BARRY PUBLICATION

Effect of prolonged exposure to ultra-violet radiation on safety nets

Project: *Measure the residual mechanical properties of nets after certain periods of intense field use and compare to the data obtained from the ageing of the nets in a QUV(accelerated weathering) chamber.*

Objective: *Determine the residual tensile strength of nets subjected to prolonged UV ray exposure and other natural outdoor factors in order to demonstrate a correlation to the results for accelerated weathering, thereby allowing the extrapolation for other regions of the world.*

The effect of UV radiation on safety nets used in alpine ski racing for example, has been a concern for many years. It was recognized that, over time, netting would deteriorate but the rate of deterioration was not well understood. It was also observed that some types of net appeared to last longer than others. To try and quantify the UV effect, the Barry Center of Excellence undertook a series of three studies starting in 2002.

This paper summarizes the results of those studies.

First Study: 500 hrs of UV exposure

The first study, conducted in 2002, was a comparative analysis involving knotted polyethylene and knotless nylon (polyamide) netting. The result of this study, which subjected net samples to accelerated weathering in a QUV chamber, was to observe that after 500 hrs of exposure, knotted polyethylene had lost 90-100% of its tensile strength whereas knotless nylon had lost only 12% of its tensile strength.

Knotless nylon netting showing no evidence of breakdown after exposure to 500 hrs QUV, and prior to being tested for residual tensile strength.

Knotted polyethylene breakdown after exposure to 500 hrs QUV, and prior to being tested for residual tensile strength.

Observations

Nylon netting is clearly more resistant to UV radiation than polyethylene under laboratory conditions. However, this test provided only partial information as to the rate of degradation and did not account for environmental or usage factors.

ACCOUNTING FOR VARIATIONS DUE TO ELEVATION, LATITUDE AND OTHER FACTORS. 1250 HOURS OF UV EXPOSURE IN A QUV CHAMBER IS COMPARABLE TO 5 SEASONS OF SERVICE IN CANADA, 6 YEARS IN GERMANY (1539 HOURS) OR 4 YEARS IN COLORADO (960 HOURS).

Second Study: 1000 hrs of UV exposure in 100 hr increments

The second study was conducted in 2003, whereby knotted polyethylene and knotless nylon net samples were again subjected to accelerated weathering in a QUV chamber but were tested for residual tensile strength every 100 hours to more clearly define the deterioration curve of the two fibres being tested.

Observations

The results were that knotted polyethylene showed a dramatic, exponential decrease in tensile strength and dropped below the safe level after only 300 hours of exposure. After 300 hours the net was faded, cracked, split and brittle with a residual tensile strength of less than 70% of the design strength.

The knotted nylon, on the other hand, showed a relatively straight line decrease in tensile strength. Indeed, the nets retained 88% of their strength 500 hours and 83% after 1000 hours. The nylon net appearance was as new after 500 hours and evidence of weathering was barely apparent after 1000 hours. (See Fig. 1)

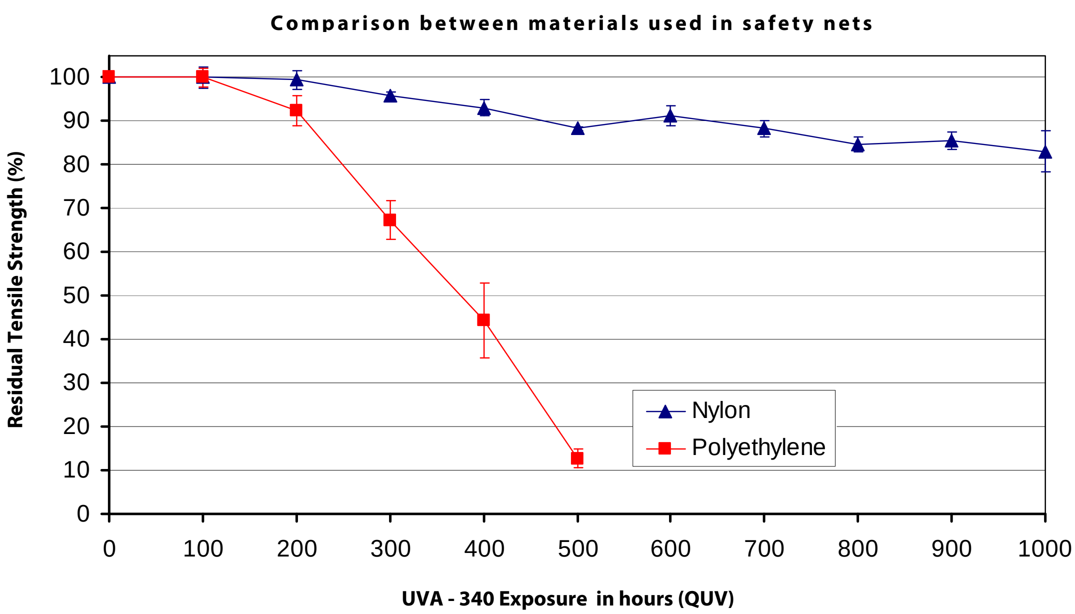

Fig.1. Residual tensile strength after exposure in QUV chamber (Ref. document 020411-2)

Third Study: 5 years of intense outdoor use

To account for real life conditions, a third study was undertaken on nets whose use corresponds to a mix of external degradation factors in order to consider situations of different latitudes, altitudes and so on. This way, the "laboratory vs. outdoor UV exposure" comparison data and the tensile strength data could be used to make a general comment on the expected long-term outdoor exposure effects of short wavelength UV (320-340 nm) on the strength properties on the safety netting being tested.

For the 'real life" testing, a set of samples of knotless nylon B-Nets were obtained from Alpine Canada Alpin (ACA) and Ski Quebec Alpin (SQA). These were part of each associations travel inventory that had been used intensively since the winter of 2003 and in both western and eastern Canada.

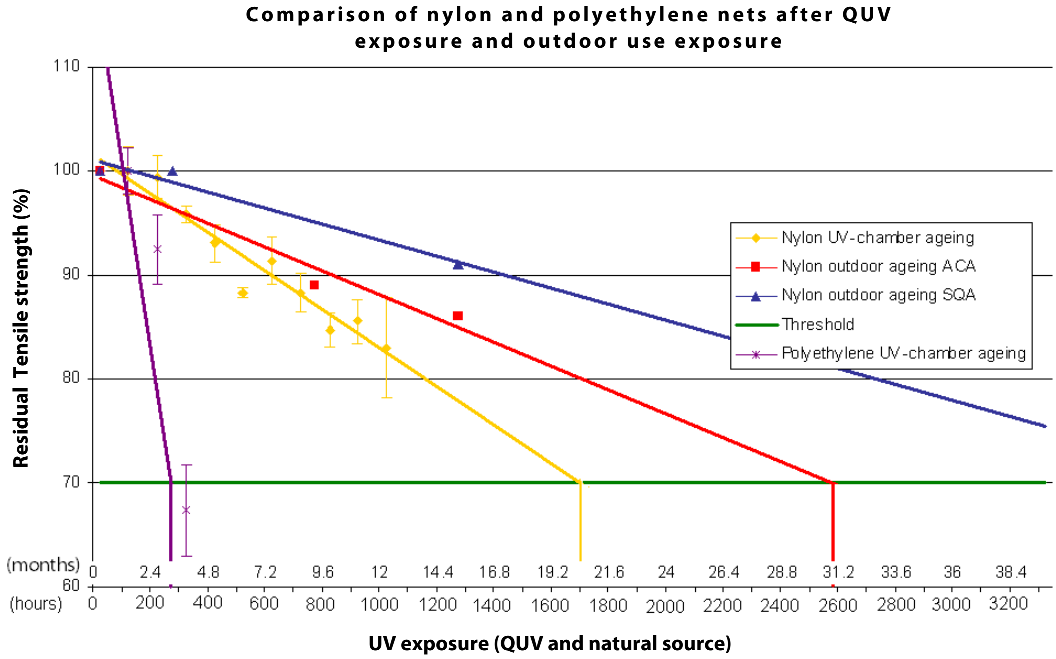

Fig.2. Residual tensile strength after exposure in QUV chamber and after exposure to intensive outdoor use.

The netting samples tested were selected from nets that appeared to be most degraded. Each was subjected to a tensile test and the results indicated (after 5 years of intensive use) tensile strength losses between 14% to 22 % of their initial tensile strength. (The industry accepted norm for retiring safety netting is a reduction in tensile strength in excess of 30 %.)

Observations

In the first two studies, it was demonstrated that knotless nylon nets resisted 1000 hrs of accelerated UV exposure with no significant loss of tensile strength. All things being equal, knotless nylon retains its tensile strength significantly longer than knotted polyethylene.

Knotless nylon remained above the industry norm of 70% of the design strength after 1000 hours (equivalent to approximately 5 seasons) whereas knotted polyethylene would need to be retired after only 300 hours (equivalent to approximately 2 seasons).

However, these studies were limited to the standardized methodology of QUV chamber ageing which assumes a constant rate of UV exposure. They did not account for variances in UV exposure due to altitude, latitude, cloud cover, ground cover or ozone layer which may have distorted the results obtained in the first two phases of the study. Also, these studies did not account for the physical effects of field service, such as abrasion, cuts, sharp bends, water absorption, knots or torsions of the material.

Note: As a result of these studies, Barry decided to use only knotless nylon in the Barry B-Net Systems and other safety nets exposed to outdoor conditions since nylon fibre proved to be more durable, resistant and reliable than the knotted polyethylene when exposed to the elements.

Conclusion

It was demonstrated that a correlation exists between the laboratory test results and the residual strength of the nets that had been in the field for five years. This validates the veracity of the results obtained in the accelerated weathering chamber and it confirms that the laboratory model may be useful in predicting the service life for these materials.

It also confirms that knotted polyethylene nets may need to be retired after only 2 years of use and that knotted nylon nets may be safely used for at least 5 years.

If you would like more information on these studies, please contact **Marc André Pilon** at the Barry Centre of Excellence – mapilon@barry.ca

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