SAMSON TECHNICAL BULLETIN

Abrasion Testing for Mining Working Lines

This picture represents the harsh conditions of underground mining.

Overview Working lines used in underground mining applications face extremely abusive environments. Synthetic ropes in this application become indistinguishable from the rock around them as ground earth and rock embeds itself within the braid. The confined spaces in these mines often means that a line will be used to pull a load around corners, across the bare rock face, or over steel edges of machinery, and the finely ground limestone used to counter the volatility of coal dust adds even more grit to the situation. The result is extreme abrasion, both external and internal, that can significantly shorten a synthetic rope's service life.

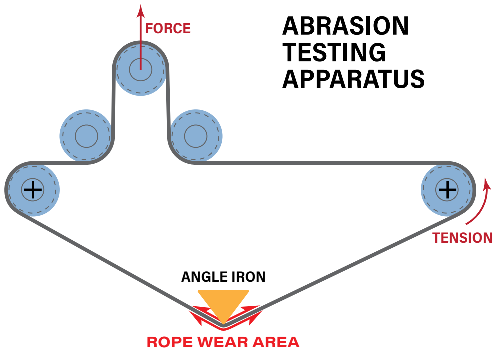
Fighting Abrasion: Increasing Service Life of Synthetic Ropes Used in Mining Applications.

In order to improve rope life under these conditions, testing has been designed to explore the effect of these conditions on synthetic ropes. The test replicates actual mine conditions as closely as possible within the lab setting, while providing a repeatable procedure that allows measured comparisons between different products. The goal is to determine the best products to match the working conditions in this demanding application.

Synthetic ropes bring very high strength and extremely light weight to mining applications along with ease of handling, improved personnel safety and reduced time required for standard operations. Finding the product that lasts the longest while countering these conditions allows you to add reduced cost to these already compelling benefits.

For the tests, Samson engineers assembled four different 100% HMPE ropes, made with both Dyneema® and Spectra® fibers, from three different major manufacturers and subjected them all to standardized lab testing designed to represent typical conditions encountered in a mine.

The tests were performed both on new rope samples and on new ropes impregnated with finely ground limestone to replicate actual mine conditions. *Saturn-12*,™ one of the tested ropes, includes a proprietary coating applied both externally and internally that has been shown to increase the rope's resistance to abrasion in other applications.



ROPE SAMPLES: **1/2" (12 mm) diameter**

TEST LOAD: **10% of new rope breaking strength, ~3,086 lb (1,400 kg)**

STROKE SPEED: **+/- 2" (50 mm) per second**

PAUSE TIME: **2.5 minutes**

FIGURE 1 Diagram of sharp edge abrasion testing apparatus.

Discussion of Test Development/Comparison

In order to recreate the abusive environment seen in underground mining, a specific testing method was developed. First, test samples were impregnated with fine ground limestone. Limestone is used to reduce the volatility of coal dust in underground mines in accordance with the requirements of ASTM C737-08. These samples were then installed on the testing equipment illustrated in Fig. 1. This allowed for samples to be loaded to a percentage of the rope's breaking strength before being cycled back and forth across the angle iron surface. The line speed and pause time between cycles were set to mimic pulling applications in which a rope is used to move a load while running across rough-edged surfaces. The same tests were performed on samples of unused rope without limestone dust impregnation.

Presentation of Results

Testing was performed on 1/2" (12 mm) diameter samples. A section of each sample was scraped across an unused piece of angle iron under load. For the samples with limestone particulate the test load was set to 10% of the rope's breaking strength (~3,086 lbs/1,400 kg). For the rope samples without particulate the test load was set to 15% of the rope's breaking strength.

Following each cycle the machine paused for 2.5 minutes. This pause time was built into the testing method to allow for heat generated in use to dissipate, similar to conditions in the real world application. The line speed was chosen to match a high-speed setting which standard vehicle winches can attain.

As shown in Fig. 2, new rope samples of *Saturn-12* without limestone particulate achieved more than 3 times the cycles before failure than the next competing sample. The results for the samples with particulate were more than 5 times higher for *Saturn-12* than the average of the other three ropes tested.

Correlation of Tested Samples to Field-broken Ropes

Following testing, broken test samples were compared to ropes previously used in underground mining applications. As Fig. 3 shows, the appearance of the broken end of the line that was tested in the lab and line that was used in the field appear identical, indicating a similar failure method.

The blue rope is an *AmSteel®-Blue* conveyor pulling line which broke while being used to restring a conveyor belt in an underground mine. This line parted while running across a rough steel surface during use. The orange rope is a lab-tested sample which had been exposed to a slurry of fine-grind limestone prior to testing across sharp edged angle iron.

Both samples show signs of abrasion damage near the failure point, indicative of contact with a rough surface while under load and the parted strands show clean cut fiber as expected for a rope running over a sharp edge.

This comparison indicates that the designed testing method successfully recreates damage developed in underground mining applications in a lab setting.

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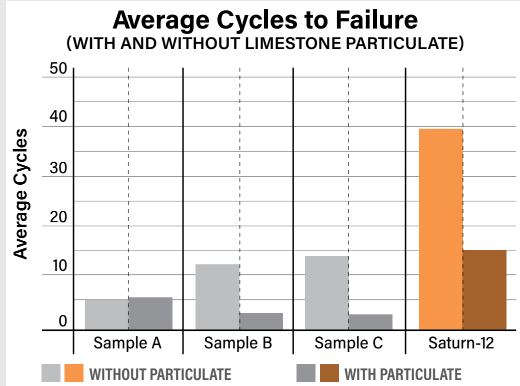
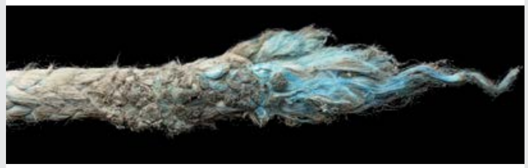
THE STRONGEST NAME IN ROPE



Saturn-12 lasted more than 5 times longer than the average of the other 3 ropes tested.

FIGURE 2 Comparison of other ropes and Saturn-12 tested lifetime.



AmSteel®-Blue conveyor pulling line, broken while being used to restring a conveyor belt.

Saturn-12 sample, broken during testing.

Both samples show similar damage at break points.

FIGURE 3 Images comparing field/test broken samples.

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