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(54) **MOBILE MODULAR HOUSE**

(57) The invention is related to a house comprising a floor unit (A), a roof unit (C), and at least three wall units (B), preferably four wall units (B), wherein at least one of said floor unit (A) or roof unit (C) includes a cross-laminated timber (CLT) panel, which comprises an inner CLT board, an outer CLT board and thermoinsulation layer

between said CLT boards, characterized in that at the connection of said wall unit (B) and at least one of said floor unit (A) or roof unit (C) the outer CLT board of said CLT panel of said floor (A) or roof unit (C) extends beyond the wall unit (B) in the direction outside of the modular house.

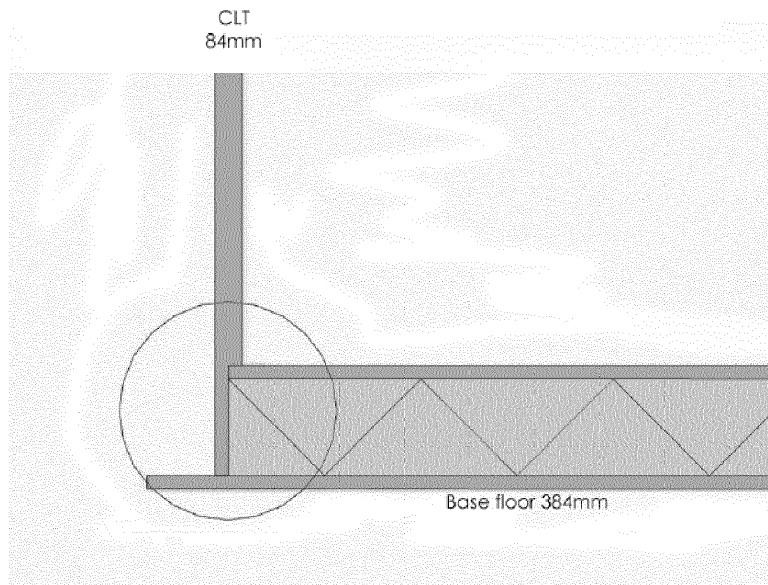


Fig. 4

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Description

[0001] The invention is related to a mobile modular houses made with a use of CLT panels, which are transported fully furnished and ready for living.

Background

[0002] Mobile modular or prefabricated houses are becoming more and more popular. The reason of that are high speed and lack of weather dependence of a house construction.

[0003] One of the most popular material for modular houses is cross-laminated timber or CLT, which has a lot of ecological benefits shown in the fig. 1, and more in-depth information on CLT's impact on greenhouse gas emissions in the link below:

<http://tallwoodinstitute.org/carbon-impacts-clt>

[0004] Different prefabricated buildings are known in the prior art.

[0005] Document CN 110005069 (A) discloses a multilayer fabricated modular house where a group of supporting columns are separately arranged on the both side of each module, main structural plates are separately arranged on the upper surfaces of the modules and two ends of the main structural plates of the adjacent modules are connected through connectors to form a fireproof barrier and a structural floor partition plate. Non-structural plates are separately arranged on the lower surfaces of the modules. A main partition wall is arranged between the modules, supporting pillars are arranged in the main partition wall, a supporting beam is arranged at the upper ends of the supporting pillars, and the main partition wall and the supporting pillars form a supporting column. The modules are placed in a single layer of a multilayer building to realize load sharing and remove the repeated supporting pillars, meanwhile novel supporting pillars are arranged, reinforced steel bars and double-threaded connector are arranged in the supporting pillars, and non-shrink concrete slurry is injected into the supporting pillars to bear more loads.

[0006] Document EP3385463 (A1) discloses an off-site manufactured construction module, comprising a floor element, a roof element, and a plurality of wall elements, wherein the elements are made of planar cross-laminated timber elements configured to form a cuboid compartment for a building, and the elements are connected to each other using wooden fastening elements. Additionally, the cross-laminated timber elements of the cuboid compartment are processed with a fire prevention fluid.

[0007] Document JP2019173498 (A) discloses a construction where floor consists of a plurality of floor members including plate-like wood members formed of an orthogonal laminate lumber (CLT). Each layer of a wooden plate are laminated and bonded so that the layers are orthogonal to each other. There are also reinforcement materials mounted on one plate surface of the wood

member which has a hollow part that is parallel to the plate surface of the wood member and extends to a direction orthogonal to the extension direction of a beam and is composed of cellulose nanofiber (CNF).

[0008] All above-mentioned modular houses have traditional way of wall-floor connection (Fig. 2).

[0009] This way of the attaching of elements is problematic when it comes to craning. The craning of this particular module is now only possible from the bottom, as the metal attachments are not strong enough to carry the base floor if the module were to be craned from the top.

[0010] According to the invention floor or wall has a slightly longer CLT-board that allows to connect elements easier, and requires less reinforcement between two elements

[0011] The benefits of the way a wall element is connected to a floor element according to the invention are two-pronged:

- firstly, without extending the outer CLT board, only a hard insulation can be used in the modular building construction, as a soft insulation would negatively impact the overall rigidity of the wall element. The panel extension allows to use either a hard insulation, a soft one or both.
- secondly, the extended panels acting as links between the wall panel to the base floor and to the roof element reinforce the insulation to its intended position, thus not allowing it to become dislocated.

[0012] This creates a far more durable connection between the elements and makes the craning of the module much more stable. It also allows to grip the module from either the bottom (floor unit) or the top (roof unit).

[0013] There is also a preferred embodiment where outer CLT boards of floor and roof extend outside the modular house at the same time.

[0014] The idea behind this is to build the exterior on the extension, so it won't need extra reinforcement.

[0015] Although CLT while being a very mobile and sturdy building material, but there is no thermal insulation. Therefore it is not the most suitable material for colder living conditions such as Scandinavia. This is why Inventors have incorporated an ecological wood-fiber insulation into our wall construction.

Summary

[0016] The house comprising a floor unit, a roof unit, and at least three wall units, preferably four wall units, wherein at least one of said floor unit or roof unit includes a cross-laminated timber ,CLT, panel, which comprises an inner CLT board, an outer CLT board and thermoinsulation layer between said CLT boards according to the invention is characterized in that at the connection of said wall unit and at least one of said floor unit or roof unit the outer CLT board of said CLT panel of said floor or roof

unit extends beyond the wall unit in the direction outside of the modular house.

[0017] Inner CLT board means the board which is closer to inside of the house, outer CLT board means the board which is further from inside of the house.

[0018] Preferably, at said connection of said wall unit and said floor and/or roof unit, the inner CLT board and the thermoinsulation layer of the floor unit and/or of the roof unit extends till the middle of said wall unit.

[0019] Preferably, the angle between the wall unit and the inner CLT board of floor unit is 90°.

[0020] Preferably, the angle between the wall unit and the inner CLT board of the roof unit is in the range from 90° to 150°, preferably is 90°, 120°, 135° or 150°.

[0021] Preferably, the difference in length between the outer CLT board and the inner CLT board of the same floor unit or roof unit is in the range from 253 mm to 388 mm.

[0022] Preferably, said CLT panel comprises - from outside to inside of the house: the outer CLT board; an air gap; an additional CLT board; a layer of flexible thermoinsulation made of wood and the inner CLT board.

[0023] Preferably, said CLT panel additionally comprises a windproof and/or waterproof membrane between said additional CLT board and the layer of flexible thermoinsulation made of wood.

[0024] Preferably, said CLT panel comprises -from outside to inside of the house: the outer CLT board, a thermoinsulation layer and the inner CLT board.

[0025] Preferably, the outer CLT board and the inner CLT board are of equal thickness.

[0026] Preferably, said CLT panel comprises -from outside to inside of the house: the outer CLT board, an air gap, an additional CLT board, a thermoinsulation layer and the inner CLT board.

[0027] Preferably, said inner CLT board is thicker than said outer CLT board.

[0028] Preferably, said floor unit comprises main ribs, reinforced ribs, crane beam and additional reinforcing in beam area.

[0029] Preferably, it is a mobile house.

[0030] Preferably, it is a modular house.

[0031] Preferably, two or more houses connect with each other along their rear walls, wherein preferably one of them is shifted with respect to the other one horizontally, along their rear walls.

Brief Description of the Drawings

[0032] Preferred embodiments of the present invention are presented in a more detailed way with reference to the attached drawing, in which:

Fig. 1 presents ecological benefits of CLT (prior art),
Fig. 2 shows traditional way of wall connection with floor or roof (prior art);

Fig. 3 presents modular house

Figs. 4 - 5 show different aspects of CLT-boards ex-

tension

Figs. 6 - 8 present different CLT panel construction in detail;

Fig. 9 presents preparation for crane;

Fig. 10 shows foundation structure;

Fig. 11 presents module assembly together;

Fig. 12 shows ground plan shape.

At figures there are use next markers:

[0033] Fig. 3: A - floor unit, B - wall unit; C - roof unit

[0034] Fig. 8: 1-multilayer wood board - load bearing part; 2-thermoinsulation; 3-three layer wooden board; and 4-air gap.

[0035] Fig. 9: 91-floor panel; 92-main ribs; 93-reinforced ribs; 94-crane beam; 95 - additional reinforcing in beam area.

[0036] Fig. 10: 101-foundation beam; 102-steel bracing fixation; 103- steel brace - rigid fixation; 104- foundation block.

Detailed Description

[0037] Preferred embodiments of the invention are described in details below. The examples serve only as an illustration and do not limit the scope of the present invention.

1. A wall-floor connection structure

[0038] Modular house according to the invention has a floor unit A, a wall units B, and a roof unit C (fig.3).

[0039] A slightly longer CLT-board allows to connect elements easier, and requires less reinforcement between two elements.

[0040] Figs. 4-5 show the way of attaching the wall element to the flooring element, according to Invention, and how it allows to crane that module from the top as well: the wall element is attached to the base floor from the side and through the CLT-board.

At joint point wall unit B and floor and/or roof unit, inner CLT board and thermoinsulation layer of floor and/or roof unit extends till a middle of said wall unit.

2. A CLT wall construction

[0041] The CLT wall construction, according to the Invention, is a specific composition and order of materials used to provide enough heat insulation and durability for year-round living even in colder temperatures, while still maintaining the mobility and breathability of a CLT construction.

[0042] In one preferred embodiment schematically the CLT panel construction presents as following (fig. 6) (from outside to inside of the house): CLT board 3, air gap 4, CLT board 3, thermoinsulation 2; and CLT board 1, wherein CLT board 1 is thicker than said CLT board 3.

[0043] In other preferred embodiment the floor, wall or

roof panel construction comprises (fig.6) (from outside to inside the house): three layer wooden board 3, air gap 4, three layer wooden board 3, thermoinsulation 2; and multilayer wood board - load bearing part 1, wherein multilayer wood board - load bearing part 1 is thicker than said three layer wooden board 3.

[0044] In other preferred embodiment the CLT panel comprises (direction from outside to inside) (Fig. 8):

CLT 19 - 27 mm;
air gap 20-40 mm;
CLT 19 - 27 mm;
windproof and waterproof membrane STEICO 2mm;
STEICO therm or Flex 150 - 250 mm;
CLT 84 mm.

[0045] The membrane used in the described construction also acts as a barrier for wind and water. The wall construction also includes one SWP-board, which is built using the same principles as the CLT-board. SWP is noticeably thinner at 19-27 mm, whereas the CLT-boards we use are 84 mm. The SWP-board is placed on the outside of the wall, and it acts as the facade of the house.

[0046] All the aforementioned elements combined amount to a single compact wall.

[0047] This wall construction allows modular building for colder environments and strengthens the construction of each module, making the complete modular house earthquake-resistant and fire-resistant.

[0048] The insulation stands at risk of being dislocated during various maneuvers such as craning or transport. Minimizing the risk of possible dislocations is important due to the building's mobile nature.

3. Craning system integrated in the base floor

[0049] The craning system, according to the invention, which is built into the base floor element of the house, allows to conveniently transfer modules from the transport trucks to their destination.

[0050] We have first-hand experience on the problems with building a modular house consisting of such big modules. The manipulation of modules of this size is very tricky and time-consuming. Our craning system is integrated into the base floor of each module, allowing us to lift a module very similarly to lifting a purpose-built transport container, and thus making the on-site craning of modules much more straight-forward.

[0051] The crane system which include reinforced panel ribs for installation crane beam inside panel consists of (fig. 9) 91- CLT panel; 92-main ribs; 93-reinforced ribs; 94-crane beam; 95 - additional reinforcing in beam area.

[0052] In the floor, there are holes with a diameter 120-150 mm, reinforced by 21 mm CLT boards, and 50 cm of distance.

[0053] Metal beams, 100-120mm, go through the holes of the base floor.

[0054] Two or more houses connect with each other

along their rear walls, wherein preferably one of them is shifted with respect to the other one horizontally, along their rear walls (Figs 11,12).

Claims

1. A house comprising a floor unit (A), a roof unit (C), and at least three wall units (B), preferably four wall units (B), wherein at least one of said floor unit (A) or roof unit (C) includes a cross-laminated timber ,CLT, panel, which comprises an inner CLT board, an outer CLT board and thermoinsulation layer between said CLT boards, **characterized in that** at the connection of said wall unit (B) and at least one of said floor unit (A) or roof unit (C) the outer CLT board of said CLT panel of said floor (A) or roof unit (C) extends beyond the wall unit (B) in the direction outside of the modular house.
2. The house according to claim 1, **characterized in that** at said connection of said wall unit (B) and said floor (A) and/or roof unit (C), the inner CLT board and the thermoinsulation layer of the floor unit (A) and/or of the roof unit (C) extends till the middle of said wall unit (B).
3. The house according to claim 1 or 2, **characterized in that** the angle between the wall unit (B) and the inner CLT board of floor unit is 90°.
4. The house according to claim 1, 2 or 3, **characterized in that** the angle between the wall unit (B) and the inner CLT board of the roof unit (C) is in the range from 90° to 150°, preferably is 90°, 120°, 135° or 150°.
5. The house according any one of claims 1 to 4, **characterized in that** the difference in length between the outer CLT board and the inner CLT board of the same floor unit (A) or roof unit (C) is in the range from 253mm to 388mm.
6. The house according to any one of claims 1 to 5, **characterized in that** said CLT panel comprises - from outside to inside of the house: the outer CLT board; an air gap; an additional CLT board; a layer of flexible thermoinsulation made of wood and the inner CLT board.
7. The house according to claim 6, **characterized in that** said CLT panel additionally comprises a windproof and/or waterproof membrane between said additional CLT board and the layer of flexible thermoinsulation made of wood.
8. The house according to any one of claims 1 to 5, **characterized in that** said CLT panel comprises

-from outside to inside of the house: the outer CLT board, a thermoinsulation layer and the inner CLT board.

9. The house according to claim 8, **characterized in that** the outer CLT board and the inner CLT board are of equal thickness. 5
10. The house according to any one of claims 1 to 5, **characterized in that** said CLT panel comprises -from outside to inside of the house: the outer CLT board (3), an air gap (4), an additional CLT board (3), a thermoinsulation layer (2) and the inner CLT board (1). 10
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11. The house according to claim 10, **characterized in that** said inner CLT board (1) is thicker than said outer CLT board (3).
12. The house according to any one of claims 1 to 11, **characterized in that** said floor unit (A) comprises main ribs (92), reinforced ribs (93), crane beam (94) and additional reinforcing in beam area (95). 20
13. The house according to any one of claims 1 to 12, **characterized in that** it is a mobile house. 25
14. The house according to any one of claims 1 to 13, **characterized in that** it is a modular house. 30
15. Two or more houses according to any one of claims 1 to 14, **characterized in that** at least two of them connect with each other along their rear walls, wherein preferably one of them is shifted with respect to the other one horizontally, along their rear walls. 35

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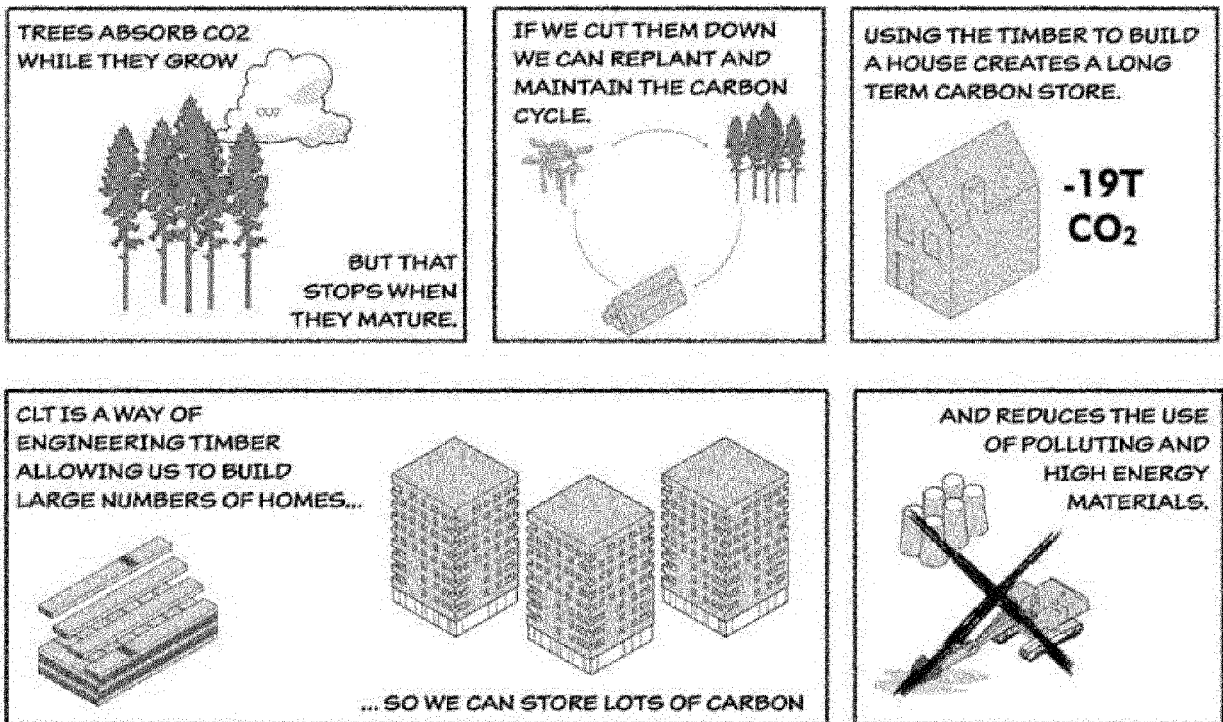


Fig. 1 (How CLT can save the world)

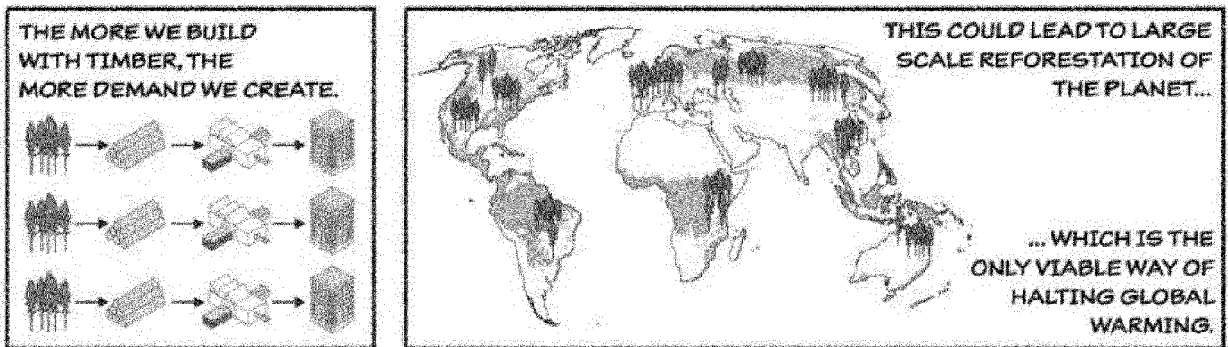


Fig. 1 - continuation (How CLT can save the world)



Fig. 2

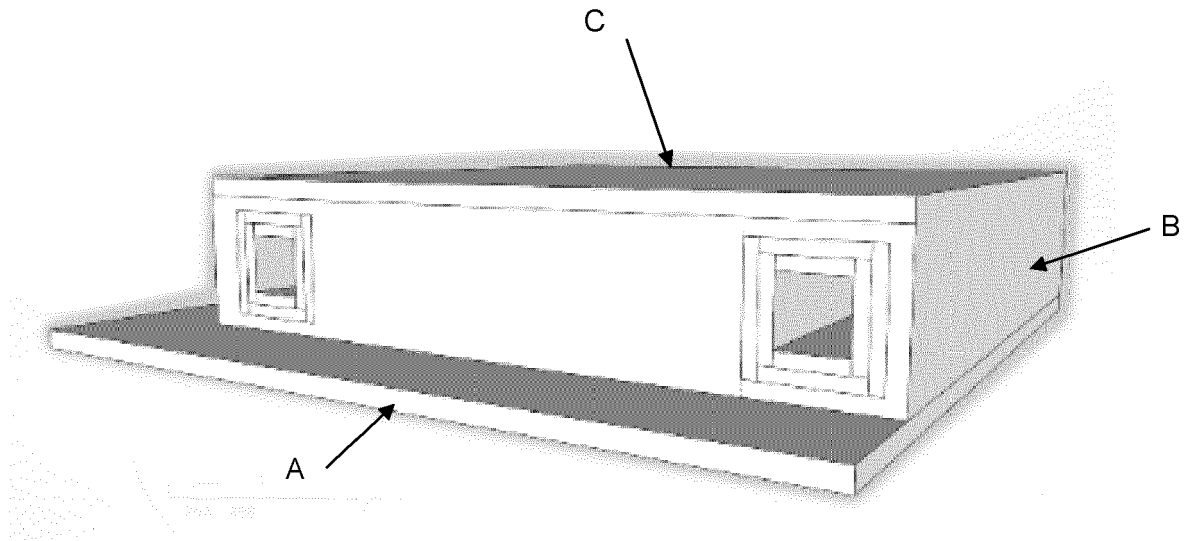


Fig. 3

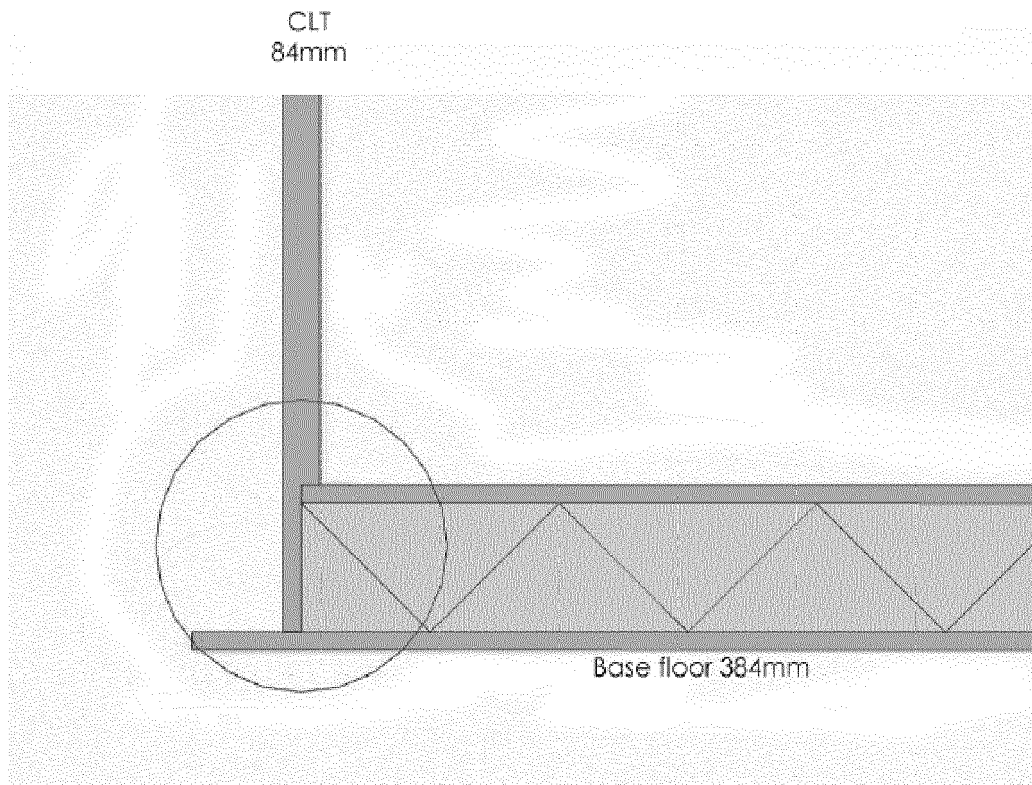


Fig. 4

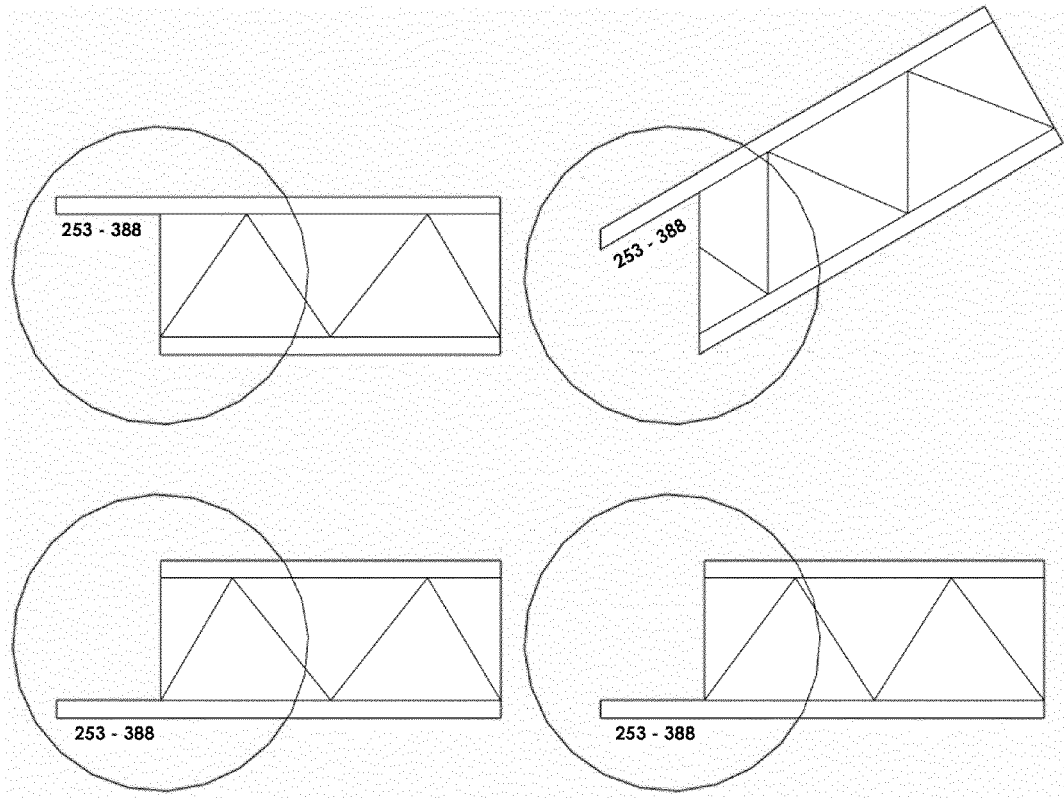


Fig. 5

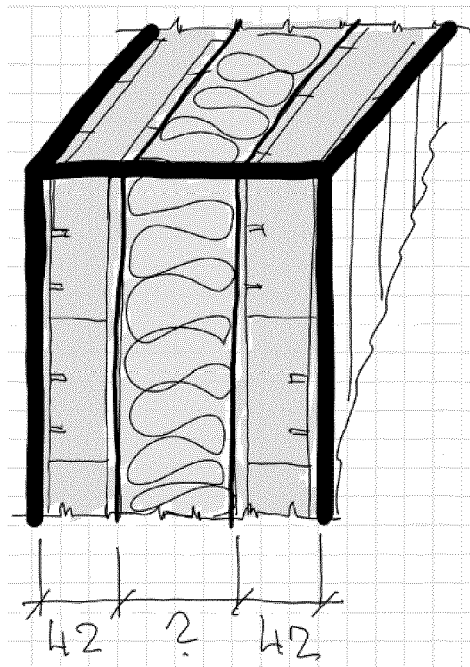


Fig. 6

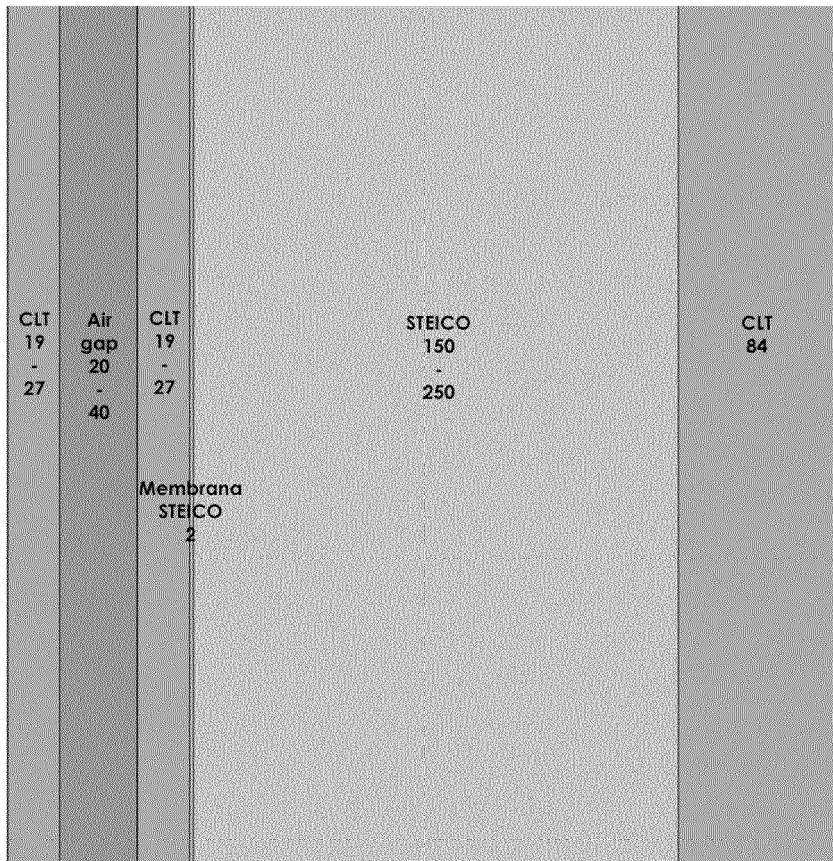


Fig. 7

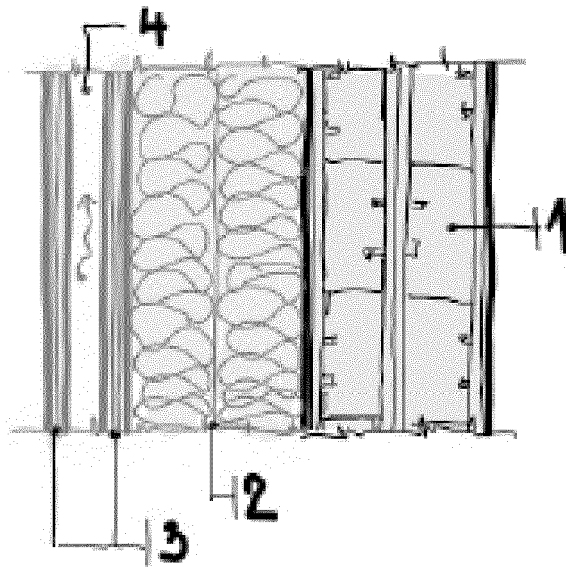


Fig. 8

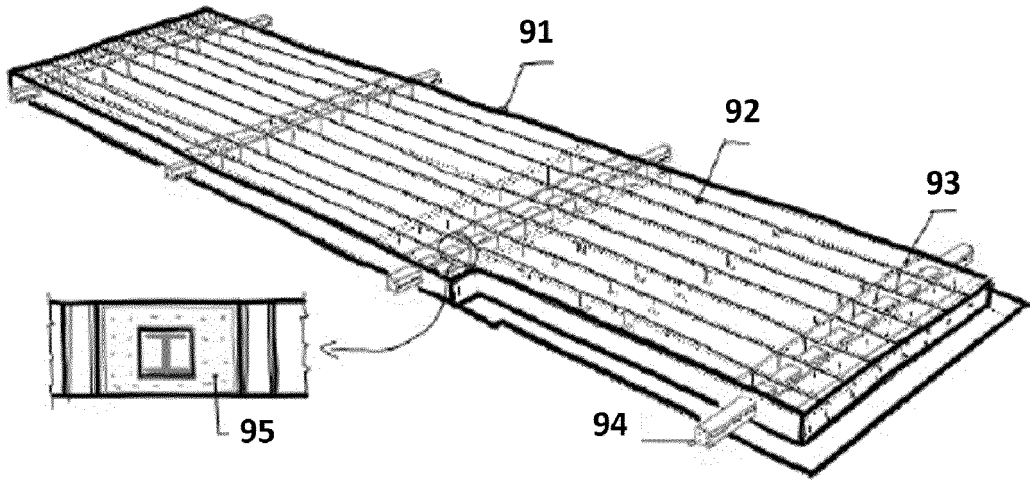


Fig. 9

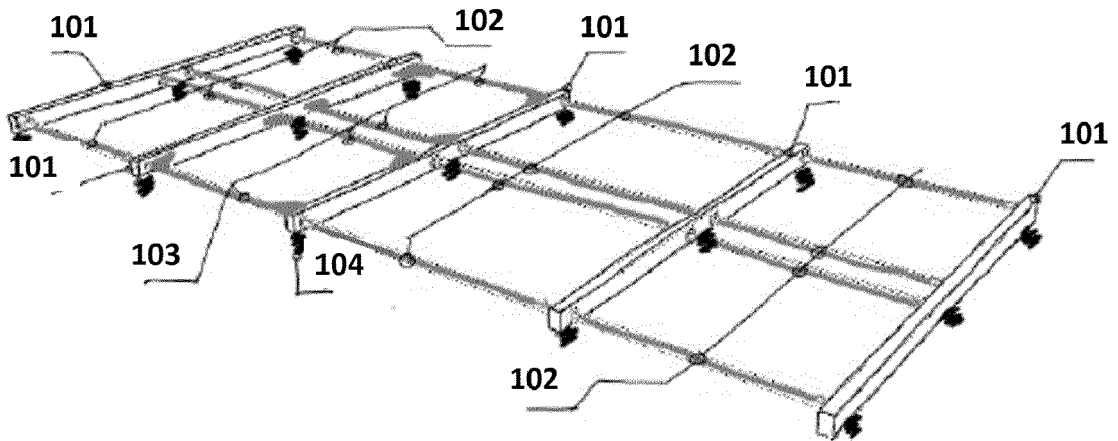


Fig. 10

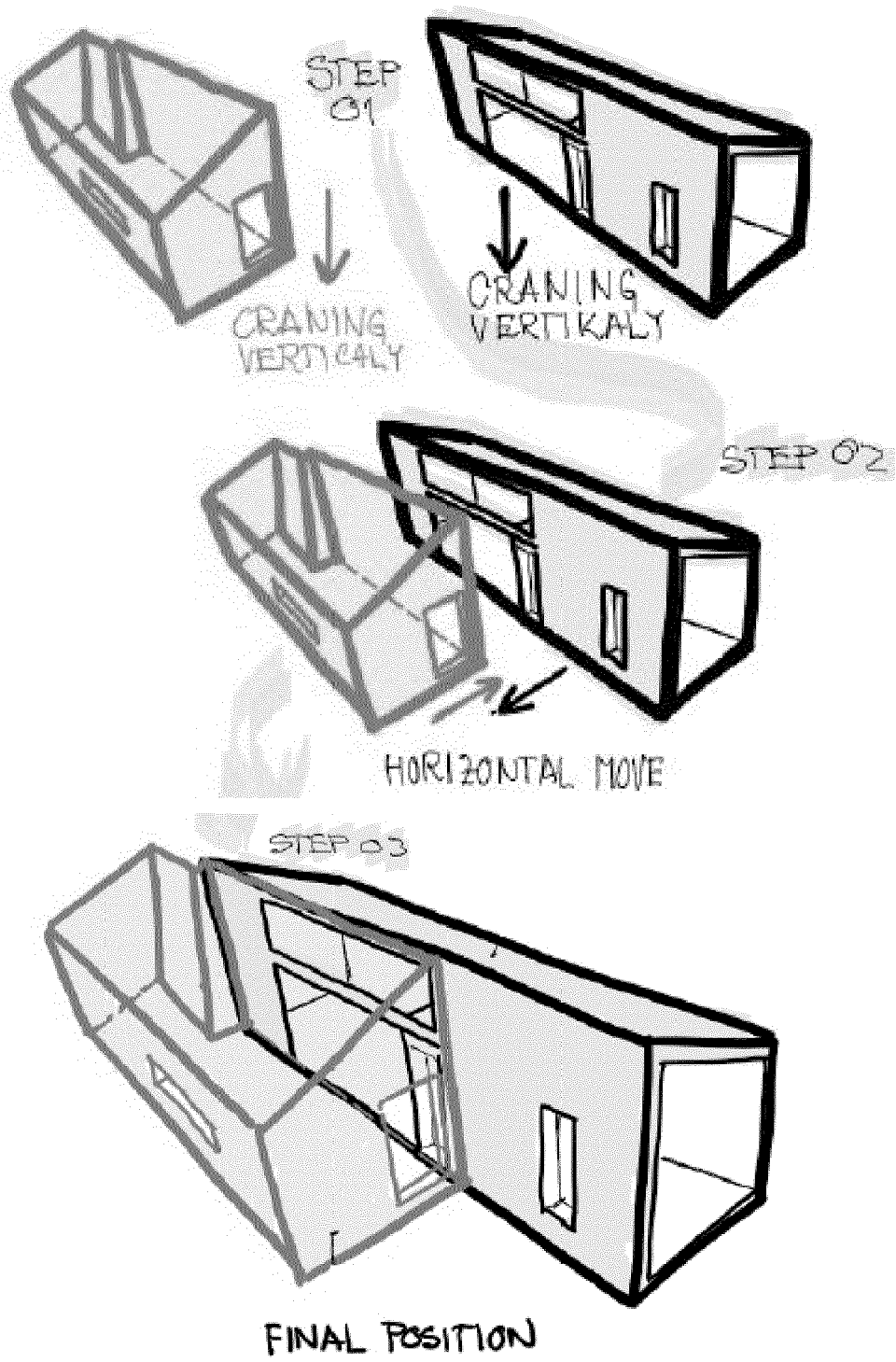


Fig. 11

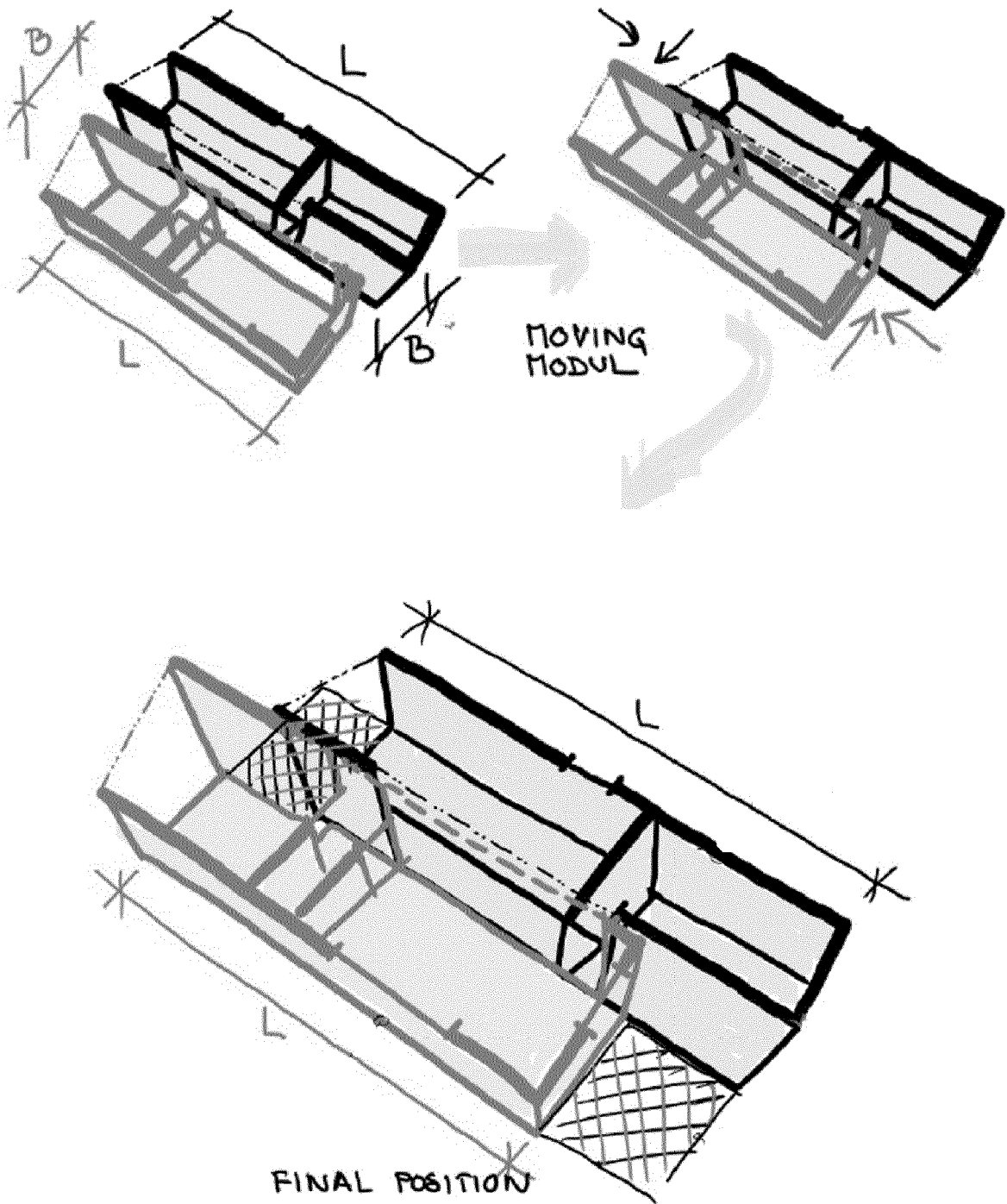


Fig. 12



EUROPEAN SEARCH REPORT

Application Number
EP 21 16 6326

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y,D	EP 3 385 463 A1 (ERONEN LEIF [FI]) 10 October 2018 (2018-10-10) * paragraph [0053] - paragraph [0192]; figures *	1-15	INV. E04B1/348 E04C2/296 E04B1/14
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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 16 September 2021	Examiner López-García, G
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