together as a sandwich like board of four layers and wearing two protective elements 27, 28 at opposite abutting surfaces of the two boards 26 being arranged in the middle of the sandwich like board. Each protective element 27, 28 has two legs 32, 33 being inserted into a slit 39 between the outer board 26 of the sandwich like board and one of the boards 26 being arranged in the middle of the sandwich like board. The slit 39 can be arranged between these boards by keeping this area free from adhesive during the manufacture of the sandwich like board from four or more layers or by cutting into the abutting surfaces of the sandwich like board.

**[0071]** The before described building element 1 has the big advantage that loads can be distributed directly to building beams because the building element itself secures the safe load bearing effect through the load bearing joint elements 6 in combination with the composite structural member 13. Therefore, the sandwich effect works crosswise to the length of the building elements 1 with a short span of 2 meters up to 2.5 meters which is a usual width of a production line for the production of insulating elements 2. The integrated load bear-

ing joint elements 6 are substituting the normally necessary steel supports behind the building elements 1. The elements 1 therefore allow thermal bridge free systems.

**[0072]** Further advantages of the building elements 1 and buildings being built up with these building elements 1 and composite structural member 13 are achieved by using adhesives 16, 29 in various areas of the building elements 1. The use of adhesives 16, 29 makes it possible to reduce or to avoid screwing and dynamic loads are covered in a much better way along the whole building elements 1 and not only punctual. Therefore, the invention provides a building element 1 for example for all non residential buildings with new possible designs. The building elements 1 can at least be produced easily and have of course a better fire resistance compared to building elements 1 having a filling of e.g. plastic foams. Because of the reduced density of the insulating element 2 being inserted into the building element 1 low thermal conductivity of  $\lambda < 35 \text{ mW/(mK)}$  can be achieved. The building elements 1 can be produced in bigger units because the reduction of the bulk density of the insulating element 2 made of mineral fibres has the advantage of less weight. Bigger units have the advantage of a faster installation. Therefore, the invention has the advantages of fire safety, better acoustical performance, better energy efficiency and real sustainability. The building element 1 can have layers made of sheet metal with a profiling erecting parallel to the width of the building element 1. Building elements 1 with lengths up to 12 m and widths up to 2.5 m are possible.

**[0073]** FIG. 8 shows a building element 1 in form of a wall element for thermal and/or sound insulation of a building façade. The building element 1 consists of an insulating element 2 made of mineral wool fibres and a binder having a bulk density of  $80 \text{ kg/m}^3$ . The insulating element 2 has two large surfaces 3 of which one can be seen in FIG. 8. Furthermore, the insulating element has four lateral surfaces 4 each being arranged perpendicular to the large surfaces 3. From FIG. 8 it can be seen that the insulating element 2 and therefore the building element 1 has two long lateral surfaces 4 running parallel to each other as well as two short lateral surfaces running parallel to each other and perpendicular to the long lateral surfaces 4.

**[0074]** Fixed to the longer lateral surfaces 4 are layers 5 made of sheet metal and building up a frame being arranged at two lateral surfaces 4 at opposite sides of the insulating element 2. Of course such layers 5 can also be provided at the shorter lateral surfaces 4. The layers 5 forming load bearing joint elements 6 which can be seen more precisely in FIGS. 10 to 14.

**[0075]** The layers 5 at the opposite lateral surfaces 4 have different shapes as can be seen from FIG. 10 which will be described in the following.

**[0076]** As can be seen for example from FIG. 10 the large surfaces 3 of the insulating element 2 are covered with a layer 7 made from sheet metal or for example from synthetic material having a high bending strength and/or shear strength. Preferably the layer 7 is made of sheet metal offering these characteristics as mentioned before.

**[0077]** The layer 7 has a bigger length than the length of the insulating element 2. Therefore, the layer 7 extends over the large surface 3 of the insulation element 2. The part of the layer 7 extending over the insulating element 2 is bent twice so that a free leg 8 of the layer 7 erects parallel to the layer 7 whereby between the free leg 8 and the layer 7 an open cavity is formed.

[0078] In the area of the second large surface 3 of the building element 1 the layer is formed in a S-shape so that additional in this area the layer 7 forms together with a leg 9 an open cavity. The leg 9 is bent twice in perpendicular directions. A cavity 11 is formed between the leg 9 and a free leg 10 of the layer 7.

[0079] A reinforcing element 12 which is a more or less vapor-proof barrier and for example made of a glass fibre fabric or a foil is arranged in the cavities between the free leg 8 and the layer 7 on the first large surface 3 and between the leg 9 and the layer 7 on the second large surface 3. The reinforcing element 12 erects starting from the two cavities as described before parallel to a lateral surface 4 of the insulation element 2. Furthermore, the reinforcing element 12 is fixed with an adhesive inside the cavities as well as to the lateral surface 4.

[0080] A composite structural member 13 according to the invention is arranged between the two legs 8 and 10. This composite structural member 13 is fixed to the legs 8, 10 with an adhesive as well as with the reinforcing element 12.

[0081] The composite structural member 13 is fixed in a clamp fit way between the legs of the integrated joint element 6 being formed by at least the legs 8 and 10. The composite structural member 13 consists of fibres, aerogel particles and at least one binder, whereby 30 wt % mineral wool fibres, 60 wt % aerogel particles and 10 wt % binder are pressed and cured to a board having a density of 190 kg/m<sup>3</sup>. This composite structural member 13 has a thermal conductivity  $\lambda$  of 0.02 W/(mK).

[0082] As can be seen from FIG. 10 two building elements 1 which have to be put together as it is shown in FIG. 11, FIG. 12 and FIG. 13 have two differently shaped load bearing joint elements 6. The differences between the two load bearing joint elements 6 of two building elements 1 which should fit together is restricted to the arrangement of the leg 8. As can be seen in FIGS. 10, 14 and 1 the load bearing joint element 6 on one lateral surface 4 spans the total length of the lateral surface 4 whereas the second load bearing joint element 6 is shorter than the width of the lateral surface 4 so that a recess 14 is provided into which the leg 8 of the load bearing joint element 6 of the neighbored building element 1 engages.

[0083] It is clear from the above description that the building element 1 as been shown in FIGS. 8 and 9 has different load bearing joint elements 6 at opposite lateral surfaces 4.

[0084] In accordance with the before mentioned description it can be seen that two building elements 1 according to FIG. 10 can be clamp fitted and that most of load will be borne in the frame having two load bearing joint elements 6 which are connected to each other by the layers 7 so that the insulating element 2 can be reduced in bulk density. On the other hand there is no need to use an insulating element 2 made of wool with a certain fibre orientation so that an insulating element 2 can be used made from mineral wool with a fibre orientation parallel to their large surfaces which may be in production the cheapest insulating element 2. Nevertheless, the insulating element 2 can have a certain fibre orientation for example perpendicular to the lateral surfaces 4 provided with the load bearing joint elements 6 to increase the compressive strength of the insulating element as well as of the building element 1 in a direction parallel to the large surfaces 3 of the insulating element 2.

[0085] As can be seen from FIG. 10 each composite structural member 13 has a planar surface 15 being suitable to adjust an adhesive 16 which is used to connect both compos-

ite structural members 13 being arranged within the load bearing joint elements 6 of neighbored building elements 1. It can be seen that the building elements 1 according to FIG. 10 are connected to each other without any mechanical fastener only by using a press fit and an adhesive 16, which is non combustible.

[0086] FIG. 11 shows the two building elements 1 according to FIG. 10 in a connected position. As can be seen from FIG. 11 the two cavities 11 together form a hollow space with an opening 17 through which a beam 18 span. The beam 18 is a stabilizing element and is H-shaped in cross section having two side legs 19 being connected via a bar 20. One of the side legs 19 is encapsulated within the two cavities 11. The beam 18 can be used to stiffen the connection of the two building elements 1 being arranged neighbored to each other in that the beam 18 runs at least nearly over the whole length of the building elements 1, preferably in that the beam 18 spans the building elements 1 being arranged lengthwise. Instead of the composite structural member 13 shown in FIGS. 10 and 11 a composite structural member 13 according FIG. 6 can be used.

[0087] Furthermore, the beam 18 can be used to carry conduits 21 for water, gas or electric energy as it is shown in FIG. 12. Additionally, FIG. 12 shows a cover 22 which is fixed to the beam 18 and/or the building element 1 and which covers the beam 18 with the conduits 21 so that the conduits 21 are protected by the cover 22. Instead of the beam 18 the hollow space 17 can be closed with a profile element 23 being T-shaped in cross section and preferably made of synthetic material which allows to clamp fit the profile element 23 into the opening of the hollow space 17 between two neighbored building elements 1. A profile element 23 is shown in FIG. 13. [0088] A further stabilizing element is shown in FIG. 12 in form of a screw 24 which spans through the composite structural member 13 connecting both legs 8 and 9 of one load bearing joint element 6 with each other. It can be seen from FIG. 12 that the screw 24 passes through one side leg 19 of the beam 18.

[0089] FIG. 14 shows a further embodiment of two building elements 1 shortly before they are connected to each other. This embodiment shows two building elements 1 which are in main aspects identical to the building element 1 as shown in FIGS. 8 to 13 and described before. The difference between the embodiments can be seen in the construction of the composite structural members 13 being inserted into the load bearing joint elements 6. These composite structural members 13 have two main surfaces of which one main surface 15 is connected to the lateral surface 4 of the insulating element 2 by means of an adhesive, whereby the second main surface 15 of the composite structural member 13 is diverging to the first main surface which is connected to the insulating element 2. This embodiment has the advantage that penetrating humidity can be diverted in the direction of a descent being provided by the two main surfaces 15 of the two composite structural members 13 being connected to each other.

#### REFERENCES

- [0090] 1 building element
- [0091] 2 insulating element
- [0092] 3 large surface
- [0093] 4 lateral surface
- [0094] 5 layer
- [0095] 6 load bearing joint element
- [0096] 7 layer

[0097] 8 leg  
 [0098] 9 leg  
 [0099] 10 leg  
 [0100] 11 cavity  
 [0101] 12 reinforcing element  
 [0102] 13 composite structural member  
 [0103] 14 recess  
 [0104] 15 planar surface  
 [0105] 16 adhesive  
 [0106] 17 hollow space  
 [0107] 18 beam  
 [0108] 19 side legs  
 [0109] 20 bar  
 [0110] 21 conduits  
 [0111] 22 cover  
 [0112] 23 profile element  
 [0113] 24 screw  
 [0114] 25 cavity  
 [0115] 26 board/web part  
 [0116] 27 protective element  
 [0117] 28 protective element  
 [0118] 29 adhesive  
 [0119] 30 web  
 [0120] 31 protective element  
 [0121] 32 legs  
 [0122] 33 legs  
 [0123] 34 web  
 [0124] 35 protective element  
 [0125] 36 longer leg  
 [0126] 37 shorter leg  
 [0127] 38 screws  
 [0128] 39 slit

1. Composite structural member with thermal and/or sound insulation characteristics for a building, comprising an insulating board (26) shaped as web part and at least one protective element (27, 28; 31; 35), whereby the web part has two opposing abutting faces and two main surfaces being arranged rectangular to the abutting faces, whereby the board (26) is made of mineral fibres and a binder and whereby the at least one protective element (27, 28; 31; 35) is substantially U-shaped in cross section, having two legs erecting parallel to each other and being connected to the web part, whereby abutting faces of at least one web parts are covered by protective elements (27, 28; 31; 35), which in combination with said web part take up loads parallel and/or rectangular to the main surfaces of the web part and which are not in direct contact to each other.

2. Composite structural member according to claim 1, characterized in that the web part has a bulk density of 150 kg/m<sup>3</sup> to 600 kg/m<sup>3</sup>, preferably 150 kg/m<sup>3</sup> to 400 kg/m<sup>3</sup> and more preferably of at least 180 kg/m<sup>3</sup>.

3. Composite structural member according to claim 1 or 2, characterized in that the web part (26) is made of at least two layers being arranged sandwich like and connected to each other.

4. Composite structural member according to claim 3, characterized in that the layers of the web part have at least one main surface being capable to be connected with an adhesive.

5. Composite structural member according to one of the claims 1 to 4, characterized in that the two protective elements (27, 28; 31; 35) are overlapping each other on opposed main surfaces of the web part.

6. Composite structural member according to one of the claims 1 to 5 characterized in that the second protective element (27, 28; 31; 35) is L-, U- or T-shaped in cross section.

7. Composite structural member according to one of the claims 1 to 6, characterized in that the two protective elements (27, 28; 31; 35) are connected to each other by connecting means like rivets, screws or the like which run perpendicular to the main surfaces of the web part.

8. Composite structural member according to one of the claims 1 to 7, characterized in that two layers of the web part are connected by at least one clamp like protective elements (27, 28; 31; 35).

9. Composite structural member according to one of the claims 1 to 8, characterized in that the protective elements (27, 28; 31; 35) are made from sheet metal, especially steel and/or aluminium with a thickness of 0.5 mm to 3.0 mm.

10. Composite structural member according to one of the claims 1 to 9, characterized in that at least one leg of the protective element (27, 28; 31; 35) is inserted into one slit of the web part, being arranged in one abutting face of the web part.

11. Composite structural member according to one of the claims 1 to 10, characterized in that at least one protective element (27, 28; 31; 35) has a width being larger than the width of the abutting face of the web part.

12. Building having at least two building elements (1) with a composite structural member (13) according to one of the claims 1 to 11 being arranged between the building elements (1), each building element (1) comprising

an insulating element (2) made of mineral fibres, comprising two large surfaces extending substantially parallel and with a distance to each other and four lateral surfaces extending substantially at right angles to the large surfaces, and

a frame made of sheet metal and being arranged at least at two lateral surfaces being arranged at opposite sides of the insulating element (2),

wherein the frame has integrated joint elements being formed correspondingly to each other and load bearing and wherein at least one integrated joint element comprises the composite structural member (13) having thermal and/or sound insulation characteristics and being made of mineral fibres and a binder whereby the corresponding integrated joint elements of the building elements (1) are connected to each other in a form fitted way and by an adhesive being provided between the composite structural member (13) and the building elements (1) facing to each other.

13. Building according to claim 12, characterized in that the adhesive between the composite structural member (13) and the building elements is non combustible.

14. Building according to claim 12 or 13, characterized in that the composite structural member (13) is connected to the insulating element (2) and/or the integrated joint elements by an adhesive, preferably with an incorporated reinforcing element, for example a fibrous web.

15. Building according to one of the claims 12 to 14, characterized in that each integrated joint element has at least two legs extending parallel to each other and being made from the sheet metal of the frame, which is connected to the insulating element (2), especially to the main surfaces of the insulating element (2) and in that each leg is formed by bending a free end of the sheet metal.

16. Composite structural member with thermal and/or sound insulation characteristics for a building, consisting of

an insulating board (26) made of mineral fibres and a binding agent and shaped as web part and two protective elements (31) being arranged at opposing ends of the board (26), each covering an abutting surface of the board (26) and each having two legs (32, 33) being in contact with one of the large surfaces of the board, characterized in that the board (26) has a bulk density of 150 kg/m<sup>3</sup> to 600 kg/m<sup>3</sup> preferably 150 kg/m<sup>3</sup> to 400 kg/m<sup>3</sup> and more preferably of 180 kg/m<sup>3</sup> to 400 kg/m<sup>3</sup>.

17. Composite structural member according to claim 16, characterized in that the board (26) is made of two layers.

18. Composite structural member according to claim 16 or 17 characterized by a bearing capacity of >60 kN when utilized as a column and/or >15 kN when utilized as a beam.

19. Composite structural member according to one of the claims 16 to 18, characterized in that the two legs (32, 33) of each protective element (31) are connected by at least one rivet or screw penetrating the board (26).

20. Composite structural member according to one of the claims 16 to 19, characterized in that the protective element

(31) is made of sheet metal, e.g. of steel or aluminium or of fibre reinforced resin, especially resin reinforced by carbon fibres or fiberglass.

21. Composite structural member according to one of the claims 16 to 20, characterized in that the board (26) is made of mineral fibres in an amount of 90 to 99 wt-% of the total weight of starting materials in the form of a collected web and a binding agent in an amount of 1 to 10 wt-% of the total weight of starting materials, whereby the collected webs of mineral fibres is subjected to a disentanglement process, whereby the mineral fibres are suspended in a primary air flow, whereby the mineral fibres are mixed with the binding agent before, during or after the disentanglement process to form a mixture of mineral fibres and binding agent and whereby the mixture of mineral fibres and binding agent is pressed and cured to provide a consolidated composite with a bulk density of 400 kg/m<sup>3</sup> to 600 kg/m<sup>3</sup>, especially 500 kg/m<sup>3</sup>.

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