SAMSON TECHNICAL BULLETIN

Published Date: October 2015

Kinking vs. Kink Banding

In the simplest terms, kinking of rope strands takes place when the rope is unloaded and compressed such that the braid distorts and the strands buckle and visibly kink. Kink banding, on the other hand, is a microscopic deformation within the fibers of a rope and isn't visible to the naked eye. In other words, kinking of a strand can be straightened when the rope is tensioned, while kink banding of fibers can be an indication of damage at the filament level.

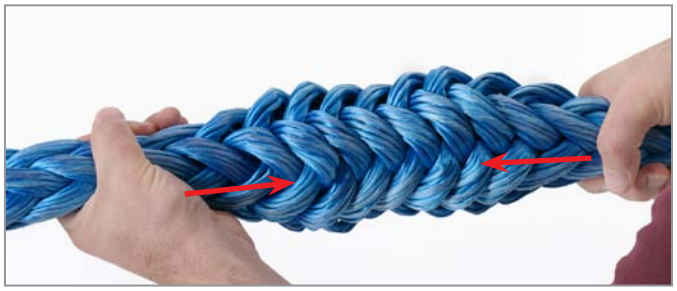

FIGURE 1 *Compression along rope's axis*

If a non-jacketed rope, such as a 12-strand (Figure 2, top), is completely free of tension and instead compressed (as shown in Figure 1), the braid will distort and yarns or strands can buckle or kink. The characteristic z-kink shape (Figure 3) is seen in any twisted structure subjected to buckling. When tension is reapplied, the braid angle returns to its as-designed value and the bends and kinks straighten out. So long as the rope is allowed to readjust, this poses no concern to the user.

FIGURE 2 *Non-jacketed rope (top) and jacketed rope (bottom)*

Jacketed ropes (Figure 2, bottom), however, don't permit the core strands to move as freely. Restricting the core strands means they can't move as easily in response to compression. This restricted movement means that the fibers in a jacketed rope can be more easily compressed and visibly kinked yarns are more likely to appear.

FIGURE 3 *Yarn kinks visible to the naked eye in a yarn taken from a jacketed rope*

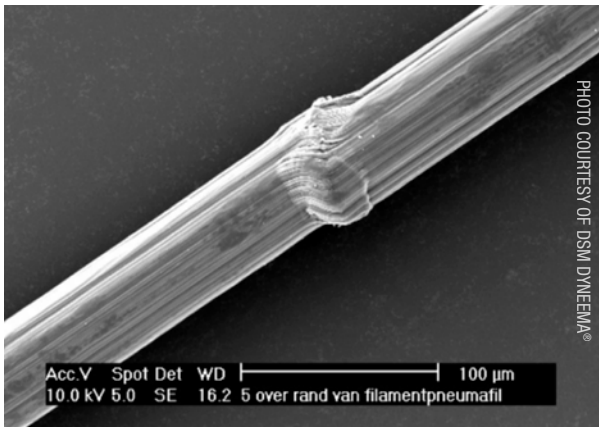

FIGURE 4 *Scanning electron microscope photo of kink banding in a polymer filament (Image in photo above is over 200 times smaller than that of the preceding kinked strand photo)*

WHAT IS KINK BANDING?

Kink banding occurs when the polymer chains in individual fibers are kinked due to high compression loads along the direction (axis) of the fiber (see Figure 4). The fibers that are used for high strength ropes consist of highly-oriented long polymer chains. These chains can be distorted at a microscopic level when a high-compressive load is applied along the axis of the fiber. This is an unusual occurrence in ropes because they are very rarely used with compressive loads applied along the fiber and because the rope structure would generally distort, as mentioned in the explanation of kinking of yarns.

If a kink band were to occur, the change would take place at the microscopic level for each individual fiber; there would not necessarily be any visible changes in the rope structure. Figure 4 illustrates this, showing changes in individual fiber over 200 times smaller than the kinked yarns in Figure 3. In fact, it would be more likely for a user to note the condition that applied the forces that created the kink banding but have no knowledge of whether kink banding existed.

SAMSON TECHNICAL BULLETIN

Published Date: October 2015

Kinking vs. Kink Banding

FIBER MAKES A DIFFERENCE

The concern over the kink banding depends on the type of fiber used. Some fiber types, such as Aramids, are affected by compression. For these types, kink banding is an indication that the fibers are being damaged. For other types, such as high modulus polyethelyne (HMPEs), the fiber is more resistant to compression and the kink banding can come out with minimal damage to the rope[1] and compression fatigue as is illustrated by the testing reported in Table 1. Even for those fibers that are damaged by kink banding, it is generally only one minor effect in a very long list of effects that can limit a rope's life.

TABLE 1: Restrained yarn buckling conclusions
FROM NOBLE DENTON AND NATIONAL ENGINEERING LABORATORY (1995)

	NUMBER OF CYCLES FOR	
FIBER TYPE	Detectable Strength Loss	Severe Strength Loss
Aramid	1,000 cycles	20,000 cycles
HMPE	20,000 cycles	200,000 cycles
Polyester	50,000 cycles	1,000,000 cycles

CONCLUSIONS

In summary, kinked yarns or strands have no significant impact on the strength or longevity of a rope. Kink banding is a microscopic phenomenon that is less common in ropes. It requires fibers to be somehow constrained such that a compressive force can be applied. If conditions were severe enough to create kink banding, it could affect the longevity and strength of some types of fiber, but in most applications (such as vessel mooring) it would be a minor contributor compared with factors such as abrasion.

In summary, kinked yarns or strands have no significant impact on the strength or longevity of a rope. Kink banding is a microscopic phenomenon that is less common in ropes. It requires fibers to be somehow constrained such that a compressive force can be applied.

[1] Marissen, Roelof, DSM *"Design with Ultra Strong Polymer Fibers,"* Materials Sciences and Applications, 2011, 2, p. 319–330.

Dyneema®

SamsonRope.com | Email CustServ@SamsonRope.com | Tel +1.360.384.4669

SAMSON® THE STRONGEST NAME IN ROPE