

A Prefabricated Roofing System And Method

Field of Invention

5 [001] The present invention relates to a prefabricated roofing system and a method of guided juxta-positioning of modular roof modules to form an integrated roof. In addition, juxta-positioning of the modular roof modules also forms an integrated ceiling.

Background

10 [002] A conventional roofing system includes a roof supporting structure and a roof covering. The roofing system may also include a thermal insulation layer, such as, a heat insulation sheet, a moisture barrier layer, a sound barrier layer and sound absorption layer. The roof supporting structure may be a rafter-purlin system or a truss system. Conventionally, construction of such a roofing system is carried out on-sites and it requires coordination of various skilled labour at
15 different times. On-site construction also requires plenty of ground space to work. On-site construction work also generates noise and dust pollutions. Execution of these on-sites construction work is often highly dependent on weather conditions, thus impacting on the entire building time schedules. Besides, working at high levels above the ground is a safety concern.

20 [003] Conventionally, only after the roofing system is completed does work on the ceiling begins. Work on the ceiling often calls for undesirable work at high levels above ground.

[004] It can thus be seen that there exists a need for a new system of prefabricating a roof system in a factory and taking advantage of this new method of installation. For example, installation of
25 a prefabricated roof tends can be completed faster. The amount of work required at height is reduced, leading to relatively safer construction work. Also, structures prefabricated in a factory or on ground tend to have better finishing and quality control. In addition, the ceiling integrally laid with the roof helps to cut down the amount of work performed at elevated heights.

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Summary

[005] The following presents a simplified summary to provide a basic understanding of the present invention. This summary is not an extensive overview of the invention, and is not

intended to identify key features of the invention. Rather, it is to present some of the inventive concepts of this invention in a generalised form as a prelude to the detailed description that is to follow.

5 **[006]** The present invention seeks to provide a prefabricated roofing system and a method of juxta-positioning roof modules on the roof supporting rafters. Some advantages of the present invention is reduction of the amount of time and skilled labour required for on-site building construction, reduced amount of work performed at elevated heights which means improving work-site safety, improvement in work efficiency, improvement in the finishing and quality
10 control, and faster completion time. Other advantages are also apparent after a reader has appreciated the working of the present invention.

[007] In one embodiment, the present invention provides a prefabricated roofing system. The prefabricated roofing system comprises a roof support system and a plurality of roof modules.
15 The roof modules are pre-designed and prefabricated in a factory, with each corner of a roof module having an L-shaped bracket for mounting onto said roof support system, wherein each said L-shaped bracket has a corner notch and a mounting leg, with said mounting leg at said corner notch being chambered, such that when a new roof module is juxtaposed in a predetermined direction to an adjacent roof module already arranged on said roof support
20 system, said new roof module is guided into position by cooperation of said chamfered mounting leg of an associated L-shaped bracket with said corner notch of the cooperating L-shaped bracket disposed on said adjacent roof module.

[008] In another embodiment of the prefabricated roofing system, a side member of each roof
25 module comprises two spaced apart projecting guides and the opposite side member comprises two cooperating apertures. Each projecting guide comprises a base plate and a skewer member. When a new roof module is brought progressively close for connection with a roof module already mounted on the rafters, the skewer member located on the roof module (already mounted on the rafters) is made to engage with the aperture located on the new roof module to help align
30 and guide juxta-positioning of the new roof module with the already mounted roof module.

[009] In another embodiment, the present invention provides a method of constructing a roof of a building. The method comprises pre-designing a roof support system and a plurality of roof

modules for mounting onto the roof support system; pre-fabricating the plurality of roof modules in a factory; transporting the prefabricated roof modules from the factory to the building site; and juxtapositioning the roof modules onto the roof support system; wherein the juxtapositioning is guided by a chamfered edge of a L-shaped mounting bracket disposed on one roof module
5 engaging a corner notch of a similar L-shaped mounting bracket disposed on a cooperating roof module.

[0010] In another embodiment, the juxta-positioning is further guided by a projecting guide disposed on a side member of the roof module cooperating with an aperture disposed on a side
10 member of the cooperating roof module. Each projecting guide comprises a skewer member. In yet another embodiment, each roof module comprises a modular roofing cover and a modular ceiling panel; when the roof modules are juxta-posed, the modular roofing covers connect up to form an integrated roof covering, whilst the modular ceiling panels connect up to form an integrated ceiling.

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Brief Description of the Drawings

[0011] This invention will be described by way of non-limiting embodiments of the present invention, with reference to the accompanying drawings, in which:

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[0012] FIG. 1A illustrates a building using a prefabricated roofing system according to an embodiment of the present invention, whilst FIG. 1B illustrates a roof support structure using a system of rafters and FIG. 1C illustrates that using a system of trusses;

25 **[0013]** FIG. 2 illustrates juxtapositioning of prefabricated roof modules according to the present invention;

[0014] FIG. 3A illustrates a corner of a roof module, a projecting guide and L-shaped support bracket according to another embodiment of the present invention, whilst FIGs. 3B-3D
30 illustrates variations of the projecting guide; and

[0015] FIG. 4A illustrates another corner of a roof module and an aperture for cooperation with the projecting guide, whilst FIG. 4B illustrates the corner with the aperture being egg-shaped and FIG. 4C illustrates the egg-shaped aperture.

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Detailed Description

[0016] One or more specific and alternative embodiments of the present invention will now be described with reference to the attached drawings. It shall be apparent to one skilled in the art, however, that this invention may be practised without such specific details. Some of the details may not be described at length so as not to obscure the invention.

[0017] FIG. 1A shows a simplified, sectional view of a building 102 in which a prefabricated roofing system 100 according to an embodiment of the present invention is incorporated. As an example, the building 102 is shown to have a high roof, such as a school, sports or convention hall; stadium; and so on. Preferably, the building 102 requires some acoustic requirements, such as, an acoustic ceiling 160. The roofing system 100 comprises a roof support structure 110, a plurality of roof modules 120 pre-designed and prefabricated in a factory, and a roofing cover 150. The roof support structure 110 may be constructed using a system of rafters 112, as shown in FIG. 1B or a system of trusses, as shown in FIG. 1C. Each prefabricated roof module 120 comprises a system of purlins so that each roof module 120 becomes a structural sub-unit. Mounted on the top of each roof module 120 is a module 152 (not shown in the figures) of the roofing cover 150 so that when each roof module 120 is juxtaposed in two predetermined directions (pitch P, lateral Q as indicated in FIG. 2), adjacent modular roofing modules 152 overlap at the edges to form the entire roofing cover 150. The roofing cover 150 is preferably made of roofing panels that are more suited for prefabrication in a factory rather than roof tiles or shingles.

[0018] In another embodiment, each roof module 120 further comprises a ceiling panel 162 disposed at a lower face of each roof module 120. Adjacent ceiling panels 162 abut or overlap at the edges as the roof modules 120 are juxtaposed in the two predetermined directions P,Q as adjacent roof modules 120 are arranged on the rafters 112. This embodiment allows the ceiling 160 to be completed at the same time of installing the entire roof, thereby leading to work productivity at the building site. This embodiment also helps to reduce the amount of work

performed at heights above the ground, thus allowing roofing and ceiling works to be carried out more safely and efficiently.

[0019] FIG. 2 shows part of the roof support structure 110 comprising a system of rafters 112 supporting the prefabricated roof modules 120. In the present invention, the roofing system 100 is preferably designed using a computer software and the roof modules 120 are prefabricated in a factory. The roofing system 100 is designed so that the rafters are spaced apart at predetermined distances, and dimensions of the roof modules 120 are then predetermined for mounting on the rafters 112. Preferably, each roof module 120 is generally quadrilateral in shape and has a width W and a length L. In one embodiment, the width W is substantially about 2.5m (or about 8 feet) or less so that they can be transported, for example, within the width of a road transport vehicle; the length L of each roof module 120 is less restrictive, for example, it may be as long as about 12m (or about 40 feet) or more. It is possible to prefabricate roof modules 120 of more than 2.5m in width but they incur additional costs due to width and height restrictions for transporting them from the factory to the building site; this may happen when the roof of an existing building is to be replaced with the roofing system 100 of the present invention. In another embodiment, the length L of each roof module 120 is about 2.5m or less whilst the width W is longer than the length L. In FIG. 2, the roof cover 150, 152 and insulating materials are not shown so that features of the roof modules 120 can be shown more clearly.

[0020] As shown in FIG. 2, the roof modules 120 are juxtaposed in two perpendicular directions, namely, in an upstream direction along the pitch P of the roofing system 100 and in a lateral, sideways Q direction. As shown in FIG. 2, installation of this roofing system 100 starts by mounting a roof module 120 at the lowest edge of the roof support structure 110. By juxtaposing the roof modules in two perpendicular directions P, Q, the modular roofing cover 152 overlap at the edges, so that rain water, for example, can flow down the roofing cover 150 by gravity without seeping through the overlapping edges. For example, to allow the roof modules 120 to be juxtaposed in the upstream, pitch (or longitudinal) direction, the edge along the width W of each roof module 120 has a pair of spaced apart projecting guides 124. The adjacent cooperating roof module 120a, to be juxtaposed with the already mounted roof module 120, has a pair of apertures 129 disposed on an edge member adjacent to that which supports the projecting guides 124. When the two roof modules 120 and 120a are brought progressively close to each other, the projecting guides 124 located on the roof module 120 are made to engage with the cooperating

apertures 129 located on the other roof module 120a, thereby helping to guide the positioning of the newly juxtaposed roof module 120a onto the rafters. Such guided positioning provided by the projecting guides 124 and apertures 129 is useful as the roof modules 120 are typically hoisted by a crane. When suspended from the crane, they sway and the swaying has to be manually controlled before the roof modules 120a are positioned, juxtaposed with the adjacent cooperating roof module 120 and then laid down on the rafters 112.

[0021] FIG. 3A is a perspective view of a corner of a roof module 120, 120a shown in FIG. 2. FIG. 3A shows a projecting guide 124 according to an embodiment of the present invention. As shown in FIG. 3A, the projecting guide 124 is formed from a sheet metal and is attached to a purlin at the width W edge of the roof module 120. Each projecting guide 124 has a base plate 125 and a skewer member 126 projecting substantially perpendicular to the base plate 125. The skewer member 126 has a top edge 127 and a lower edge 128. In one embodiment, the top edge 127 is substantially perpendicular to its base portion 127a and the lower edge 128 is at an angle to the top edge 127 so that the skewer member 126 is tapered. In another embodiment, the top edge 127 is at an acute angle to the base portion 127a so that the skewer member 126 is pointing upwards at an angle, which is also with respect to a horizontal plane of the roof module. FIG. 3B shows an elevation view of the projecting guide 124 in the direction of the skewer member 126. As shown in FIG. 3B, both the top edge 127 and lower edge 128 are formed with partial circular surfaces. Alternatively, the shape of the top or lower edge may be varied; the top edge 127 or lower edge 128 may not be part circular; for example, FIG. 3C shows only the top edge 127 of the skewer member 126 has a part circular surface, whilst FIG. 3D shows the top and lower edges of the skewer member 126 are not formed with any rounded surfaces.

[0022] FIG. 4A is a perspective view of another corner of a roof module 120, 120a and it shows the aperture 129 located on an edge member. As shown in FIG. 4A, the aperture 129 is oblong and symmetrical in shape but has dimensions larger than the outline of the cooperating skewer member 126. For example, the dimensions of the aperture 129 are substantially about 10 mm larger than the outline of the skewer member 126. When two adjacent roof modules 120, 120a are brought progressively close for connection with each other, the skewer member 126 located on the roof module 120 is made to engage with the aperture 129 located on the roof module 120a to help align the two roof modules 120, 120a together on the rafters. The aperture 129 being larger than the skewer member 126 helps to compensate for dimensional tolerances and, at the

same time, allows easier engagement of the skewer member 126 with the aperture 129 when the roof module 120a is still suspended by the crane.

[0023] FIG. 4B shows the above corner of the roof module 120, 120a but with the aperture 129 being egg-shaped. FIG. 4C shows the egg-shaped aperture. The egg-shaped aperture 129 is shaped and dimensioned substantially larger than the cooperating skewer member 126, so that when two adjacent roof modules 120, 120a are brought close for connection with each other, the skewer member 126 engages with the aperture 129 to help align the two roof modules 120, 120a together on the rafters. As shown in FIG. 4C, the upper edge of the aperture 129 is curved or rounded and the lower edge has a relative bigger curve than the upper edge. The arrows in FIG. 4C indicate the free-play of the skewer member 126 inside the aperture 129. The egg-shaped aperture 129 is advantageous in that when two roof modules are brought together for connection, the lower part of the aperture 129 is larger and it becomes easy for the skewer member 126 to engage with the associated aperture 129. When the roof modules 120, 120a are brought progressively closer to each other, the freedom for the skewer member 126 to move in the aperture 129 becomes progressively smaller. As the newly added roof module 120a is finally juxtaposed with the cooperating roof module 120 and lowered down onto the rafters 112, the narrower, upper part of the aperture 129 helps to further locate and align the newly added roof module 120a with the roof module 120 already mounted on the rafters 112; in this manner, cooperation of the projecting guide 124 and the associated aperture 129 helps to align and juxtapose a newly added roof module 120a to another roof module 120 disposed on the rafters 112.

[0024] As can be seen in FIGs. 2 and 3A, each roof module 120, 120a is supported, at least at four corners, on the rafters 112, with each corner having a L-shaped bracket 140. Each L-shaped bracket 140 comprises an attachment leg 142 and a mounting leg 144. The attachment leg 142 is attached to the edge member of the roof module 120, for example, by screws, whilst the mounting leg 144 is for securing the roof module 120, 120a onto the rafters 112. The mounting leg 144 has a hole 145 through the thickness of the L-shaped bracket for it to be secured to the rafter by means of a bolt and nut. The mounting leg 144 is formed with a corner notch 146 such that the corner notch 146 also extends partially to the attachment leg 142, as shown in FIGs. 2 and 3A. In addition, a corner of the mounting leg 144 (adjacent the corner notch) is chamfered 148. When two adjacent roof modules 120, 120a are brought together for connection with one

another, the chamfered edge 148 of the mounting leg 144 of one roof module 120a cooperates with the corner notch 146 of the adjacent L-shaped bracket disposed on the other roof module 120, thereby helping to guide juxtapositioning of the two adjacent roof modules, in addition to cooperation of the projecting guides 124 and apertures 129. When the two roof modules 120, 120a are juxtaposed, the cooperating mounting legs 144 interlock with one another; this feature allow a roof module 120 to be secured on the rafter at only two brackets 140 by bolts/nuts through the holes 145. The corner notch 146 of the L-shaped bracket on the roof module 120 also puts a limit on any unintentional uplifting of an adjacent roof module 120.

[0025] In one embodiment, the opening width X of the corner notch 146 is substantially half the width of the L-shaped bracket 140. An advantage of this feature is that all the L-shaped brackets 140 becomes identical and this allows this easier implementation of the present invention. In another embodiment, the opening width X of the corner notch 146 is less than half the width of the L-shaped bracket 140. With this embodiment, there will be two types of L-shaped brackets 140a, 140b, which differ substantially in the width of the brackets; preferably, the width of the mounting legs 144 of the first type of L-shaped bracket 140a is substantially equal to the width X of the corner notch 146 of the cooperating L-shaped bracket 140b.

[0026] As can be seen in FIGs. 2 and 3A, a lower face of each roof module 120, 120a is lined with a ceiling module 162. The mounting legs 144 of the L-shaped bracket 140 are disposed below the structural purlin of the roof modules to accommodate the thickness T of the ceiling module 162. As shown in FIG. 3A, the height H of the corner notch 146 is preferably higher than the thickness T of the ceiling module 162. When adjacent roof modules 120, 120a are arranged on the rafters, the adjacent ceiling modules are laid side by side to form the entire ceiling 160. This embodiment allows the ceiling 160 to be completed at the same time of installing the entire roofing system 100. This helps to reduce the amount of work performed at heights above the ground, thereby allowing roof and ceiling works to be carried out more safely and efficiently.

[0027] Whilst not shown in the figures, the ceiling module 162 is made up of a number of panels, in which adjacent panels are interlocked with one another. In one embodiment, the ceiling module 162 has spaced apart holes or apertures 163. When the hollow interior of the roof modules 120 are filled with a sound absorbing material, some of the sound waves generated inside the building 102 go through the holes/apertures 163 on the ceiling module 162 and are

absorbed; in this way, most of the sound waves are not reflected by the ceiling module 162 and echo is substantially reduced. At the same time, the sound absorbing material disposed in the roof modules 120 may also act as a thermal insulation layer. In a similar manner, when a sound barrier layer is disposed below the roofing cover 150, air borne sound will be substantially cut off from entering the building 102.

[0028] The method of prefabricating and installing the roofing system 100 according to the present invention has advantages over conventional methods. Some of the advantages according to the present invention are as follows:

- reduction in the amount of time and skilled labour required for on-site construction;
- increased safety due to reduction in the amount of work required on-site and at elevated heights;
- improvement in work efficiency; and
- increased certainty of meeting construction schedules.

[0029] While specific embodiments have been described and illustrated, it is understood that many changes, modifications, variations and combinations thereof could be made to the present invention without departing from the scope of the invention. For example, the projecting guides may be disposed on the roof modules to be juxtaposed to that already arranged or mounted on the roof rafters and the cooperating egg-shaped apertures are inverted. In another example, the projecting guides and cooperating apertures may be alternatively disposed on the longitudinal edges of the roof modules. In another example, the roof covering may alternatively be installed after the roof modules are juxtaposed and secured onto the roof support system. In yet another example, the surface of the roof covering 150 may be disposed with artificial or real grass.

CLAIMS:

1. A prefabricated roofing system comprising:
a roof support system; and
5 a plurality of roof modules that are pre-designed and prefabricated in a factory, with each corner of a roof module having an L-shaped bracket for mounting said plurality of roof modules onto said roof support system, wherein each said L-shaped bracket has a corner notch and a mounting leg, with said mounting leg at said corner notch being chambered, such that when a new roof module is juxtaposed in a predetermined direction to an adjacent roof module already
10 arranged on said roof support system, said new roof module is guided into position by cooperation of said chamfered mounting leg of an associated L-shaped bracket with said corner notch of the cooperating L-shaped bracket disposed on said adjacent roof module.
2. A system according to claim 1, wherein said roof support system comprises two or more
15 spaced apart rafters.
3. A system according to claim 2, wherein said predetermined direction is in a width W direction of said roof module, and said roof module width is substantially a spacing between two said rafters.
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4. A system according to claim 1, wherein said predetermined direction is in a lateral or longitudinal L direction of said roof module.
5. A system according to any one of claims 1-4, wherein each L-shaped bracket is mounted
25 on an associated rafter via said mounting leg whilst it is mounted onto a side member of the associated roof module via an attachment leg.
6. A system according to claim 5, wherein said corner notch extends to said attachment leg.
- 30 7. A system according to any one of claims 1-6, wherein said two roof modules further comprising separately a projecting guide and a cooperating aperture.

8. A system according to claim 7, wherein said projecting guide comprises a base plate and a skewer member projecting substantially perpendicular to said base plate.

9. A system according to claim 8, wherein the skewer member comprises a base portion that is substantially perpendicular to said base plate and the skewer member is at an acute angle to said base portion so that the skewer member is pointing upwards.

10. A system according to claim 8 or 9, wherein said skewer member is tapered.

11. A system according to any one of claims 7-10, wherein said aperture is oblong in shaped.

12. A system according to any one of claims 7-10, wherein said aperture is egg-shaped.

13. A system according to any one of the preceding claims, wherein each said roof module further comprises a modular roof cover, such that after juxtaposition, adjacent said modular roof covers overlap in said predetermined direction.

14. A system according to claim 13, wherein adjacent roof modules are juxtaposed in a second direction substantially perpendicular to said predetermined direction, so that adjacent modular roof covers overlap along edges in two directions to form an integral roof covering.

15. A system according to claim 15, wherein each said roof module further comprises a modular ceiling panel, so that adjacent modular ceiling panels are juxtaposed in two directions to form an integral ceiling.

16. A method of constructing a roof of a building, said method comprising:

pre-designing a roof support system and a plurality of roof modules for mounting onto said roof support system;

pre-fabricating said plurality of roof modules in a factory;

transporting said prefabricated roof modules from the factory to the building site; and

juxtapositioning said roof modules onto said roof support system; wherein said juxtapositioning is guided by a chamfered edge of a L-shaped mounting bracket disposed on one

roof module engaging a corner notch of a similar L-shaped mounting bracket disposed on a cooperating roof module.

17. A method according to claim 16, wherein said juxtapositioning is further guided by a projecting guide disposed on a side member of said roof module cooperating with an aperture disposed on a side member of said cooperating roof module.

18. A method according to claim 16 or 17, wherein each said roof module further comprises a modular roof cover, and juxtapositioning said roof modules causes edges of adjacent modular roof covers to overlap and form an integrated roof covering.

19. A method according to claim 18, wherein each said roof module further comprises a modular ceiling panel, and juxtapositioning said roof modules causes said modular ceiling panels to form an integrated ceiling.