Hidden damage in slings corrosion and ultraviolet light

by Dennis St. Germain

Strength loss associated with metal corrosion of wire rope and ultraviolet light degradation of synthetic fibers.

In 1989, a presentation was made on our new synthetic high performance Twin-Path® slings to a rigging group at a shipyard in St. John, New Brunswick. Their facility was located adjacent to the Bay of Fundy, a body of salt water. At the time, they were building outsized modules weighing up to 500 tons inside a huge building and then moving the modules outdoors to be lifted into a dry dock for final assembly of a finished ship. To make these heavy lifts the shipyard had been using a set of four inch diameter by ninety foot long wire rope slings. Because these slings were so heavy and awkward to handle, they were stored outdoors beside the dry dock subjected to the elements that included cold, heat, salt air and rain. After only two years of this exposure the wire rope slings had to be replaced due to the corrosive effects of the environment.

The benefits of these new High Performance Twin-Path® slings were explained to the riggers, including lighter weight and ease of handling compared to the heavy steel slings. Surprisingly, the riggers explained a benefit we did not think of. The shipyard team identified the fact that the Twin-Path® slings could be stored inside after use and would not be subjected to the debilitating effects of weather. Based on this, they were willing to spend extra money on Twin-Path® slings with the same capacity as their four inch wire rope slings. The synthetic slings would not rust and have to be replaced making Twin-Path® slings less expensive in the long run and a bargain for the shipyard. Ultimately, those slings lasted fifteen years.

It is a fact that corrosion of steel from exposure can be slowed by various methods like painting, galvanizing, plating, and covering with heavy grease, but nonetheless, many accidents have occurred because the hidden damage was not identified by normal inspection. Several bridges have collapsed into the chasm below from rust and corrosion of strength bearing members that went unnoticed by the professionals hired to make the determination. In 1967, the Silver Bridge between West Virginia and Ohio collapsed into the river below killing 46 people. In 1983, a section of the Mianus Bridge on I-95 in Connecticut collapsed killing 3 people. Both of these tragedies were blamed on the failure of inspectors to identify corrosion. Wire rope slings and crane ropes have also failed from exposure and lack of proper inspection causing serious injury, death and monumental property damage.

Synthetic materials used for running ropes and slings are not subject to hidden damage from rust and corrosion, but they are weakened in much the same way by exposure to ultraviolet light. Ultraviolet (UV) light is light that has a shorter wavelength than violet, and is not visible to the human eye. UV light degrades synthetics by transferring energy into the fibers. This energy can cause damage by breaking down the molecular bonds in a fiber's structure.

The main source of UV light is the sun, but some UV light is also created by welding arcs, fluorescent lighting, and Xenon light which is now used in automobiles as a brighter headlamp. Generally, darker colors provide better UV resistance than lighter colors. Thicker materials resist UV light better than thinner. Thicker materials allow the surface to suffer UV degradation while retaining strength in the

UV-Degradation Testing Results at 500 Hours Exposure

Fiber Type	No UV Exposure	No Cover	DBL Yellow Poly Cover	DBL Org-Red Poly Cover	DBL Black Poly Cover	CoverMax® Cover
	Base Line	Percentage of Strength LOST at 500 Hours of UV Exposure to Covers/Fiber				
Polyester	100%	36%	12%	9%	5%	2%
Aramid	100%	28%	26%	27%	9%	2%
K-Spec®	100%	12%	N/A	N/A	N/A	1.13%

(N/A indicates that K-Spec® load bearing core fiber is never used inside these types of covers)

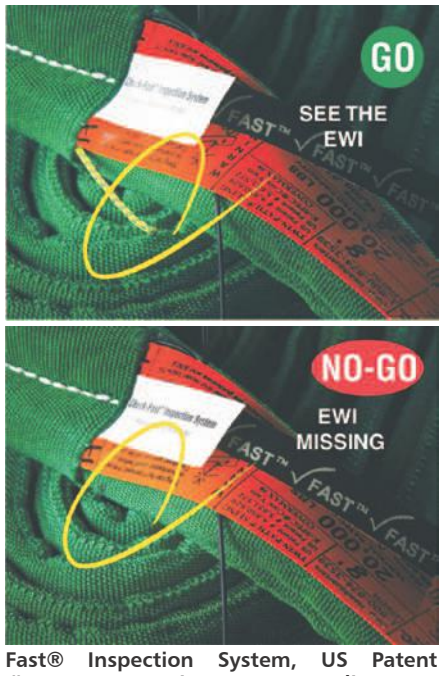
inner core material.

A research study by the WSTDA published in 2003 confirmed what industry experts already suspected. Long term UV exposure reduces the breaking strength of web slings. Polyester web slings lost up to 30% of their strength during the first 12 months of exposure, after which the strength loss leveled off. Nylon web slings showed a strength loss of up to 50%-60% after 36 months of exposure with no indication of leveling off. This report is available for purchase at www.wstda.com. The important question is this: Should web slings be given a maximum life expectancy like the 5 year shelf life of synthetic fall protection gear?

The other most common synthetic sling is called a roundsling. These products have a strength bearing core inside a protective cover or jacket. It has always been assumed that the roundsling cover, no matter the thickness or color, protected the load bearing core from UV degradation. Only recently has it been discovered that there is a wide variance in the UV protection levels provided by different roundsling covers. Testing has found that while some covers provide adequate protection, others do not. Since ultraviolet light can cause loss of strength to synthetic fibers and is essentially hidden damage similar to the corrosion of steel, the inspector needs education to recognize the issues involved.

The following chart displays test results of UV degradation to varying roundsling cores and covers used by riggers around the world. This testing was requested by Slingmax® Rigging Solutions and conducted independently by Murdock Webbing Company in the United States and DSM in The Netherlands. Murdock Webbing performed UV testing and residual strength testing was done by DSM Dyneema®. Despite being much more expensive than our initial "flashlight testing," it shows the same basic results. The field test of any cover may be quite simple. If you hold a flashlight against the cover and do not see light shining through the other side, it's a good sign.

A study of the above chart shows the vast difference in the protection afforded by various types of roundsling covers. The dark green Covermax® is much thicker than other roundsling covers and therefore, the loss of the sling's core strength is negligible. Roundslings protected by the thinner lighter colored covers lost the most core strength.



Fast® Inspection System, US Patent #7,661,737. Foreign Patents Pending

The next question is this: Is there a mechanical way to determine "hidden" UV damage in a roundsling? The answer is yes! On February 16, 2010 the United States issued a patent to Slingmax® Rigging Solutions (US #7,661,737) for a pre-failure warning indication system for all roundslings. It's called the Check-Fast® inspection system. The following is a brief explanation of how it works.

Every roundsling is made up of multiple wraps of the same strand of fiber. For ease of math, let's say a sling rated for 1,000 lbs. would require 10 wraps. A sling of the same core yarn rated for 10,000 lbs. would have at least 100 wraps, and so on. A roundsling made with the Check-Fast® inspection system adds an extra wrap called a "sacrificial strand." The ends of this independent strand are equally tensioned among the other load bearing core yarns via a "weak link." The weak link material has a calculated lower breaking strength than the core yarn material. Also, it degrades faster when exposed to ultraviolet light. Therefore, when the sling is exposed to severe overload or in this case, severe UV damage, the weak link breaks first, well before the remaining strands reach their failure point. Finally, a colored External Warning Indicator (EWI) strand is attached to the weak link and will disappear inside the sling cover when the weak link fails. This is what the rigger looks for upon each inspection. If you see this indicator yarn and there is no other cover damage, it is a GO! If the roundsling is subjected to severe overload when tensioned, or in this case, severe UV deterioration, the weak link breaks and whips the indicator strand inside the cover so fast it makes an audible POP sound.

Pictured above is yellow 9800GN nylon web sling material protected by Slingmax® Covermax® roundsling tubing. The exposed webbing faded to white after 334 hours of UV exposure. When the nylon web was pulled out of the protective Slingmax® cover, you can see the original yellow color remains. It shows no UV degradation to the protected webbing.

The inspector who is charged with validating the safety of rigging gear should be trained to identify hidden damage to wire rope and synthetics alike. Broken wires, cuts, weld splatter, corrosion and other forms of visual indicators of strength loss may lead an inspector to assume that there is also some form of hidden damage that cannot be easily identified by the naked eye. Wire rope strands can be opened by a trained individual to inspect the interior and the core. Now with the Check-Fast® inspection system, there is an objective way to determine if a roundsling is fit for use. A final benefit is eliminating the subjectivity of the hand over hand inspection method commonly used for roundslings.

Knowledge of hidden damage is paramount for any safety inspection program. Length of service, exposure to the elements, and any other potential cause of concealed damage should be primary concerns no matter the sling material. Inspectors need the training and education necessary to realize the potential for hidden damage and, when necessary, to take the appropriate action to remove damaged slings from service. WRN