STIFFENING MEANS FOR STRUCTURAL ELEMENTS

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ABSTRACT

Stiffening means for structural elements is formed by helically wound wires. These wires are wound in several different paths with several wires in each path. Each path follows the contour of a section having straight sides, and the wire portions in said sides constitute straight braces. The sections having the straight sides are arranged in such an adjacent relationship that adjoining sides will engage each other, the straight wires in adjoining sides being interconnected at coincident points.

14 Claims, 11 Drawing Figures
STIFFENING MEANS FOR STRUCTURAL ELEMENTS

This invention relates to stiffening means for structural elements, said means being formed by helically wound wires.

According to the invention, the wires are wound in several different paths with several wires in each path. Each path follows the contour of a section having straight sides and the wire portions in said sides constitute straight braces, the sections having the straight sides being arranged in such an adjacent relationship that adjoining sides will engage each other, and the straight wires in adjoining sides being interconnected at coincident points.

The stiffening means according to the present invention thus is a mat of helically wound wires. The mat can be readily handled for a great many uses, particularly the manufacture of sandwich constructions. The mat functions as a shear element by reason of the straight wires in adjoining sides since these wires are interconnected in coincident points. The boundary layer between two helical systems can thus be considered to function as a stiff plate. In fact, the boundary layer will contain a trussing of braces which is capable of transmitting forces from one plane of the mat to the other plane thereof.

The mat of helically wound wires can be utilised as stiffening means for both planar and curved structural elements. The latter may present both single and double curvature. The stiffening means can be used for example in the building of boat hulls, automobile bodies and airplane wings.

In a specific embodiment, the means is part of a supporting structure which essentially consists of helically wound wires. Characteristic of the stiffening means is that the sections having the straight sides together entirely fill out an outer contour having straight sides, said sections thus stiffening a structure consisting of a plurality of helically wound wires which are wound exclusively along said outer contour having straight sides and form straight braces at said sides, and the wires wound along the outer contour are wound in a direction opposite to the other helically wound wires to which they are connected at coincident points. The supporting structure thus realized is of very light weight and possesses great surface stiffness. It is therefore especially suited for use in combination with insulating material as an insulated ceiling or wall element in a coffered ceiling or wall.

The invention will be more fully described hereinafter with reference to the accompanying drawings which illustrate some embodiments, chosen by way of example, of the stiffening means in coaction with structural elements.

IN THE DRAWINGS

FIGS. 1 and 2 are end views of two different embodiments;
FIGS. 3-5 are diagrammatic end views of three other embodiments;
FIGS. 6 and 7 are end views of two further embodiments which relate to the supporting structure of helically wound wires;
FIGS. 8-10 are diagrammatic cross-sections of three further embodiments of the supporting structure; and FIG. 11 is a top plan view of a supporting structure.

In the embodiment illustrated in FIG. 1 the wires are wound in four different paths 1-4 with several wires in each path, the wires in all of the paths 1-4 being wound in the same direction. Each path follows the contour of a section having straight sides 5-8 and being of square shape. Said section, however, may also be of rectangular, triangular or parallel trapezoid shape. The wire portions in the straight sides 5-8 of the sections form straight braces. The wires in all sections will normally be of the same cross-section but could of course have different cross-sections. Usually, the wires are of iron but they could also be of another material such as aluminum. The aluminium wires may be hollow to reduce weight and material consumption.

The sections 1-4 having the straight sides 5-8 are arranged in such an adjacent relationship that the adjoining sides 5 and 7 will engage each other, the straight wires in adjoining sides 5 and 7 being interconnected, for instance by welding, at coincident points.

The sections 1-4 having the straight sides 5-8 are arranged in such an adjacent relationship that the straight sides 6 between the adjoining engaging sides 5 and 7 infinitely merge into each other and collectively support a flat structural element 9 connected with the wires in said sides. The structural element 9 may be a plate, a sheet or like layer. The flat structural element 9 is fastened for instance by welding, gluing or by means of clips to the wires of the support which comprises the sides 6 and thus stiffens the surface proper of the element 9. As shown in the drawing, the sides 6 lie in one and the same plane and thus constitute the support of a planar structural element 9 connected to the wires in said sides 6. In another embodiment, the straight sides 6 may make an angle with each other, collectively constituting the support of a curved, flat structural element connected to the wires in said sides 6.

In the embodiment illustrated in FIG. 1, those straight sides 8 of the sections 1-4 which lie opposite the straight sides 6 having the structural element 9 fastened to them, are adapted to carry another flat structural element 10 which is connected to the wires in said straight sides 8. As shown in the drawing, the straight sides 8 lie in one and the same plane and carry a planar structural element 10 which is plane-parallel with the planar element 9.

In the embodiment illustrated in FIG. 2, each path 11-14 of the helically wound wires follows the contour of a section having straight sides 15-18 and being rectangular without being square. Apart from this, the embodiment illustrated in FIG. 2 differs from that in FIG. 1 only in that the planar structural element 10 has been replaced by longitudinal structural elements 20 formed by rods or like means. These elements 20 are connected to the wires at the points where the sides 18 which are opposed to the sides 16 supporting the planar structural element 19, infinitely merge into each other, i.e. opposite the adjoining interconnected sides 15 and 17. Besides, elements 20 are arranged at the outer edge of the sides 18 at the paths 11 and 14.

The embodiment shown in FIG. 3 differs from that of FIG. 1 only in that the paths 21-27 of helically wound wires follow the contours of triangles instead of squares. The arrows in the Figure are meant to illustrate that the wires in all of the paths 21-27 are wound in the same direction. The planar flat structural elements connected to the mat of helically wound wires are designated 29 and 30. At least one of these struc-
ural elements could be replaced by elements corresponding to the rods 20.

In the embodiment shown in FIG. 4 the paths 31-35 of the wires helically wound in the same direction follow the contours of trapeziums, the planar mat formed of these helically wound wires being connected to the two planar flat structural elements 39 and 40.

Also in the embodiment shown in FIG. 5 the paths 41-48 of wires helically wound in the same direction follow the contours of trapeziums. These, however, are arranged in such a way in relation to each other that the straight sides between the adjoining interconnected sides make angles with each other and together constitute the support of a pair of tubular structural elements 49 and 50 connected to the wires of said sides. Of course, other embodiments of structural elements having both single and double curvature may be chosen.

The wires wound in paths shall not always follow throughout the length of the helices, the contour of the same section having the straight sides but in certain cases and particularly where structural elements having single and double curvatures are to be stiffened, said section may be changed, for instance by alteration of the pitch of the helices. The change can also be provided by altering, in the winding operation, the cross-section of the crown on which the helices are wound. Besides, the contour may of course be changed by alteration both of the crown and of the pitch of the helices. The embodiment shown in FIG. 5 may be subjected to such alteration. This will successively reduce or increase the size of the trapezoid sections, which will give a more construction of a cross-section that tapers toward one end.

Each system of helices comprises several wires. The number of wires in the systems of helices is dependent upon the cross-section of the wire, the desired pitch and the unsupported length over which buckling occurs. The appearance of the section is warranted by the distance between the structural elements on the two sides, the desired surface stiffening effect and the distribution of the longitudinal and lateral forces. Thus, for instance, the triangular embodiment provides the possibility of transmitting large lateral forces. A great number of wires give a large surface stiffness to the layer connected to these wires and permits using a smaller wire diameter.

At the manufacture, the mat of helically wound wires is first made, the adjoining helices being united by welding or other fastening process at the points of contact. Then one plate or sheet is fastened to the mat. In the next phase the other structural element is fastened to the mat. The finished construction can readily be filled out with a composition such as urethane foam.

Like the other embodiments of the supporting structure illustrated, the supporting structure in FIG. 6 has rectangular cross-section. The supporting structure includes two multiwire systems of helically wound wires, the wires 52 of one system being wound in one direction while the wires 53 in the other system are wound in the other direction. The metal wires 52 and 53 in the two systems preferably have the same cross-section, but in certain cases the wires 52 and 53 may be of different large cross-section.

The wires 52 in one system are wound in a path which follows the contour of the rectangular section of the supporting structure, the wire portions in the sides of the supporting structure forming straight braces. The wires 53 in the other system are wound in several separate paths 54-58 each of which follows the contour of a rectangular section, the wire portions in the sides of the sections forming straight braces. The rectangular sections of the paths 54-58 together entirely fill out the section of the supporting structure insofar as the sides of the sections 54-58 engage each other and the sides of the section of the supporting structure.

The wires 52 and 53 in the two systems are interconnected for instance by welding at coincident points. Apart from the wires 52 and 53, the supporting structure also includes longitudinal metal rods 59 which are arranged at least at the corners of the section of the supporting element. However, longitudinal rods 59 may be arranged also at common corners of such sections 54-58 as together entirely fill out the section of the supporting structure.

As will appear from FIG. 6, the wires 52 in one system are oriented externally of the longitudinal rods 59 of the supporting structure, while the wires 53 in the other system are oriented internally of the longitudinal rods 59.

The wires 52 in the multiwire helix surrounding the section of the entire supporting structure may be for instance seven in number, while each helix 54-58 may include two wires 53. The number of wires 52 in the surrounding helix is dependent upon the geometrical shape of the section, the number of internal helices 54-58 and the number of wires in said internal helices.

For instance, the structure may be so designed that the adjoining helices meet at the adjoining corners and that a longitudinal rod 59 meets at the same point. One of the surrounding helix wires is also connected at the same crossing so that a space framework is obtained, i.e. a structural system statically determined in space.

The longitudinal rods 59 being distributed over the supporting structure, loads acting toward the centre thereof are readily taken up in that the juxtaposed tension and compression members are caused to function and that in the space framework distributes the load onto adjoining rods so that the effect of the load is spread and the entire construction is forced to contribute in taking up the load.

The embodiment shown in FIG. 7 essentially differs from that in FIG. 6 in that the wires 53 in the other system are wound in several different paths 60-68 each of which follows the contour of a triangular section. These triangular sections 60-68 together entirely fill out the rectangular section of the supporting structure which has longitudinal rods 59 only at its corners. Without the aid of internal longitudinal rods the helices thus produce a lateral distribution of the load to two tension and compression members 59.

As shown in FIG. 7, the supporting structure comprises seven wires 52 while each of the helices 60-68 includes three wires 53. In this case also, a space framework is provided. A concentrated force toward the centre of the supporting structure is transmitted to the longitudinal bars 59 in that tension and compression is developed in the wire network formed by the helices at the upper and the lower side, respectively, of the supporting structure. The rods of the internal helices 60-68 in the vertical plane transmit transverse forces between said two sides.

In still another embodiment the supporting structure is composed only of the two systems of helically wound wires 52 and 53. A surrounding helix consisting of sev-
eral wires 52 is thus filled with small internal helices made up of several wires 53.

It will appear from FIGS. 8–10 that the internal helices 53 may be varied in a great many ways within the space defined by the external helix 52. Thus, the internal helices 53 may be of different sizes, as is shown in FIG. 9 where all internal helices are of rectangular cross-section. The internal helices may be of different configuration, as is shown in FIG. 10 where one helix is of rectangular cross-section while the other internal helices have triangular cross-sections. The number of longitudinal rods 59 may also be varied within broad limits.

The arrows in FIGS. 8–10 are meant to show that it is only the external helix 52 that is wound in one direction while all internal helices 53 are wound in the other direction.

The supporting structure, the upper side of which is shown in FIG. 11, may be of the nature shown in FIGS. 8 and 9. The sides of three internal helices 53 thus engage the upper side of the supporting structure, which side is determined by the external helix 52. The rods extending along the longitudinal edges of the upper side are designated 59.

According to the invention, at least some of the helices 53 are filled with insulating material. The insulating material may be loose wool filled into plastic bags. With the use of vacuum the bags are readily introduced into the structure. When the vacuum is abolished the insulating material which is at least partly elastic well fills out the hollow space of the structure.

What I claim and desire to secure by Letters Patent is:

1. Stiffening means for structural elements, said means being formed by helically wound wires, wherein the wires are wound in several different paths with several wires in each path, each path following the contour of a section having straight sides and the wire portions in said sides constituting straight braces, and wherein the sections having the straight sides are arranged in such an adjacent relationship that adjoining sides will engage each other, the straight wires in adjoining sides being interconnected at coincident points.

2. Stiffening means as claimed in claim 1, wherein the sections having the straight sides are arranged in such an adjacent relationship that the straight sides between the adjoining interconnected sides infinitely merge into each other and together constitute the support of a flat structural element connected to the wires in said sides.

3. Stiffening means as claimed in claim 2, wherein the straight sides between the adjoining interconnected sides lie in one and the same plane and together carry a planar flat structural element connected to the wires in said sides.

4. Stiffening means as claimed in claim 2, wherein the straight sides between the adjoining interconnected sides make angles with each other and collectively support a curved flat structural element connected to the wires in said sides.

5. Stiffening means as claimed in claim 2, wherein the sections having the straight sides are arranged in such an adjacent relationship that those straight sides which are opposed to the straight sides between the adjoining interconnected sides, infinitely merge into each other and collectively carry another flat structural element connected to the wires in said sides.

6. Stiffening means as claimed in claim 2, wherein the sections having the straight sides are arranged in such an adjacent relationship that those straight sides which are opposed to the straight sides between the adjoining interconnected sides, infinitely merge into each other, longitudinal structural elements formed by rods or like means being connected to the wires where said sides infinitely merge into each other.

7. Stiffening means as claimed in claim 1, wherein the sections having the straight sides together entirely fill out an outer contour having straight sides, said sections collectively stiffening a structure comprising a plurality of helically wound wires which are wound exclusively along said outer contour having straight sides and constitute straight braces at said sides, and wherein the wires wound along the outer contour are wound in a direction opposite to the other helically wound wires to which they are connected at coincident points.

8. Stiffening means as claimed in claim 7, wherein longitudinal structural elements consisting of rods or like means are provided at least at the corners of the outer contour, where they are connected to the wires.

9. Stiffening means as claimed in claim 8, wherein longitudinal structural elements consisting of rods or like means are arranged at common corners of such sections as together entirely fill out the outer contour.

10. Stiffening means as claimed in claim 1, wherein the sections having straight sides together entirely fill out a rectangular outer contour.

11. Stiffening means as claimed in claim 10, wherein the sections having straight sides and together entirely filling out the rectangular outer contour, are rectangular.

12. Stiffening means as claimed in claim 10, wherein the sections having straight sides and together entirely filling out the rectangular outer contour, are triangular.

13. Stiffening means as claimed in claim 10, wherein at least one of the sections having straight sides and together entirely filling out the rectangular outer contour, is rectangular while the other sections are triangular.

14. Stiffening means as claimed in claim 1, wherein at least some of the sections having straight sides are filled out with insulating material.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,871,149 Dated March 18, 1975

Inventor(s) HANS CHRISTER GEORGII

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Title page, [73] Assignee: BORGHILD GEORGII

Signed and Sealed this

ninth Day of September 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks