The Study of Knot Performance

Exploring the Secrets of Knotted Cordage to Understand How Knots Work

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Knot Performance in the Knot Books

The Rich Resources of Knot Studies

A handful of devoted writers have made significant contributions to our store of knowledge about how knots work.

From the earliest treatises on knots, written mainly by sailors, through the encyclopedic works by Ashley and Day in mid-20th century, to the standard modern presentations and reports of recent scientific studies, various writers have supplied us with a storehouse of information about knots. We are fortunate to have a reports of investigations of knot history and knot lore such as those collected by Turner & van de Griend, conclaves of knot enthusiasts such as the International Guild of Knot Tyers, and reports of the practical experience of climbing, rescue, sailing, and angling groups. Their work is essential to anyone interested in knots and knot tying. Taken together, these sources are rich in discussing knot performance.

All of the major knot books mention the three aspects of knot performance, security, stability, and strength. A few of them describe tests of knot security. Many of them directly mention knot structure, the parts of a knot such as a bight or crossing, knot strength and where knots break, friction, nip, load, and instability. Some show that previous explanations of how knots work are mistaken. The best of the writers, like Clifford Ashley and Cyrus Day, admit the limits of their ability to understand knot performance.

The Limitation of Most Knot Studies

But these knot studies have been limited mainly to tying and using knots and neglect many aspects of knot performance. I have not found many studies of knot mechanics or discussions of how knots work and how they fail to work. None of the knot books that I have seen explain the devices that knots are made up of or show how they create friction, and only recently have physicists published diagrams of the forces on a loaded knot.

The curious thing about the neglect of knot performance is that so many writers come so close to the matter, but do not directly ask the fundamental questions, follow an analytical procedure, examine the function of a knot's structural parts, or present a description of knot performance. They do not discuss why ropes configured in their various ways behave the way they do.

The neglect of knot study is not limited to knot specialists or the writers of knot books. Knot performance has been largely ignored by both the popular and technical press. Few scientists and engineers have taken note of knots as physical devices, and the general public seems indifferent to them. Mathematicians, who have contributed so much to our understanding of knot structure, have understandably not directed their attention to studying the environment, materials, and mechanics that affect the performance of practical knots.

Many other devices and gadgets have engaged the interest of both serious and popular investigators as well as of the reading public. Numerous books explain to a lay person how things work. In any number of encyclopedias and "How Things Work" books, a lay person will find explanations of how other devices work, everything from electric toasters to atomic bombs, and usually in a page or two. A recent volume tells the history of the screw in

delightful prose, and others trace the development of everyday things. But there is precious little on the way knots work. Even the major encyclopedias fail to take up the subject.

When I ask questions about the physical properties of knots—whether of ski patrollers, anglers, or sailors or of engineers and physicists—the most frequent reply is, "I had never thought of that." In view of the fact that security, stability, and strength are the chief aspects of knot performance and are the fundamental properties in knots, it is unfortunate that so many knot books fail to treat them at length, that so many ignore the distinction, and that so many neglect the subject altogether.

Notes on Knot Performance in Charles Warner

Charles Warner makes numerous brief comments on the security and strength of knots. Following is a topical index to references on knot performance in his book *A Fresh Approach to Knotting and Ropework.*

viii. Preface. General comment on structure and performance.
31 Twin knots, slipping, sliding
34 Strength and security
34 Deformation
59 …spaces…
46.2 A "long line of friction"
33 Binding, crossing, etc.
39 Arrangement
143 Quick Release, 127, 146, 153, 153 (bis)
163 Unequal thickness, 166, 178
163 Backup, 52 (terms), 178 ; tightened "on to itself" (or not); 207 ("extra security")
168 Wear on rope; kindliest knot
210 Testing

Security

xii load…tension, 36 slip; 44 nip definition., 94 "friction over long lengths," 97 1/3, 127, 131, 139, 141, 142, 142 bis, backup 144, 152, 163, 164, 174, 165, 168, 171, 204, 241, 207; Ch. 11; 133 Ch 15 ff.

Stability

xiii 1/3 Binding, 30 upset (dressing + snugging), 42 Twins, conversion; 145!, 165? (Twins)

Strength

23, 27, 34 (nothing on breaking point); 73, 69, 128 1/3, 130 3/4 ! f., 146, 166; Tests and comparison: 47 (Bimini Twist), 200, 210

References to Knot Security in Clifford Ashley

In his discussion of knot failure, Clifford Ashley is careful to distinguish knot security from knot strength. As aspects of security, he mentions two kinds of failure, slipping and deformation, which he calls capsizing. When he describes his tests of security, however, he does not mention capsizing. In his presentation of individual knots, he often comments "this knot is secure" or "it slips," or "it capsizes," or words to that effect, but he never treats these topics directly nor discusses them again at length. Ashley made numerous other comments on knot security, slippage, and coming apart.

Ashley mentions security frequently:

273, 274 Tests of security

In Chapter 18 on Bends, Ashley writes more often of security, as would seem natural.

50 #295 "does not untie or slip" [=secure]
54 #331 "The Lineman's Loop is secure"
55 #337 Drapper (sp?) Fly Hitch "is particularly secure"
56 #343 "Water Knot ... is both secure and strong." {This is contrary to current views}
56 #345 "the most secure of the three"
59 #356 "Neither is particularly secure."
60 #373 "...provided the surface is not too slick," (a particular knot will suffice)
65 #407 a knot that will not "work loose"
74 #459 "perhaps not so secure"
78 #488 "which is equally secure"
189 #1045 "may appear to be insecure" (See this reference)
218 #1198 Sacrifice symmetry to security
257¶4"a wet rope is both stronger and more slippery than a dry one."
#1409 Instability
258 #1410 Contrast of Strength and security in a Sheet Bend and Overhand Knot
268 #1480–1 Clear distinction and contrast between strength and security.
222 ¶3 Quote. (See this reference)
257 ¶2 "not to be trusted"
258 #1406–1409 This is a particularly important reference.
259 #1406 This is unclear to me: "With the ends arranged as shown, it is more secure bend than many far more trustworthy knots." This sounds self contradictory. Is Ashley being wry here, or is this a slip? Perhaps he meant "far more *trusted* knots."

Tests of Security in Knots

16 #631 Tests. My initial tests were not weighted
273 Results of security tests
267 #1474

Comparative security of various knots for joining ropes of unequal circumference:
Sheet Bend, #1464–71, various bends, Square Knot, Double Carrick Bend, #1405–1407.

Ashley's Comments on Other Knots

The Bowline has been under suspicion for some time:
186 #1015 A Lieutenant Alston
258 #1405 This condemnation of a Granny Knot is not entirely unequivocal. This is about as close as anyone ever gets to praise for a Granny Knot

216 #1183 Tendency for a Half Knot, used as a crossing knot: “when not in use they would be liable to loosen and get out of adjustment.”