Tensile Testing of Wire Ropes and Strand with Video Extensometers

Video extensometry enables rope manufacturers to measure breaking force, yield strength, elongation, and modulus of elasticity through failure.

TEST CHALLENGE

Quality assurance and quality control testing is imperative for rope manufacturers to help ensure proper strength of the product. ASTM A-931 covers the tensile testing of steel wire ropes and strands at room temperature. The purpose of the test is to determine the breaking force, yield strength, elongation and modulus of elasticity.

When testing rope it is common to experience high-energy specimen failures. If a traditional contacting extensometer is used it will likely be damaged and/or turned into a projectile if it has not been removed prior to failure. For steel rope, the extension is often measured by crosshead displacement, but movement in the gripping method and slack within the load train will result in an inaccurate measurement.

To avoid damage to the extensometer it must be removed prior to specimen failure. The specimen will be under load so this poses significant risk to the operator as there is potential for the specimen to break whilst removing the extensometer. If the extensometer is still attached at failure, it may be thrown off and apart from destroying the extensometer, it poses a significant danger to anyone in the vicinity. Furthermore, reduction in rope diameter and twisting can cause the contact points to slip or the device to fall off. The knife edges will cause stress concentrations that could lead to premature failure. For materials that are sensitive to stress, these issues with the contact points will result in low strength and modulus values. For these reasons, a non-contact solution is the measurement method of choice.

MTS SOLUTION

For more accurate measurement of metal wire and multi-strand twisted wire, MTS recommends the MTS Advantage™ Non-Contacting Video Extensometer (AVX). Driven by powerful cameras, processors and software, the AVX delivers unprecedented speed, accuracy and flexibility for non-contact measurement.

The video gage camera functionality is as accurate as a contacting extensometer but without any of the drawbacks. It works well with all specimen types and gage lengths including large diameter (>125 mm) and long samples (>6 m). The camera can be positioned at a safe distance and the operator does not need to move it prior to failure avoiding the risks to equipment and operators. The ability to post-process a test enables further measurements to be made even after the rope has been tested to failure. This enables focused measurements to be made on areas of interest such as the area of failure or sections where the rope is spliced. Additionally, the video extensometer does not touch the specimen and will not create stress concentrations at the area of contact, which may reveal the rope to be stronger and/or stiffer than previously believed. As a result, the rope manufacturer can optimize products based on better material characterizations and potentially sell a higher specification product.
For the most precise AVX results, the test must be setup properly. To select a lens, the user must estimate the gage length, total elongation and rope length before starting the test. A general purpose lens with a working distance greater than 500 mm and a large field of view should work. Make sure that the video camera sees adequate light by positioning the light at the same height as the camera, but far enough back to illuminate the entire specimen.

Video extensometers work by tracking patterns of light and dark on a live video image. Users generally use natural surface patterns, speckle patterns, or dots and lines. MTS recommends a series of light and dark bands around the rope to create an ideal target. The lines need to be placed around the entire circumference of the rope to ensure that they are visible if the rope twists. Use the software to position target cross hairs on the center of the target. Applying a slight pre-load ensures that the specimen is pulled straight during the test. Once the test is set up, running the test is as simple as starting the AVX then starting the test machine. Example load versus % stain data in the graph to the right.

**BENEFITS**

The MTS Non-Contacting Advantage Video Extensometer (AVX) provides greater test flexibility and ease of use for performing difficult to measure strain using conventional means. The AVX enables higher accuracy and greater overall versatility than edge-to-edge non-contact extensometers. It performs axial, axial-transverse, orthogonal, rotational and dual-average measurement. The AVX also supports numerous setups, including multi-camera, multi-segment and multi-point strain. This new level of flexibility helps characterize non-homogenous materials such as composites, and allows test professionals to perform more precise studies of failure mechanisms and other complex events.