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(54) **AN IMPROVED FLOOR/CEILING JOIST ARRANGEMENT**

(57) A floor/ceiling joist arrangement for at least two stacked modular buildings or parts of buildings, at least one stacked modular building or part of a building having a ceiling comprising a plurality of spaced apart structural support ceiling joists carrying a ceiling member. At least one stacked modular building or part of a building having a floor comprising a plurality of spaced apart structural

support floor joists carrying a floor member. The ceiling joists and the floor joists being configured relative to one another when the two modular buildings or parts of buildings are in an assembled configuration so that at least part of the floor joists and the ceiling joists are disposed in the space between the ceiling joists and the floor joists respectively.

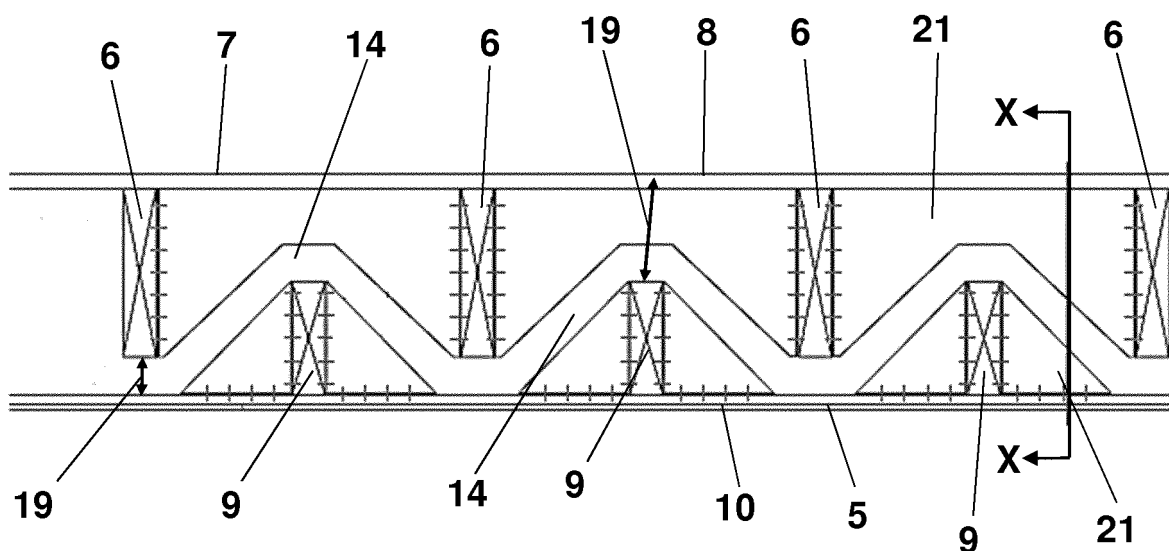


Figure 5

Description

[0001] The present invention relates to an improved floor/ceiling joist arrangement and in particular to a floor/ceiling joist arrangement for reducing the floor/ceiling joist depth in prefabricated pods.

[0002] The design and construction of temporary and permanent residential and commercial dwellings has been increasingly taking place in technical design studios and factories in recent times. This type of construction is now directly competing with the more traditional contemporaneous build techniques on the building site. This more design focused building development is occurring as a result of downward pressure on u-values of all building components. This focus on thermal efficiency of building products has been imposed by carbon emission reduction legislation worldwide. This has resulted in the expansion of the modular or pod type construction of not only specific rooms of buildings but of entire floors of buildings as well as modular design and construction of roof structures. These modular buildings or parts of buildings are predesigned in the factory with specially insulated structurally sound walls such as SIP panels.

[0003] One problem arising with this modular construction and assembly of modular buildings or parts of buildings in a factory occurs where these modular buildings or parts of buildings are stacked on top of one another for multi-story buildings. The empty space or void taken up by typical joist based floors and ceilings stacked on top of one other can be significant. Ceiling joists are typically 150mm tall and floor joists are typically 225mm tall. When two modular structures are stacked on top of one another the gap between the ceiling of the lower modular structure and the floor of the upper modular structure is approximately 400mm.

[0004] It is an object of the present invention to obviate or mitigate the problem of dead space between the ceiling and floor of stacked modular buildings or parts of buildings.

[0005] Accordingly, the present invention provides a floor/ceiling joist arrangement for at least two stacked modular buildings or parts of buildings, at least one stacked modular building or part of a building having a ceiling comprising a plurality of spaced apart structural support ceiling joists carrying a ceiling member and at least one stacked modular building or part of a building having a floor comprising a plurality of spaced apart structural support floor joists carrying a floor member, the ceiling joists and the floor joists being configured relative to one another when the two modular buildings or parts of buildings are in an assembled configuration so that at least part of the floor joists and the ceiling joists are disposed in the space between the ceiling joists and the floor joists respectively.

[0006] Ideally, the ceiling joists and the floor joists are staggered relative to one another.

[0007] Advantageously, this configuring/staggering of the floor and ceiling joists reduces the amount of dead

space between the floor and ceiling member of the at least two stacked modular buildings or parts of building by reducing the distance between the adjacent floor member and ceiling member.

[0008] Ideally, the floor member is on an upper surface of the floor joists only.

[0009] Preferably, the ceiling member is on a lower surface of the ceiling joists only.

[0010] Ideally, the space around and between the lower ends of the floor joists is open.

[0011] Preferably, the space around and between the upper ends of the ceiling joists is open. Advantageously, the space around and between the lower end of the floor joists and the upper end of the ceiling joists being open in combination with the ceiling and floor joists being configured/staggered allows part of the floor joists and the ceiling joists to be disposed in the space between the ceiling joists and the floor joists respectively in an assembled configuration.

[0012] Ideally, up to 1/3 of the height of the floor joists and the ceiling joists are disposed in the space between the ceiling joists and the floor joists respectively in an assembled configuration.

[0013] Preferably, up to 1/2 of the height of the floor joists and the ceiling joists are disposed in the space between the ceiling joists and the floor joists respectively in an assembled configuration.

[0014] Ideally, up to 2/3 of the height of the floor joists and the ceiling joists are disposed in the space between the ceiling joists and the floor joists respectively in an assembled configuration.

[0015] Ideally, the ceiling joists run substantially parallel to one another.

[0016] Preferably, the floor joists run substantially parallel to one another.

[0017] Ideally, the jointing arrangement has support means for supporting the floor of the upper building on the ceiling of the lower building in the assembled configuration. By reference to building in this specification we also mean part of a building.

[0018] Preferably, the support means is a peripheral support means.

[0019] Ideally, the support means comprises at least part of the exterior weather proofing means of the jointing arrangement.

[0020] Preferably, the support means extends substantially in alignment with the perimeter of the building.

[0021] Ideally, the support means comprises a first seating arrangement extending at least part of the way along or proximal the ends of the ceiling joists.

[0022] Preferably, the support means comprises a first seating arrangement extending parallel to at least part of the ceiling joists.

[0023] Preferably, the support means comprises a second mounting arrangement extending at least part of the way along or proximal to the end of the floor joists.

[0024] Ideally, the second mounting arrangement extends substantially in alignment with the perimeter of the

building.

[0025] Ideally, the first seating arrangement and the second mounting arrangement are in alignment in the assembled configuration of the stacked modular buildings.

[0026] Ideally, the support means acts primarily as a structural support for mounting the upper building on the lower building.

[0027] Preferably, the support means acts as a spacer means to ensure a gap exists between the free end of the floor joists and the mutually opposing ceiling member and the free ends of the ceiling joists and the mutually opposing floor member.

[0028] Ideally, the joists have reinforcing means. Advantageously, the reinforcing means increases the flexural rigidity of the floor and ceiling. This compensates for the open ended nature of the free ends of the floor and ceiling joists.

[0029] Preferably, adjacent joists have reinforcing means extending there between. Ideally, the reinforcing means comprise one or more stiffening gussets.

[0030] Preferably, a first embodiment of stiffening gusset is formed for engaging and spanning between two mutually opposing surfaces of two adjacent joists.

[0031] Ideally, the first embodiment of stiffening gusset is formed for engaging the underside of the floor or the upper side of the ceiling surface between adjacent joists.

[0032] Preferably, the first embodiment of stiffening gusset is a one piece gusset.

[0033] Preferably, a second embodiment of stiffening gusset is formed for engaging two mutually opposing surfaces of one joist.

[0034] Ideally, the second embodiment of stiffening gusset is a two piece gusset.

[0035] Preferably, the stiffening gusset comprises a plate for extending between at least one side of the joist and the ceiling member or floor member and at least one flange for coupling the plate to the joist.

[0036] Ideally, the stiffening gusset comprises two flanges on opposing ends of the plate for coupling the gusset to two adjacent joists.

[0037] Preferably, the reinforcing means comprises a plurality of reinforcing means spaced apart longitudinally along the length of the joists

[0038] Ideally, the reinforcing means is manufactured from steel, preferably galvanized steel.

[0039] Preferably, the reinforcing means comprises 2-3mm steel plate.

[0040] Ideally, the joists are timber joists.

[0041] Preferably, the seating arrangement is a timber lath.

[0042] Ideally, the mounting arrangement is a timber joist.

[0043] Preferably, the mounting arrangement has the same dimensions as the floor joist.

[0044] Ideally, the floor joists are 225mm deep and 44mm wide. The length is selected to suit the building or part of a building.

[0045] Preferably, the ceiling joists are 150mm deep and 44mm wide. Again, the length is selected to suit the building or part of a building.

[0046] It will of course be appreciated that the invention is in no way limited to timber joists of these dimensions which are supplied as working examples only.

[0047] Ideally, the walls of the building are provided by SIP panels being structurally insulated panels comprising OSB outer rigid boards sandwiching an insulation material.

[0048] Ideally, the internal surface of the walls are lined with plasterboard.

[0049] According to a further aspect of the invention, there is provided a modular building with at least two stacked modular building components, the modular building having a floor ceiling joist arrangement for at least two stacked modular building components, at least one stacked modular building component having a ceiling comprising a plurality of spaced apart structural support ceiling joists carrying a ceiling member and at least one stacked modular building component having a floor comprising a plurality of spaced apart structural support floor joists carrying a floor member, the ceiling joists and the floor joists being configured relative to one another when the two modular building components are in an assembled configuration so that at least part of the floor joists and the ceiling joists are disposed in the space between the ceiling joists and the floor joists respectively.

[0050] Ideally, the ceiling joists and the floor joists are staggered relative to one another.

[0051] The skilled man will appreciate that all preferred or optional features of the invention described with reference to only some aspects or embodiments of the invention may be applied to all aspects of the invention.

[0052] It will be appreciated that optional features applicable to one aspect of the invention can be used in any combination, and in any number. Moreover, they can also be used with any of the other aspects of the invention in any combination and in any number. This includes, but is not limited to, the dependent claims from any claim being used as dependent claims for any other claim in the claims of this application.

[0053] The invention will now be described with reference to the accompanying drawings which show by way of example only one embodiment of a jointing arrangement and modular building in accordance with the invention. In the drawings:

Figure 1 is an elevation view of the side X:X of the modular building;

Figure 2 is an elevation view of the side Y:Y of the modular building;

Figure 3 is a section view through the floor and ceiling of the X:X side of the modular building;

Figure 4 is an exploded section view through the floor and ceiling of the X:X side of the modular building;

Figure 5 is a section view through the floor and ceiling

of the Y:Y side of the modular building;

Figure 6 is a perspective view of a first embodiment of gusset plate; and

Figure 7 is a perspective view of a second embodiment of gusset plate.

[0054] In the drawings, there is shown a modular building indicated generally by the reference numeral 1 for any number of residential, commercial or industrial uses. The modular building 1 has two stacked modular building components 2, 3 an upper modular building component 2 set or stacked on top of the lower building component 3. The modular building 1 has a jointing arrangement indicated generally by the reference numeral 4 for the two stacked modular building components 2, 3. The upper modular building component 2 has a floor 8 see especially Figure 5 having four spaced apart structural support floor joists 6 carrying a floor member 7. The lower modular building component 3 has a ceiling 5 having three spaced apart structural support ceiling joists 9 carrying a ceiling member 10. The ceiling joists 9 and the floor joists 6 are staggered relative to one another when the two modular building components 2, 3 are in an assembled configuration so that at least part of the floor joists 6 and the ceiling joists 9 are disposed in the space 14 between the ceiling joists 9 and the floor joists 6 respectively. The ceiling member 10 comprises a rigid board mounted on the joists 9 and a plasterboard attached to the rigid board.

[0055] Advantageously, this staggering of the floor joists 6 and ceiling joists 9 reduces the amount of dead space 14 between the floor member 8 and ceiling member 10 of the two stacked modular building component 2, 3 by reducing the distance between the adjacent floor member 8 and ceiling member 10. The floor member 8 is on an upper surface of the floor joists 6 only. The ceiling member 10 is on a lower surface of the ceiling joists 9 only. The space between and around the lower ends of the floor joists 6 is open and the space between and around the upper ends of the ceiling joists 9 is also open. Advantageously, the lower ends of the floor joists 6 and the upper ends of the ceiling joists 9 having open space there around in combination with the ceiling joists 9 and floor joists 6 being staggered allows part of the floor joists 6 and the ceiling joists 9 to be disposed in the space between the ceiling joists 9 and the floor joists 6 respectively in an assembled configuration. The floor joists 6 and the ceiling joists 9 run substantially parallel to one another.

[0056] In an embodiment not illustrated in the drawings, the floor and ceiling joists run transverse one another. In this embodiment, the ceiling joists or the floor joists have spaced apart gaps for receiving part of the floor joists or the ceiling joists respectively. In this embodiment, the floor and ceiling joists run perpendicular to one another.

[0057] In the embodiment illustrated in the drawings, the ceiling joists 9 run substantially parallel to one another

and the floor joists 6 run substantially parallel to one another. The jointing arrangement 4 has a support arrangement 16 see especially Figures 3 and 4 for supporting the floor of the upper building 2 on the ceiling of the lower building 3 in the assembled configuration. By reference to building in this specification we also mean part of a building. The support arrangement 16 is a peripheral support arrangement 16. The support arrangement 16 forms a part of the exterior weather proofing arrangement of the jointing arrangement 1. The support arrangement 16 extends substantially in alignment with the perimeter of the building 1.

[0058] The support arrangement 16 has a first seating arrangement 17 extending along or proximal the ends of the ceiling joists 9. The support arrangement 16 also has a first seating arrangement 17 extending parallel to at least part of the ceiling joists 6. The support arrangement 16 has a second mounting arrangement 18 extending along or proximal to the end of the floor joists 9. The second mounting arrangement 18 extends substantially in alignment with the perimeter of the building 1. The first seating arrangement 17 and the second mounting arrangement 18 are in alignment in the assembled configuration of the stacked modular buildings 1, see especially Figure 3. The support arrangement 16 acts primarily as a structural support for mounting the upper building 2 on the lower building 3. The support arrangement 16 also acts as a spacer to ensure a gap 19 exists between the free end of the floor joists 6 and the mutually opposing ceiling member 10 and the free ends of the ceiling joists 9 and the mutually opposing floor member 8.

[0059] The joists 6, 9 have reinforcing members 21, see especially Figures 6, 7 and Figure 5. Advantageously, the reinforcing members 21 increases the flexural rigidity of the floor and ceiling. This compensates for the open ended nature of the free ends of the floor and ceiling joists 6, 9. Adjacent joists 9 have reinforcing members 21 extending there between. The reinforcing members have one or two stiffening gussets 23, 24. A first embodiment of stiffening gusset 23 shown in Figure 6 is formed for engaging and spanning between two mutually opposing surfaces of two adjacent joists. The first embodiment of stiffening gusset 23 is formed for engaging the underside of the floor member or the upper side of the ceiling surface between adjacent joists 6, 9. In the drawings the gusset 23 is illustrated below the floor member 8. The first embodiment of stiffening gusset 23 is a one piece gusset 23. A second embodiment of stiffening gusset is formed for engaging two mutually opposing surfaces of one joist. The second embodiment of stiffening gusset 24 illustrated in Figure 7 is a two piece gusset. The stiffening gusset 24 has a plate 25 for extending between at least one side of the joist 9 and the ceiling member 10 and a flange 26 for coupling the plate 25 to the joist 9 and ceiling member 10.

[0060] The first embodiment of stiffening gusset 23 has two flanges 26 on opposing ends of the plate 25 for coupling the gusset 23 to two adjacent joists 6. The reinforcing

ing members 21 have a plurality of reinforcing member 21 spaced apart longitudinally along the length of the joists 6, 9.

[0061] The reinforcing members are manufactured from steel, preferably galvanized steel. The reinforcing members comprises 2-3mm steel plate. The joists 6, 9 are timber joists. The seating arrangement 17 is a timber lath preferably 50mm by 50mm. The mounting arrangement 18 is a timber joist 18. The mounting arrangement 18 has the same dimensions as the floor joist 6. The floor joists 6 are 225mm deep and 44mm wide. The length is selected to suit the building 1 or part of a building 1. The ceiling joists 9 are 150mm deep and 44mm wide. Again, the length is selected to suit the building 1 or part of a building 1.

[0062] It will of course be appreciated that the invention is in no way limited to timber joists of these dimensions which are supplied as working examples only. Any suitable material and dimensions can be provided.

[0063] The walls 31 of the building 1 are provided by SIP panels 32 in one embodiment being structurally insulated panels comprising OSB outer rigid boards 33 sandwiching an insulation material 34. The internal surface of the walls 31 are lined with plasterboard 35.

[0064] In relation to the detailed description of the different embodiments of the invention, it will be understood that one or more technical features of one embodiment can be used in combination with one or more technical features of any other embodiment where the transferred use of the one or more technical features would be immediately apparent to a person of ordinary skill in the art to carry out a similar function in a similar way on the other embodiment.

[0065] In the preceding discussion of the invention, unless stated to the contrary, the disclosure of alternative values for the upper or lower limit of the permitted range of a parameter, coupled with an indication that one of the said values is more highly preferred than the other, is to be construed as an implied statement that each intermediate value of said parameter, lying between the more preferred and the less preferred of said alternatives, is itself preferred to said less preferred value and also to each value lying between said less preferred value and said intermediate value.

[0066] The features disclosed in the foregoing description or the following drawings, expressed in their specific forms or in terms of a means for performing a disclosed function, or a method or a process of attaining the disclosed result, as appropriate, may separately, or in any combination of such features be utilised for realising the invention in diverse forms thereof as defined in the appended claims.

Claims

1. A floor/ceiling joist arrangement for at least two stacked modular buildings or parts of buildings, at

least one stacked modular building or part of a building having a ceiling comprising a plurality of spaced apart structural support ceiling joists carrying a ceiling member and at least one stacked modular building or part of a building having a floor comprising a plurality of spaced apart structural support floor joists carrying a floor member, the ceiling joists and the floor joists being configured relative to one another when the two modular buildings or parts of buildings are in an assembled configuration so that at least part of the floor joists and the ceiling joists are disposed in the space between the ceiling joists and the floor joists respectively.

2. A floor/ceiling joist arrangement as claimed in claim 1, wherein the ceiling joists and the floor joists are staggered relative to one another.
3. A floor/ceiling joist arrangement as claimed in claim 1 or claim 2, wherein the floor and ceiling joist arrangement reduces the amount of dead space between the floor and ceiling member of the at least two stacked modular buildings or parts of building by reducing the distance between the adjacent floor member and ceiling member.
4. A floor/ceiling joist arrangement as claimed in any one of the preceding claims, wherein the floor member is on an upper surface of the floor joists only and the ceiling member is on a lower surface of the ceiling joists only.
5. A floor/ceiling joist arrangement as claimed in any one of the preceding claims, wherein the space around and between the lower ends of the floor joists is open and the space around and between the upper ends of the ceiling joists is open.
6. A floor/ceiling joist arrangement as claimed in any one of the preceding claims, wherein up to 2/3 of the height of the floor joists and the ceiling joists are disposed in the space between the ceiling joists and the floor joists respectively in an assembled configuration.
7. A floor/ceiling joist arrangement as claimed in any one of the preceding claims, wherein the ceiling joists run substantially parallel to one another and the floor joists run substantially parallel to one another.
8. A floor/ceiling joist arrangement as claimed in any one of the preceding claims, wherein the floor ceiling joist arrangement has a jointing arrangement having a support means for supporting the floor of the upper building on the ceiling of the lower building in the assembled configuration.

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9. A floor/ceiling joist arrangement as claimed in claim 8, wherein the support means comprises a first seating arrangement extending at least part of the way along or proximal the ends of the ceiling joists, the first seating arrangement extending parallel to at least part of the ceiling joists. 5
10. A floor/ceiling joist arrangement as claimed in claim 8 or claim 9, wherein the support means comprises a second mounting arrangement extending at least part of the way along or proximal to the end of the floor joists. 10
11. A floor/ceiling joist arrangement as claimed in claim 9 and claim 10, wherein the first seating arrangement and the second mounting arrangement are in substantial alignment in the assembled configuration of the floor/ceiling joist arrangement. 15 20
12. A floor/ceiling joist arrangement as claimed in any one of claims 8 to 11, wherein the support means acts primarily as a structural support for mounting an upper building on a lower building. 25
13. A floor/ceiling joist arrangement as claimed in any one of claims 8 to 12, wherein the support means acts as a spacer means to ensure a gap exists between the free end of the floor joists and the mutually opposing ceiling member and the free ends of the ceiling joists and the mutually opposing floor member. 30
14. A floor/ceiling joist arrangement as claimed in any one of the preceding claims, wherein the joists have reinforcing means for increasing the flexural rigidity of the floor and ceiling. 35
15. A modular building with at least two stacked modular building components, the modular building having a floor/ceiling joist arrangement as claimed in any one of the preceding claims. 40

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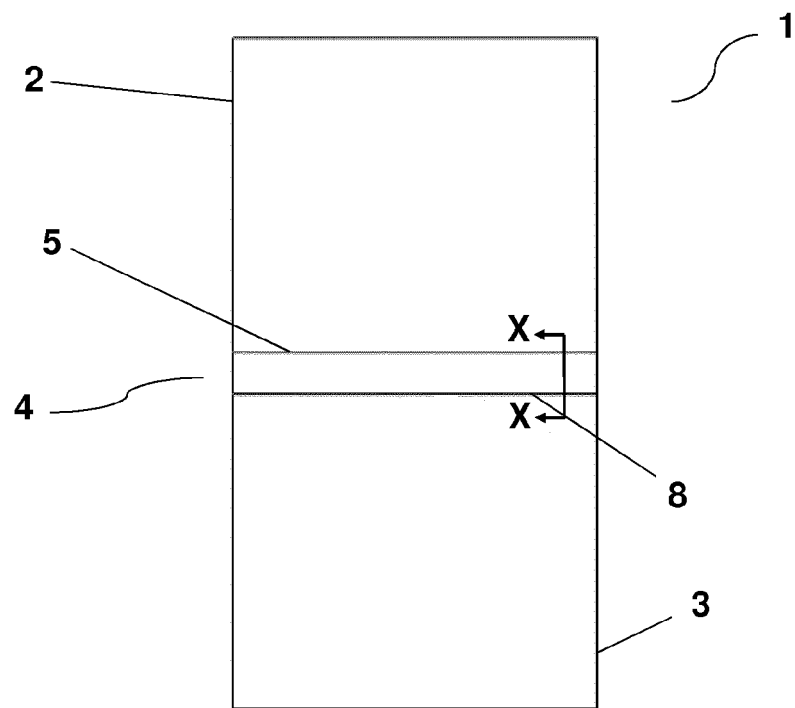


Figure 1

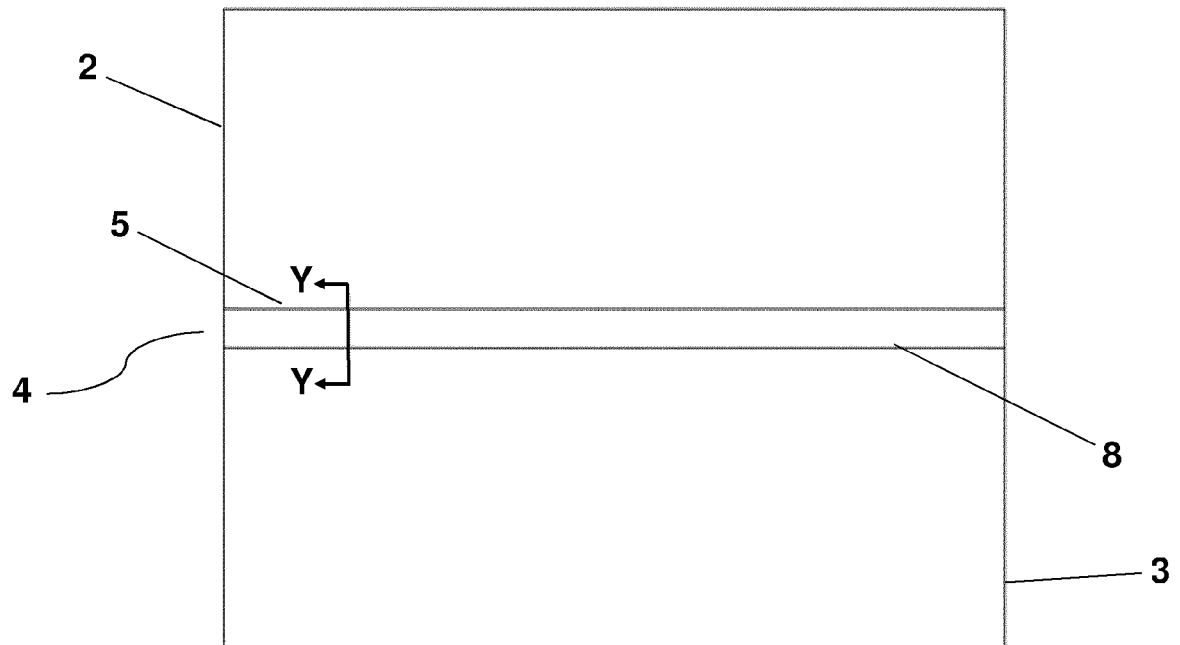


Figure 2

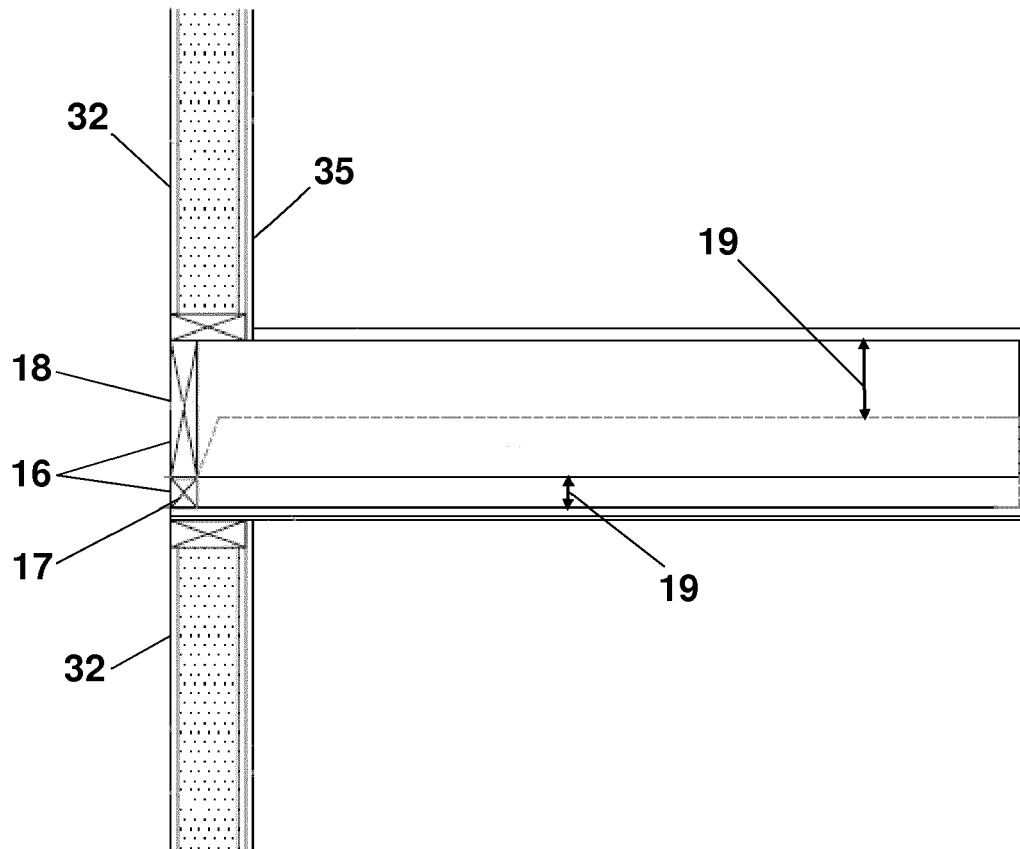


Figure 3

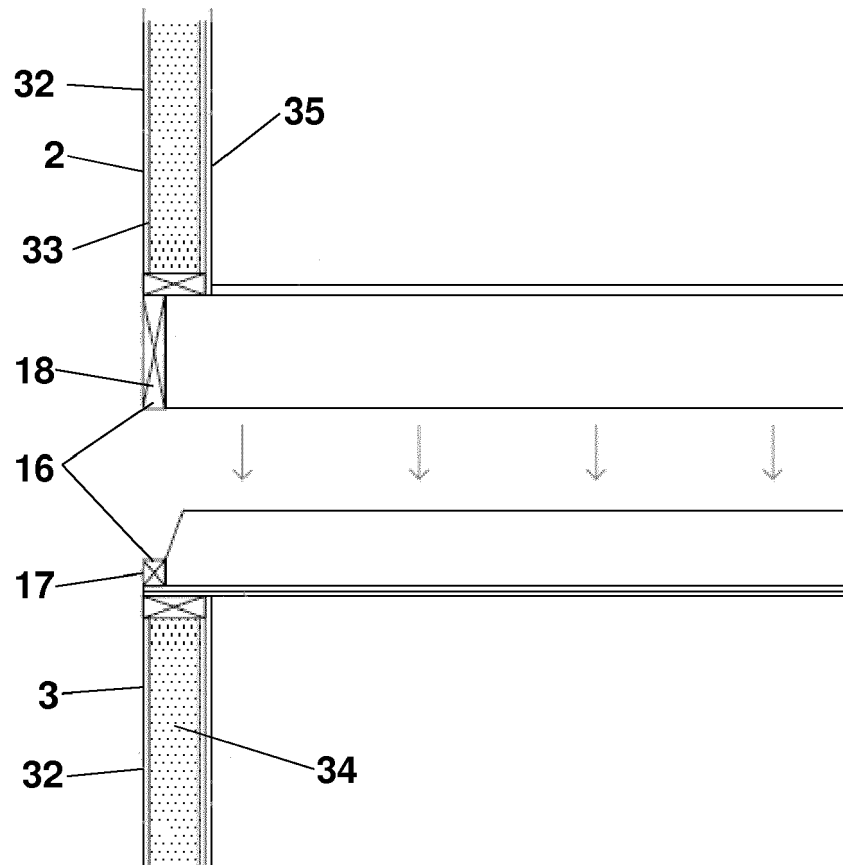


Figure 4

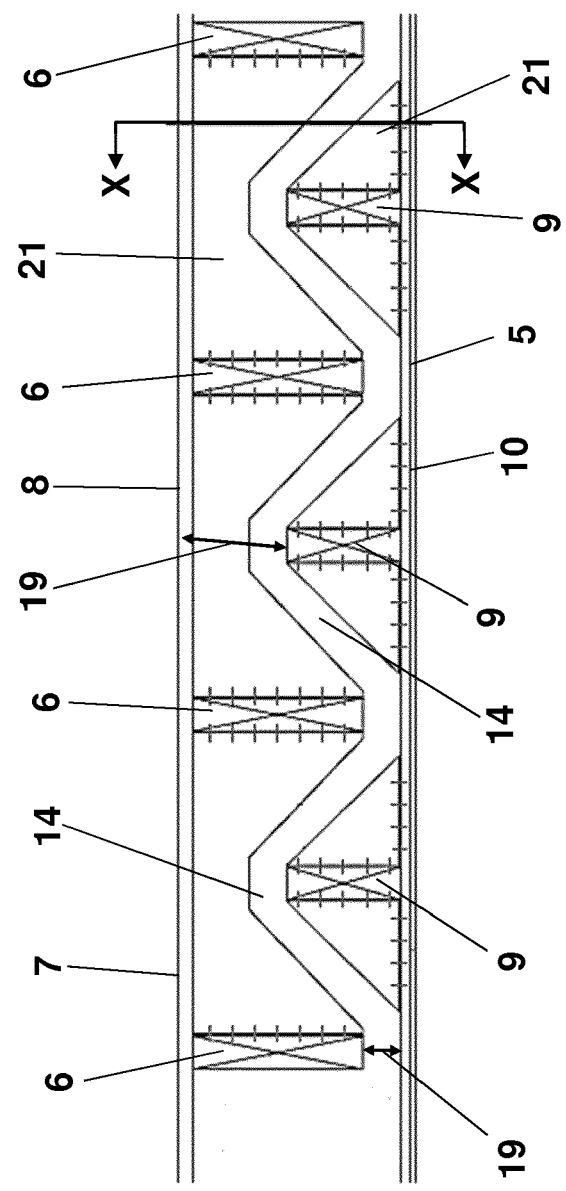


Figure 5

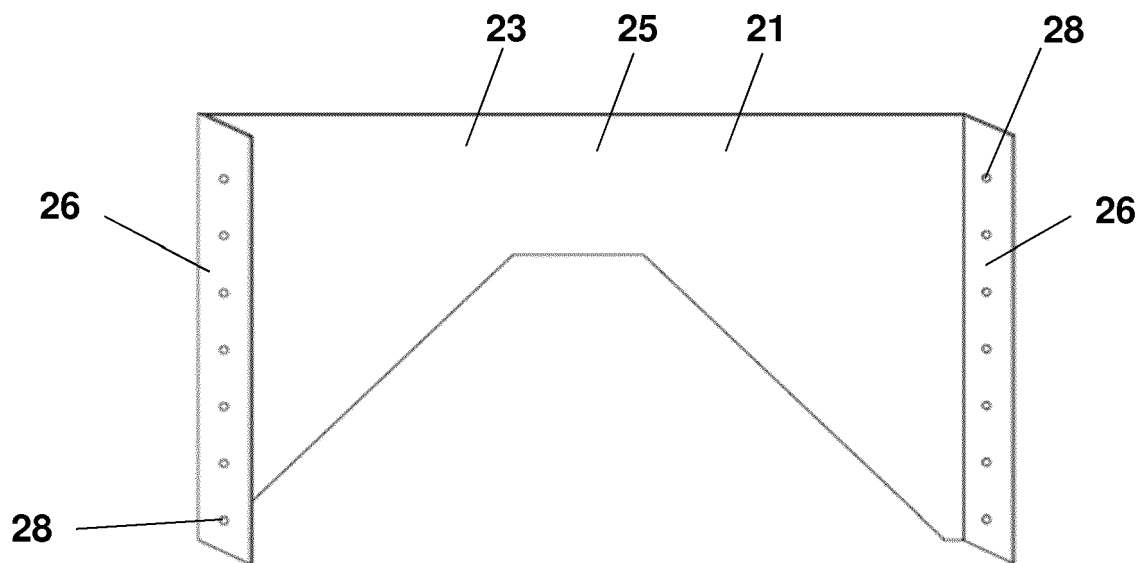


Figure 6

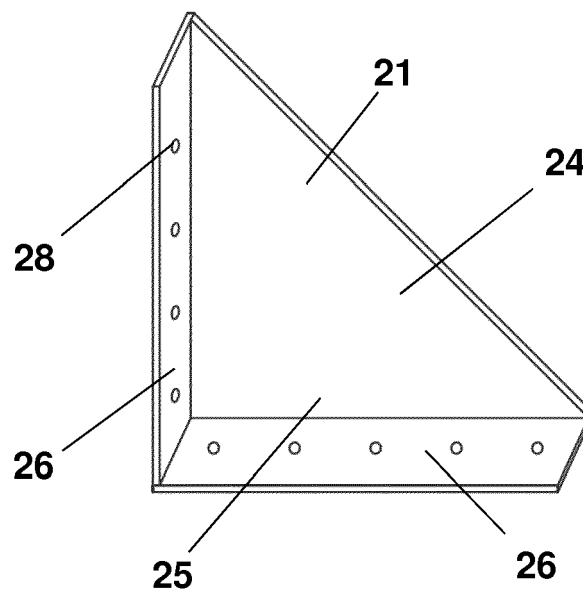


Figure 7



EUROPEAN SEARCH REPORT

Application Number
EP 15 19 0044

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 13 September 2016	Examiner Demeester, Jan
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			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 15 19 0044

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82