ABSTRACT: A cable-suspended roof structure is provided to span wide areas as, for example, stadiums, coliseums, arenas, playing fields and the like. More specifically, a roof is provided in which cables under tension extend between substantially centrally located tension ring means and a surrounding continuous or enclosed ringlike compression member, their ends being anchored securely therein and said cables being under tension. An upper and a lower double layer of cables is employed and compression spreader means spanning between each cable of either set and each of the proximate cables of the other set.
CABLE-SUSPENDED ROOF STRUCTURE

SUMMARY OF THE INVENTION

A cable-roof structure is particularly adapted to cover wide areas in part because it is the most economical method of spanning such wide areas and in part because of its lightness, structural and architectural advantages to be derived. A cable-roof structure is one in which steel cable is the load-bearing, structural element and the use of trusses and beams and intermediate supporting columns may largely be avoided. This invention, more specifically, is concerned with a cable-suspended structure which quite simply can be produced as a roofing structure having a substantial lightness while at the same time being inherently stable under both positive and negative loading conditions. Further, this invention is concerned with the use of cables in a cable-roof suspension system in which the individual cables are kept in equilibrium and the inherent elastic stability of cable suspenders is dampened and restrained to combat motion, sometimes referred to as “flutter” which may occur upon being subjected to exterior dynamic forces as in the case of wind, mobile and seismic load and, conceivably, from sound waves or vibrations in the ground set up by vehicular traffic. In this invention cables function as suspenders between a centrally or medially located tension ring and surrounding an elevated compression structure wherein the cables are under tension. More particularly, two layers or sets of cables are employed. One set is superposed with respect to the other set in such manner that each cable of the superposed set divides the space between the proximate cables of the lower set and each cable of the upper set is in relation to each cable of the lower set equidistantly spaced therebetween and compression spreader means is securely fixed at its ends to said closely adjacent cables of the two sets. It is also a part of the invention to arrange that the compression spreader means function as roofing and space enclosing element to shield the area beneath the cable from the forces of nature.

DRAWINGS

FIG. 1 is a half plan view of the building structure according to this invention;
FIG. 2 is a transverse schematic sectional view of the structure of FIG. 1;
FIG. 3 is a cross-sectional detail view of a compression element used in the building;
FIG. 4 is an enlarged cross-sectional view of a tension ring employed in the construction of a building;
FIG. 5 and FIG. 6 are schematic views illustrating modes of adapting the tension ring structure for various uses;
FIG. 7 is an upright cross-sectional view of a compression ring employed at the apex of the central dome of the structure shown in FIG. 2;
FIG. 8 is a cross-sectional view taken on line 8-8 of FIG. 1;
FIG. 9 is a cross-sectional view taken on line 9-9 of FIG. 1 and FIGS. 10 and 11 are enlarged detailed views of the joints shown in FIGS. 8 and 9.

DESCRIPTION OF THE INVENTION

In the drawings, particularly in FIGS. 1 through 9, is illustrated a preferred form of the invention as embodied in a building.

A compression ring 12 is supported on a plurality of columns 14 which rise above the ground a suitable height to insure that roofing structure enclosed by the building is adequately elevated that the space thereby enclosed is desirably open for use in games and sports and spectacles. The compression ring 12 is preferably formed of composite steel and reinforced cast concrete. It is continuous and may be annular or eccentric in shape as determined by the architectural concept being carried out.

Centrally located within the compression structure 12 is a tension ring 16, as shown in FIG. 4, which may be of boxlike configuration. In cross section ring 16 may be triangular comprising legs 18, 20 and 22 of steel arranged to meet at the respective corners of the triangular section of the ring and there joined either by welding or riveting or other suitable technique. Also referring to FIG. 4, said tension ring 16 is further composed of three quadrangular chords 65, 66 and 67 which supply the necessary tangential resistance to tension forces.

Two sets of suspender cables are employed. One set is a lower layer designated 24 and the other set being an upper layer designated 26. The inner ends of cables 24, by means of clevises 28 are connected to one of the angles of ring 16 and extend outward and by anchors 30 are secured immovably in the ringlike compression 12. In a similar manner each cable 26, by means of a clevis 32, extends outwardly and is secured by anchor 34 to compression structure 12.

Referring to FIGS. 8 and 9, it will be seen that the cables 26 divide the space between pairs of overlying cables 32 equally and conversely each of the overlying cables 32 equally divides the space between any pair of subjacent cables 26. This arrangement comes about by reason of the cables of the two layers all radiating outward from the tension ring to the compression structure in a substantially uniform manner with the spaces between the pairs of cables of each set being equally divided by the offset over or underlying cables of the other set.

It is also an important feature of this cable-roof suspension system that the spacing or separation of any cable of one set is equidistant from each of the proximate paired cables of the other set as is shown in FIGS. 8 and 9 irrespective of the fact that both sectional views are taken at two different radial distances from the axis of the structure. This arrangement, when rigid separators 34 are disposed between proximate cables, results in an accordion-pleated roof structural arrangement in which the pleats closer to the center of the structure are in effect tighter or more upright; and, conversely, the same pleats near the perimeter of the structure are less steep and less upright.

By insuring that the distance between each cable 26 and each of the proximate cables 32 is the same irrespective of their extension outward from the tension ring, makes it possible that the rigid separators 34 can be provided by employing rigid wooden structural elements commonly available in the lumber market. For example, the separators 34 may be plywood sheets of uniform lengths or widths anchored at their ends to the cables in the manner shown in FIG. 10. Also see FIG. 11.

Suspended beneath the tension ring 16, as can be seen in FIG. 4, is housing structure 40 which may be so arranged as to provide rooms 42 having viewing windows 44 that may be either used as projection or light rooms or as viewing rooms such as shown in FIG. 5. Housing 40 may also include a corridor 46 which extends annularly around and beneath tension ring 16 for the convenience of people moving to or from rooms 42. A space 48, as well as the space within the open-work tension member 16, may be employed for installation of service conduits, drain equipment, air conditioning equipment and the like. By providing beneath the floor of housing 40 a pair of rails 50, travelling television and photographic cabs 52 may be suspended and moved to follow the action of activity taking place within the building and below these viewpoints.

To enclose the space within tension ring 16, arched beams 60 may be seated against that portion of the ring designated 18 in FIG. 4 and arise therefrom toward the apex of the building at which point is supplied an upright second compression ring 64. Such beams may be of laminated wood construction, but obviously they may likewise be manufactured of steel in any of the well known and available techniques.

Compression ring 64 may be caged by any acceptable roofing structure whether planar or domed or conical, all as may be chosen by the designer.

It is believed an appreciation of the concept involved herein and of this invention may better be had by the recitation of a
few pertinent measurements. In the example columns 14 would be approximately 200' high and support a compression structure having a face penetrated by cables 24 and 26 of about 4' in height. The tension ring 16 would desirably have a height in the neighborhood of 14' to 16' and would be suspended about 70' below the height of the ringlike compression member 12. In this example tension ring 16 is conceived as being about 400' in diameter with the arched beams forming the concavo-convex domelike roofing structure bearing thereon, rising about 80' or just slightly higher than the elevation of the compression structure. Compression ring 64, for convenience of illustration, might be about 20' in width and possibly 10' in height.

In the foregoing has been set forth the details of a preferred embodiment of the invention. It will, of course, be recognized by those skilled in the art that alterations and modifications without departure from the principles of the invention may be made.

I claim:
1. A building, comprising:
   a tension ring located in elevated relation to the earth in a medial position with respect to an area to be covered;
   a ringlike compression structure supported in surrounding and elevated relation with respect to said tension ring;
   a first set of suspender cables anchored to and spanning between said compression structure and said tension ring;
   a second set of suspender cables also anchored to and spanning between said compression structure and said tension ring, said second set being in superposed relation to said first set;
   each cable of said second set being located above and medi ally between a juxtaposed pair of cables of said first set, the spacing of any cable of either set with respect to a proximate cable of the other set being equidistant throughout their lengths; and stiff separator means spanning between each cable of either set and each of the proximate cables of the other set.
2. A building according to claim 1 in which there is roofing structure spanning the space defined by said tension rings and borne thereby.
3. A building according to claim 2 in which the roofing structure comprises a concavo-convex domelike structure.
4. A building in accordance with claim 1 in which the compression structure is annular.
5. A building in accordance with claim 1 in which the compression structure is eccentric in plan configuration.
6. A building structure in accordance with claim 4 in which the tension ring is located at the axis of the annular compression structure in a concentric manner.
7. A building structure in accordance with claim 6 in which the tension ring is annular and is located with relation to the compression structure in nonaxial relationship.
8. A building structure in accordance with claim 1 in which the compression structure is supported and borne by a plurality of columns.