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(54) ROOF STRUCTURES

(71) I, DONALD, KEITH GUDGEON, of 1B Belmont Road, Singapore 10, of Australian nationality, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to roof structures, in particular those incorporating trusses, and to a special bolt used in the construction of the trusses.

Roof structures for industrial plants generally incorporate a number of trusses, interconnected by further trusses and tie bars, on which the roofing is supported. The structure is supported on columns, generally at the points of intersection of the trusses.

Simple trusses comprise a latticework formed by pair of parallel chord members in vertically spaced relationship interconnected at intervals by a series of bracing strut members which intersect the chord members, the members being connected together at their points of intersection by gusset plates.

The trusses may be of welded or bolted construction. Advantages of bolted construction are that the trusses can be assembled on site from pre-fabricated components without requiring skilled welding techniques, and may subsequently be simply taken apart or altered as required.

Roof structures are subject to so-called "dead" and "live" loads, the former being due to the weight of the structure and roofing itself, and the latter arising from forces of the elements, i.e. wind and rain, and from any personnel or equipment required on the roof for maintenance purposes.

In industrial plants, the roof may additionally be required to support "hung" loads, i.e. industrial equipment suspended from the roof. The roof structure in the region of these "hung" loads will therefore have to be strengthened to support the additional loading, unless the entire roof structure is designed to accommodate hung loads.

If only certain parts of the roof structure are to support hung loads, these parts will usually be made of stronger construction when the roof is built. However, the layout of industrial plant may change frequently, resulting in alteration of the requirements for hung loads, and this may require substantial re-construction of the roof.

It is an object of the invention to provide a roof structure which may be readily adapted to suit changing plant layouts, by incorporating in the structure trusses which may be conveniently strengthened to support hung loads as required.

The present invention accordingly provides a roof truss formed by a latticework constructed from a plurality of elongate members connected together by means including bolts each having two threaded end portions for receiving respective nuts and an intermediate head portion, said latticework being constructed with the use of one end only of each bolt, the other ends of the bolts being free for attachment of additional members to strengthen the truss.

The invention further provides a roof structure formed from a plurality of roof trusses of the kind described above.

Preferably, the bolts are made of high-strength steel. The truss may conveniently have the simple structure described above, i.e. a pair of spaced chord members interconnected at intervals by bracing strut members which intersect the chord members, the members being connected together at their points of intersection by gusset plates. According to the required position of hung loads, some or all of the members of the truss may then each be reinforced with respective additional members, which may be of equal dimensions and strength to the existing members, or of greater or lesser strength, as required. A roof structure incorporating such trusses may thus be readily adapted to changes in plant layout, without requiring extensive reconstruction work or skilled labour.

The invention further provides a method of constructing such a roof structure formed from a plurality of trusses, the method comprising constructing each truss with a lattice-work, designed to bear dead and live loads on the roof, of members connected together by bolts each having two threaded end portions for receiving respective nuts and an intermediate head portion, only one end of the bolt being used in forming said lattice-work, interconnecting said trusses to form a basic roof structure, and bolting on one or more additional members to one or more of the trusses by means of the other ends of the bolts, to strengthen the roof structure to support hung loads as and when required.

The invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional view of a two ended bolt, showing how it serves to attach one member of a truss to a gusset plate, and how an additional member may be attached;

Figure 2 is a sectional view of the central head of the bolt along the line X—X in Figure 1;

Figure 3 is a sectional view of a packing washer along the line X—X in Figure 1;

Figure 4 is a plan view of a roof structure;

Figure 5 is a side elevation of part of the roof structure showing a truss;

Figure 6 shows the detail A in Figure 4.

Figure 1 shows a bolt 1 with two threaded portions 2 and 3 and a central head 4. A structural member 5 of a truss is attached to a gusset plate 6 by means of the portion 2 of the bolt and a nut 7 threaded on the portion 2 with washer if required. Figure 2 shows a possible configuration of flats 8 for tightening.

When the truss is to be strengthened to support hung loads, the member 5 is augmented by an additional member 9, which is attached to the gusset plate 6 by means of the second threaded portion 3 of the bolt and a further nut 10 with washer if required, a packing washer 11 being inserted between the member 9 and plate 6. The packing washer provides frictional support between the additional member 9 and gusset plate 6, and is shown in Figure 3 with an octagonal shape, although any other convenient shape may be used.

The additional member 9 may be of greater, lesser or equal strength to the member 5, depending on requirements.

Figure 4 shows in plan view part of a roof structure which basically consists of two sets of parallel spaced trusses 12, the trusses of one set extending perpendicular to the trusses of the other set, with which they intersect, the structure being supported on columns 13 at the points of intersection of the trusses.

In Figure 5 part of a truss 12 and two columns 13 are shown in side elevation. Column braces 14 are provided at the upper end of the columns connected to the truss 12, and purlins 15 are carried by the truss to support the roofing. Parallel trusses are also interconnected by ties 16 at intervals.

The detail "A" in Figure 5 is shown in Figure 6, and shows the location in the truss 12 of the two-ended bolts 1 described with reference to Figure 1, the number and location of bolts being as required.

One chord member 17 is connected to two strut members 18 of the truss at this point by means of a gusset plate 19, each member being bolted onto the gusset plate 19 by bolts 1.

As previously described, normally only one end of each bolt 1 is used to construct the basic truss, the other end being free for attachment of strengthening members when hung loads are to be supported.

The roof structure particularly described and illustrated in Figures 4 and 5 is envisaged for use in tropical developing countries, where plant layout is likely to change frequently, and skilled constructional workers, e.g. welders, are hard to come by.

The trusses are assembled using jigs. Each column is a heavy steel section, but all trusses are made from readily available steel angles or similar and the purlin is a thin section C-Channel or similar. The column braces are of thin section RHS or similar. The jigs enable the basic member to be assembled by local labour without affecting accuracy; only one quality control supervisor is therefore necessary. Natural ventilation and light can be provided anywhere on the roof by means of standardised lantern roofs.

The foundations, columns and some framing of this roof structure are designed for the full dead load, live load (wind and maintenance) and hung loads whereas the main roof supporting members other than the above members are only designed for dead load and live load. However, they are pre-drilled and bolted together with special bolts and therefore additional steel members need be inserted only at those positions where roof loads are actually hung. If that load is removed the strengthening member is also removed and re-used elsewhere.

To cope with heavy rainfall in tropical storms, roof gutters can be provided which bring the water from the roof to drains in the factory floor, but this is undesirable as a blockage of the floor drains can flood the plants. For this reason, large roof gutters are preferably adopted outside the plant where leakage can cause no harm.

In areas of water shortage, water can be collected easily from the roof for various industrial or domestic usage, which is especially of importance during dry seasons.

WHAT I CLAIM IS:—

1. A roof truss formed by a latticework constructed from a plurality of elongate members connected together by means including bolts each having two threaded end portions for receiving respective nuts and an intermediate head portion, said latticework being constructed with the use of one end only of each bolt, the other ends of the bolts being free for attachment of additional members to strengthen the truss.

2. A roof truss as claimed in claim 1 wherein the latticework comprises a pair of parallel spaced chord members interconnected at intervals by bracing strut members which intersect the chord members, the members being connected together at each point of intersection by bolting on to a gusset plate using one end only of each bolt, the free ends of the bolts in the truss all being on the same side of the truss.

3. A truss as claimed in claim 1 or 2 wherein said truss is strengthened by the bolting on of at least one additional member by means of said free ends of the bolts.

4. A roof truss as claimed in claim 3 wherein a packing washer is located over the head of each bolt used for bolting on said at least one additional member.

5. A roof truss as claimed in claim 3 or 4 wherein said at least one additional member is bolted on parallel to an existing member of the truss of identical length.

6. A roof truss as claimed in any preceding claim wherein each bolt is made of high strength steel.

7. A roof structure formed from a plurality of roof trusses as claimed in any preceding claim.

8. A roof structure as claimed in claim 7 and comprising two sets of parallel spaced trusses, the trusses of one set extending perpendicular to and intersecting the trusses of the other set, the structure being supported on columns at points of intersection of the trusses.

9. A method of constructing a roof structure formed from a plurality of roof trusses as claimed in claim 7 or 8 comprising constructing each truss with a latticework, designed to bear dead and live loads on the roof, comprising elongate members connected together by means including bolts each having two threaded end portions for receiving respective nuts and an intermediate head portion, only one end of the bolt being used in forming said latticework, interconnecting said trusses to form a basic roof structure, and bolting on one or more additional members to one or more of the trusses by means of the other ends of the bolts, to strengthen the roof structure to support hung loads as and when required.

10. A roof truss substantially as herein described with reference to the accompanying drawings.

11. A roof structure substantially as herein described with reference to the accompanying drawings.

12. A method of constructing a roof structure substantially as herein described and claimed in claim 9.

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