In some embodiments, the present invention includes ribbed woven materials, methods for increasing the abrasion resistance of a material, methods for providing an indication of wear, ropes configured to provide one or more alerts as a total breaking weight of a rope is approached, woven rope cover systems for rope-like materials, woven rope structures having ribs, and nonwoven ropes comprising strands including nonwoven strands of material that are configured in a rope construction and further comprising one or more woven rope cords displaced within the nonwoven rope construction.
Fig. 3

Fig. 4
WOVEN ROPE W/ CORE

WOVEN ROPE NO CORE

BRAIDED ROPE W/ CORE (KERNMANTLE)

Fig. 11A  Fig. 11B  Fig. 11C

BRAIDED ROPE SOLID OR HOLLOW

TWISTED ROPE

Fig. 11D  Fig. 11E

KNITTED ROPE

Fig. 11F  Fig. 11G

 Typical twisted, braided or untwisted yarn strand

 Woven strand with warp and fill yarns, may also have a core structure
RIBBED WOVEN MATERIAL


BACKGROUND OF THE INVENTION

[0002] Rope products may have numerous applications, and previous types of rope products are known in the art. The present invention relates generally to novel rope products, processes, and related applications.

SUMMARY OF THE INVENTION

[0003] In an embodiment, the invention is directed to a ribbed woven material comprising a plurality of warp threads; a plurality of weft threads, wherein the warp and weft threads are interwoven together; and at least one woven rope having a thickness which is greater than that of the warp threads, wherein the at least one woven rope is woven into the material in the warp direction and extends outwardly in a longitudinal rib formation from the surface of the material.

[0004] In another embodiment, the invention is directed to a ribbed woven material comprising a plurality of warp threads; a plurality of weft threads, wherein the warp and weft threads are interwoven together; and at least one woven rope having a thickness which is greater than that of the warp threads, wherein the at least one woven rope is woven into the material in the weft direction and extends outwardly in a rib formation from the surface of the material.

[0005] In another embodiment, the invention is directed to a method for increasing the abrasion resistance of a material comprising providing a plurality of warp threads; providing a plurality of weft threads; weaving the warp and weft threads together; weaving at least one woven rope having a thickness which is greater than that of the warp threads into the material in the warp direction, wherein the woven rope extends outwardly in a longitudinal rib formation from the surface of the material.

[0006] In yet another embodiment, the invention is directed to a method for providing an indication of wear for an industrial strap comprising providing a plurality of warp threads; providing a plurality of weft threads; weaving the warp and weft threads together; weaving at least one woven rope having a thickness which is greater than that of the warp threads into the material in the warp direction, wherein the woven rope extends outwardly in a longitudinal rib formation from the surface of the material; forming the ribbed woven material into an industrial strap; utilizing the industrial strap to lift or carry objects; and using the wear on the ribbing as an indication of when to replace the industrial strap.

[0007] In still another embodiment, the invention includes a woven rope having an indicator as the total breaking weight of the rope is neared. In one embodiment, the rope comprises indicator warp yarns having maximum load weights that are less than the total breaking weight of the entire rope.

[0008] A woven rope cover system for rope-like materials, wherein the rope cover comprises a plurality of interfacing individual fibers interlaced in a regular order, wherein the interfacing fibers are arranged to form a tubular shape having a hollow center configured to house a rope-like structure. In some embodiments, the woven rope cover system may include a rope-like structure disposed within the hollow center of the rope cover such that a space is present between the rope-like structure and the rope cover.

[0009] In yet another embodiment, the present invention includes a woven rope structure having a surface with one or more ribs extending beyond the surface. In another embodiment, the present invention includes a non-woven rope including nonwoven strands of material that are configured in a rope construction and further comprising one or more woven rope cords displaced within the nonwoven rope construction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] A full and enabling disclosure of the present invention is set forth in the specification, which refers to the appended figures, in which:

[0011] FIG. 1a illustrates a cross-sectional embodiment of the ribbed woven material of the invention.

[0012] FIG. 1b illustrates an expanded cross-sectional embodiment of a rib of the invention.

[0013] FIG. 2 illustrates a cross-sectional alternate embodiment of the ribbed woven material of the invention.

[0014] FIG. 3 illustrates a sectional view in the weft direction, through an embodiment of the ribbed woven material of the invention.

[0015] FIG. 4 illustrates a sectional view in the weft direction, through an alternate embodiment of the ribbed woven material of the invention.

[0016] FIG. 5 illustrates a sectional view of an embodiment of a woven rope showing the relative position of the strands during the first pick of a weaving process.

[0017] FIG. 6 illustrates a sectional view of an embodiment of a woven rope showing the relative position of the strands during the second pick of a weaving process.

[0018] FIG. 7 illustrates sectional view of an embodiment of a woven rope showing the relative position of the strands during the third pick of a weaving process.

[0019] FIG. 8 illustrates a sectional view of an embodiment of a woven rope showing the relative position of the strands during the fourth pick of a weaving process.

[0020] FIG. 9a illustrates a side view of a woven rope.

[0021] FIG. 9b illustrates a side view in accordance with an embodiment of the present invention, where the woven rope provides gradual auditory and visual indicators of breakage.

[0022] FIG. 9c illustrates a side view with an embodiment of the present invention, where the woven rope provides gradual auditory and visual indicators of breakage after being exposed to greater strain than in the illustration of FIG. 9b.

[0023] FIG. 10a illustrates a cross-sectional view of a woven rope cover with an internal rope in accordance with and embodiment of the present invention.

[0024] FIG. 10b illustrates the woven rope cover of FIG. 10a being utilized in a winch system.

[0025] FIGS. 11A-G illustrate embodiments of the present invention utilizing woven rope with other strands to form ropes.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0026] Reference now will be made in detail to the embodiments of the invention, one or more examples of which are set forth below. Each example is provided by way of explanation of the invention, not a limitation of the invention. In fact, it will be apparent to those skilled in the art that various modi-
fications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment, can be used on another embodiment to yield a still further embodiment.

Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents. Other objects, features and aspects of the present invention are discussed in or are obvious from the following detailed description. It is to be understood by one of ordinary skill in the art that the present discussion is a description of exemplary embodiments only, and is not intended as limiting the broader aspects of the present invention.

The present invention is directed to a ribbed material that may be useful in industrial straps, harnesses, and other embodiments. In certain embodiments, the ribbed material is used to sew or otherwise manufacture a load-bearing strap, sling, harness, or support. The strap, sling, harness, or support may, in an embodiment, then be used for the containment, holding, or transportation of heavy aircraft, rigging, engine, shipbuilding, or other industrial or construction-related tools and parts.

In a particular embodiment, the invention may comprise an industrial sling used to lift, move, and transport heavy loads. The industrial sling may be any type known in the art. In some embodiments, the sling may be a flat sling, a round sling, a bridie sling, a roundingsling cover, an endless sling, or an eye-to-eye (also known as “eye & eye”) sling. The ribbed material of the invention may also be utilized to manufacture or sew cover materials for a sling. In such an embodiment, the interior material of the sling may be referred to as the stuffer. The sling or cover materials may be single-layered or multi-layered.

In an embodiment, the material of the invention comprises a woven webbing. The term “woven”, as used herein, means interlacing individual fibers in a regular order. Any method of weaving known in the art may be utilized in this invention. Similarly, any weave pattern known in the art may be utilized in the webbing including, but not limited to, a plain weave, a twill weave, a satin weave, a tabby weave, a taffeta weave, a matt weave, a basket weave, a rib weave, computer-generated interlacings, and combinations thereof. The fibers may have any configuration known in the art. For example, the configuration of the fibers may be circular, ovular, elliptical, or flat.

In a particular embodiment, the woven webbing may comprise fibers or filaments based upon aromatic copolyamides. In one embodiment, the material may comprise fibers or filaments based upon meta-, para-aramids. In a particular embodiment of the invention, the meta-, para-aramid may be co-poly-(paraphenylene/3,4'-oxydiphenylene terephthalamidate), illustrated by the following chemical structure:

\[
\text{\[
\begin{array}{c}
\text{NH} & \text{NHO} & \text{OC} & \text{CO} \\
\end{array}
\text{\[
\begin{array}{c}
\text{NH} & \text{NHO} & \text{OC} & \text{CO} \\
\end{array}
\end{align}
\]}
\]
\]

[0027] In this embodiment, the webbing may have high tensile strength, high thermal resistance, high abrasion resistance, low shrinkage at high temperatures, high fatigue resistance, high chemical and heat stability, and low moisture regain.

[0028] In certain embodiments, if used, the meta-, para-aramid fibers may be woven into a webbing with other fibers known in the art. By way of example, the other fibers may comprise para-aramid fibers, meta-aramid fibers, nylon, polyesters, polyolefins, amide polymers or copolymers, or combinations thereof.

[0029] In an embodiment, the fibers used to create the material may be pretreated or lubricated prior to construction. Any pretreatment or lubricant should not leach into the fiber or adhere to any metal surfaces during use of the final product.

[0030] In an embodiment, the fibers of the woven material may be more than 500 denier. In other embodiments, the fibers may be more than 1000 denier. In still further embodiments, the fibers may be more than 2000 denier. In another embodiment, the fibers may be more than 3000 denier. In yet another embodiment, the fibers may be more than 4000 denier. In some embodiments, the fibers may be of any denier in the range of about 250 denier to about 6000 denier, including each intermittent value and range therein.

[0031] The “ribbed” aspect of the material may be created by weaving a plurality of woven ropes into the material. One or more of the warp or weft strands of the material may be replaced with one or more of the woven ropes to create the ribs. In an embodiment, the woven ropes project outwardly from the exterior surface of at least the load-bearing side of the woven material. In an embodiment, the woven rope ribbing extends in the longitudinal direction of the strap. In another embodiment, the woven rope ribbing extends in a latitudinal direction of the strap. In some embodiments, the woven rope ribbing may extend in both the longitudinal and latitudinal directions of the strap.

[0032] If the woven rope is woven into the material as a longitudinal rib in the longitudinal direction of the material, the material may have increased longitudinal stiffness, which may be beneficial for load-bearing materials. In addition, by configuring the woven rope longitudinally along the material, the final product, such as a lifting sling, when not loaded, may slide along the cargo more easily due to a greater degree of smoothness in the longitudinal direction of the lifting sling. If flexibility in the longitudinal direction is desired for the final product, such as a lifting sling, it may be preferable to provide the ribbing along the latitudinal direction of the material.

[0033] In an embodiment, the ribs of the inventive material may be provided in spaced rows along the length or width of the material. The ribs of the inventive material may be spaced equidistantly from one another or may be spaced intermittently. In an embodiment, each rib may comprise a single woven rope. In other embodiments, each rib may be made from two or more woven ropes woven near to, adjacent to, or on top of one another. The woven rope may be the same size
or thickness as the yarns of the woven material or, in an embodiment, may be larger and/or thicker than the yarns of the woven material. In still another embodiment, the woven material may include a bundle of yarns and the woven rope is placed on top of the bundle of yarns, thereby creating a raised rib effect by the combination of the bundle of yarns and the woven rope. In an embodiment, the ribs of the material may extend outwardly from the wall of the material at least 1/2 inch. The height and number of ribs to be implemented into the material may be customized as needed for each application.

In an embodiment, the fibers of the woven rope may comprise any natural or synthetic material known in the art. In an embodiment, the fibers comprise meta-, para-aramid fibers, meta-aramid fibers, cotton, nylon, Teflon-coated fibers, shaped fibers, glass fibers, basalt fibers, carbon fibers, high modulus polyethylene fibers, liquid crystal polymer fibers, hollow fibers, nylon, polyesters, polypropylene, polyethylene, polyphenylene sulfide, polyetheretherketone, polyolefins, amide polymers or copolymers, or combinations thereof. In an embodiment, the fibers of the woven rope may be more than 500, denier. In other embodiments, the fibers may be more than 1000 denier. In yet other embodiments the fibers may be more than 2000 denier. In another embodiment, the fibers may be more than 3000 denier. In yet another embodiment, the fibers may be more than 4000 denier. In some embodiments, the fibers may be of any denier in the foregoing ranges, including each intermittent value.

The construction of the woven rope itself can be illustrated with reference to the FIGS. 5-9. In an embodiment of the woven rope, referring specifically to FIG. 5, the first pick, all yarns except 1, 4, 8, 12, 16, 20, and 24 may be down relative to a needle yarn 35. The needle yarn 35 traverses across, between the warp yarns which are up and those which are down, as illustrated. As the needle comes across the yarn, the bobbin reciprocates to loop with the needle yarn, the bobbin yarn being shown at 37. In this embodiment, the needle yarn forms a weft strand, with strands 1-25 forming warp strands and strands 26-30 forming core strands.

In the second pick, illustrated in FIG. 6, only warp yarns 3, 7, 11, 15, 19 and 23 are down, the remainder being up. Again, the needle traverses, the bobbin reciprocates and the needle returns thus carrying the needle yarn 35 across and looping with the bobbin yarn 37, as shown. Subsequent to the first and each succeeding pick, the reed moves axially relative to the direction of yarn travel, to compress the weave.

In the third pick, shown in FIG. 7, all strands except 2, 6, 10, 14, 18, and 22 are down. Also, strands 1, 4, 8, 12, 16, 20, and 24 which were up in pick one have changed position with strands 2, 6, 10, 14, 18, and 22, which are up in the third pick, the cross over placing the respective sets of strands on the side of the weft strand opposite from that where they were previously located. Thus, the odd numbered picks result in alternating the position of the identified sets of strands as indicated.

In the fourth pick, shown in FIG. 8, strands 5, 9, 13, 17, 21, and 25 are down and the remainder are up. In comparison to the second pick, FIG. 6, strands 3, 7, 11, 15, 19, and 23 have moved from below the needle yarn 35 in pick two to above the weft strand in pick four. Note also that strands 1 and 25 have likewise moved.

It should also be noted that whether up or down, in this previously-described embodiment, strands 26-30 always have the same relative position in that they remain the center of the five sets of strands. While the two sets of strands above and below may exchange position relative to the weft strand on alternate picks, strands 26-30 remain unwoven and untwisted in this embodiment of the invention. These strands may function as core strands to give the cordage a solid feel. In other embodiments, the core strands may be omitted or woven.

Since in the odd numbered picks (FIGS. 5 and 7) the sets of strands straddling the weft strand are switched, the case with the even numbered picks (FIGS. 6 and 8), tension on the weft strand, which traverses the groups of strands progressively along the length of the woven mass, operates to bring the strands into orientation to produce a round product. If no tension were applied to the weft strand, an essentially flat product would result. By tensioning the weft strand, a product may be produced that has a ratio of cross-sectional thickness to width of 0.75 to 1.0, resulting in a generally round product that is woven.

The foregoing process is illustrative of one embodiment of the present invention, and one of ordinary skill in the art would readily appreciate that alternative processes may be employed, including by employing looms that do not use needles to weave. For example, in alternate embodiments, a shuttle loom may be employed, in which the shuttle contains a bobbin of weft thread and passes back and forth between the layers of warp yarns during the weaving process. Other types of looms also include, by way of example and without limitation, shuttle, rapier, air jet, and water jet looms.

With respect to the construction of the ribbed woven material of the invention, reference will be made to FIGS. 1-4. FIG. 1 illustrates a ribbed material of the invention in the form of a generally tubular fabric having ribs on all outer sides of the woven material. The interior of the tubular fabric may be stuffed or left hollow in various embodiments. FIG. 2 illustrates a ribbed material of the invention configured in a single layer and having ribs on only one side of the material.

The ribbed material shown in FIGS. 1-4 is shown with ribs 46 running longitudinally 42 with the fabric. The ribs 46 are raised from the exterior surface 47 of the fabric to project outwardly. The ribs 46 are disposed next to one another at substantially regular intervals 48 on at least one surface of the material. FIG. 1B illustrates an exploded view of two of the ribs 46 of the material. The ribs 46 are comprised, in this example, of a woven rope 53 having weft strands 61 and warp strands 62. The weft strands 61 and warp strands 62 are interwoven as discussed above.

In FIGS. 3-4, only two ribs are shown. In FIG. 3, the ribs are shown on a single layer of material, the ribs being on both the upper and lower sides of the material. In FIG. 4, the ribs are located only on one side of the material.

As noted above, the number of ribs 46 implemented in a particular material can vary according to the proposed use thereof. The ribs 46 may be arranged at substantially identical distances 48 from one another or varied according to the end use requirements.

In FIGS. 3-4, the weft threads 51, the warp threads 52, and the ribs 46 are shown. The ribs 46, shown in FIGS. 1-2, are formed by weaving a woven rope 53 into the basic fabric of the material. In an embodiment of the invention, one or more juxtaposed warp threads 52 of the fabric can be replaced with one or more strands of the woven rope 53 in order to form the ribs 46.
In some embodiments, the thickness of the woven rope 53 may be greater than that of the warp threads 52. The thickness of woven rope 53 also may be greater than the thickness of the weft threads 51. The degree to which ribs 46 project beyond the outer surface 57 of the material is indicated as projection height 56. The projection height 56 for the ribs can vary, but may be, in an embodiment, greater than the thickness of the material. In some embodiments, the projection height may be 5% to 200% greater than the thickness of the material, including each intermittent value therein. In some embodiments, the projection height may be at least 5% greater than the thickness of the material. In another embodiment, the projection height 56 for the ribs may be at least 10% greater than the thickness of the material. In another embodiment, the projection height 56 for the ribs may be at least 20% greater than the thickness of the material. In yet another embodiment, the projection height 56 may be up to 50% greater than the thickness of the material and, in still another embodiment, the projection height may be 100% greater than the thickness of the material. In an embodiment, the thickness of woven rope 53 may be at least twice as great as the thread thickness, or the diameter, of warp threads 52 and weft threads 51. In still further embodiments, the material itself may have increased thickness under the woven rope, such that the material’s localized increased thickness and the woven rope combine to form a raised projection.

In another embodiment, present invention includes a woven rope having extended ribs. The ribs in this embodiment may serve the same purposes as with the woven material discussed above, such as improved abrasion resistance and wear indication. In such embodiments, the ribs on the woven rope structure may be comprised, by way of example, of woven elements or twisted yarn combinations that form the raised ribs.

In an embodiment, the ribbed aspect of the inventive material provides an indication of the wear resistance of the material. For example, a lifting sling may be used to lift a heavy object by wrapping the object with one or more slings and using a mechanical device such as a hoist or crane to lift the object. As the sling is loaded with the weight of the object, the sling will move and slip against the object. This movement causes abrasions which, over time, may cause the fibers of the web to become cut and/or weakened. In the present invention, however, as the ribbing becomes worn, it indicates that the load bearing properties of the material may be reduced. When the ribbing is worn to the point that it is flush with the material itself, the industrial product may be replaced.

In addition to the indicator properties that the ribbing provides the material, the use of woven rope in the ribbing provides the material with surprisingly enhanced abrasion resistance. Because the ribs bear a large portion of the wear when in use, the material will last longer in use than if no ribs were present. However, as set forth in the examples, the use of woven rope in the present invention provides significant improvement over a ribbed material using mere filament yarns, twines, or monofilament wire for the ribbing.

The ribbed woven material of the invention may be coated to improve abrasion resistance, reduce friction, improve ultraviolet resistance, or to otherwise protect the material. Such coatings are well known in the art. In a particular embodiment, only the ribbed elements may be coated. In this embodiment, the coating costs are reduced. Additionally, by not fully coating the material, moisture can transfer through the material and the material will dry naturally. This can be a significant benefit in industries where mildew and water retention in slings or harnesses are common issues. Coating the ribbed elements only can also allow the structural fibers of the material to move and elongate more easily, thereby producing a higher tensile strength than would be found in a fully coated product.

[0057] Breakage System

In some embodiments, and as illustrated in FIGS. 9a, 9b, and 9c, the present invention is directed to woven ropes that include auditory and/or visual indicators of breakage prior to a complete break of the woven rope. In typical braided, twisted rope constructions, equal pressure is applied throughout the breakage area such that most, if not all of the individual fibers of the rope themselves are broken at once. The present invention, however, improves on previous constructions by providing various warnings to a user that maximum load conditions may be approaching.

[0059] The woven ropes provided in the present invention may be constructed as indicated above. By way of example, and with reference to FIG. 9, woven ropes of the present invention may include both warp yarns 102 and weft yarns 104. As provided in embodiments of the present invention, these materials may provide the warnings necessary for use in embodiments of the present invention. For example, although most ropes are given maximum load requirements, the warp yarns 102 and/or weft yarns 104 may include maximum load weights that are less than the total breaking weight of the entire rope or that are less than the maximum load weight of other yarns in the rope. For example, in some embodiments, some or all warp yarns and/or weft yarns in a rope may have maximum load weights that are between about 20 and about 80% of the total breaking weight of the entire rope. In other embodiments, the warp yarns 102 and weft yarns 104 may include maximum load weights of between about 40 and 60% of the total breaking weight of the entire rope. In such instances, as the maximum weight is approached, the warp yarns 102 and weft yarns 104 will start to break, thereby providing a user with visual and auditory warnings of approaching breakage.

[0060] As shown in FIG. 9a, an exemplary woven rope includes warp yarns 102 and weft yarns 104. As shown, FIG. 9b, the rope is subjected to strain, and some of the weft yarns 104 begins to break as shown by broken weft yarns 104. In this manner, broken weft yarns 104 may provide an indication that the total breaking weight of the entire rope is being neared or that a certain threshold of strain or stress has been met. As shown in FIG. 9c, the exemplary rope has undergone additional stress and some of the warp yarns 102 have broken as shown by broken warp yarns 102. These broken warp yarns 102 may provide an additional indication of a certain threshold being met or neared for the entire rope.

[0061] In some embodiments, additional materials, such as a distinct weft strand or a distinct warp strand of a different material than the other weft and/or warp strands of the rope, may be incorporated into a rope to provide an indication of a threshold being met or neared. For example, in one embodiment, such distinct weft strands or a distinct warp strands may be of a weaker material than the remaining weft or warp strands of the rope, such that when the weaker distinct weft strand and/or distinct warp strands are broken an indication is provided. In still other embodiments, an additional material, such as a yarn that does not otherwise serve as a weft strand or warp strand, may be incorporated into a rope to provide an indication of a threshold being met or neared.
[0062] In addition, to provide even greater indications of breakage, some or all weft yarns and warp yarns may be of various colors such that a user may determine when a particular breaking point is reached or is being reached. For example, in some embodiments, some weft yarns may be of a different color, for example red, than the other materials, such as white, utilized in the rope construction. As load conditions are being reached, those red weft yarns will start to break and will thereby provide the user with a clear indication of possible breakage.

[0063] Woven Rope Covers

[0064] In additional embodiments of the present invention, the invention may be directed to covers of cables, core yarns, or other rope-like materials with woven rope. As illustrated in FIGS. 10a and 10b, in such embodiments, a cable 200 or the like is placed within a woven rope cover 202. In the depicted embodiment, as shown in FIG. 10a, a space 204 provides a gap between cable 200 and woven rope cover 202. Such covers may provide additional protection, i.e. abrasion resistance, to the internal rope or material such that the little to no deformation may come to it. In addition, such construction provides advantages over typical rope cover constructions utilizing braided or twisted rope. In previous constructions, as the outer cover is pulled, for example in a winch or other device, it will tighten around the internal rope or material, i.e., the free space between the outer cover and the internal rope will reduce. This provides additional surface contact between the outer cover and internal material, and leads to issues of melting the internal material as heat is created through the additional surface contact.

[0065] However, with the current constructions, utilizing a woven rope material, such disadvantages are lessened. When a woven rope is pulled by a winch device its circumference is not substantially lessened, as illustrated in FIG. 10b. Accordingly, heat is not transmitted to the internal material at the same rate as it is in previous constructions thereby putting less strain on the internal material. Such constructions are advantageous over previous constructions and provide additional utility in high-temperature situations, including desert or other high-temperature environments.

[0066] Rope Constructions Utilizing Woven Rope

[0067] In additional embodiments of the present invention, woven strands utilizing warp and filament materials, as discussed above, may be utilized in the construction of various ropes. For example, in some embodiments, woven ropes, with or without core materials, may be constructed utilizing woven strands. In addition, braided rope (with or without core materials), as well as twisted and knitted rope, may be constructed utilizing woven strands in the construction. Such ropes may be constructed with woven strands alone, or they may further utilize twisted, braided, untwisted, knitted, or any other type of yarns. The use of such woven strands provides traditional ropes and materials with additional levels of abrasion resistance, less elongation, firmer construction, as well as improved energy absorption.

[0068] Due to the construction of woven rope, weaving can provide a rope with less length of yarns per rope length, thereby reducing material usage and the inherent elongation of the yarns used. Further, using woven rope components in the construction of a traditional rope or woven rope provides a characteristic of the individual yarns within a rope staying essentially in place during loading and unloading. Such a configuration may reduce splaying, which is the effect in which a braided or twisted rope can open (i.e., move to a larger diameter allowing space between yarn bundles) and close. In addition, in the foregoing embodiments, woven rope may provide an increased ability for the rope to stay intact when cut, thereby reducing the effect of fraying of the individual parts of the rope.

[0069] FIGS. 11A-G illustrate exemplary embodiments of the present invention. As shown, different configurations having woven strands with either twisted, braided, or untwisted yarn strands are shown. Any amount of woven strands may be incorporated as suitable for a particular application. In one exemplary embodiment, as shown in FIG. 11G, a core may be made of woven strands and the cover may be made of braided ropes. In the illustrated embodiments, the proportion and/or placement of woven strands may be modified within the scope of the present invention. In some embodiments, woven rope may be combined with more than one of twisted, braided, or untwisted yarn strands. In addition, the woven strands in a rope embodiment may vary in size, shape, and/or materials. Similarly, the non-woven strands in a rope embodiment may vary in size, shape, and/or materials. In some particular embodiments, woven strands at or near the outside of the rope may serve to reduce abrasion and wear damage.

[0070] Due to the inherent advantages of woven ropes and small cordage ropes, conventional ropes may be improved by using woven ropes as components to improve performance. These performance improvements may include lower stretch due to the lower elastic elongation of the woven rope components (less yarn twist) and higher strength per unit rope weight due the woven construction having straighter yarn bundles. Additional improvements may also include, as indicated above, reduced fraying of woven ropes that could be cut in application and an improved tendency of the woven rope bundles to hold together under compression loading (less splaying of the fibers) which may reduce the amount of debris that can be lodged inside a rope in application. The woven rope components have demonstrated higher strength per unit weight and lower stretch under load. In addition, woven strands may provide a more firm and stiffer rope product, and such embodiments may also provide improved energy absorption. By using these woven components, a rope designer can add these features into a conventional rope design by adding smaller woven rope components to make a conventional rope. These woven rope components can be used in virtually any conventional rope design including twisted strand ropes, braided, double braided, braided kernmantle ropes, and knitted ropes. In addition, these embodiments may be incorporated into products and materials, such as, for example, the ribbed woven material discussed above.

[0071] Although particular embodiments of the invention have been described using specific terms, devices, and methods, such description is for illustrative purposes only. The words used are words of description rather than of limitation. It is to be understood that changes and variations may be made by those of ordinary skill in the art without departing from the spirit or the scope of the present invention, which is set forth in the following claims. In addition, it should be understood that aspects of the various embodiments may be interchanged in whole or in part. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred versions contained therein.
What is claimed is:

1. A ribbed woven material comprising:
   a. a plurality of warp threads;
   b. a plurality of weft threads, wherein the warp and weft threads are interwoven together; and
   c. at least one woven rope having a thickness which is greater than that of the warp threads or the weft threads, wherein the at least one woven rope is woven into the material in the warp direction or the warp direction and extends outwardly in a rib formation from the surface of the material.

2. The material of claim 1 wherein the woven ropes are spaced equidistant from one another.

3. The material of claim 1 wherein the ribs that are formed extend outwardly from one side of the material.

4. The material of claim 1 wherein the ribs that are formed extend outwardly from both sides of the material.

5. The material of claim 1 wherein the woven rope has a thickness that is at least 10% greater than that of the warp threads.

6. The material of claim 1 wherein the material is a tubular fabric.

7. The material of claim 1 wherein the weave pattern is selected from the group consisting of a plain weave, a twill weave, a satin weave, a tubby weave, a twillita weave, a mott weave, a basket weave, a rib weave, computer-generated interlacings, and combinations thereof.

8. The material of claim 1 wherein the warp and/or weft thread configuration is selected from the group consisting of circular, oval, elliptical, and flat.

9. The material of claim 1 wherein the warp, weft, and/or woven rope threads are selected from a fiber of the group consisting of meta-, para-aradim fibers, para-aradim fibers, meta-aradim fibers, cotton, rayon, Teflon®-coated fibers, shaped fibers, glass fibers, basalt fibers, carbon fibers, high modulus polyethylene fibers, liquid crystal polymer fibers, hollow fibers, nylon, polyesters, polypropylene, polyethylene, polyphenylene sulfide, polyetheretherketone, polycrystalline, amide polymers or copolymers, and combinations thereof.

10. The material of claim 1 wherein warp, weft, and/or woven rope threads have a denier greater than the amount selected from one or more of the following: 500 denier, 1000 denier, 2000 denier, 3000 denier, and 4000 denier.

11. A rope configured to provide an alert as a total breaking weight of a rope is approached, wherein the rope comprises a woven rope having indicator yarns displaced within the rope, wherein the indicator yarns have maximum load weights that are less than the total breaking weight of the entire rope.

12. The rope of claim 11 wherein the woven rope further comprises indicator filaments having maximum load weights that are less than the total breaking weight of the entire rope.

13. The rope of claim 12 wherein the indicator warp yarns and the indicator filaments are a different color than the remainder of the woven rope.

14. The rope of claim 12 wherein the indicator warp yarns and the indicator filaments have maximum load weights that are about 20 and about 80% of the total breaking weight of the entire rope.

15. The rope of claim 12 wherein the indicator warp yarns and the indicator filaments have maximum load weights that are about 40 and about 60% of the total breaking weight of the entire rope.

16. The rope of claim 12 wherein the indicator warp yarns and the indicator filaments have maximum load weights that are less than 80% of the total breaking weight of the entire rope.

17. A woven rope cover system for rope-like materials, wherein the rope cover comprises a plurality of interlacing individual fibers interlaced in a regular order, wherein the interlacing fibers are arranged to form a tubular shape having a hollow center configured to house a rope-like structure.

18. The woven rope cover system of claim 17 further comprising a rope-like structure disposed within the hollow center of the rope cover such that a space is present between the rope-like structure and the rope cover.

19. The woven rope cover system of claim 17 wherein the rope cover comprises at least one rib that projects from a surface of the woven rope cover, wherein the rib is optionally comprised of woven rope.

20. A nonwoven rope comprising strands comprising nonwoven strands of material that are configured in a rope construction and further comprising one or more woven rope cords displaced within the nonwoven rope construction.

21. The nonwoven rope of claim 20 wherein the nonwoven rope comprises strands that are arranged in one or more constructions selected from the group consisting of twisted, braided, double braided, braided kermantle, and knitted.

22. The nonwoven rope of claim 20 wherein the woven rope cords are smaller in diameter than the nonwoven strands of material.

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