Aviation Management Tech Tips

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NONMETALLIC LEAD LINES—THE GOOD, THE BAD, AND THE UGLY

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Nonmetallic or synthetic cable material has been in use for many years in some industries and the San Dimas Technology and Development Center (SDTDC) has also been monitoring their construction and performance. Within the last few years, the SDTDC has sponsored a field trial and recently performed a market search for synthetic cable material manufacturers. The market search consisted of a technical review of new material characteristics and care requirements. This tech tip provides a summary of the information learned over the years.

The Good

Nonmetallic cables are lighter and can be easily carried by one person. Nonmetallic cables are easier to handle because most do not take a permanent deformation or "set" in the form of bends like steel cables, and are therefore easier to coil. Most synthetic cables are not prone to kinking. Some cables have acceptable snap back characteristics, while others do not.

The Bad

The care of nonmetallic cables is significantly more demanding than its steel counter part. Nonmetallic cables are analogous to climbing or rappelling rope when considering care. The high strength synthetic cables have an open weave (more so than climbing rope) in which dirt, sand, and other foreign materials can penetrate the bundle. The imbedded foreign particles can act as a cutting device and slowly sever fibers within strands while the cable is under load. Most of these failures (cut fibers) cannot be easily inspected, and failure of the nonmetallic cable can occur well below the ultimate strength of the new cable.

Synthetic cables are susceptible to abrasion since their fibers are exposed. Abrasion resistance is increased with available urethane coatings, but debris can still enter fibers and between strands at spliced locations. Other coatings cover the entire strand bundle to reduce or eliminate penetration of the strand bundle by foreign material. Although these coatings make the cable stiffer, this stiffness memory is not as severe as steel cable. Additionally, these coatings make inspection very difficult.

Nonmetallic cables are higher in initial cost and do not last as long as steel cables. Nonmetallic cables are sensitive to ultra-violet (UV) degradation. Some ropes lose 30 percent of their initial strength after 5 to 6 months of sun exposure. Field-testing found that a cable, after 2 years of use, failed at approximately 7,700 pounds. The original strength of the cable (when new) was 14,000 pounds. If nonmetallic cables were put to use in the field, this strength reduction would probably require mandatory retirement of cable after 1 year of service.

Stream-back is a problem with nonmetallic cables, since they are much lighter than steel. If broken in flight, the cable can stream-back and make contact with the tail rotor. While weights could attached at various points along the length of the cable, reducing or eliminating stream-back into the tail rotor, these weights would also increase the weight of the cable, thus making it perhaps as difficult to handle as the current steel cable. Also, nonmetallic cables are sensitive to compression loads.

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In attaching a weight to the cable, the weight would need to squeeze the cable so that it would not slip its position. This squeeze places a compressive load on the cable and will result in a premature failure of the cable in terms of a significantly lower strength or life.

The Ugly

Manufacturers suggest that detailed use records be kept; hence, a log indicating the load supported by the nonmetallic cable for each use. This record would be required for any liability claims in case of an accident; otherwise, the fiber/cable manufacturer would deny liability, with cause. In addition to use records, detailed rope care and handling records would be required. A multiyear field-evaluation would require that each year all cables and their records would be sent to SDTDC for destructive testing. During the evaluation, the field would be required to buy new cables annually. This evaluation would continue until a statistically significant data base existed for cables used in the helicopter environment.

Manufacturers of synthetic fiber define a dynamic environment as loads ± 20 percent of the working load. Rope manufacturers define a shock load as a sudden load that exceeds the workload by 10 percent. Sling load transport by helicopter would be considered both a dynamic and shock environment. As such, manufacturers do not have adequate knowledge, experience, or data to properly define a required margin of safety for the ultimate strength of the synthetic cable to give a known service life. In other words, it is believed that manufacturers will not recommend, certify, or stand behind a cable sold for use under helicopters other than up to the first time it is attached to the helicopter. Some manufacturers have indicated a safety factor of 20 would be required for a dynamic environment (although not defined as a helicopter external load environment). This would require that a 3,000-pound working load cable would require an ultimate new strength of 60,000-pound. This cable would be about an inch in diameter, and thus probably eliminate the easy handling benefits of synthetic cables.

Summary

Nonmetallic cables for use as lead lines in the helicopter operations are not acceptable. While nonmetallic cables have been in use in other industries for a considerable length of time, they are still considered immature for helicopter operations due to the ± 20 percent dynamic and +10 percent shock environment limitation, strict care and handling requirements, UV degradation, poor abrasion resistance, and other issues contained above. When more data are available to better predict margins of safety for the helicopter flight environment, these cables should be evaluated again.