A plastic impregnated wire rope is provided with plastic bands between its core and its outer strands so as to prevent contact between the wires of the core and those of the outer strands during flexing of the rope. This produces a substantial increase in the life of the rope. The method for manufacturing such rope involves wrapping plastic bands on the core just prior to laying outer strands on the core and on top of the plastic bands. Thereafter, the so formed rope is impregnated with molten plastic, which is then allowed to solidify.
Fig. 1

Fig. 3
PLASTIC IMPREGNATED WIRE ROPE WITH INTERNAL SEPARATING BANDS

FIELD OF THE INVENTION

This invention generally relates to a plastic impregnated wire rope. More specifically, it relates to a wire rope that, in addition to plastic impregnation, has internal separating bands positioned between the outer strands of the rope and the core strands to prevent direct contact between these strands during flexing of the rope and thereby extend the life of the rope. The invention also relates to the method of manufacturing such wire rope.

BACKGROUND OF THE INVENTION

Plastic impregnated wire ropes are well known in the art. An example of such wire rope is disclosed in U.S. Pat. No. 4,120,145 by Chiappetta et al. where a wire rope is impregnated with a plastic material between a lubricated core and lubricated outer strands of the rope. However, direct contact between the wires of the outer strands of the core and those of the outer strands of the rope will still occur during flexing of the rope under working conditions and this contact prematurely damages the wires and shortens the life of the rope.

Another example of a fully plastic impregnated or plastic filled wire rope is disclosed in U.S. Pat. No. 4,667,462 belonging to the present applicant. In this case, the plastic material fills essentially completely all the interstices between the strands and the individual wires of the rope. Again, however, during operation of the rope, contact between the wires of the outer strands of the rope and the wires of the outer strands of the core is not prevented by such full plastic impregnation, leading to degradation and eventual premature failure of the rope.

Therefore, there is a need for an improved plastic impregnated rope, in which contact between the wires of the outer strands of the rope and the wires of the outer strands of the rope’s core would be essentially prevented.

There are prior art patents that recommend placing a protective layer such as a plastic ridge or protective inserts such as plastic strips to prevent contact between the wires of the outer strands and those of the core of a wire rope. Canadian Patent No. 648,788 of Alfred Dietz discloses the ridge construction and U.S. Pat. No. 4,166,355 discloses the construction using non-metallic inserts. In both cases, however, the gaps between the outer strands of the wire rope and the strands of the core are completely blocked by such devices and thus no plastic impregnation of the rope could take place since molten plastic would not be able to flow through such ridge or such protective inserts or strips.

SUMMARY OF THE INVENTION

The present invention obviates the above mentioned disadvantages and provides a plastic impregnated wire rope having a wire rope core and outer strands wound around said core, which is characterized in that said wire rope is provided with plastic bands between the core and the outer strands, said bands having such size and shape as to essentially prevent contact between the wires of the core and those of the outer strands during operation of the rope, but without substantially impeding the flow of molten plastic into and within the wire rope during plastic impregnation of said wire rope. The core of such wire rope is usually an IWRC (independent wire rope core). The resulting wire rope is a plastic impregnated rope with a controlled plastic separation between the outer rope strands and the outer core strands.

The plastic bands may be made of any suitable material that would be durable and prevent contact between the wires of the core and the outer strands. Preferred materials are thermoplastics and particularly thermoplastic elastomers of which the preferred one is polypropylene. Other materials, such as high density polyethylene, nylon, etc., can also be used and even materials such as textile strips may be suitable if properly made to prevent contact between the wires during flexing of the wire rope when it is being operated.

The bands may be of various shapes and sizes or thicknesses depending on the size and geometry of the rope. Normally, there will be as many bands as there are outer strands in the rope. Preferably, the bands have arcuate faces in contact with the outer strands, essentially matching the contour of the outer strands.

The wire rope provided with the plastic bands as described above may be fully impregnated or filled with a plastic material or only partially impregnated. In this latter case, the core may be not fully impregnated, but mostly left as a lubricated core, and/or the impregnation may not go all the way to the outer periphery of the rope.

The method of producing the plastic impregnated rope of the present invention essentially comprises:

(a) forming a wire rope core and moving it towards a closing station;
(b) forming outer strands for the wire rope and moving them towards the closing station;
(c) winding the outer strands around the core at the closing station;
(d) wrapping plastic bands of predetermined size and shape over the wire rope core at the entrance to the closing station, prior to winding of the outer strands around said core, said plastic bands being laid on the core so as to provide controlled plastic separation between the outer strands and the core while leaving sufficient spacing between the bands to allow flow of molten plastic therethrough; and
(e) after closing the wire rope with the plastic bands positioned between the outer strands and the core, impregnating said wire rope with a molten plastic material and subsequently allowing said plastic material to solidify.

The wire rope core is normally an independent wire rope core that is lubricated and formed with the help of a preforming head as is known in the art. The outer strands are also normally lubricated and made in a conventional manner. The closing station may consist of closing dies, again as is known in the art. The plastic bands may be guided towards the closing station and laid on the core just as the strands are being laid and closed on the core over said bands, to form the rope. To facilitate laying of the bands on the core in a proper manner, a hollow frusto-conical device may be
mounted around the core, near the entrance to the closing dies, which device is connected to the performing head and rotates therewith. The device has slots on its internal surface for guiding the plastic bands towards the core and allowing them to be laid on the core in a predetermined manner, usually so as to follow the same lay as the outer strands. In this manner, when the closing of the rope has been done, the outer strands will rest on the plastic bands and will not be in contact with the core below them, the bands insuring a constant, controlled plastic separation between the outer strands of the rope and those of the core.

[0017] Once the rope is closed as described above, it is then impregnated with plastic material, for example by running it through an extrusion head as disclosed, for instance, in U.S. Pat. No. 4,609,515 which belongs to the present applicant, and the disclosure of which is incorporated hereinto by reference. Also, in lieu of a full filling of the rope as disclosed in the above patent, one may impregnate the rope only partially so that, for example, the core would not be fully impregnated or the periphery of the outer strands would be free of plastic. The impregnation would, however, exist between the outer strands and the core where the plastic separating bands are provided. The impregnation of the wire rope with plastic material need not be done right after closure of the rope. In fact, after closure, the rope may be wound on a reel and stored until the impregnation procedure is undertaken. Thus, the two procedures may take place at different times, as may be convenient to the manufacturer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The invention will now be described with reference to the appended drawings in which:

[0019] FIG. 1 shows a schematic cross-sectional view of an eight strand plastic impregnated wire rope with plastic bands between the outer strands and the core in accordance with the present invention;

[0020] FIG. 2 is a schematic longitudinal view of an arrangement for carrying out the first stage of the method of the present invention, producing a non-impregnated rope with plastic bands between the outer strands and the core;

[0021] FIG. 3 is an end view of the device used in the arrangement of FIG. 2 for guiding plastic bands towards the core; and

[0022] FIG. 4 is a schematic, longitudinal, generally cross-sectional view of an extruder arrangement suitable for carrying out the second stage of the method of the present invention, namely the plastic impregnation of the rope.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The present detailed description of the invention relates to a preferred, non-limitative embodiment thereof as illustrated in the drawings where the same features are designated by the same reference numbers.

[0024] Referring to FIG. 1, it shows the wire rope 20 of the present invention having eight outer strands 12 and an independent wire rope core 14 with eight outer core strands 16. The wire rope 20 also has eight plastic bands 15 which prevent contact between the outer strands 12 and the outer strands 16 of the core 14. This contact is prevented not only when the rope is stationary, but also and especially when it is operational. Preferably, the bands 15 have an accurate outer surface 17 which contacts the outer strands 12, matching the rounded portion of said strands 12.

[0025] There is enough space left between the plastic bands 15 to allow molten plastic flow into and within the rope, and in the present embodiment, the rope 20 is fully impregnated with the plastic material 18.

[0026] FIG. 2 illustrates the first stage of the method of manufacturing the rope of the present invention. In this FIG. 2, a rotating performing head 22 is used to make a lubricated IWRC core 14 which is shown here in a longitudinal view rather than in cross-section as in FIG. 1. This core is moved toward the closing dies 24 as shown by arrow 23. Lubricated outer strands 12 are also made in a conventional manner and moved toward the closing dies 24 while being rotated so as to be wound around the core 14 in the closing operation. In accordance with the present invention, plastic bands 15 are wrapped onto the core 14 so as to be positioned under the outer strands 12 when the latter are wound around the core 14 on which such bands 15 have been laid. The laying of the bands 15 may be assisted by a hollow frusto-conical device 26 mounted around the core 14 and connected to the preforming head 22 by bolts 25 so as to rotate at the same speed as said preforming head 22. Device 26 has eight internal guiding slots 28 as illustrated in FIG. 3. These slots 28 guide the bands 15 so that they are laid on the core with the same lay as the outer strands and, therefore, are positioned precisely under the outer strands as they are wound on the core. This produces the first stage wire rope 10 which has all the elements of the present invention except that it is not impregnated with a plastic material.

[0027] FIG. 4 illustrates the second stage of the method of the present invention, namely the plastic impregnation. Here, the first stage wire rope 10 passes through an extrusion cross head 31 of an extruder where molten plastic is supplied through passages 32, 33, 34 as shown by the arrows. The plastic is supplied under pressure and penetrates the rope 10 between dies 36 and 37 of the extruder. The rearward flow of plastic pushes out excess lubricant 35 at the rear of the die 36 and out of the cross head 31. A third die 38 is connected by holes 39 to the atmosphere and serves to remove excess molten plastic material 18 from the surface of the impregnated wire rope 20. After leaving the extruder, the impregnated wire rope 20 is cooled to solidify the plastic material and then wound on a reel or the like, constituting the final product of the present invention.

[0028] It should be noted that other rope impregnating methods could be used which are known in the art, particularly when partial impregnation of the rope is desired.

[0029] Several samples of an 8 strand plastic impregnated wire rope were prepared, with plastic bands provided between the outer strands and the core in accordance with the present invention and compared to the same kind of plastic impregnated wire rope, but without such bands. The comparison was done by subjecting such samples to a fatigue test using a ratio of the sheave diameter to the diameter of the rope of D/d=25:1 and a load of 85,800 lbs (39,000 kg). The average of standard plastic impregnated rope samples (without bands) took 150,000 cycles to destruction, while the average of plastic impregnated wire
rope samples with plastic bands between the outer strands and the core took 189,223 cycles to destruction, leading to an improvement in the life of the rope of 26.1%. This is a significant improvement obtained due to the present invention.

1. A plastic impregnated wire rope having a wire rope core and outer strands wound around said core, characterized in that said wire rope is provided with plastic bands between the core and the outer strands, said bands having such size and shape as to essentially prevent contact between the wires of the core and those of the outer strands during operation of the rope, but without substantially impeding the flow of molten plastic into and within the wire rope during plastic impregnation of said wire rope.

2. A plastic impregnated wire rope according to claim 1, in which the plastic bands are made of a thermoplastic material.

3. A plastic impregnated wire rope according to claim 2, in which the thermoplastic material of the bands is a thermoplastic elastomer.

4. A plastic impregnated wire rope according to claim 3, in which the thermoplastic elastomer is polypropylene.

5. A plastic impregnated wire rope according to claim 1, in which the plastic bands have an arcuate face in contact with the outer strands.

6. A plastic impregnated wire rope according to claim 1, which comprises full plastic impregnation of said wire rope.

7. A plastic impregnated wire rope according to claim 1, which comprises partial plastic impregnation of said wire rope.

8. Method of producing a plastic impregnated wire rope which comprises:

(a) forming a wire rope core and moving it towards a closing station;

(b) forming outer strands for the wire rope and moving them towards the closing station;

(c) winding the outer strands around the core at the closing station;

(d) wrapping plastic bands of predetermined size and shape over the wire rope core at the entrance to the closing station, prior to winding of the outer strands around said core, said plastic bands being laid on the core so as to provide controlled plastic separation between the outer strands and the core, while leaving sufficient spacing between the bands to allow flow of molten plastic therethrough; and

(e) after closing the wire rope with the plastic bands laid between the outer strands and the core, impregnating said wire rope with a molten plastic material and subsequently allowing said plastic material to solidify.

9. Method according to claim 8, wherein wrapping of the plastic bands over the wire rope core is done with the help of a hollow frusto-conical device mounted and rotating around the core at the entrance of the closing station, said device having slots on its internal surface for guiding the plastic bands towards the core and allowing them to be laid on the core in a predetermined manner.

10. Method according to claim 9, wherein the bands are laid on the core so as to follow the same lay as the outer strands.

11. Method according to claim 8, wherein the wire rope core being formed is an independent wire rope core.

12. Method according to claim 8, wherein the wire rope core being formed is a lubricated core.

13. Method according to claim 8, wherein the outer strands being formed are lubricated strands.

14. Method according to claim 8, wherein eight outer strands are used together with eight plastic bands on which said outer strands are positioned.

15. Method according to claim 8, wherein plastic impregnation of the wire rope is carried out as a separate operation after forming the non-impregnated rope with plastic bands laid between the core and the outer strands.