SAMSON TECHNICAL BULLETIN

Mixed Moorings

Overview Due to the increasing popularity of high-modulus synthetic fibers (HMSF) in mooring, there have been increasing instances where shipowners or operators are attempting to introduce these synthetic lines into their mooring systems, in conjunction with existing wire lines. Samson studied the effects of using HMSF mooring lines with wire rope mooring lines, and developed recommendations for these "mixed mooring" scenarios.

Conversion Process

The use of synthetic auxiliary lines (typically polyester fiber) in conjunction with wire rope primary mooring lines has been widely accepted, provided they are arranged and used symmetrically about the midship. When properly planned and managed, there are times when synthetic fiber mooring lines can be added in combination with existing wire. In some cases, it even provides additional security. However, the combined use of synthetic and wire rope primary mooring lines, a "mixed mooring," has historically been discouraged due to the potential for large differences in elastic elongations, especially with vessels using fixed brake winches. [1]

With the increased popularity of HMSF synthetic fiber mooring lines that have elastic elongation in the same order of magnitude of traditional wire rope, the issue of mixed moorings has resurfaced. Many vessel operators want to take advantage of the new synthetic technology due to its ergonomics and overall economic value, but do not want to retrofit an entire vessel prior to extensive field trials. The most common solution is to request a single line for trial and to use it in parallel with the existing mooring lines. This practice can still create a dangerous situation if the elongations and breaking strengths are not carefully matched.

SCENARIO 1 Even though high-modulus fiber rope has published elastic elongations similar to the elastic elongation of wire rope, the differences can still be very significant. For example, if a core-dependent HMSF jacketed mooring line is used in a trial with a wire rope as a breast line as shown in the graphic scenario in Fig. 1, the wire rope would see an increased tension (see Table 1 for actual results). This difference would effectively limit the holding power of the mooring system, but would not likely produce catastrophic results immediately. In this instance, the wire rope would fatigue at a much higher rate than the core-dependent HMSF jacketed mooring line which over time would create premature failure of the wire rope mooring lines (see Fig. 2). [2]

SCENARIO 2 Changing the position of the high-modulus synthetic fiber lines can minimize the line tension differential. In an actual mooring scheme, the majority of the lines sent ashore are used to restrain a combination of lateral and longitudinal forces as well as yaw moments;

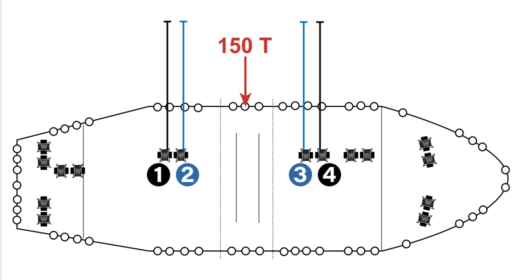

FIGURE 1 MOORING SCHEMATIC [1].
Blue lines represent core-dependent jacketed HMSF mooring line and the black lines represent wire rope.

TABLE 1 Line tension comparison for Figure 1.
(Where total applied load = 150 metric tons)

MOORING LINE	LOAD	% OF NEW ROPE BREAKING STRENGTH
#1 – Wire Rope	44 metric tons	**37%**
#2 – Turbo-DPX™	31 metric tons	**25%**
#3 – Turbo-DPX™	13 metric tons	**25%**
#4 – Wire Rope	44 metric tons	**37%**

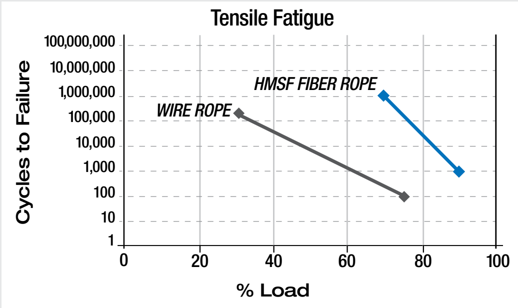

FIGURE 2 Tensile Fatigue Comparison.

therefore this situation will still produce tension differentials between dissimilar material mooring lines. For simplicity, we assume a vessel uses the mooring arrangement in Fig. 3. By placing the synthetic lines side-by-side, the situation is no longer dependent on the overall elastic elongation differences between the wire rope and the synthetic fiber mooring lines. However, this mooring arrangement creates an unbalanced system, where the vessel's stern can be displaced more than the bow (see Table 2).

This is further complicated by combining a new synthetic rope with the existing wire rope. Wire rope, like synthetic fiber rope, will degrade over its lifetime, which will likely affect its strength and the elongation characteristics. The degraded strength and elongation could result in the wire rope taking even more load and fatiguing at an increased rate. Without proper testing of the wire rope mooring lines, the addition of synthetic fiber rope is further discouraged.

SCENARIO 3 Changing out a complete set of lines can effectively minimize the load and elongation differentials that the two previous scenarios described. If the complete set of spring lines is changed to synthetic, the lateral restraining forces will be equally distributed and the resultant elongations will be equal in both directions.

Conclusion

Mixed moorings, not including the use of auxiliary or secondary lines, even with high-modulus synthetic fiber ropes, can have negative effects on mooring systems and should only be used if testing is performed and the load/elongation characteristics are carefully matched. To successfully implement a change from wire rope mooring lines to HMPE synthetic mooring lines, we recommend contacting our Commercial Marine Sales Division or Application Engineering. Samson has also produced detailed information on how to successfully retrofit a vessel and achieve safe and long service life from HMPE mooring lines. See *Retrofitting Ships from Wire to High-Performance Synthetic Mooring Lines* technical bulletin for additional information.

For other available Technical Bulletins, please contact your Samson representative or visit our website: ***SamsonRope.com***

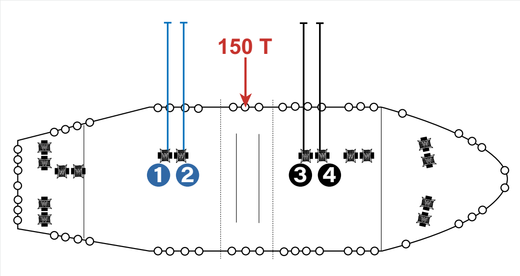

FIGURE 3 MOORING SCHEMATIC [2].
Blue lines represent core-dependent jacketed HMSF mooring line and the black lines represent wire rope.

TABLE 2 Line tension comparison for Figure 3.
(Total applied load = 150 metric tons and 60m leads)

MOORING LINE	DISPLACEMENT
#1 – Turbo-DPX™	0.60 meters
#2 – Turbo-DPX™	0.60 meters
#3 – Wire Rope	0.32 meters
#4 – Wire Rope	0.32 meters

REFERENCES

[1] OCIMF, *Mooring Equipment Guidelines, Fourth Edition,* Section 1.5.

[2] DSM supplied data.