BRAIDED COMBINED CORDAGE

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Braided ropes with a diameter up to a maximum of 20 mm. are known. Formed strands have not hitherto been used in the manufacture of such braided ropes but yarns or twines instead, and the cords could only be manufactured as a hollow or tubular braid. In the case of thicker ropes or cables built up of strands it was necessary to lay ropes either with a cable lay or with a hawser lay.

The disadvantage of these ropes, especially when they are made from fully synthetic fibres, is the loop formation which occurs especially when the tension to the rope is relieved suddenly.

In addition, laid ropes made from fully synthetic raw materials had to be subjected to a special fixing process after manufacture.

These disadvantages are obviated according to the present invention by the strings, lines, ropes, cords or the like being braided in the normal way from formed strands.

The present invention is therefore a combination of the forming process and the normal braiding process.

By this means, the following advantages are obtained:

On the one hand, with the former laying of formed strands with a cable or hawser lay, the material experiences a shortening due to twisting of about 33½%, based on the initial length. On the other hand, in the process according to the present invention when working, for example, formed strands on a special six-strand rope-braiding machine, the shortening in relation to the initial material is only 20–22%.

Twisting results in a reduction in strength and a small degree of twisting (shortening) represents better utilisation of material in relation to strength.

The rope can be worked comparatively loosely.

An unlaying of the rope with a loose construction is also excluded with a sudden load. The strands cannot spring back (no loop formation). A fixing process is unnecessary.

The rope can be satisfactorily spliced. The splice does not show any thickening. (With a thickened splice, the thickening represents a source of danger.)

The rope is also not deformed by tension or acceleration and it is non-horning.

The rope having a formed strand/braid construction has a weight advantage of 10–12% over the cable-laid rope.

FIG. 1 shows the make up of a yarn having an S-twist using components having a Z-twist,
FIG. 2 shows a schematic sectional view of a strand in accordance with the invention having 16 yarns in the outer layer; 9 yarns in the inner layer and a filament bundle as core, while FIG. 3 shows a schematic side view partially broken away to illustrate details of construction of a strand of the type shown in FIG. 2, having an outer layer of yarn with a Z-twist, an inner layer of yarn with an S-twist, and a monofilament bundle as core,
FIG. 4 shows the twist formation of a rope to be manufactured according to the invention, while FIG. 5 illustrates by way of example an arrangement for braiding the strands,
FIG. 6 shows a cross section of the braided rope of the invention having a central core, illustrating the disposition of the S-twisted and Z-twisted strands about the core.

For the rope described, six strands are required, each strand being made as a twisted formation; three strands have a Z-twist (see the three Z-strands in FIG. 4), the arrangement being such that the inner layers of the Z-strands are made of yarns with a Z-twist and the outer layers of yarns with an S-twist in the forming process. As regards the other three strands (the three S-strands), the converse forming process is used, i.e. the inner layers consist of yarns with an S-twist and the outer layers of yarns with a Z-twist. The strands have a S-turn in the rope.

For a soft or loose strand/braid rope, the following procedure may be employed:

Example for 3 S-Strands; 6 mm. 5 mm. of Nm. 2/0.9
Plastic Component Yarn
Strand formation:
Core yarn—1×Nm. 2/0.9 S.
Inner layer—6×Nm. 2/0.9 S.
Outer layer—12×Nm. 2/0.9 S.
Twist of strands—S.

Example for 3 Z-Strands; 6 mm. 5 mm. of Nm. 2/0.9
Plastic Component Yarn
Strand formation:
Core yarn—1×Nm. 2/0.9 Z.
Inner layer—6×Nm. 2/0.9 Z.
Outer layer—12×Nm. 2/0.9 Z.
Twist of strands—Z.

The six-strand bobbins are braided to form a hawser or cable on a special rope-braiding machine. The three S-bobbins run in one direction of curvature and the three Z-bobbins also in one direction of curvature. The strand bobbins of the six-strand rope-braiding machine have two constant cord brakes over the rim of the bobbin flange. (Grooves machined in the rim of the bobbin prevent the brake cord from slipping off.) A fully mechanical brake controlled by a lever pressure arm renders possible a constant working of the strand in the rope-forming process.

The ropes are not subsequently fixed, but are ready for use on leaving the rope-braiding machine. The lines and ropes of this construction can be spliced, both with a long splice and an eye splice.

A mechanical brake for a braiding machine is shown by way of example in FIG. 5. In detail, 1 is the brake drum, 2 the brake pulleys, 3 the brake shafts, 4 the brake band roller, 5 the steel brake band, 6 the brake band tightening screw, 7 the cross-member, 8 the balancing lever arm with tightening slots, 9 the brake cord, 10 the tension springs, 11 the positioning slots, 12 the bobbin flange, 13 the tensioning screw for the brake cord, 14 the brake cord hook, 15 the spring tensioning nut, 16 the spring tensioning screw, 17 the spring pin, 18 the brake plate, 19 the path of the strands and 20 the braiding point.

A strand bobbin 12 is connected by a driving pin to a brake drum 1. Arranged on the cross-member 7 of the bobbin support is a brake band tensioning screw 6, to which is fixed a steel brake band 5. This brake band 5 passes over the brake drum 1 to the brake band pulley 4. The brake band pulley 4 is mounted together with a balancing lever arm 8 on the brake shaft 3. Secured fast to the balancing lever arm 8 and the brake band pulley 4 is a brake plate 18 serving as support for the idling brake pulleys 2. If the balancing lever arm 8 is moved in the same direction. This movement is imparted to the steel brake band 5, so that in this way the latter is either slackened off or tight.
ended. Due to these changing tensions, different braking forces are set up and these act on the brake drum 1. The brake drum 1 is connected in known manner to the strand bobbin 12. Therefore, the different braking forces have a regulating action on the strand 19 which runs off the strand bobbin 12. The strand 19 travels over the brake pulleys 2 to the braiding point 20. The strand bobbin 12 is initially braked by a brake cord 9. Due to this initial braking of the strand bobbin 12, the discharging strand 19 tends to force the balancing lever arm 8 out of the rest position. The tension springs 10 counteract the pressure of the strand 19. With correct adjustment of the tension springs 10 by displacement of the spring pin 16 in the slots 11 and by regulating the springs 19 by the locking nut 15 thereof, the brake means can be so adapted to any strand diameter that the strand tension is uniformly and automatically regulated. On starting the working process, the strand bobbin 12 is completely filled with a strand 19 and the diameter thereof is thus large. As the strand 19 runs off, the diameter of the bobbin is steadily reduced. The delivery speed of the strand is constant. As the bobbin diameter becomes progressively smaller, the bobbin 12 must rotate more quickly. Since the strand 19 pulls the unwinding bobbin 12 (lagging bobbin), the initial loading of the strand 19 becomes greater as the speed of the bobbin increases. The resultant greater strand tension acts automatically on the brake rollers 2 in such a way that the balancing lever arm is lowered, this movement slackening off the brake band 5. By this process, the tension of the strand is automatically adjusted to all the different bobbin diameters which occur, so that the loading of the strand remains the same from the commencement to the end of the operation.

The procedure for the manufacturing of a six-stranded hawser from plastic bundles of filaments is as follows:

1. The six-stranded plastic bundle of filaments is given a protective twist. The turns necessary for this twist are calculated from fixed values. The auxiliary numbers necessary for calculating the twist are the same for all bundle counts, but different for each yarn count. The effect of the protective twist is that tension is stored in the plastic bundles of filaments.

2. The foretumed bundle of filaments, now termed a yarn component, is further processed to form a twisted yarn, i.e. each component of the yarn is turned several times in one direction which is opposite to the protective twist rotation of the single bundle of filaments. The yarn is so wound that the foretumed (protective twist of bundle) and the twist of the yarn largely cancel each other out. The yarn must be completely balanced. By this method, the tension stored in the component is compensated for by the tension in the twisted yarn which is formed. The twisted yarn is free from tension and has a low degree of twist.

3. These tension-free yarns of plastic bundle components are thereafter wetted and impregnated on a polishing machine. By suitable adjustment of the drying cylinder of a polishing machine, the rotation is simultaneously reduced.

4. The strand is either manufactured on a stationary strand-forming machine or formed in pairs on the rope walk from the yarns. The strand formation is so maintained that the tensions set up are largely balanced out. This balancing of the tension is achieved by the fact that the twists of the inner layers of the strand are opposite to the twists of the outer layers of the strand, and thus twist counteracts twist. The tension set up in the core of the strand (inner layers) is balanced by the tension of the outer layers.

In spite of the twines with different directions of twist in one element (strand), the strand is formed in a single working operation, so that the twist angle of all twines worked in the strand is the same. These low-twist, tension-free strands are laid on a six-flyer "mammoth normal rope-braiding machine." The laying is effected in such a way that no tensions are set up in the final product comprising the finished rope. Three strands of SZ formation are opposite to the other three strands with a ZS formation. The rope has low-twist and is free from torsion.

5. Tension cancels out tension and twist balances out twist. In the laying process by the normal braiding method, the strands are given an insignificant amount of additional rotation. The laying of a rope in hawser lay results in shortening by about 15% of the finally formed strand. When laying formed strands by the normal braiding process, on the other hand, there is only a shortening of 2-3%. In the ratio between initial length of material and final rope with a hawser lay (33% 5% total shortening) and the final rope with the six-strand braided-formed construction, the total shortening is therefore reduced by about 30%. The (33% minus 10 to 12% rotation (equal to shortening) means reduction in strength. Less rotation (equal to less shortening) produces a better degree of material utilisation. The effect is to be seen in that with equal braiding strength of the different ropes, the braided construction possesses the following advantages:

- Better utilisation of material.
- Increased safety.
- Smaller weight.
- Better handling.
- Cheaper cost per metre of rope.
- Smaller rotation.
- Unconditional dimensional stability.
- Longer life of the rope.
- Elimination of the fixing process, and others.

6. Referring to FIG. 6, as core (heart) this rope has a two-stranded multi-filament helical heart of plastic filament yarns of the above type with a foretum. Of course, the filament yarns may be of copper wire where a 3-stranded copper wire helical heart as an electrical conductor in the rope is desired, the same laying procedure being used but with three strands rather than two. This heart is prepared as follows:

The strands 3H (see FIG. 6) for this helical heart are formed with very strong compression and provided with an excessive amount of twist. When laying such hard strands to form a two-stranded helical heart, the strands are provided in the laying process with an excessive amount of foretum. The laying length on the contrary is kept very short. Due to this accumulation of tension and twist, the expansion power of the helical heart is very high. This extension in the heart is desirable and necessary. With sudden overloading of a six-stranded normally braided rope, the elongation reserve of the helical heart is so high that there is no possibility of the core (heart) breaking. The bed of the strand is the heart, which ensures that the shape of the rope is maintained. If the heart of the rope is correct, the shape of the rope is guaranteed and the dangerous lateral pressure of the strands does not become operative. This means that the arrangement of the strands remains just the same as when the rope was formed by the braiding process. With permanent forming of the finished rope, (normally braided six-stranded rope), the effective life and the reliability is considerably increased, even with suddenly occurring overload.

As may be seen from FIGURE 1, the yarn I may be composed of three components a, b, c. twisted together to form a yarn having multiple components, on the other hand, are provided with a Z-twist in the fibers making up the same, each component being provided with an inner core consisting of a bundle of monofilaments F. In like manner, a yarn may be prepared having a Z-twist by twisting S-twisted components in Z-direction to form a yarn having the Z-twist.

FIGURE 3 shows a strand 3' having an outer layer.
of yarn \( I_2 \) with a \( Z \)-twist consisting of \( S \)-twisted yarn components \( a, b, \) and \( c \), as well as an inner layer of yarn \( I_4 \) having an \( S \)-twist, the inner layer of yarn consisting of yarn components having a \( Z \)-twist. Under the inner layer of yarn a monofilament bundle \( 2' \) is provided as a core.

The arrangement of FIG. 3 can be seen more clearly from FIG. 2 wherein the outer layer of \( Z \)-twist yarn \( I_2 \), consisting of 16 yarns in the outer layer, surrounds the inner layer of \( S \)-twisted yarns, consisting of 9 separate yarns \( I_4 \). Of course, each yarn includes three components \( a, b, \) and \( c \) twisted in opposite direction to the direction of the yarn in the strand. Within the inner layer of yarn \( I_4 \), the filament bundle \( 2' \) is provided as core.

It will be appreciated from FIG. 4, that the strands having an outer layer of \( Z \)-twisted yarns will be twisted in the braiding to form the rope structure so that they are disposed in the rope in \( S \)-twisted form. The opposite direction of twist in the rope, of course, will be used for those strands having an outer layer of yarn twisted in \( S \)-direction. Thus, the three \( S \)-twisted strands in the braid of the rope are strands having an outer layer with a \( Z \)-twist while the three \( Z \)-twisted strands in the braid of the rope are those having an outer layer strand of yarn with an \( S \)-twist.

I claim:

1. Braided string, line, rope, cord, and the like, from formed strands having a low degree of twist, comprising a plurality of strands having an inner layer of yarn provided with a \( Z \)-twist and an outer layer of yarn provided with an \( S \)-twist, and a plurality of strands having an inner layer of yarn provided with an \( S \)-twist and an outer layer of yarn provided with a \( Z \)-twist, said strands being braided together, said strands being composed of yarns twisted in opposite direction to the corresponding direction of twist of the respective strands in the braid and the twisted yarns including formed components twisted in opposite direction to the corresponding direction of twist of the respective yarns.

2. Braided string, line, rope, cord and the like, according to claim 1 wherein the tension of the twisted components balances the tension of the twisted yarns formed therefrom.

3. Braided string, line, rope, cord and the like, according to claim 1 wherein the tension of the strands having a predominant twist in one direction is balanced by the tension of the strands having a predominant twist in the opposite direction in the braided structure.

4. Braided string, line, rope, cord and the like, according to claim 1 wherein a multifilament core is provided therein.

5. Braided rope and the like from formed strands containing a core and having a low degree of twist, comprising a plurality of strands each having an inner layer of yarn provided with a \( Z \)-twist in the strand and an outer layer of yarn provided with an \( S \)-twist in the strand, a plurality of strands each having an inner layer of yarn provided with an \( S \)-twist in the strand and an outer layer of yarn provided with a \( Z \)-twist in the strand, the \( Z \)-twist yarn in said strands having a plurality of components provided with an \( S \)-twist in said yarn, and the \( S \)-twist yarn in said strands having a plurality of components provided with a \( Z \)-twist in said yarn, said strands being braided together, with the strands having the outer layer of \( S \)-twist yarns being given a \( Z \)-twist in the braid and the strands having the outer layer of \( Z \)-twist yarns being given an \( S \)-twist in the braid, and a multifilament core in the braid including at least two strands twisted together.

6. Rope and the like according to claim 5 wherein said \( S \)-twist components have an inner multifilament core and a protective \( Z \)-twist and said \( Z \)-twist components have an inner multifilament core and a protective \( S \)-twist.

7. Braided string, line, rope, cord, and the like, according to claim 1, wherein the formed strands consist in part of untwisted monofilaments.

8. Braided string, line, rope, cord, and the like, according to claim 1 wherein the strands consist at least in part of yarns of synthetic filaments.

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