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(54) PERMANENT FRAMEWORK, BUILDING STRUCTURE, AND SPATIAL ENTITY SETTING-OUT CONSTRUCTION METHOD

(57) The present application provides a permanent framework, a building structure, and a spatial entity setting-out construction method. The permanent framework comprises two first frameworks (1) that are oppositely arranged in parallel; each first framework (1) is provided with a first profile panel (11) for attaching to a foundation, and a second profile panel (12) perpendicular to the first profile panel (11); a first pouring cavity (A) for pouring concrete is formed between the two second profile panels (12); the two second profile panels (12) are connected by means of tying connecting members (2); the tying connecting members (2) are provided in the first pouring cavity (A); the surface of the first profile panel (11) opposite to the surface for attaching to the foundation and the surface of the second profile panel (12) located at the outer side of the first pouring cavity (A) are provided with construction control lines and/or construction control planes. The permanent framework can realize high-precision construction surveying and setting-out, and entity setting-out in spatial entity setting-out construction.

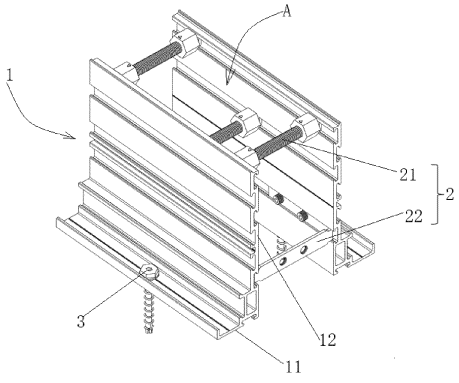


FIG. 1

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Description

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present disclosure claims the benefit of priority to Chinese Patent Application No. CN202210987643.4, filed on August 17, 2022, the entire disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure pertains to the technical field of prefabricated building walls, and in particular to a permanent formwork, a building structure, and a spatial entity setting-out construction method.

BACKGROUND

[0003] Construction setting-out involves measuring and setting out the planar position and elevation of a building (structure) on the drawing to the construction site or engineering entity through instrument measurement, ruler measurement, and other methods. For example, ink lines are used to mark out the axis and one-meter line as the basis for construction positioning. The accuracy of construction setting-out itself and the positioning accuracy therefor play a crucial role in controlling the construction tolerance of a finished surface.

[0004] In conventional construction setting-out, it is difficult to preserve the ink lines for a long time during the construction process, and the human errors and accumulated errors caused by repeated measurement and setting-out adversely affect the accuracy of the construction finished surface. Although entity setting-out is easier to preserve, it has stricter requirements on the accuracy of construction setting-out itself and the positioning accuracy therefor. The existing formwork establishing methods, which utilize steel, wood, and other materials as removable or permanent formworks and employ clamps, bolts, and diagonal braces for installation, hardly meet the construction measurement and setting-out requirements for high-precision entity setting-out.

SUMMARY

[0005] It is an objective of the present disclosure to provide a permanent formwork, a building structure, and a spatial entity setting-out construction method, in order to solve the technical problem that the existing formwork establishing methods for removable formworks are difficult to achieve high-precision construction measurement and setting-out and entity setting-out.

[0006] To achieve the aforementioned objective, the technical solution adopted in the present disclosure is as follows. A first aspect of the present disclosure provides a permanent formwork, including two parallel and opposing first formworks. Each of the first formworks has a first profile panel for attaching to the foundation and a second profile panel perpendicular to the first profile panel.

[0007] A first concreting cavity for concreting concrete is formed between the two second profile panels, the two second profile panels are connected by a tie connector located inside the first concreting cavity.

[0008] A side of the first profile panel facing away from the foundation and a side of the second profile panel located outside the first concreting cavity each have a construction control line and/or construction control plane.

[0009] Further, the construction control line includes a positioning line for fixing with the foundation, and the construction control plane includes at least one of foundation leveling layer finished surface, thermal insulation layer finished surface, floor heating layer finished surface, stone bonding layer or wood floor leveling layer finished surface, and floor heating boundary insulation strip finished surface.

[0010] Further, the first formwork is of a spliced structure.

[0011] Further, both the first profile panel and the second profile panel are made of fiberglass-reinforced polyurethane profiles.

[0012] Further, the first profile panel and the second profile panel are integrally formed.

[0013] Further, a reverse side of the first profile panel and a reverse side of the second profile panel are each formed with multiple first slots. A front side of the first profile panel and a front side of the second profile panel are each formed with multiple second slots. The reverse side of the first profile panel is the side that is intended to be attached to the foundation, and the reverse side of the second profile panel is the side facing the first concreting cavity.

[0014] Further, at least part of the first slots and at least part of the second slots are arranged in an asymmetric and staggered pattern.

[0015] Further, at least part of the construction control lines and/or construction control planes are located on walls of the second slots.

[0016] Further, a level gauge is installed inside one second slot.

[0017] Further, the tie connector includes a first pull piece and a second pull piece. The first pull piece is a threaded rod, and the second pull piece is a U-shaped pull piece. The U-shaped pull piece includes a central connecting piece and two parallel flanks located on two sides of the central connecting piece. Each flank is formed with a threaded hole, and the two flanks are respectively fixed to the two second profile panels using screws.

[0018] Further, the U-shaped pull piece includes two L-shaped connecting pieces which are assembled into the U-shaped pull piece through a detachable connection.

[0019] Further, the U-shaped pull piece further includes a straight connecting piece which is configured

to connect the two L-shaped connecting pieces.

[0020] Further, the permanent formwork further includes at least two parallel and spaced second formworks. An extension direction of the second formworks is perpendicular to an extension direction of the first formworks in three-dimensional space, and the two second formworks are respectively connected to the two first formworks through connecting pieces. The first formworks and the second formworks form different forms of corner joints in space, and a second concreting cavity for concreting concrete is formed between the two second formworks arranged in parallel.

[0021] Further, the shapes of the cross-sections of the first formwork and the second formwork are the same.

[0022] A second aspect of the present disclosure provides a building structure, including the permanent formwork as described above.

[0023] Further, the building structure is a guide wall, a structural column, or a lintel.

[0024] A third aspect of the present disclosure provides a spatial entity setting-out construction method including:

assembling straight formworks, which includes pulling two parallel and spaced first formworks toward each other from front or reverse sides to form a straight formwork for entity setting-out, wherein two straight formworks oriented in different directions intersect in space to form different types of corner joints; and

assembling corner formworks, which includes using a prefabricated first formwork to assemble at a corner joint to form different types of corner formworks.

[0025] Further, pulling two parallel and spaced first formworks toward each other from the front or reverse sides to form the straight formwork for entity setting-out includes: connecting the two first formworks by pulling after the tie connector is engaged with a slot of the first formwork.

[0026] The permanent formwork provided by the present disclosure includes two parallel and spaced first formworks. Each of the first formworks has a first profile panel for attaching to the foundation and a second profile panel perpendicular to the first profile panel. The two second profile panels are connected by a tie connector. A first concreting cavity for concreting concrete is formed between the two second profile panels. A side of the first profile panel facing away from the foundation and a side of the second profile panel located outside the first concreting cavity each have a construction control line and/or construction control plane. The permanent formwork is not affected by previous construction errors of the site during entity setting-out, and can re-establish a three-dimensional construction positioning reference in space. It can achieve measurement and setting-out accuracy level of finished surfaces in one single step through entity construction setting-out in the site, and reduce human errors caused by repeated measurement and setting-out such as pilot measurement and projection measurement, as well as accumulated errors caused by step-by-step measurement and setting-out according to the construction sequence, thereby achieving high-precision construction measurement and setting-out and entity setting-out.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] In order to illustrate the technical solutions in the embodiments of the present disclosure more clearly, the drawings used in the description of the embodiments or the conventional technology are briefly described below. It is apparent that the drawings in the following description show only some embodiments of the present disclosure, and other drawings may be obtained by those of ordinary skill in the art based on these drawings without any creative efforts.

FIG. 1 is a schematic structural view of a permanent formwork provided in an embodiment of the present disclosure;

FIG. 2 is a schematic structural view of a first formwork of the permanent formwork provided in an embodiment of the present disclosure;

FIG. 3 is a schematic structural view of an L-shaped connecting piece of the permanent formwork provided in an embodiment of the present disclosure;

FIG. 4 is a schematic structural view of a straight connecting piece of the permanent formwork provided in an embodiment of the present disclosure;

FIG. 5 is a schematic structural view of a corner joint of the permanent formwork provided in an embodiment of the present disclosure;

FIG. 6 is a schematic structural view of an installation scenario of the permanent formwork provided in an embodiment of the present disclosure;

FIG. 7 is a flow chart of a spatial entity setting-out construction method for the permanent formwork provided in an embodiment of the present disclosure;

FIG. 8 is a schematic structural view of a corner joint structure of male corners of a permanent formwork provided in an embodiment of the present disclosure;

FIG. 9 is a schematic structural view of a corner joint structure of a male corner and a female corner of a permanent formwork provided in an embodiment of the present disclosure; and

FIG. 10 is a schematic structural view of a corner joint structure of female corners of a permanent formwork provided in an embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0028] To clarify the objectives, technical solutions, and advantages of the embodiments of the present disclosure, the technical solutions in the embodiments of the present disclosure will be described clearly and completely hereinafter in conjunction with the drawings in the embodiments of the present disclosure. Apparently, the described embodiments are only a part of the embodiments of the present disclosure, rather than all embodiments. Based on the embodiments in the present application, all other embodiments obtained by those of ordinary skill in the art without creative efforts fall within the scope of protection of the present application.

[0029] In the description of the present disclosure, it should be understood that the terms "including" and "having" used in this paper, as well as any variations thereof, are intended to cover non-exclusive inclusion. For example, processes, methods, systems, products, or devices that include a series of steps or units are not necessarily limited to those steps or units explicitly listed, but may include other steps or units that are not explicitly listed or are inherent to these processes, methods, products, or devices.

[0030] In the present disclosure, unless otherwise expressly specified and limited, terms such as "connect", "joint", "fix", "install", etc. should be interpreted in a broad sense. For example, a connection may be mechanical or electrical; may be direct or indirect via an intermediary; may refer to the internal communication between two components or the interaction between two components. Unless otherwise explicitly defined, for those skilled in the art, the specific meaning of the above terms in this paper can be understood based on the specific circumstances.

[0031] It should be understood that the terms "length", "width", "up", "down", "front", "rear", "left", "right", "vertical", "horizontal", "top", "bottom", "inside", "outside", and other terms indicating orientation or positional relationships are based on the orientation or positional relationships shown in the drawings. These terms are solely used to facilitate the description of the present disclosure and simplify the description, and do not indicate or imply that the devices or components referred to must have specific orientations or be constructed and operated in specific orientations. Therefore, these terms should not be construed as limitations on the present disclosure.

[0032] The terms "first" and "second" are solely used for descriptive purposes and should not be interpreted as indicating or implying relative importance or implicitly specifying the number of the technical features referred to. Thus, features modified by "first" and "second" may explicitly or implicitly include one or more of these features. In the description of this paper, unless otherwise stated, the meaning of "multiple" is two or more. In this paper, the term "and/or" merely describes the associative relationship between associated objects, indicating that there can be three types of relationships. For example, A and/or B can represent sole existence of A, existence of both A and B, and sole existence of B.

[0033] The following provides a detailed description of the permanent formwork, the building structure, and the spatial entity setting-out construction method provided by the present disclosure in conjunction with specific embodiments.

[0034] FIG. 1 is a schematic structural view of a permanent formwork provided in an embodiment of the present disclosure, and FIG. 2 is a schematic structural view of a first formwork of the permanent formwork provided in an embodiment of the present disclosure. Referring to FIG. 1 and FIG. 2, the first aspect of the embodiments of the present disclosure provides a permanent formwork, including two parallel and opposing first formworks 1. Each of the first formworks 1 has a first profile panel 11 for attaching to the foundation and a second profile panel 12 perpendicular to the first profile panel 11. The two second profile panels 12 are connected by a tie connector 2. A first concreting cavity A for concreting concrete is formed between the two second profile panels 12. The tie connector 2 is positioned inside the first concreting cavity A. A side of the first profile panel 11 facing away from the foundation and a side of the second profile panel 12 located outside the first concreting cavity A each have a construction control line and/or construction control plane.

[0035] Each of the first formworks 11 has a first profile panel 11 for attaching to the foundation and a second profile panel 12 perpendicular to the first profile panel 11. In this embodiment, the first profile panel 11 is fixed to the foundation through fixing elements during the installation of the permanent formwork. A first concreting cavity A for pouring concrete is formed between the two second profile panels 12. This embodiment imposes no specific limitation on the distance between the two first formworks 1. The distance between the two second profile panels 12 in this embodiment is the thickness of the concrete structure to be concreted, which can be preset in advance according to actual needs.

[0036] The two second profile panels 12 in this embodiment are connected by a tie connector 2 arranged inside the first concreting cavity A. This embodiment imposes no specific limitation on the specific form of the tie connector 2. The permanent formwork in this embodiment does not require subsequent formwork disassembly and removal, reducing the generation of construction waste. The first formwork 1 in this embodiment adopts prefabricated parts, eliminating the need for on-site processing of the formwork during assembly construction, reducing the interference of cross-construction on site, and greatly shortening the construction period of entity setting-out, reducing unnecessary repeated setting-out, and improving the work efficiency of on-site

construction.

[0037] This embodiment imposes no specific limitation on the specific material of the first formwork 1. For example, the first formwork 1 may be made of a material with a linear expansion coefficient close to that of concrete and a small difference in material deformation, so that the overall structural strength and dimensional accuracy of the concreted component are high. For example, the first formwork 1 in this embodiment may be made of fiberglass-reinforced polyurethane material.

[0038] In this embodiment, a side of the first profile panel 11 facing away from the foundation and a side of the second profile panel 12 located outside the first concreting cavity A each have a construction control line and/or construction control plane. For example, the construction control plane in this embodiment may be a foundation leveling layer finished surface, a floor heating layer finished surface, or a floor leveling layer finished surface. The construction control line and/or construction control plane in this embodiment are located on the permanent formwork, which unifies the dimensional reference and construction rule in the entity setting-out.

[0039] The permanent formwork in this embodiment includes two parallel and spaced first formworks. Each of the first formworks has a first profile panel for attaching to the foundation and a second profile panel perpendicular to the first profile panel. The two second profile panels are connected by a tie connector. A first concreting cavity for concreting concrete is formed between the two second profile panels. A side of the first profile panel facing away from the foundation and a side of the second profile panel located outside the first concreting cavity each have a construction control line and/or construction control plane. The permanent formwork is not affected by previous construction errors of the site during entity setting-out, and can re-establish a three-dimensional construction positioning reference in space. It can achieve measurement and setting-out accuracy level of finished surfaces in one single step through entity construction setting-out in the site, and reduce human errors caused by repeated measurement and setting-out such as pilot measurement and projection measurement, as well as accumulated errors caused by step-by-step measurement and setting-out according to the construction sequence.

[0040] In a specific embodiment, referring to FIG. 1 and FIG. 2, the construction control line includes a positioning line H1 for fixing with the foundation, and the construction control plane includes at least one of foundation leveling layer finished surface M1, thermal insulation layer finished surface M2, floor heating layer finished surface M3, stone bonding layer or wood floor leveling layer finished surface M4, and floor heating boundary insulation strip finished surface M5. The construction control line in this embodiment includes a positioning line H1 for fixing with the foundation. For example, when the first profile panel 11 of this embodiment is connected to the foundation via bolts 3, the positioning line H1 for fixing with the foundation may be a drilling line for bolts. This permanent formwork can calculate the self-precision and positioning accuracy of the setting-out entity based on the technical indicator of a construction tolerance limit $\Delta=\pm 1$mm for the finished surface. Through entity construction setting-out in the site, it can achieve the measurement and setting-out accuracy level of the foundation leveling layer finished surface M1, the thermal insulation layer finished surface M2, the floor heating layer finished surface M3, the stone bonding layer or wood floor leveling layer finished surface M4, and floor heating boundary insulation strip finished surface M5 in one single step, and reduce human errors caused by repeated measurement and setting-out such as pilot measurement and projection measurement, as well as accumulated errors caused by step-by-step measurement and setting-out according to the construction sequence. The foundation leveling layer finished surface M1, the thermal insulation layer finished surface M2, the floor heating layer finished surface M3, the stone bonding layer or wood floor leveling layer finished surface M4, and the floor heating boundary insulation strip finished surface M5 serve not only as control lines for the construction quality of various processes of a concealed work, but also as verification standards for the construction acceptance of each process. The first formwork of this embodiment is provided with a cutting positioning line H2 in the height direction.

[0041] Unified dimensions are the fundamental principle for achieving collaborative work among various processes. This permanent formwork integrates the construction control lines of various processes in both planar and elevation control dimensions during entity setting-out by providing construction control lines and/or surfaces on the side of the first profile panel 11 facing away from the foundation and on the side of the second profile panel 12 located outside the first concreting cavity A. With the assistance of millimeter-level measurement and setting-out accuracy, this permanent formwork unifies the construction and installation dimensions on site through the construction control lines during entity setting-out. In the time dimension of the construction cycle, unified construction and installation dimensions serve as an intangible rule carrier, clarifying the on-site construction interface for subsequent and collaborative work.

[0042] In a specific embodiment, the first formwork 1 is of a spliced structure. The first formwork 1 in this embodiment is of a spliced structure, allowing technicians to splice the first formwork 1 of different lengths according to on-site needs, providing strong flexibility.

[0043] In a specific embodiment, both the first profile panel 11 and the second profile panel 12 are made of fiberglass-reinforced polyurethane profiles. The material of the first profile panel 11 and the second profile panel 12 in this embodiment is the high-performance composite material, fiberglass-reinforced polyurethane. This material has a low expansion coefficient, low shrinkage rate, high strength, light weight, and low thermal conductivity. The first formwork 1, as a construction permanent form-

work of an entity setting-out member, has a linear expansion coefficient close to that of concrete, so that there is a small difference in material deformation between the two, and the overall structural strength and dimensional accuracy of the concreted component are high.

[0044] In some embodiments, the first profile panel 11 and the second profile panel 12 are integrally formed, making the manufacturing process simple. The permanent formwork in this embodiment is made of fiberglass-reinforced polyurethane and is produced through a pultrusion process. The permanent formwork has a stable structural size and high bending strength.

[0045] Further, referring to FIG. 1 and FIG. 2, a reverse side of the first profile panel 11 and a reverse side of the second profile panel 12 are each formed with multiple first slots 13. A front side of the first profile panel 11 and a front side of the second profile panel 12 are each formed with multiple second slots 14. The reverse side of the first profile panel 11 is the side that is intended to be attached to the foundation, and the reverse side of the second profile panel 12 is the side facing the first concreting cavity A. The shapes of the first slots 13 and the second slot 14 of the permanent formwork in this embodiment are set according to construction standards and construction practices. Both the first slots 13 and the second slots 14 in this embodiment are universal slots. The first formwork 1 of this embodiment is provided with seven general construction slots, distributed on the front and reverse side of the first formwork 1. The first slots 13 on the front side and the second slots 14 on the reverse side are arranged in an asymmetric and staggered manner. The first slots 13 and the second slots 14 in this embodiment are arranged in an asymmetric staggered manner, which can improve the strength of the first formwork 1.

[0046] Further, referring to FIG. 2, at least part of the construction control lines and/or construction control planes are located on walls of the second slots 14. In this embodiment, the foundation leveling layer finished surface M1, the thermal insulation layer finished surface M2, the floor heating layer finished surface M3, the stone bonding layer or wood floor leveling layer finished surface M4, and the floor heating boundary insulation strip finished surface M5 on the first formwork are all set on the walls of the second slots 14. In FIG. 2, the first formwork 1 integrates both the construction control lines and construction control planes for quality control acceptance, as well as a multi-functional, expandable universal slots for construction, on both the front and reverse sides.

[0047] In some embodiments, a level gauge is provided inside one second slot 14. By providing a level gauge inside the second slot 14, the level gauge can verify the levelness of the installation during installation of the permanent formwork. This embodiment does not impose any specific structural limitations on the level gauge.

[0048] The permanent formwork in this embodiment can standardize the spatial positioning and dimensional criteria for full-field construction control through its own precision, and define the access methods for expandable functional components through a universal construction interface. It can also establish a standardized, unified, multifunctional, and expandable universal construction interface platform while performing entity setting-out.

[0049] In a specific embodiment, referring to FIG. 1, the tie connector 2 includes a first pull piece 21 and a second pull piece 22. The first pull piece 21 is a threaded rod, with both ends of the threaded rod fixed to the two second profile panels 12 respectively. The threaded rod is arranged inside the first concreting cavity A. The second pull piece 22 is a U-shaped pull piece. The U-shaped pull piece includes a central connecting piece and two parallel flanks located on two sides of the central connecting piece. Each flank is formed with a threaded hole, and the two flanks are respectively fixed to the two second profile panels 12 using screws. The first pull piece 21 and the second pull piece 22 in this embodiment are both installed inside the two first formworks 1. After the construction of the permanent formwork is completed, they do not need to be removed. The first pull piece 21 and the second pull piece 22 in this embodiment are easy to install, making the construction site clean and orderly.

[0050] Further, FIG. 3 is a schematic structural view of the L-shaped connecting piece of the permanent formwork provided in an embodiment of the present disclosure. Referring to FIG. 3, the U-shaped pull piece includes two L-shaped connecting pieces 221 which are assembled into the U-shaped pull piece through a detachable connection. The U-shaped pull piece in this embodiment is formed by splicing two L-shaped connecting pieces 221 through a detachable connection, allowing the two L-shaped connecting pieces 221 to be spliced to form intermediate connecting parts of different lengths, which can be applied to the fabrication of concrete structures of different thicknesses.

[0051] Further, FIG. 4 is a schematic structural view of a straight connecting piece of the permanent formwork provided in an embodiment of the present disclosure. Referring to FIG. 4, the U-shaped pull piece further includes a straight connecting piece 222 which is configured to connect the two L-shaped connecting pieces 221. In this embodiment, using the straight connecting piece 222 to connect two L-shaped connecting pieces 221 expands the adjustable range of the length of the intermediate connecting part of the U-shaped pull piece.

[0052] In a specific embodiment, FIG. 5 is a schematic structural view of a corner joint of the permanent formwork provided in an embodiment of the present disclosure, and FIG. 6 is a schematic structural view of an installation scenario where the permanent formwork provided in an embodiment of the present disclosure is attached to an invisible door frame. Referring to FIG. 5 and FIG. 6, the permanent formwork further includes at least two parallel and spaced second formworks 4. An extension direction of the second formworks 4 is perpendicular to an extension direction of the first formworks 1 in three-dimensional space, and the two second formworks

4 are respectively connected to the two first formworks 1 through connecting pieces 5. The first formworks 1 and the second formworks 4 form different forms of corner joints in space, and a second concreting cavity B for concreting concrete is formed between the two second formworks 4 arranged in parallel.

[0053] FIG. 5 illustrates a type of corner joint formed when a guide wall intersects with a structural column. This type of corner joint consists of five prefabricated standard formworks (the first formworks 1 located on the left, right, and front sides, and the second formworks 4 located on the left and right sides, where the structure of the second formworks 4 in this embodiment is the same as that of the first formworks 1). These five prefabricated standard formworks are assembled and combined through a first connecting piece 51 and a second connecting piece 52 both with threaded holes. Two first formworks 1 are pulled toward each other from the reverse sides, and two second formworks 4 are pulled toward each other from the front sides. The front side of the first formwork 1 located on the right side and the reverse side of the second formwork 4 located on the right side are assembled and combined through the first connecting piece 51. The front side of the first formwork 1 located on the left side and the reverse side of the second formwork 4 located on the left side are assembled and combined through the first connecting piece 51. The front side of the first formwork 1 located on the front side and the front sides of the two first formworks 1 located on the left and right sides are assembled and combined through the second connecting piece 52. The first connecting piece 51 and the second connecting piece 52 are pressed and positioned with set screws after installed at the universal construction interface. After measurement and setting-out are finished, the corner formwork pieces are fixed on the construction site with bolts 3.

[0054] In some embodiments, the shapes of the cross-sections of the first formwork 1 and the second formwork 4 are the same. The first formwork 1 and the second formwork 4 in this embodiment may be the same formwork unit, and the manufacturing method therefor is simple. When the first formwork 1 and the second formwork 4 are combined for different corner joints, different cuts are made to the first formwork 1 and the second formwork 4. Of course, in other embodiments, the first formwork 1 and the second formwork 4 may be different formwork units.

[0055] The formwork establishment process of the permanent formwork in this embodiment does not involve subsequent formwork disassembly and removal, reducing the generation of construction waste. The permanent formwork precisely measures and sets out the on-site construction control lines and/or construction control planes in both planar and elevation dimensions during the three dimensional entity setting-out process. From the material selection and mouth shape setting of the standard unit formwork to the factory prefabrication and on-site assembly of the formwork pieces, the construction tolerance Δ can be controlled throughout the entire process to be within $\pm$1mm. Consistent dimensional criteria and construction interfaces are maintained the same from concealed works to finished surfaces. The permanent formwork provides a customized on-site verification standard for various processes at the construction site during the three dimensional entity setting-out process, ensuring that subsequent construction is not affected by previous construction. Different trades, disciplines, and subcontractors can work simultaneously, saving coordination costs and efficiently advancing the construction schedule.

[0056] A second aspect of the present disclosure provides a building structure, including the permanent formwork as described in the above embodiments.

[0057] In a specific embodiment, the building structure may be a guide wall, a structural column, or a lintel. This embodiment does not impose any specific limitations on the specific form of the building structure.

[0058] The building structure of this embodiment includes the aforementioned permanent formwork, and the formwork establishment process of the permanent formwork does not involve subsequent formwork disassembly and removal, reducing the generation of construction waste. The permanent formwork precisely measures and sets out the on-site construction control lines and/or construction control planes in both planar and elevation dimensions during the three dimensional entity setting-out process. From the material selection and mouth shape setting of the standard unit formwork to the factory prefabrication and on-site assembly of the formwork pieces, the construction setting-out accuracy Δ can be controlled throughout the entire process to be within $\pm$1mm. Consistent dimensional criteria and construction interfaces are maintained the same from concealed works to finished surfaces. The permanent formwork provides a customized on-site verification standard for various processes at the construction site during the three dimensional entity setting-out process, ensuring that subsequent construction is not affected by previous construction. Different trades, disciplines, and subcontractors can work simultaneously, saving coordination costs and efficiently advancing the construction schedule.

[0059] FIG. 7 is a flow chart of a spatial entity setting-out construction method for the permanent formwork provided in an embodiment of the present disclosure. Referring to FIG. 7, a third aspect of the embodiment of the present disclosure provides a spatial entity setting-out construction method which utilizes the permanent formwork described in the aforementioned embodiments. The method includes:

[0060] S101, assembly of straight formworks, including pulling two parallel and spaced first formworks toward each other from the front or reverse sides to form a straight formwork for entity setting-out, where two straight formworks oriented in different directions intersect in space to form different types of corner joints.

[0061] The first formworks of this embodiment are established by pulling from the front or reverse sides according to the actual situation of construction setting-out, forming the straight part of the entity setting-out. Exemplarily, FIG. 1 shows the establishment method of pulling from the reverse sides of two standard first formworks 1. The first formworks 1 are connected by pulling after the first pull piece 21 and the second pull piece 22 are engaged with the universal construction interfaces of the first formworks 1. After measurement and setting-out are finished, the straight formwork is fixed on the construction site with bolts 3.

[0062] S102, assembly of corner formworks, including using a prefabricated first formwork to assemble at a corner joint to form different types of corner formworks.

[0063] FIG. 8 is a schematic structural view of a corner joint structure of male corners of a permanent formwork provided in an embodiment of the present disclosure; FIG. 9 is a schematic structural view of a corner joint structure of a male corner and a female corner of a permanent formwork provided in an embodiment of the present disclosure; and FIG. 10 is a schematic structural view of a corner j oint structure of female corners of a permanent formwork provided in an embodiment of the present disclosure. Referring to FIG. 8 to FIG. 10, straight formworks oriented in different directions intersect in space to form different types of corner joints. Each type of corner joint is composed of a prefabricated standard first formwork 1, which forms a complete entity setting out. Different types of corner formwork pieces and straight formwork pieces of different lengths are assembled and combined through straight connecting pieces with threaded holes. The straight connecting pieces are pressed and positioned with set screws after installed at the universal construction interfaces. The assembled formwork pieces are the smallest units for controlling the accuracy of on-site entity setting out. In this embodiment, the female corner refers to the inwardly recessed wall corner, while the male corner refers to the protruding wall corner. During the process of on-site entity setting-out, the corner formwork pieces and the straight formwork pieces determine the precise relative positional relationship between the entity setting-out components through their own absolute dimensional accuracy, and achieve precise construction positioning for the entire site's plane and elevation control through construction control points.

[0064] The prefabricated formworks in this embodiment eliminates the need for on-site processing of the formwork during assembly construction, reduces the interference of cross-construction on site, and greatly shortens the construction period of entity setting-out, thereby reducing unnecessary repeated setting-out and improving the work efficiency of on-site construction.

[0065] The permanent formwork in the spatial entity setting-out construction method of the present disclosure includes two parallel and spaced first formworks. Each of the first formworks has a first profile panel for attaching to the foundation and a second profile panel perpendicular to the first profile panel. The two second profile panels are connected by a tie connector. A first concreting cavity for concreting concrete is formed between the two second profile panels. A side of the first profile panel facing away from the foundation and a side of the second profile panel located outside the first concreting cavity each have a construction control line and/or construction control plane. The permanent formwork is not affected by previous construction errors of the site during entity setting-out, and can re-establish a three-dimensional construction positioning reference in space. It can achieve measurement and setting-out accuracy level of finished surfaces in one single step through entity construction setting-out in the site, and reduce human errors caused by repeated measurement and setting-out such as pilot measurement and projection measurement, as well as accumulated errors caused by step-by-step measurement and setting-out according to the construction sequence.

[0066] The three dimensional entity setting-out of the permanent formwork in this embodiment provides a customized on-site verification standard for various processes at the construction site, ensuring that subsequent construction is not affected by previous construction. Different trades, disciplines, and subcontractors can work simultaneously, thereby saving coordination costs and efficiently advancing the construction schedule.

[0067] In the above description, the descriptions of reference terms such as "an embodiment", "some embodiments", "exemplarily", "specific examples", etc., refer to that the specific features, structures, materials, or characteristics described in conjunction with the embodiment or example are included in at least one embodiment or example of the present disclosure. In this specification, the illustrative expressions of the aforementioned terms do not necessarily refer to the same embodiment or example. Moreover, the specific features, structures, materials, or characteristics described can be combined in an appropriate manner in any one or multiple embodiments or examples. In the absence of any contradiction, those skilled in the art can combine and integrate different embodiments or examples described in this specification, as well as the features of different embodiments or examples.

[0068] The above embodiments are only for illustrating the technical solutions of the present disclosure, and are not intended to limit them. Although the present disclosure has been described in detail with reference to the aforementioned embodiments, those skilled in the art should understand that they can still modify the technical solutions described in the aforementioned embodiments, or equivalently substitute some or all of the technical features; all such modifications or substitutions do not make the essence of the corresponding technical solution deviate from the scope of the technical solutions of the embodiments of the present disclosure.

Claims

1. A permanent formwork, comprising:

   two parallel and opposing first formworks, wherein each of the first formworks has a first profile panel for attaching to a foundation and a second profile panel perpendicular to the first profile panel;
   wherein a first concreting cavity for concreting concrete is formed between the two second profile panels, the two second profile panels are connected by a tie connector located inside the first concreting cavity; and
   a side of the first profile panel facing away from the foundation and a side of the second profile panel located outside the first concreting cavity each have a construction control line and/or construction control plane.

2. The permanent formwork according to claim 1, wherein the construction control line comprises a positioning line for fixing with the foundation, and the construction control plane comprises at least one of foundation leveling layer finished surface, thermal insulation layer finished surface, floor heating layer finished surface, stone bonding layer or wood floor leveling layer finished surface, and floor heating boundary insulation strip finished surface.

3. The permanent formwork according to claim 1, wherein the first formwork is of a spliced structure.

4. The permanent formwork according to claim 1, wherein both the first profile panel and the second profile panel are made of fiberglass-reinforced polyurethane profiles.

5. The permanent formwork according to claim 1, wherein the first profile panel and the second profile panel are integrally formed.

6. The permanent formwork according to any one of claims 1 to 5, wherein a reverse side of the first profile panel and a reverse side of the second profile panel are each formed with a plurality of first slots, a front side of the first profile panel and a front side of the second profile panel are each formed with a plurality of second slots, the reverse side of the first profile panel is a side that is intended to be attached to the foundation, and the reverse side of the second profile panel is a side facing the first concreting cavity.

7. The permanent formwork according to claim 6, wherein at least part of the first slots and at least part of the second slots are arranged in an asymmetric and staggered pattern.

8. The permanent formwork according to claim 6, wherein at least part of the construction control lines and/or construction control planes are located on walls of the second slots.

9. The permanent formwork according to claim 6, wherein a level gauge is installed inside one second slot.

10. The permanent formwork according to any one of claims 1 to 9, wherein the tie connector comprises a first pull piece and a second pull piece, wherein the first pull piece is a threaded rod, and the second pull piece is a U-shaped pull piece, wherein the U-shaped pull piece includes a central connecting piece and two parallel flanks located on two sides of the central connecting piece, wherein each flank is formed with a threaded hole, and the two flanks are respectively fixed to the two second profile panels using screws.

11. The permanent formwork according to claim 10, wherein the U-shaped pull piece comprises two L-shaped connecting pieces which are assembled into the U-shaped pull piece through a detachable connection.

12. The permanent formwork according to claim 11, wherein the U-shaped pull piece further comprises a straight connecting piece which is configured to connect the two L-shaped connecting pieces.

13. The permanent formwork according to any one of claims 1 to 12, wherein the permanent formwork further comprises at least two parallel and spaced second formworks, wherein an extension direction of the second formworks is perpendicular to an extension direction of the first formworks in three-dimensional space, and the two second formworks are respectively connected to the two first formworks through connecting pieces, wherein the first formworks and the second formworks form different forms of corner joints in space, and a second concreting cavity for concreting concrete is formed between the two second formworks arranged in parallel.

14. The permanent formwork according to claim 13, wherein shapes of cross-sections of each first formwork and each second formwork are the same.

15. A building structure, comprising the permanent formwork according to any one of claims 1 to 14.

16. The building structure according to claim 15, wherein the building structure is a guide wall, a structural column, or a lintel.

17. A spatial entity setting-out construction method, utilizing the permanent formwork according to any one of claims 1 to 14, and comprising:

assembling straight formworks, which comprises pulling two parallel and spaced first formworks toward each other from front or reverse sides to form a straight formwork for entity setting-out, wherein two straight formworks oriented in different directions intersect in space to form different types of corner joints; and
assembling corner formworks, which comprises using a prefabricated first formwork to assemble at a corner joint to form different types of corner formworks.

18. The spatial entity setting-out construction method according to claim 17, wherein pulling two parallel and spaced first formworks toward each other from the front or reverse sides to form the straight formwork for entity setting-out comprises: connecting the two first formworks by pulling after the tie connector is engaged with a slot of the first formwork.

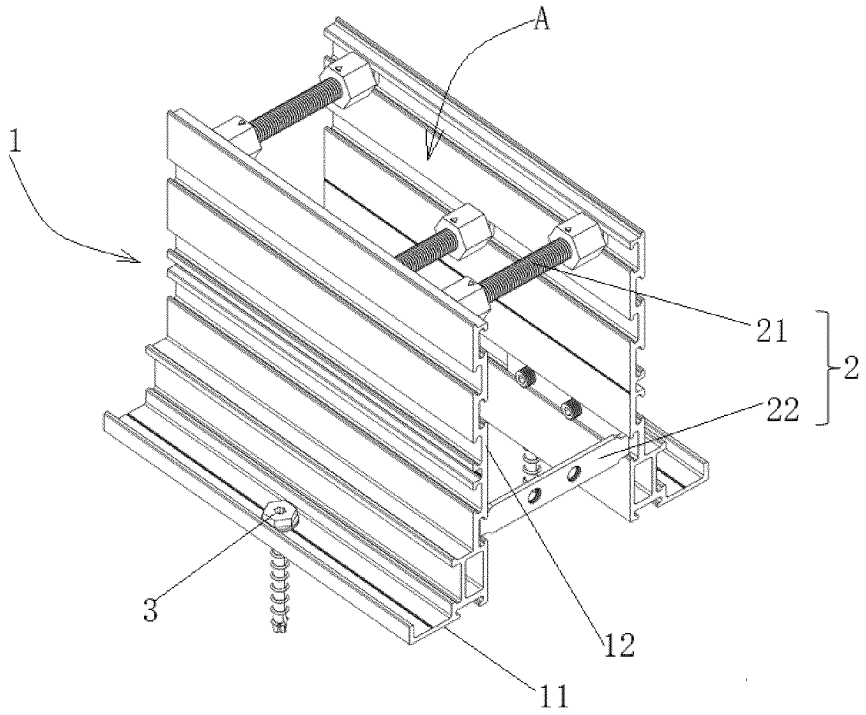


FIG. 1

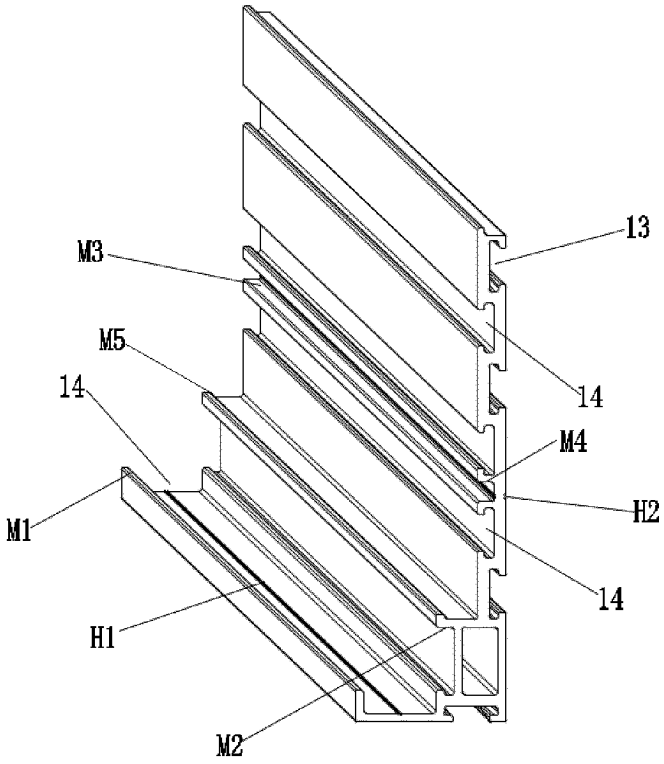


FIG. 2

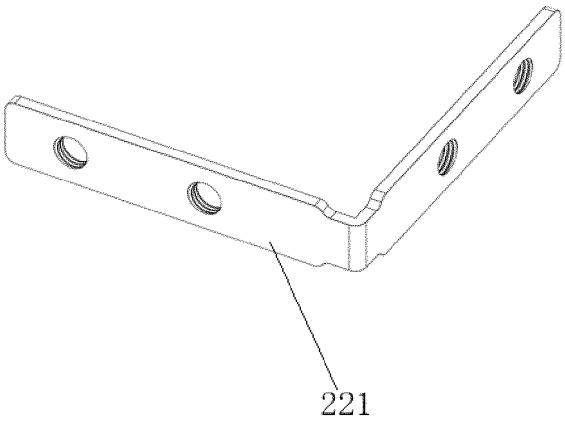


FIG. 3

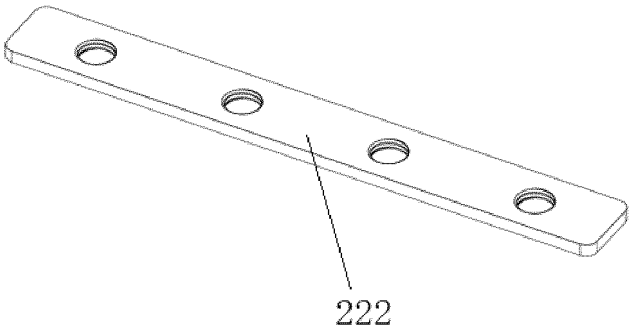


FIG. 4

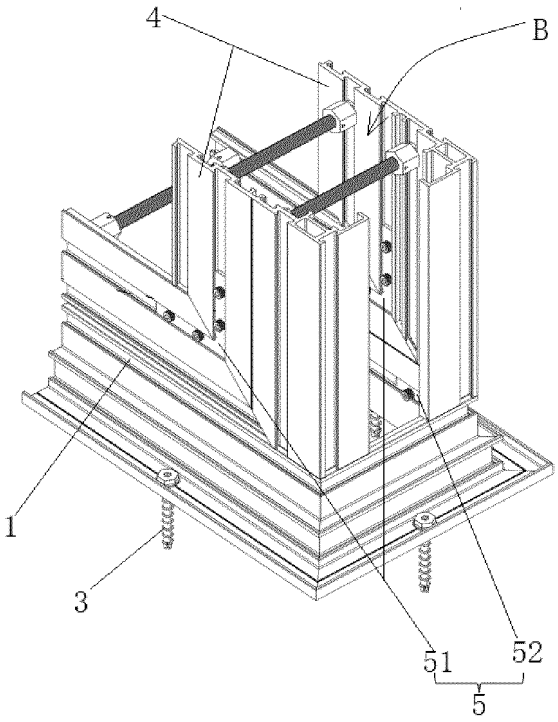


FIG. 5

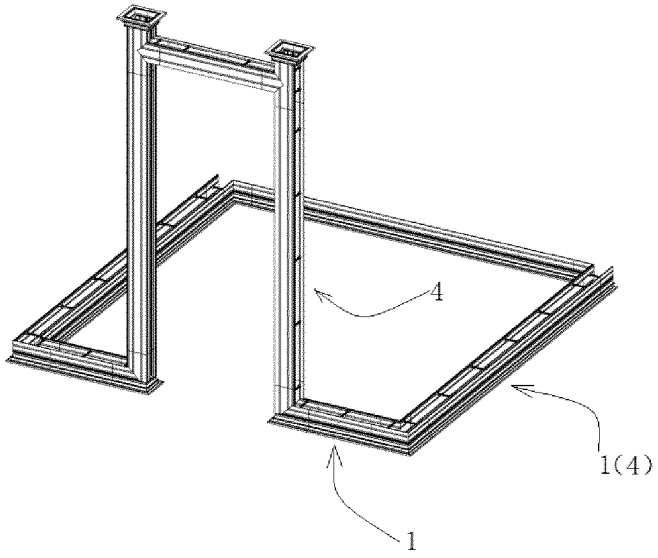


FIG. 6

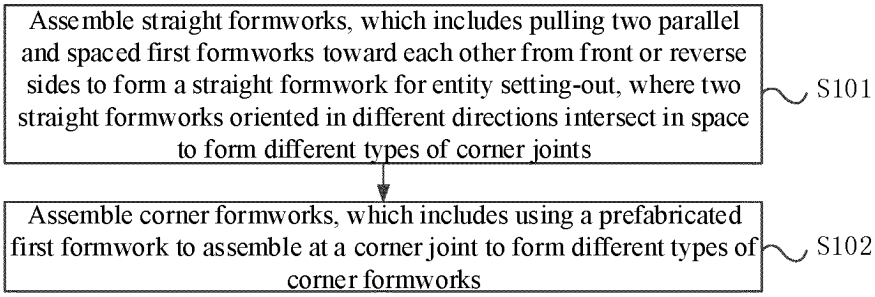


FIG. 7

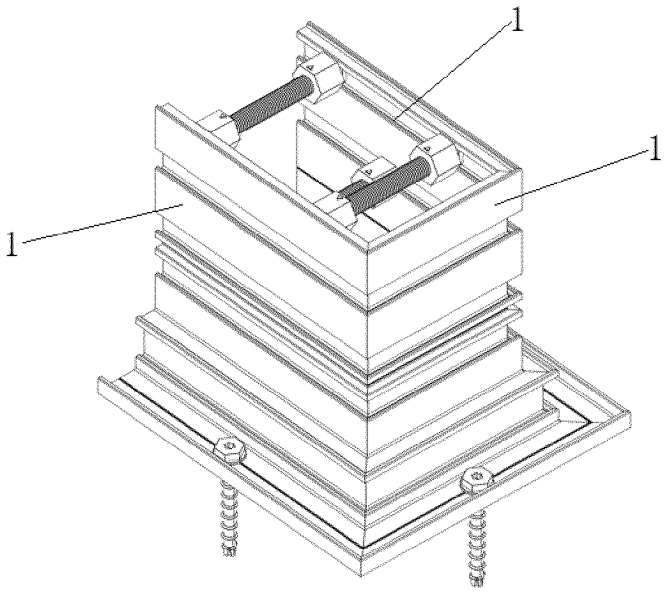


FIG. 8

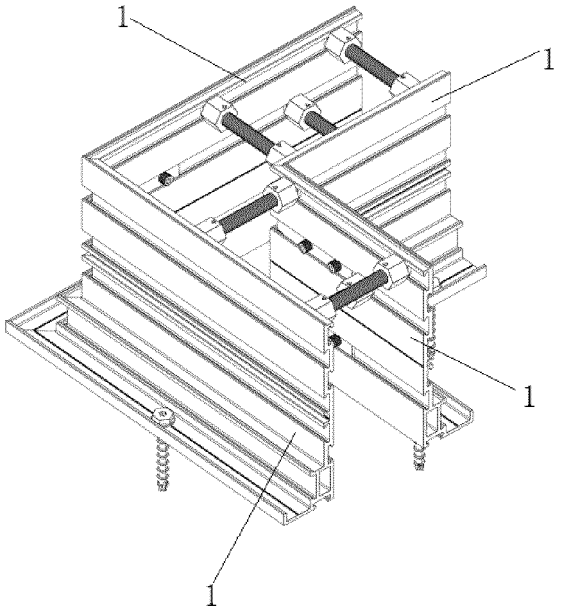


FIG. 9

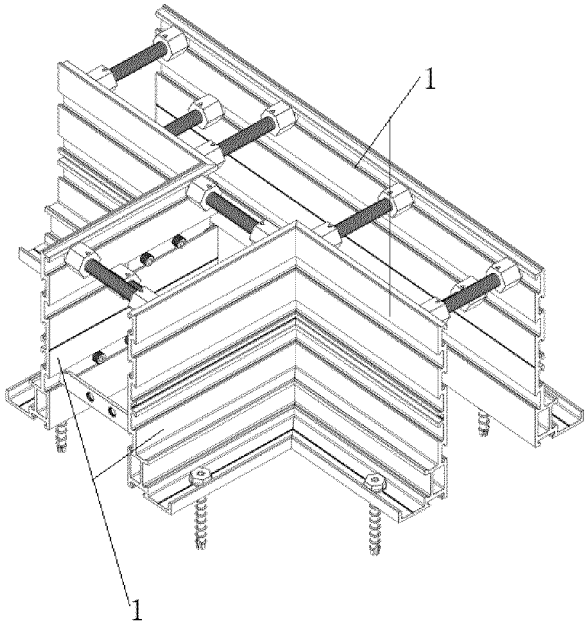


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/112003

A. CLASSIFICATION OF SUBJECT MATTER

E04B 2/86(2006.01)i; E04C 3/34(2006.01)i; E04C 3/20(2006.01)i; E04G 21/14(2006.01)i; E04G 21/18(2006.01)i; E02D27/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:E04B2,E04C3,E04G21,E02D27

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS; CNTXT; DWPI; WPABS; CNKI; USTXT; EPTXT; JPTXT; WOTXT; ENTXT; VEN; ISI Web of Knowledge; 万方, WANFANG; 超星, CHAOXING: 免拆, 模板, 型材, 混凝土, 浇筑, 对拉, 腔, 定位, 成型, 支模, template, prefabricated, panel, cavity, formwork, Non-dismantling

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 115419194 A (HEYI JINGZHI (SHANGHAI) TECHNOLOGY CO., LTD. et al.) 02 December 2022 (2022-12-02) claims 1-18, and description, paragraphs 0045-0078, and figures 1-10	1-18
X	CN 213417871 U (LANGFANG ZHUORUI BUILDING MATERIAL CO., LTD.) 11 June 2021 (2021-06-11) description, paragraphs 0026-0035, and figures 1-7	1-18
A	CN 114837404 A (SHANGHAI BAOYE GROUP CORP., LTD.) 02 August 2022 (2022-08-02) entire document	1-18
A	CN 106088578 A (ZHUMADIAN YONGTAI ARCHITECTURAL ENERGY-SAVING MATERIALS EQUIPMENT CO., LTD.) 09 November 2016 (2016-11-09) entire document	1-18
A	US 2008216445 A1 (LANGER FELIX) 11 September 2008 (2008-09-11) entire document	1-18

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 October 2023	**02 November 2023**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/112003

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 115419194 A	02 December 2022	None	
CN 213417871 U	11 June 2021	None	
CN 114837404 A	02 August 2022	None	
CN 106088578 A	09 November 2016	None	
US 2008216445 A1	11 September 2008	None	

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 202210987643 **[0001]**