Deutscher Alpenverein

Careful what you trust – the aging of sling material

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Last year we published background information and practical tips on the use of sling material in our article 'Tales from the Sling Jungle' (Panorama 5/ 2104). We were suspicious that narrow Dyneema slings (6-8 mm width) lose much of their strength after just a few years of use and could prove in the lab that polyethylene slings are subject to a surprisingly intense aging process. That led to further questions: By how much is sling strength reduced in everyday use? How are the different types of slings affected? Are there recognizable patterns of strength loss and age/ use? Since the standards do not take any mechanical or environmentally caused aging processes into account, users have to be responsible for checking their gear and for retiring it according to their own judgment. Nothing close to those ten years of maximum life that most sling manufacturers claim will be reached with frequent use! With respect to the question which criteria we are to use when evaluating our slings, we could find answers during the last few months.

Spotlight on webbing

Following up on last year's results, we've been collecting sown slings made from Dyneema (PE), polyamide (PA), and mixed fabric (PE/PA), all of which had been in personal use. All of those slings are subject to the same norm (EN 566) which prescribes a minimum breaking load of 22 kN when new. We only looked at webbing because the load-bearing fibres are not protected by a sheath or mantle here. Kern Mantel constructions as in Dyneema cords were not included in this study. We could only include material for which we could obtain sufficient auxiliary information on year of purchase, intensity of use, application, etc. Each collected sling received a kind of ID card on which the relevant information was recorded. We classified the appearance of the slings (see fig. 1 to 3) in the three following categories by their surface properties. The criteria were fuzziness, bleaching and dirtiness:

Category 1: hardly any surface signs of wear and tear

Category 2: slight surface signs of wear and tear

Category 3: strong surface signs of wear and tear

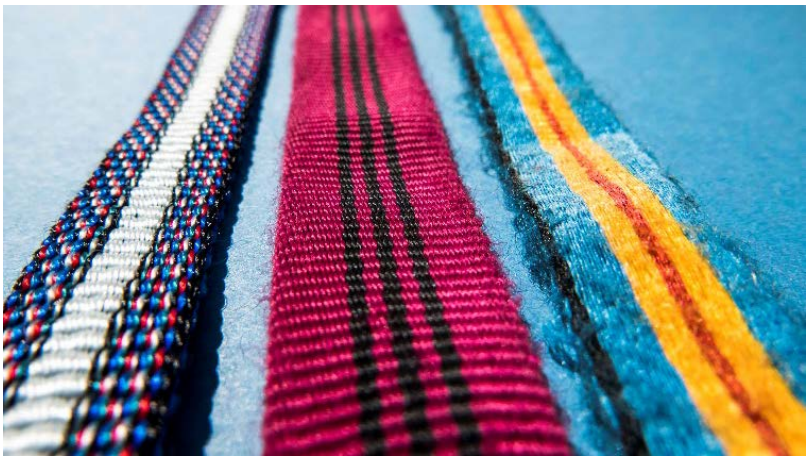


Fig. 1: Polyamide slings (PA) left to right: cat. 1, 2, 3

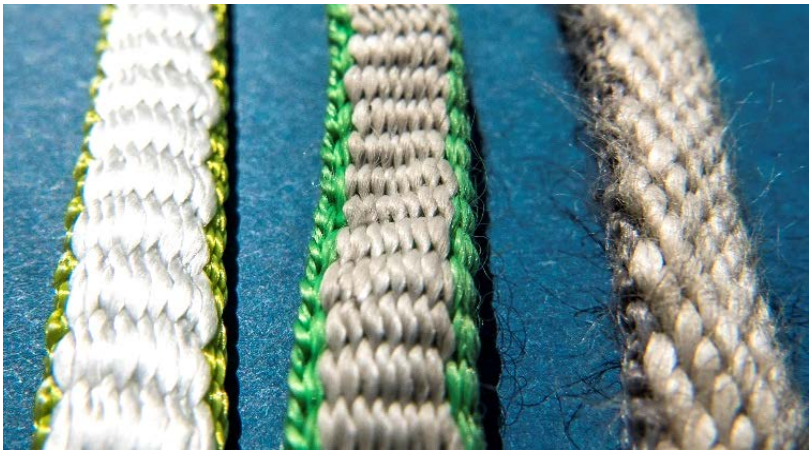


Fig. 2: Dyneema slings (PE) left to right: cat. 1, 2, 3

Fig. 3: Mixed fibre slings (PA/PE) left to right: cat. 1,2,3

To evaluate the deleterious effects of wear and tear and environmental impacts that showed up in use, we then tore 163 slings in our lab. We were hoping to find a connection between the visible changes in surface properties and the technical properties to find usable criteria for retiring used slings. To test the strength of the slings we used a quasi static test according to the norm.

Three strength categories were defined for the evaluation:

- Strength >=22 kN: optimum strength, sling fulfills norm
- Strength 16-22kN: the sling broke at less of the norm requirement of 22 kN, but the strength of the sling was still ok
- Strength <=16 kN: critical threshold of strength not reached, failure probable.

We selected a **critical strength threshold of 16 kN** because, depending on the material, knots will reduce the strength of webbing slings by up to 75%. At the point of directional change the maximum force occurring in a fall is up to 6 kN, in isolated extreme cases maybe even 8 kN. If, for example, a Dyneema webbing sling shortened with an overhand knot is used as a point of protection, its strength will be reduced to half of the initial value. If the initial value, without the knot, is 16 kN, the sling with the overhand knot will break at a load of about 8 kN.

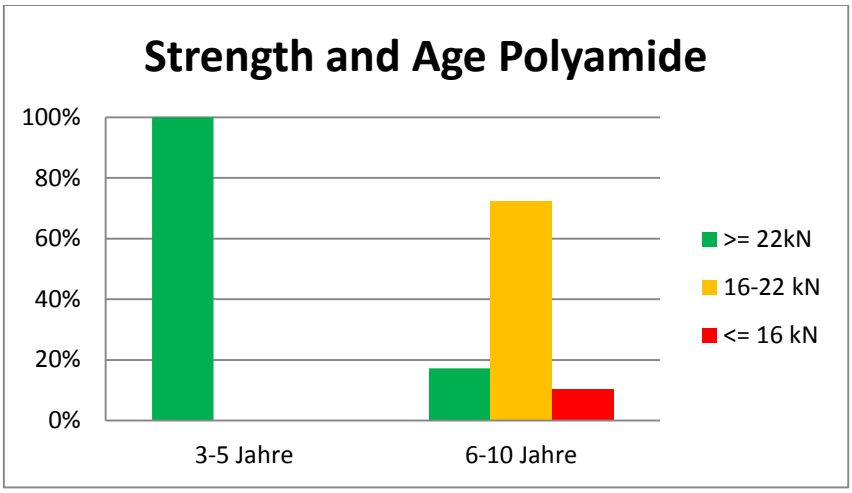
Looking at various webbing materials

The results of the tests were remarkable. 139 of the 163 slings tested showed a residual strength below the norm (22 kN), and half of the tested Dyneema slings showed breaking forces of less than the critical value of 16 kN!

Polyamide (PA)

Polyamide slings (fig. 1) are the classical, about 1.5 to 2 cm wide and usually colourful slings. PA is the only sling material that is also available unsown. In that case, the strength must be indicated with marker threads. One thread indicates 5 kN of strength. We could prove a direct correlation between age, frequency of use, and loss of strength in the 47 polyamide slings we tested.. Those PA slings that showed low strength values after less than three years of use had been very frequently used as quickdraws. In that application, the low strength values are not to be considered critical since quickdraws are, after all, not used with knots. While no critical reduction in strength could be proven in 'normal' PA slings after 3 to 5 years of use, it became clear that after 6 to 10 years of use more than 80% of them showed lower strength than the norm requires. However, only 10% were in the critical category, and all of those had been used a lot – their poor condition was obvious. 6 to 10 year old slings that had been used rarely and consequently looked used, but overall undamaged (category 1 and 2), had fairly high residual strength. The assumption was borne out: PA slings that exhibit no

serious outside signs of wear and tear have breaking strengths close to the norm even when they are more than five years old. So there is a clear correlation between the outside appearance and strength.

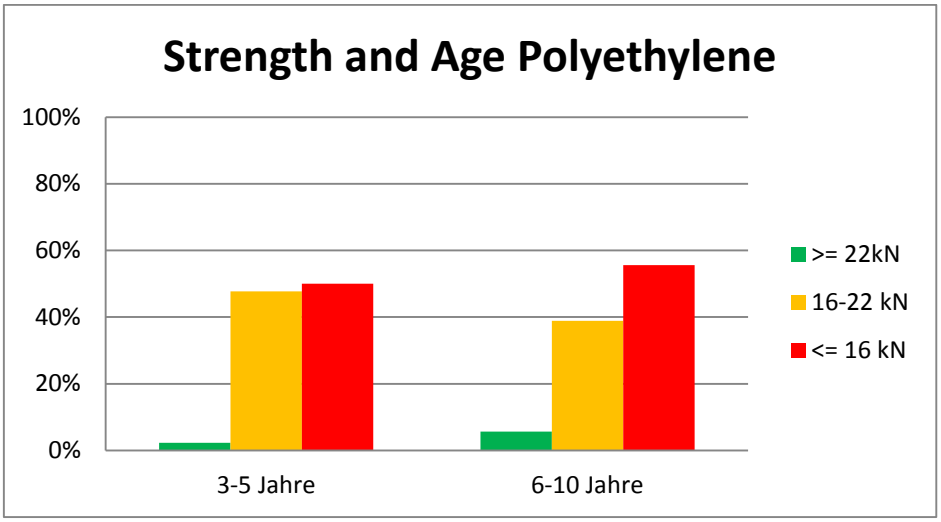


Dyneema (Polyethylene – PE)

Dyneema slings (fig. 2) are thin, light and white. The woven coloured edge is usually polyamide and is not designed to absorb force. The bright white material gets darker with time due to dirt.

The 67 Dyneema slings we tested also showed an unequivocal correlation between residual strength and age. For example, slings that had been used for less than three years still held almost 20 kN on average while the 3 to 5 year old Dyneema slings exhibited only 16 kN residual strength on average. They should really be on the retirement list. Dyneema, too, must be evaluated differently for different uses. Here, too, a use as a quickdraw (alpine climbing too) is less problematic, because in this application strength is not reduced further by knots. Like polyamide, poor looking Dyneema slings also exhibit lower breaking forces than slings that look alright. There is a clear correlation between appearance and strength here too! It's also proven that age is reflected in appearance: The material is bright white when new. It gets darker and darker through use and becomes fuzzy from the friction in knots, on the rock, etc. That makes it possible to deduce strength from appearance.

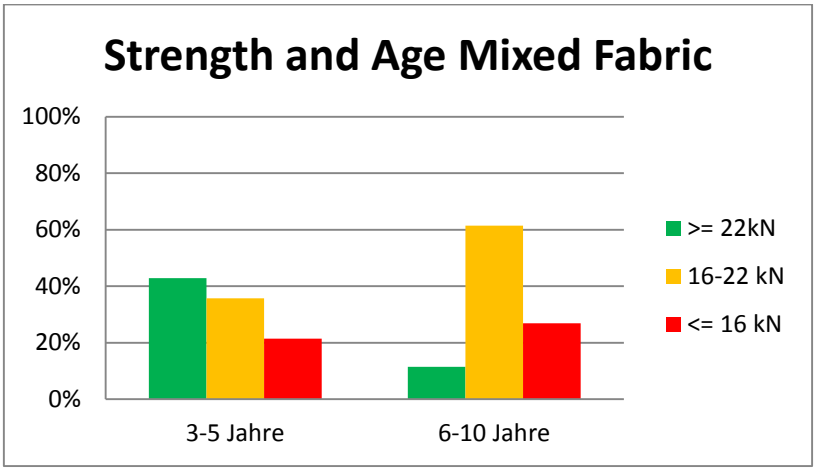
Another assumption from last year's tests was also confirmed: thicker Dyneema slings (>= 10 mm) show higher strength after a comparable degree of use than thin ones! Thinner slings that had been in use for 3 to 5 years held, on average, 1 kN less than the thicker ones.



Mixed fabric

Mixed fabric slings (fig. 3) are interwoven PE and PA fibres which gives them a white and a coloured portion of fabric.

The mixed fibres showed an age related decrease in strength too. Many of the mixed fabric slings we tested were used medium to less heavily and consequently still held between 17 and 22 kN. Those slings that had been used 3 to 5 years and held less than 16 kN were clearly within optical category 3. Among the 6 to 10 year old slings only 11% were still in the norm interval while as many of 28% of the slings broke at less than the critical value. However, their poor condition was clearly visible (category 3). So, mixed fibres also allow a recognition that there is a correlation between surface quality and strength. This outward appearance was closely correlated with age and intensity of use.



Conclusion

It is a fact that a significant age-caused reduction in breaking strength can occur in all three sling types in real world use. Almost half of all slings tested were subject to an immense reduction of strength. Especially PE slings showed particularly low values here. The manufacturers give a maximum ten year life span, even if the product has never been used. In spite of that, we found PE slings that were older than ten years, but had been used rarely and still exhibited very high strength. On the other hand, PE slings that were older than ten years, but used rarely, had lost a lot of strength. Thin Dyneema slings in particular need to be treated with caution with respect to aging.

There is a correlation between surface quality and strength in all three materials too. If the outward appearance is poor, it's very probable that the strength is reduced. The degree of fuzziness as an indicator for mechanical aging is a fairly reliable predictor. The few slings in category 3 that still had high strength values had been used little (0 – 10 or 10 – 25 days/ year.

The application, e.g. is a slings is only used as an alpine quickdraw or a belay station cordelette, has no direct relevance on strength reduction according to current knowledge. However, gear that is hanging exposed in a face can suffer some dramatic losses of strength, as shown by a study of slings from Rätikon. A Dyneema quickdraw that had been fixed in the route 'Silbergeier' for just 1 ½ years broke at as little as 11 kN. Another piece of evidence that the utmost caution is warranted with slings that are fixed in routes!

Table 1: Correlation of diverse factors, observed for all materials

	Pe	Pa	Pe/Pa
Strength and thickness	**+**	**-**	**-**
Strength and age	**++**	**++**	**+**
Strength and optical status	**++**	**++**	**++**
Age and optical status	**+**	**+**	**+**

-: no correlation

+: correlation

++: strong correlation

What does that mean for users?

Retire fuzzy, dirty slings

In light of these results we recommend to always retire all slings with clearly visible negative changes of the surface quality (category 3) as those can exhibit critical strength values. That is particularly true for fuzzy, bleached and dirty slings. Pay special attention to slings that are used with knots (e.g. belay station cordelettes, horn slings, threads …).

Stay on top of the age of your slings

Since 2007 the norm demands that the year of manufacture is displayed on each sown webbing sling. Unfortunately, this marking is often not readable anymore after just a few days of use. You should memorize the year of purchase of your slings!

Aging plays a bigger role with Dyneema slings than with polyamide or mixed fibres. It is recommended to retire Dyneema slings after no more than 3 years once they look used (category 2). Dyneema slings should be retired five years after purchase even if they were rarely used. Since quickdraws are not knotted, they can be used a few years longer. But if you fall frequently, you stress your quickdraws more and should be thinking about retiring them earlier rather than later...

Polyamide and mixed fabric slings can be used for 6 to 10 years as long as their outer appearance is alright. If you use your gear a lot however you should inspect it closely and retire it earlier if necessary.

For a **belay station cordelette** we recommend either the classic thick polyamide slings or mixed fibre slings. PA offers the best margin because of its high energy absorption potential. Dyneema webbing slings should only be used at a belay station as an exception, and if possible only if it shows no significant signs of wear.