METHOD AND FABRIC FOR PIPE REINFORCEMENT

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ABSTRACT

Wire fabric for forming concrete pipe reinforcing cages, which cages have longitudinal and circumferential wire strands. The circumferential defining wire strands of the fabric at the bell-forming end of the fabric include a plurality of interconnected closed loops, each loop being capable of expansion longitudinally of the strand. The longitudinal strands at the bell-forming end of the fabric may also constitute rigidly interconnected closed loops. Also disclosed is fabric including longitudinally compressible strands at the male forming end of the fabric such that a circular male end can be formed on an elliptical cage, for example, by compressing the male forming end of the fabric.

24 Claims, 8 Drawing Figures
METHOD AND FABRIC FOR PIPE REINFORCEMENT

RELATED APPLICATIONS

This application is related to my copending patent application, METHOD AND FABRIC FOR PIPE REINFORCEMENT, Ser. No. 330,605, filed on even date herewith and assigned to the same assignee as this invention.

BACKGROUND OF THE INVENTION

The present invention relates to wire fabric for reinforcing concrete pipe. Such fabric normally is a network of wire strands. When rolled into a cylindrical cage, the wire strands extending the length of the cage are usually called longitudinals and those encircling the cage are called circumferentials. Some refer to the longitudinal wires as "weft" wires and the circumferential wires as " warp" wires.

The reinforcing cages are formed either circularly or elliptically with one enlarged end. The enlarged end is called the "bell" end of the fabric. When the cage is formed and cast in cement, the enlarged or "bell" end receives the non-enlarged or "spigot" end of a succeeding pipe.

One technique for forming the bell end in a wire cage involves the use of non-rectilinear, for example corrugated, circumferential strands at the bell end of the fabric. After the cage is formed, the corrugated strands are expanded radially outwardly. They straighten to some extent and thereby form the enlarged bell end.

One possible drawback to this method is that when stress forces are placed on the pipe, the corrugations or non-rectilinear deformations tend to straighten still further, thereby allowing the concrete to crack. When the pipe is buried in the ground, the weight of the dirt compressing the pipe tends to force the bell end to stretch outwardly to either side. The resulting forces of tension on the corrugated circumferentials tend to straighten them and thereby cause the concrete to crack.

SUMMARY OF THE INVENTION

In the present invention, fabric is employed which minimizes or substantially eliminates cracking problems at the bell end of the pipe even when the bell end is formed by outward expansion of the cage. At least one of the circumferential defining strands at the bell-forming or female end of the fabric includes a plurality of interconnected closed loops, expandable longitudinally of said strand. When the cage is formed, this strand can be expanded radially outwardly, each of the loops expanding longitudinally. This longitudinal expansion is facilitated by the fact that the sides of each loop collapse or close towards one another. Because the loops are closed, they resist expansion after they are cast in concrete. Forces tending to close or longitudinally expand the loop further tend to work against one another because of the concrete trapped within the loop (see FIG. 5). Accordingly, the problems of cracking after the concrete pipe has been formed and is stressed are substantially minimized.

In one aspect of the invention, the interconnected closed loops can be formed by welding two strands of corrugated wire back to back, at their abutting nodes. In the alternative, wire can be eliminated altogether. A strip of expanded metal can be employed to define the plurality of closed loops.

In another aspect of this invention, longitudinally compressible strands are provided at the male or spigot forming end of the fabric. The closed loop strands described above are capable of such compression, as would be corrugated strands. After the fabric is formed as a cylinder, the male or spigot end strands are compressed radially inwardly to make the male end of the cage of a smaller diameter. Also, this process can be used to form a circular male end on an elliptical cage.

These and other aspects and objects of the present invention will be more fully appreciated and understood by reference to the written specification and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of fabric made in accordance with the present invention having closed loop circumferentials at the bell end and having longitudinals with a non-rectilinear deviation at the bell-forming end;

FIG. 2 is a perspective view of the fabric of FIG. 1 formed into a reinforcing cage;

FIG. 3 is a plan view of fabric having both closed loop circumferentials and closed loop longitudinals at the bell-forming end thereof;

FIG. 4 is an end elevational view of the fabric of FIG. 3 formed into an elliptical cage with a circular bell end;

FIG. 5 is a schematic stress diagram for a closed loop circumferential in concrete;

FIG. 6 is a schematic stress diagram for a corrugated circumferential in concrete;

FIG. 7 is a fragmentary view of a closed loop fabric of an alternative construction; and

FIG. 8 shows a cage formed of fabric of the present invention with a compressed male end.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the preferred embodiment, the fabric I for forming a cage 10 having a bell end 11 includes strands which will be the longitudinals 20 and circumferentials 30 of cage 10 (FIGS. 1 and 2). The circumferentials at the bell-forming end of the fabric, i.e., the bell-forming circumferentials 40 comprise a plurality of interconnected closed loops 41, expandable longitudinally with respect to bell-forming circumferential strands 40. Bell-forming circumferentials 40 can be radially expanded to form bell 11, but resist any expansion once embedded in concrete (FIG. 5).

Longitudinal and circumferential defining strands, 20 and 30, are made of a material suitable for pipe reinforcing cages. Steel wire is the standard, but the use of equivalent materials is conceivable. Circumferential defining strands 30 are rigidly connected to longitudinal defining strands 20 by means of welding or the like. Preferably, one or the other set of strands is merely laid on top of the other and is welded in place. However, the strands could be interwoven without departing from the spirit and broader aspects of the present invention.

Bell end circumferentials 40 comprise a plurality of interconnected closed loops 41. One way of forming such a strand is to slit a single strip of metal at spaced intervals and then expand it laterally. Such a strand
would be a strip or strand of expanded metal. The loops
3
41 would be diamond-shaped, and would be interconnected at their apexes along their major axes.

Such closed loop strands could also be formed by corrugating two thin wire strands at regular intervals and welding them together in their mirror image positions at their corresponding nodes (FIG. 7). While bell-forming circumferentials 40 need not consist entirely of closed loops 41, it is preferable that closed loops 41 are at least regularly spaced throughout the length of bell-forming circumferentials 40 since such regular spacing facilitates smoother radial expansion of bell-forming circumferentials 40 into bell 11.

Closed loops 41 must be expandable longitudinally with respect to bell-forming circumferential strands 40. Thus, when bell-forming circumferentials 40 are expanded radially, closed loops 41 stretch out or expand longitudinally and thereby actually increase the effective length of bell-forming circumferentials 40.

Once concrete is poured around cage 10 and bell 11, closed loops 41 will actually resist further expansion, even though they are readily expandable before being embedded in concrete or the like. In FIGS. 5 and 6, the stress forces on a closed loop 41 (FIG. 5) are compared to those on a corrugated circumferential 70 having corrugations 71 (FIG. 6). When a pipe is placed in the ground and buried, forces of compression on the pipe are bound to tend to stress corrugated circumferential 70 at the crown and invert of the pipe in an elongating direction as indicated by the arrows A. This will cause corrugated circumferential 70 to tend to expand, thereby applying forces generally in the directions indicated by arrows B. It can be clearly seen that such stressing will tend to force the concrete apart and create fissures and cracks. In contrast, the elongating or tensioning forces A on closed loop circumferentials 40 will not tend to create such fissures because the loops 41 will not tend to expand. Specifically, the force B on one side of the loop will be counteracted by the force C on the opposite side acting through the cement which is trapped within the closed loop. Similarly, the force D will be counteracted by the force E. Thus, the tendency for the cement to crack around closed loop circumferentials 40 will be greatly minimized.

Loops 41 are relatively small in area, in order to maximize on the advantages of better stress distribution as illustrated in FIGS. 5 and 6. Thus, for example, the area defined by each loop 41 should be less than the area defined by adjacent longitudinals 20 on two sides and adjacent circumferentials 30 on the other two sides. If they are not, the advantages of stress distribution illustrated in FIGS. 5 and 6 will be minimized by the fact that forces of compression on the end bell of the fabric will actually tend to compress concrete through the openings defined by loops 41. The use of loops of smaller area will minimize this effect.

Although not necessary to the practice of that aspect of the invention discussed above, the alternative embodiment fabric shown in FIG. 3 includes bell end longitudinal portions 50 of longitudinals 20 which are comprised of closed loops 51 similar to closed loops 41 of bell end circumferentials 40. The construction of longitudinal portions 50 can be identical to that of the construction of closed loop circumferentials 40. The presence of such closed loops 51 allows one to expand longitudinal end portions 50 to different lengths, thereby facilitating the formation of a circular bell on an elliptical cage (discussed more fully in conjunction with my copending application METHOD AND FABRIC FOR PIPE REINFORCEMENT, Ser. No. 330,605, filed on even date herewith). Yet, cracking problems are minimized by the closed loop configuration.

The formation of the FIG. 3 fabric into an elliptical cage with a circular bell end is shown in FIG. 4. Note that the longitudinals on the major axis of the ellipse are not expanded at all or only to a slight degree. The longitudinals on the minor axis of the ellipse, on the other hand, are expanded substantially so that all longitudinals at the bell end are formed to the same radius.

The cage 10 shown in FIG. 8 is like that shown in FIG. 2, except that it includes a compressed male end 12. The fabric from which the FIG. 8 cage was made included a closed loop strand 40 at the male forming end. Once the fabric was formed into a cylinder, the female or bell end 11 was expanded while the male end 12 was compressed. The loops 41 of strands 40 at female end 11 are longitudinally expanded, or in other words, the sides of each loop 41 are closed towards one another. The loops 41 of strand 40 at the male end 12, on the other hand, are longitudinally compressed. In effect, the sides of these loops 41 are opened away from one another, the connected ends of the loops being closed towards one another. This radial compression can be achieved by applying a radially inwardly directed force to the sides of the cage at male end 12.

OPERATION

In operation, the fabric 1 is first rolled into a cage 10, either circular or elliptical. The bell end 11 of the fabric is then expanded radially, the closed loops 41 expanding longitudinally with respect to bell end circumferentials 40. With the bell end 11 formed, the cage 10 is placed in a mold and concrete or other plastic is poured therearound. It is not inconceivable that the fabric of the present invention could be used to make reinforcing cages for pipe made of synthetic organic plastics as well as inorganic plastics such as concrete.

The use of closed loop portions 50 at the bell end of the longitudinals 20 further facilitates the job of expanding the bell end 11. This is particularly true when a circular bell must be formed on an elliptical cage as shown in FIG. 4. Those longitudinal strand portions 50 which must deviate farthest from the minor axis of the ellipse may readily be expanded farther by the greater expansion of the individual loops 51 therein. The closed loop configuration in both the circumferentials and the longitudinals render the concrete pipe less apt to crack under stress.

Thus, the various aspects of the present invention greatly facilitate the formation of the bell end of cages through radial expansion. Of course, it is understood that the above are merely preferred embodiments of the invention and that many alterations can be made without departing from the spirit and broader aspects of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Fabric for forming concrete pipe reinforcing cages comprising: a network of interconnected separate longitudinal defining strands and separate circumferential defining strands of material suitable for forming a con-
crete pipe reinforcing cage, said strands defining the separate longitudinal and separate circumferential strands respectively of the reinforcing cage when the fabric is formed; and at least one separate end circumferential defining strand joined to said longitudinal defining strands at the female forming end of the fabric which is independent of said other circumferential defining strands, said one circumferential defining strand comprising a plurality of interconnected closed loops expandable longitudinally of said one strand; expanding said one circumferential strand radially outwardly to thereby form an enlarged female end on said cage.

14. The method of claim 13 in which said forming step comprises forming a fabric in which said one strand comprises a strand of expanded metal.

15. The method of claim 13 in which said forming step comprises forming fabric in which said one strand comprises a pair of regularly corrugated strands joined together in their mirror image positions at their respective nodes.

16. The method of claim 13 in which said forming step comprises forming a fabric in which said one strand comprises a plurality of diamond-shaped segments joined to each other at their apexes along their major axes.

17. The method of claim 13 in which said forming step comprises forming a fabric having at least two of said one circumferential strands at the bell forming end of said fabric.

18. The method of claim 13 in which said forming step comprises forming a fabric in which said longitudinal defining strands include at least one closed loop therein expandable longitudinally of said longitudinal defining strands at the bell-forming end of said longitudinal defining strands.

19. The method of claim 18 in which said forming step comprises forming a fabric having at least two of said one circumferential strands at the bell forming end of said fabric.

20. The method of claim 18 in which said forming step comprises forming fabric in which said one strand comprises a pair of regularly corrugated strands joined together in their mirror image positions at their respective nodes.

21. The method of claim 18 in which said forming step comprises forming a fabric having at least two of said one circumferential strands at the bell forming end of said fabric.

22. The method of claim 13 in which said forming step also comprises said fabric including at least one longitudinally compressible circumferential defining strand at the male forming end of the fabric; said method further including the step of compressing said one circumferential strand radially inwardly to thereby form a smaller male end on said cage.

23. The method of claim 22 in which said forming step comprises forming fabric in which said longitudinally compressible circumferential defining strand comprises a plurality of interconnected closed loops compressible longitudinally of said longitudinally compressible strand.

24. A method for forming concrete pipe reinforcing cages comprising: forming into a generally cylindrical cage a fabric having a network of rigidly interconnected separate longitudinal defining strands and separate circumferential defining strands of material suitable for forming a concrete pipe reinforcing cage, said strands defining the separate longitudinal and separate circumferential defining strands respectively of the reinforcing cage when the fabric is formed; and having at least one separate longitudinal defining strand joined to said longitudinal defining strands at the female forming end of the fabric which is independent of said other circumferential defining strands, said one circumferential defining strand comprising a plurality of interconnected closed loops expandable longitudinally of said one strand; expanding said one circumferential strand radially outwardly to thereby form an enlarged female end on said cage.

25. A method for forming concrete pipe reinforcing cages comprising: forming into a generally cylindrical cage a fabric having a network of interconnected separate longitudinal defining strands and separate circumferential defining strands of material suitable for forming a concrete pipe reinforcing cage, said strands defining the separate longitudinal and separate circumferential defining strands respectively of the reinforcing cage when the fabric is formed; and having at least one longitudinally compressible circumferential defining strand at the male forming end of the fabric; said method further including the step of compressing said one circumferential strand radially inwardly to thereby form a smaller male end on said cage.

26. A method for forming concrete pipe reinforcing cages comprising: forming into a generally cylindrical cage a fabric having a network of rigidly interconnected separate longitudinal defining strands and separate circumferential defining strands of material suitable for forming a concrete pipe reinforcing cage, said strands defining the separate longitudinal and separate circumferential defining strands respectively of the reinforcing cage when the fabric is formed; and having at least one longitudinally compressible circumferential defining strand at the male forming end of the fabric comprising a plurality of interconnected closed loops compressible longitudinally of said one strand; compressing said one longitudinally compressible circumferential strand radially inwardly to thereby form a smaller male end on said cage.