The present invention relates to a novel arrangement of umbrella type frame structure to be used as a principal structure of buildings, which is light and very strong using least members and is characterized in that the umbrella type frame structure has square or substantially square roof surface in its plan view consisting of a funnel-shaped angular pyramid, the apex of which is located at the lowest position, and is supported by a pillar provided at the lowest portion, wherein diagonal beams are projected from the top of the supporting pillar to four corners of the roof, wherein corners are connected each end of the upper chords of a plurality of truss beams which are parallel to each side of the roof and have a depth corresponding to each span, and the upper and lower chords of the adjacent truss beams are connected as a unit and the vertical section of each truss beam consists of a part of a continuous zig-zag shape, the depth of which is made uniform or successively smaller from the outermost end to the center of the roof.

For a better understanding of the invention reference is taken to the accompanying drawings, in which—

FIG. 1 is a perspective view of the umbrella type frame structures embodying the invention.

FIG. 2 is also a perspective view illustrating the manner of assembling the stays and diagonal beams and upper frames only,

FIG. 3 is a plan view of FIG. 2,

FIG. 4 is a side view of same,

FIG. 5 is a sectional side elevation taken on the line A—A of FIG. 3,

FIG. 6 is a partial view of the beam,

FIGS. 6 and 7 represent elevations of each truss beam respectively, and

FIG. 8 is a diagrammatic perspective view of a portion of the frame work illustrating the manner of assembling each truss beam.

FIG. 9 is a partial sectional view along line A—A of FIG. 3. The view is tipped to be horizontal for simplicity.

FIG. 10 is similar to FIG. 9 and shows another embodiment.

An embodiment of the invention will be explained with reference to the accompanying drawings, in which 1 represents the roof having square or almost square shape in its plan view and funnel-shaped angular cone or pyramid with its apex at the lowest position and 2 represents a pillar for supporting the central portion.

According to the invention, diagonal beams 3 are projected from the top 2a of the pillar 2 towards four corners of the roof 1, to which corners are connected both ends of the upper chord 4a of a number of truss beams 4 which are parallel to each side of the roof 1 and having the depth varying according to the length or span, or uniform depth, and the upper chord 4a and lower chord 4b of adjacent truss beams 4 are connected together by diagonal members as a unit in such manner that the vertical section of truss beams passing through the center of the roof and normal to truss beams forms a continuous zig-zag shape which becomes smaller successively from the periphery towards the center, or has uniform depth.

Referring to FIGURES 6 to 8, each truss beam 4 is comprised of two parallel upper chords 4a, a lower chord 4b parallel to either of said upper chords, and lattice members 4c connecting the lower chord 4b to the upper chords 4a in zig-zag fashion at desired intervals. The transverse cross section of the truss is always a V shape formed by the upper and lower chords at corners and the lattice members at two sides. The upper chords and the lower chord, for instance, can be made of structural angle steel, and the lattice members, for instance, can be made of either structural angle steel or steel bars. One end of each lattice member is fixed to the upper chord by any conventional means, such as welding, riveting, bolting, etc., forming a suitable angle between the chord and the member. The other end of each lattice member is fixed to the lower chord in a similar manner to the upper chord forming an angle between the chord and the member depending on said angle between the member and the upper chord. The upper chords are longer than the lower chord, and each end portion of upper chords in the truss is connected to that end portion of the lower chord which is located on the same side of the truss by means of lattice members 4c.

Referring to FIG. 1, a plurality of upper chords in the trusses thus formed are connected to the diagonal beams 3 at suitable intervals and in parallel to sides of the polygonal truss formed by lines connecting the ends of said diagonal beams 3. The lower chords 4b depend from the upper chords 4a by means of the lattice members 4c of individual trusses. It should be noted here that the lower chord 4b of any truss beam is free from the diagonal beams 3 and any members of adjacent trusses 4.

Each V-shaped truss beam 4 in a sector defined by two adjacent diagonal beams 3, is connected to the adjoining truss beam 4. The connection is made by attaching upper chords 4a as shown in FIGURE 9. Any suitable attaching means may be used, such as nuts and bolts, rivets, welds, etc.

Similarly each individual V-shaped truss beam 4 may be formed of two planar trusses each having an upper chord 4a and a lower chord 4b. The two planar trusses are thus fastened together along lower chords 4b to form the V-shaped truss beam of FIGURE 10. For the sake of clarity the other figures show the structure as being comprised of only a single upper and lower chord at each connection point.

According to the invention, there are a plurality of concentric closed loops formed of truss beams 4 connected to the diagonal beams such that the respective sides of the loops are parallel as seen in FIGURE 3. The length along the periphery of the closed loops decreases from the outermost loop to the innermost loop.

Therefore, where any closed loop crosses the diagonal beam, the three structural members—two upper chords of adjacent trusses to be connected and the diagonal beam—are connected at one point. That is to say, if an end of an upper chord 4a of a truss beam is connected to a certain point of the diagonal beam 3, then the end of the chord 4a of the adjacent truss beam to be joined thereto must be connected to the same point on the opposite side of diagonal beam 3.

By arranging a required number of the umbrella shaped unit structures constructed as above described in parallel a structural body having a required area can be constructed.

The function of the umbrella type frame structure according to the invention will now be explained. Load on the roof 1 does not absolutely cause the bending stress on the diagonal beams 3 as the characteristics of the umbrella shape and also no collapse occurs due to the reduction of stress on both sides of the compressive load only acts on the beam 3, and accordingly the diagonal beam 3 may have such a sectional area as to resist the compressive stress only so that the beam may be made smaller size and light in weight and also very simple in its shape.

Now considering the load on the truss beams 4, as the results of the loads as shown by the arrow B in FIG. 2.
having its apex at the lowest position, said structure being supported at the apex by a fixed pillar having diagonal beams projecting therefrom and extending to each corner of said structure and truss beams having upper and lower chords, each truss beam having two upper chords and one lower chord, said upper chords of each truss beam connecting adjacent diagonal beams, said upper chords forming a number of spaced, concentric, closed loops with respective sides of said loops substantially parallel, said lower chords being substantially parallel to said upper chords and spaced below and connected intermediate thereto, said lower chord of each truss beam being free from connection with said diagonal beams and from connection with any members of adjacent truss beams, and lattice members connecting said lower chord to both of said upper chords in zig-zag fashion including connections between end portions of the upper chords and respective end portions of the lower chord so that the tensile force acting on said upper chords due to said funnel structure are compensated for to a predetermined extent with compressive forces acting on said upper chords due to vertical distributed loads inherent to said truss structure.

2. A frame structure as claimed in claim 1 wherein the height of each truss beam is successively reduced from the outermost truss beam to the innermost truss beam.

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