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Field of Invention

This invention relates to a photovoltaic roof assembly that forms the primary envelop of a building consisting of 2 main components namely the lattice mounting system and photovoltaic panels.

Background of Invention

Building Integrated Photovoltaic systems (BIPV) are usually highly customized and require tailored made PV mounting structures. Highly skilled labor is required to install these BIPV systems and therefore increasing cost and time. Most of the existing BIPV requires that the roof is larger than a certain gradient for example at least 22 degree so that the photovoltaic panels can overlap one another resembling conventional roof tiles to provide water tightness.

Existing PV roof assembly systems usually comprises of many items in order to achieve water tightness. Some roof assembly systems require that the supporting structure to be largely flat and therefore welded steel lattice structure is constructed to achieve the desired flatness. The use of welding of steel structure means that on-site labor will be intensive and cannot be sufficiently cost competitive. The other important factor to be considered in BIPV is aesthetic and should not be appeared as after thought.

US2004011354 discloses a framing system for photovoltaic panels to form a waterproof roof. Frames in the form of extrusions are provided to integrate the edge of a PV panels to the adjacent ones.

US 20070157963 discloses a photovoltaic roof tile assembly system in which tracks and tiles have mating features and the tile can be interlocked with the track.

WO2008052816 discloses curved roof tile like modular photovoltaic element for building roofs.

FR2924729 discloses a support structure for photovoltaic solar panel on industrial building roof, has support rails mounted perpendicularly on industrial sections on which solar panels and accessories of panels are fixed.

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Summary of invention

The present invention provides an integrated photovoltaic roof assembly that is capable of watertight and readily installable on a conventional truss and purlin roof structural support. The invention can be mounted on roof structural support without restriction on the gradient of the roof.

One of the objectives of the present invention is to enable the construction of a lattice mounting structure that consists of a plurality of receptacle frames with flushed surface and guide ribs that match a corresponding number of photovoltaic panels. The construction of the said lattice mounting structure does not require welding and has provisions for thermal expansion and contraction.

The said lattice mounting structure of the present invention comprises of two different elongated profiles, namely the long and short profiles, interconnected perpendicularly to one another to form a plurality of rectangle receptacle frames with sufficient mechanical strength. Each of the rectangle frames has a generally flushed flat surface to match a photovoltaic panel. The long profile has provision to allow the short profile to be partially overlapped and attached to create frames of flushed surface. There are further provisions on the long and short profiles for guiding ribs for enclosing the photovoltaic panel edges and fixing means, and gutters for draining out condensates and water leakages.

The photovoltaic panel is preferred to be polymer framed with a flat base to attach to the rectangle frames of the lattice mounting structure seamlessly. The photovoltaic panel is secured to the mounting structure by structural adhesive or adhesive tapes. The gaps between adjacent photovoltaic panels are sealed using outdoor sealant. A metal strip can be attached onto the gap to clamp down the photovoltaic panels providing further waterproofing.

According to another object of the invention, frameless glass-glass photovoltaic laminates can also be mounted onto the rectangle frames of the lattice mounting structure to form a PV roof assembly.

Yet another object of the invention is glass panel and metal panel without photovoltaic cell can also be attached to the lattice mounting structure as part of the PV roof assembly to serve different purposes such as day lighting.

The long profiles are attached and secured in perpendicular to the roof purlins and the short profiles runs parallel to the purlins. There are further provisions on the profiles to conceal the wires for the photovoltaic system thereby providing an aesthetically pleasing assembly when view from the underside of the roof assembly.

Drawing Description

Figure 1 illustrates the integration of photovoltaic roof assembly on roof 1, canopy 2 and façade 3.

Figure 2 shows an exploded view of the photovoltaic roof assembly.

Figure 3 shows a preferred embodiment of the short profile 21

Figure 4 shows a preferred embodiment of the long profile 41.

Figure 5 shows the cross-section of a polymeric photovoltaic panel 81.

Figure 6 illustrates a typical roof mounting of the photovoltaic roof assembly.

Figure 7 shows the lattice mounting structure with a plurality of flushed flat rectangle frames for accommodating a corresponding number of photovoltaic panels.

Figure 8 is a close-up view of the preferred photovoltaic roof assembly perpendicular to the short profiles.

Figure 9 shows the cross-section view of the preferred photovoltaic roof assembly on roof purlin.

Figure 10 is a close-up view showing the long profile 41 mounted onto the roof purlin 62 using self-tap screws 67.

Figure 11 shows the rectangular receptacle frame 102 formed by long profile 41 and short profile 21.

Figure 12 shows a cross-section view of the preferred photovoltaic roof assembly illustrating the high bond adhesive tape.

Figure 13 is a close-up cross section view showing a preferred installation method using holding bar 68 with self-tap screw 69.

Specific embodiment of the Invention

The integrated photovoltaic roof assembly replaces conventional building materials while generating electricity using a minimum number of components for mounting to achieve mechanical reliability and waterproofing. The integrated photovoltaic roof assembly does not require special tool such as welding for the installation of the lattice mounting structure.

The integrated photovoltaic roof assembly consists of a plurality of photovoltaic panels 81 and the lattice mounting structure. The lattice mounting structure consists of 2 main components namely the long profile 41 and the short profile 21.

The long profiles 41 are fastened onto the roof purlin 62 by self-tap screws 67. Screws are self-tap thus reducing the need for thread cutting, reducing material preparation time. The long profiles 41 are mounted along the inclination of the roof. In other words, the long profiles 41 are oriented perpendicularly to the purlins 62. The long profiles 41 are mounted at pre-determined intervals to each other and thereafter, followed by the mounting of the short profiles 21. The short profiles 21 are pre-cut to pre-determined dimension to mount onto the long profiles 41 at right angle. Both ends of the short profiles 21 are capped with a rubber cap 63 to allow for slight movement/expansion of the mounting structure due to heat, wind and other loading. The short profiles 21 are secured onto the long profiles 41 by self-tap screws 67. This setup completes the lattice mounting structure.

Photovoltaic panels can be mounted onto the lattice mounting structure by several methods. One of the preferred methods is the use of structural adhesive tapes with high bonding strength and also with inherent water proofing property. The photovoltaic panels 81 are applied all round with high bond double sided tape 64. The Photovoltaic panels are then applied onto the lattice mounting structure. Slight pressures are applied on the top of the Photovoltaic panels around the polymeric frames to ensure good adhesion and flatness to seal out water. Backer rods 65 are then placed in between the gaps between the Photovoltaic panels 81. Thereafter, weatherproof sealant 66 is administered in between the gaps to seal up the gaps. This sealant provides a secondary sealing, keeping water from penetrating into the roof assembly.

Another preferred installation method for attaching the photovoltaic panels to the lattice mounting structure uses elastic foam tape such as EPDM material instead of the high bond double sided tape 64. Then Photovoltaic panels 81 are placed onto the lattice mounting structure. After which, EPDM foam rods will take the place of backer rod 65, fill all the gap in between the edges of the Photovoltaic panels 81. Holding bars 68 preferably made of extruded aluminium are then fastened onto the lattice mounting structure 101 via self-tap screws 69 holding the Photovoltaic panels 81 in place while compressing both sets of elastic foam creating a water tight system.

The short profile 21 is an extruded aluminum alloy profile. Surface treatment can be clear anodized or colored anodized to different thickness for different usage. Surface 26 is flat and to be rested on surface 43 of the long profile 41. V-notch 22 is a feature intended to guide the drilling of holes for the installation of the short profile 21 to the long profile 41. Surface 23 on the short profile 21 is for the seating of the photovoltaic panel 81 frame surface 85, which has either high bond tape or EPDM foam tape applied. Guiding rib 24 on the short profile 21 has two purposes namely to provide a means for the alignment of the Photovoltaic panels 81; and for guiding the self-drill screw when the holding bar 68 is used to secure the Photovoltaic panels 81. Gutter 25 is to contain any condensate formed underneath the Photovoltaic panel 81. Gutter 25 further channels

the condensates or water leakage toward the long profile 41 where it will be further drained into the gutter 45 of the long profiles 41 and be drained out of the roof assembly.

The long profile 41 is an extruded aluminium alloy profile. Surface treatment can be clear anodized or colored anodized to different thickness for different usage. The bottom surface 49 of the long profile 41 rests on the roof purlin 62. The V-notch 48 guides the positioning of the self-tape screw 67 when fixing the long profile 41 onto the roof purlin 62. Feature 42 is a "catch" for standard cable conduit cover and the space within acts as a compartment for cables inter-connecting the photovoltaic panels 81. A step rib 43 provides a datum for the base 26 of the short profile 21 to be seated and enables the mounting surface 23 of the short profile 21 to be flushed with the mounting surface 46 of the long profile 41. In other words, the height between the mounting surface 23 and the base 26 of the short profile 21 is of the same height between the mounting surface 46 and the step rib 43 of the long profile 41. The slot 44 on the long profile 41 provides grip for the tying of self-tap screw 67 that fixes the short profile 21 onto the long profile 41. The gutter 45 serves the purpose of collecting the condensate occurring at the underside of the photovoltaic panels 81 and also water channeled from gutter 25 of the short profile 21 to drain out following the inclination of the roof assembly. The flat mounting surface 46 is where the photovoltaic panel 81 is attached upon and where either the high bond adhesive tape or elastomeric foam is applied. The guiding rib 47 serves the same function as the guiding rib 24 on the short profile 21 to align the photovoltaic panel edges and to allow self tapping screws to be affixed.

The polymeric frame 84 is of a material that has good weather resistance and chemical stability. A preferred polymeric material for the frame is polyurethane with suitable UV stabilizer and fire retardant. The polymeric frame 84 fully encased the edges of the PV laminate 83 thus providing water tightness between the PV laminate 83 and the polymeric frame 84. The polymeric frame 84 provides additional protection from water infiltration into the photovoltaic laminate 83 and hence extends the operating life span and reliability of the photovoltaic panel 81. The underside of the frame surface 85 is applied with either high bond adhesive tape 64 or EPDM foam tape before

mounting onto the lattice mounting structure. Drip stop 82 is molded on the underside of the polymer frame 84 to facilitate the flow of condensate and cause it to drop into the gutter 25 of the short profile 21. The top surface 86 of the polymeric frame 84 can be textured with different pattern for improved aesthetic. Junction box with cables and connectors of the photovoltaic panels is located at location that will not obstruct the mounting of the photovoltaic panel 81 onto the lattice mounting structure.

The dimension of the rectangular receptacle frames 102 formed by the long profiles 41 and the short profiles 21 is determined by the dimension of the photovoltaic panel 81. For example, the distance between any two adjacent long profiles 41 running in parallel is based on the length of the photovoltaic panels 81 and the distance between two short profiles 21 running in parallel is based on the width of the photovoltaic panels 81. In other words, the guild ribs on the short and long profiles 21, 41 respectively which formed the four outer edges of the rectangular receptacle frames match the dimension of the photovoltaic panel 81.

Once all the photovoltaic panels are secured onto the lattice mounting structure, the cables and connectors are routed into the space 42 of the long profile 41 and then capped with conduit cover for both protection and tidiness.

Besides photovoltaic panels, glass panels without solar cells can also be attached onto the lattice mounting structure using similar attachment methods. The glass panels are preferred to be of the same size and thickness as the photovoltaic panels to achieve aesthetic pleasing appearance and ease of installation. Glass panels can serve as day lighting and viewing window as in the case of conventional glass canopy. Non glass panels such as metal and composite cladding panels of the

same size and thickness as the photovoltaic panels can also be attached onto the lattice mounting structure to serve specific purpose. For example, metal panel with air vent can be fitted as part of the roof assembly. The present invention can also be extended to totally non photovoltaic application to construct a roof of glass or composite cladding.

Claims

1. A photovoltaic roof assembly comprises a lattice mounting structure having a plurality of perpendicularly interconnected profiles forming a plurality of rectangular receptacle frames each to accommodate a photovoltaic panel.
2. The photovoltaic roof assembly as claimed in claim 1 wherein the interconnected profiles comprise a plurality of short profiles overlapping onto long profiles forming a plurality of rectangle frames.
3. The photovoltaic roof assembly as claimed in claim 2 wherein each of the plurality of rectangle frames has a flushed surface for a photovoltaic panel to be mounted.
4. The photovoltaic roof assembly as claimed in claim 3 wherein the long profile consist of a base to be mounted onto the underlying roof structure such as a purlin, at least a step rib for the short profile to be seated, at least a gutter groove for draining away condensates and water leakage, a flat mounting section for the photovoltaic panel to be mounted, at least a guide rib for enclosing the photovoltaic panel edges and provisions for wires to be kept.
5. The photovoltaic roof assembly as claimed in claim 4 wherein the short profiles consist of a base, a flat mounting section for the photovoltaic panel to be attached, a gutter for draining off the condensates and a guide rib for the enclosing the photovoltaic panel edges.
6. The photovoltaic roof assembly as claimed in claim 5 wherein each of the short profiles is placed onto the step ribs of the two perpendicularly adjacent long profiles such that the flat mounting section of all the profiles are flushed.
7. The photovoltaic roof assembly as claimed 6 wherein each of the profiles is a single element preferably made of aluminum alloy extrusion.
8. The photovoltaic roof assembly as claimed in claim 7 wherein the photovoltaic panel is attached on the flat mounting section of the lattice mounting structure and aligned with the guild ribs of both the short and long profiles.
9. The photovoltaic roof assembly as claimed in claim 8 wherein the photovoltaic panels are mounted onto the lattice mounting structure using structural adhesives.
10. The photovoltaic roof assembly as claimed in claim 9 wherein outdoor sealant is applied to seal the gap between adjacent photovoltaic panels.

11. The photovoltaic roof assembly as claimed in claim 10 wherein a metal strip preferred to be an extruded aluminum profile is fitted to the guide ribs of the lattice mounting structure to clamp down the photovoltaic panels.
12. The photovoltaic roof assembly as claimed in claim 1 wherein the photovoltaic panel is a photovoltaic panel with polymer frame.
13. The photovoltaic roof assembly as claimed in claim 1 wherein the photovoltaic panel is a laminate, glass or metal composite.