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## 3.5 Ropes and Knots

### 3.5.1 Introduction

All ties or fastenings that use rope or cordage fall into three general classifications: knots, hitches, and bends. All are "knots" in the full sense of the term, and there are some ties which have more than one classification, their purposes being interchangeable.

The following are the basic definitions to understand ropes, cordage and knots:

#### **Bend**

a knot which ties the ends of the two free ropes together, or the action of knotting two ropes together (same origin as the word "bind").

#### **Braided**

laid rope manufactured by twisting fibers together into yarns, yarns into strands, and strands into rope. The lay of the rope is the spiral twist of the strands. This rope resembles plaited rope in construction except that it is made up of a great number of yarns instead of strands. Braided rope is balanced by having an equal number of left-hand and right-hand turns. This is actually two ropes, one inside the other. The outer rope is called the cover or sheath and the inner one, the core; both are braided.

#### **Cordage**

a comprehensive word for any line, whatever its size or material, which has no special purpose.

#### **Fiber (or filament)**

the smallest element of material forming the individual fibers of rope

#### **Heart (or core)**

a textile product (yarn, strand, small diameter rope etc.) placed in the center of a rope and serving as a support for the strands around it.

#### **Hitch**

a knot that secures a rope to a post, ring, spar or rail, etc., or to another rope which takes no part in tying the knot. A hitch won't keep its shape on its own. In climbers' jargon, a "hitch" is often just a temporary fastening.

#### **Knot**

in the restricted sense, is a tie made in a rope and usually requires the manipulation of only one end.

#### **Lay**

the direction, either left-handed or right-handed, of twist in the strands of rope; also the nature (tight, medium or loose) of that twist.

#### **Line**

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a general label for most cordage with no special purpose. Line is also used to refer to rope that does have a purpose, such as clothesline, heaving line, fishing line.

**Plaited**

an eight-strand rope that is made up of four right-hand and four left-hand turned strands, laid in pairs. Two pairs of strands are twisted to the right and two pairs of strands are twisted to the left. They are braided together such that the pairs of strands of opposite twist alternately overlay one another. This type of construction resists rotation and is used for flag halyards, clothes lines, etc.

**Rope**

any cordage over .4 inch in diameter.

**Staple**

graded fibers or chopped filaments for rope making (rope made from staple has a fibrous or fuzzy surface due to all the ends).

**Strand**

yarns twisted together in the opposite direction to that of the yarn itself; a major element in the complete rope. Rope made with strands-not braided-is "laid line".

**Tracer**

a means of distinguishing one rope from another or one manufacturer from another by the use of yarns, tapes or other markers in a rope, either externally, internally or both. Also referred to as a marker.

**Yarn**

any number of individual fibers or filaments twisted together as the first stage in rope making.

### 3.5.2 Safety Considerations

Standard Laboratory Precautions

### 3.5.3 Preparations

Standard Laboratory Practices

### 3.5.4 Minimum Standards & Controls

Consideration of a possible fracture match should be taken.

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A drawing or photocopy of the rope or a photocopy of a rope of the same type of physical construction, along with all the pertinent measurements shall be included in the notes.

### **3.5.5 Instrumentation**

None for physical examination and physical comparison.

See other fiber manual sections for specific fiber comparison techniques if performed.

### **3.5.6 Procedure or Analysis**

#### **3.5.6.1 - Knots**

If the rope has any knots, hitches or bends, those should be identified if they are germane to the case. This identification should not be attempted unless the examiner has more than a layman's knowledge about this subject.

Identification of the knot, hitch or bend will be made by determining how the questioned item is tied and comparing it to photographs or drawing in reputable text. A photocopy of the photograph or drawing shall be included in the examiner's notes. The examiner's report shall identify the knot, etc., by its proper name, if that is able to be determined.

#### **3.5.6.2 - Cordage**

The full identification of the rope's construction is done by identifying the physical construction and identifying the materials of which the rope is composed.

Case-specific situations may deem full identification of the materials themselves (i.e. fiber identification and comparison) as optional, based on agreement with the submitting agency.

- When comparing a questioned rope to a submitted known rope, an elimination of a common source is reached when any difference in physical construction or materials is observed.
- The examiner's notes shall reflect the physical construction of the rope.
- Identification of the fibers/filaments shall be reached by following the appropriate fiber analysis procedures

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A cordage examination is primarily a process of deconstructing the rope or cordage by dissecting its individual components. Each of these elements can have a number of sub-elements, all of which shall be characterized. These elements include, but are not limited to, the following:

- Construction—Diameter, colors, braided/plied, direction of twist, number of crowns or turns per inch, number of plies/strands/braids, presence and appearance of any core, coatings, or tracers.
- Plies/Strands/Braids—Twisted or non-twisted, direction of twist for each, crowns or turns per inch for each, staple or filament fibers.
- Cordage examinations of multiple samples can be carried out concurrently. If meaningful differences are noted between the samples at any point during the examination, the samples are deemed different and no additional characterization is required.
- A complete cordage examination and comparison (if deemed necessary) includes the analysis and comparison of the constituent fibers using the appropriate microscopical, chemical, and instrumental techniques

Note: A sample to be used for composition testing should not be cut from ends of cordage if there is a possibility of physically matching a questioned item to a known item. It is recommended that the known sample be collected away from the existing end(s) and the location marked.

One of three results can be reached after evaluating and comparing the known and questioned cordage samples:

- Cordage samples being compared are dissimilar if one or more meaningful differences is present (for example, color, fiber type, overall construction).
- Cordage samples being compared cannot be distinguished if no meaningful differences are present.
- A cordage comparison is inconclusive if no determination can be made as to whether differences observed are meaningful (for example, condition of the sample, wide range of components, sample heterogeneity).

### 3.5.7 References

[Rope – Construction Examples and Diagrams](#) (compilation of various gathered diagrams)

[ASTM E2225-19a – Standard Guide for Forensic Examination of Fabrics and Cordage](#)

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Wiggins, K., "Recognition, Identification and Comparison of Rope and Twine," Science and Justice, Vol 35, No. 1, 1995, pp. 53–58

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<http://www.ropecord.com/new/terminology.php>

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