Number of Rope Failures
amongst German and Austrian Mountaineers and Climbers
since 1968

by Pit Schubert

The fear of a rope failure comes from that time, when hemp ropes were used, until the end of the fifties (figure 1.).

Figure 1: A hemp rope used in the fifties, photo by P. Schubert

Many of those hemp ropes were broken. I lost two friends at that time. If hemp ropes were wet and later on dried, they dried only at the surface. Because of the capillary effect, the dampness stayed for a long time in the rope, and because hemp is a natural product, the hemp rotted. At that time it was possible to tear a 15 mm rope by hand force. Two of my friends tested their hemp rope at the end of the climbing season in such a way. They fixed the rope at a doorhandle. Together they pulled with their body weight, the doorhandle withstood the force, but not the rope. - At that time the rope was intended while climbing only to help the second climber, if he had not enough power. For the first climber it was not allowed to fall, because of the possibility of rope failure. - If nowadays sport climbers used hemp ropes we would have hundreds of thousands of injured or killed climbers each year.

This danger ended with the use of ropes made from polyamide (Perlon, Nylon), since the end of the fifties. From that time on the number of rope failures decreased dramatically, because Perlon and Nylon cannot rot and because of their better strength (more correctly: because of the higher energy absorbing capacity of this plastic material).

The table I shows all rope failures of German and Austrian mountaineers and climbers since the end of the sixties. Until 1982 a maximum of two rope failures each year happened. Not more! Normally the climber was killed.

Rope Failures of German and Austrian Climbers since 1968

Year	No. of rope failures	Mountain or mountain range	Result
1968	1	Zillertaler Alpen	(*)
1969	1	Berggeistturm / Wetterstein	(+)
1970	-		
1971	-		
1972	1	Piz Palü	(+)
1973	-		
1974	1	Fluchthorn	(+)
1975	1	Erster Sellaturm	(+)
1976	-		
1977	1	Gesäuse	(+)
1978	2	Grundschartner and Eiger	(+) (+)
1979	2	Geislerspitze and Westliche Zinne	(+) (+)
1980	-		
1981	2	3. Sellaturm and Laserzwand	(+) (+)
1982	1	Hörndlwand	(+)
1983	-		
1984	-		
1985	-		
1986	-		
1987	-		
1988	-		
1989	-		
1990	-		
1991	-		
1992	-		
1993	1	Hörndlwand	(*)
1994	1	Gehrenspitze	(+) (+) (*)
1995	-		
1996	-		
1997	-		
1998	-		
1999	-		
2000	-		
2001	-		

(+) = killed
(*) = survived

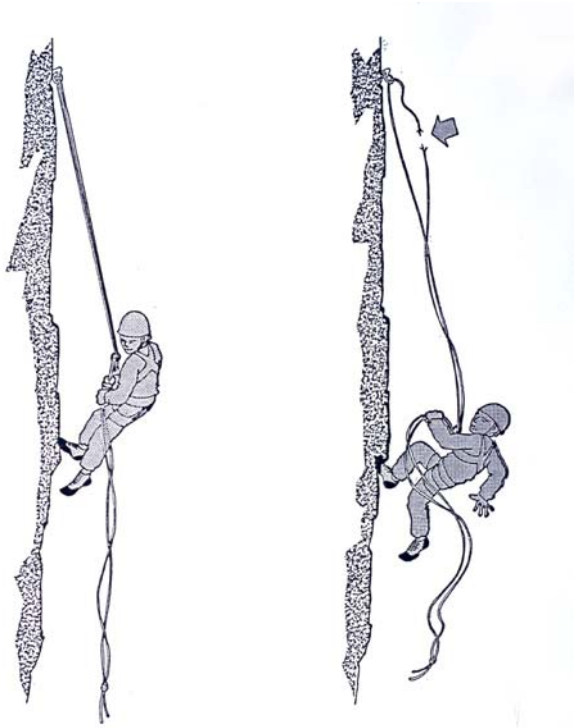

Figure 2: Rope failure during abseiling (influence of acid) , figure by G. Sojer

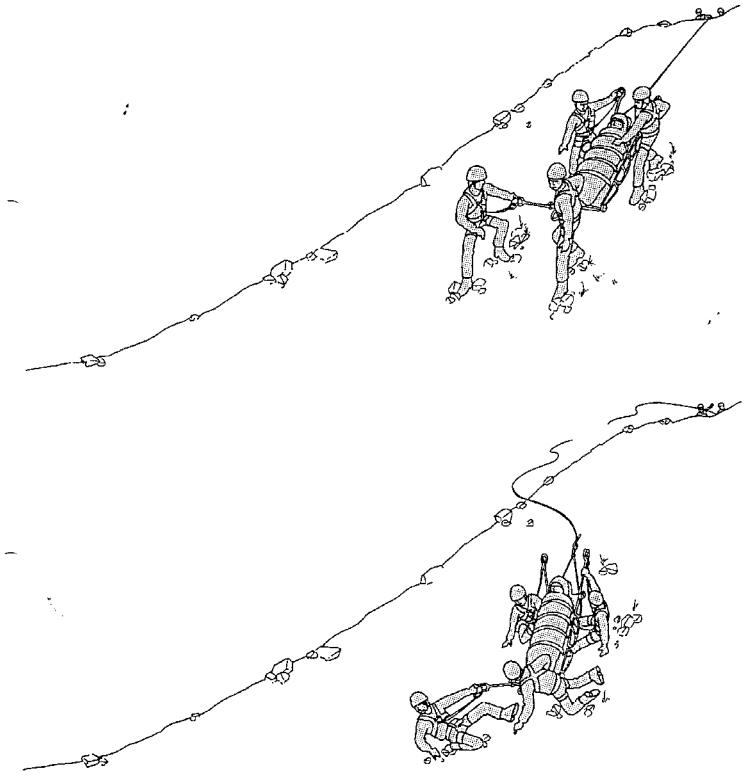

Figure 3: Rope failure during training a mountain rescue team (influence of acid), figure by G. Sojer

From 1983 until today, that is**,** within the last 19 years, there were only two rope failures

amongst German and Austrian mountaineers and climbers. And this under circumstances of hundreds of thousands of falls amongst sport climbers each year. This shows that our ropes are much stronger than we believe (more correctly: our ropes have higher energy absorbing capacity).

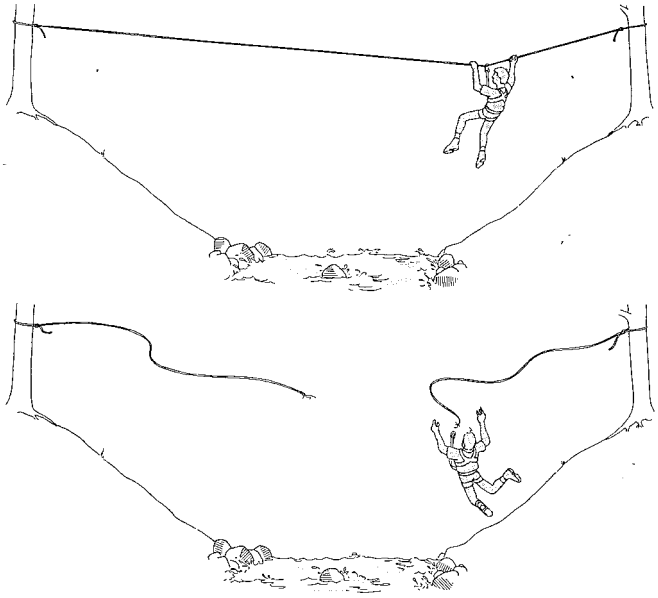

Figure 4: Rope failure during a flying fox activity, also called Tyrolean Traverse (influence of acid), figure by G. Sojer

In my opinion, the reason why rope failures have reduced since 1983, is, that from that time on the German and Austrian climbers used twin ropes more and more, when alpine climbing, also on routes of low difficulty. If one rope breaks, there is redundancy, the second rope may absorb the rest of the falling energy. And twin ropes have an energy absorbing capacity over sharp edges which is, depending on the sharpness of the edge, up to double that of a normal single rope.

Figure 5: The broken rope during abseiling, photo by P. Schubert

All rope failures in the table happened with single ropes and in the alps. During this time no complete rope failure happened with twin or half ropes (used double). And no rope failure happened in a Klettergarten or at an artificial climbing structure (indoor climbing).

But, it is necessary to add nine(!) rope failures more in the time since 1983 amongst German and Austrian mountaineers and climbers. The causes were either a misuse of the rope or the rope already damaged by some kind of polyamide contaminant, such as acid. The details are as follows.

The misuse was using a half rope or a twin rope in a single strand. This happened five times out of nine times altogether. The reason why they are not recorded in the table is because it is a misuse. Such misuse happened in 1973 on the Schreckhorn in Switzerland, in 1981 on the Olperer in Austria, and in 1990 on the Großglockner, also in Austria (all three climbers were killed), and two rope failures in the last year (2001), when toprope climbing (bottom lowering); both climbers survived. Both these rope failures were not investigated by me (I stopped working for the DAV from the beginning of the last year). All the other mentioned ropes were investigated by me.

Figure 6: A rope failure by a fall over a sharp rock edge, photo by P. Schubert

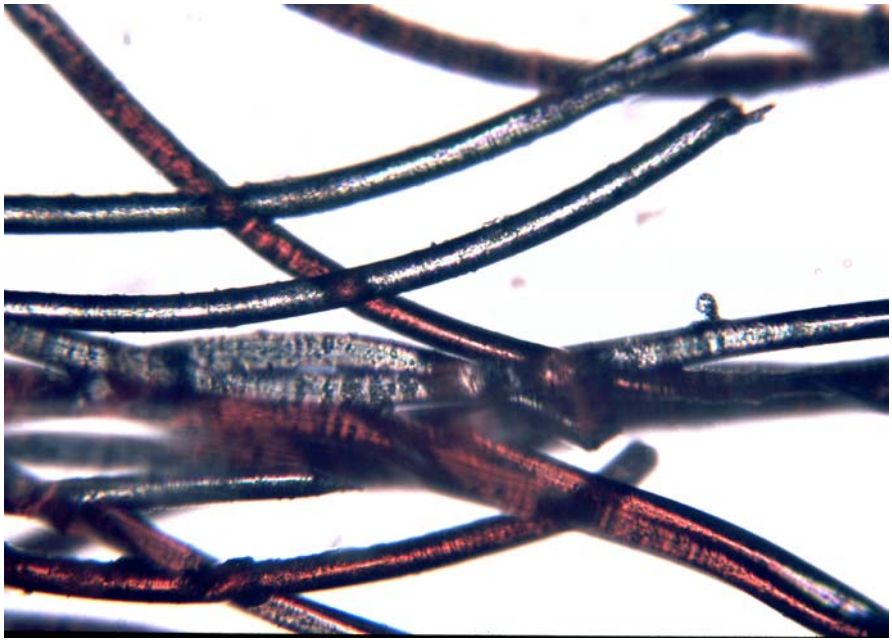

Figure 7: Filaments of the broken rope during abseiling, photo by P. Schubert

The reason for the remainder of the nine rope failures, which are not recorded in the table, is the influence of polyamide contaminants. In three of the four rope failures the influence of the acid was found out by the chemical institute of the Bavarian Police Headquarters. Fortunately no climber was killed. One of these rope failures happened in the Wilder Kaiser, on the Predigtstuhl during abseiling (Figure 2).

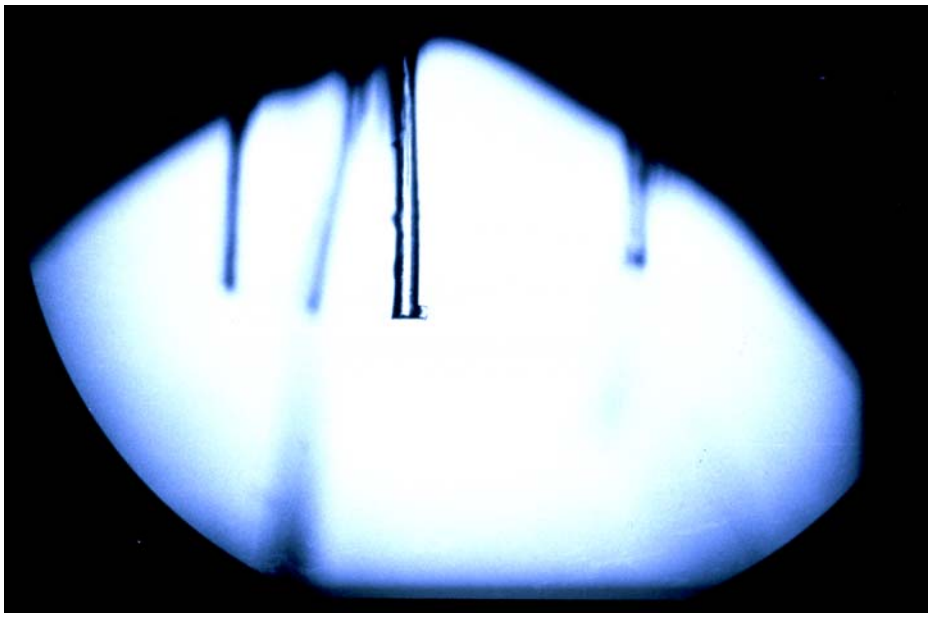

Figure 8: Filaments of a broken rope, when loaded over a sharp rock edge, photo by P. Schubert

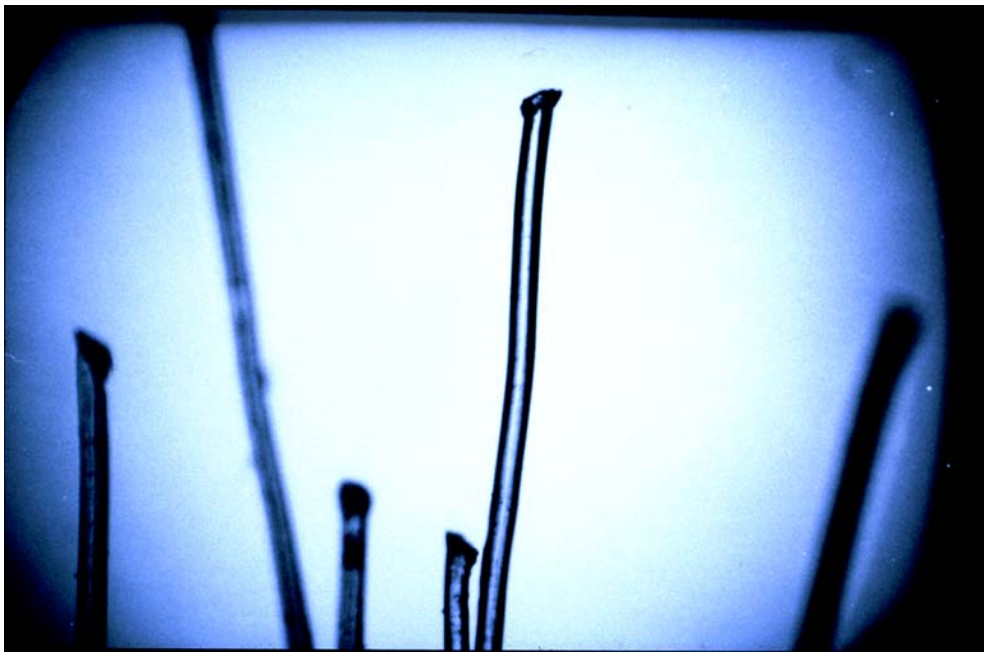

Figure 9: Filaments of a broken rope, when loaded on the Dodero test-machine (normal rope testing in accordance with the standard, EN and UIAA Standard), photo by P. Schubert

The second rope failure happened during a training of mountain rescue teams on a not very steep slope (see Figure 3) and the third rope failure happened during a flying fox (Tyrolean

Traverse) activity (Figure 4). In all three cases the load was so low, that a breakage of the rope is unbelievable, except if already damaged by acid or some other polyamide agressive ontaminant.

Figure 10: Filaments of a rope failure due to being cut by a knife, photo by P. Schubert

There are two characteristics indicative of polyamide rope failure due to acid contamination. One characteristic is the general appearance: Figure 5 shows a rope broken by the influence of acid (both ends look similar), and Figure 6 shows a broken rope, loaded over a sharp rock edge (both ends look quite different).

The second characteristic is the microscopic appearance of the ends of the polyamide filaments. Figure 7 shows the effect of acid, no heads at the ends of the filaments, because the rope does not absorb energy; I tested ropes which came in contact with acid on the Dodero-test-machine, they break like a shoelace.

Figure 11: The fourth rope failure by polyamide aggresives contamination happened here, at the rock edge, photo by P. Schubert

Figure 8 shows the effect of a sharp rock edge (when loaded by fall over a sharp rock edge), small heads on the ends of the filaments, because the rope absorbs a part of the energy. To complete this explanation: Figure 9 shows the filaments of a rope which has failed on the Dodero-test-machine, broken at the orifice, large heads due to large energy absorption.

And Figure 10 shows the filaments of a rope failure, due to being cut by a knife. - Every man should be careful, if he wants to get rid of his wife. Cutting can be recognized under the microscope. Last year, when I told this to some German mountain guides, one of them asked: Okay - but what shall we do then? - End of joke.

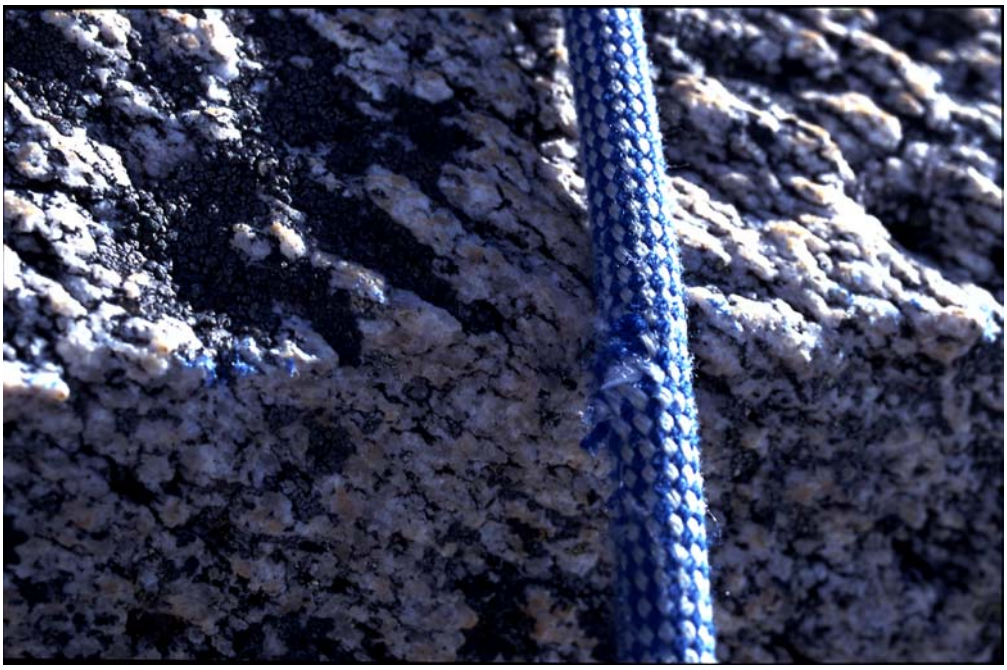

Figure 12: No rope failure, only the sheath was damaged a little bit, photo by P. Schubert

The fourth rope failure by polyamide aggresive contamination I was unable to investigate, because when I was informed the rope no longer existed. This rope failure happened near Rudolfshütte (in the Glockner range in Austria). I investigated the circumstances using similar ropes. The rope failure happened during abseiling on a single strand with a single rope of about 11 mm diameter, loaded over a rock edge (Figure 11); the climber was killed. I went with the mountain guide, who was the trainer of the climbers when the accident happened, and at the place of the accident loaded different similar ropes in the same way.

Figure 13: The thirty-nine-year-old rope: No-complete rope failure, only the sheath broke completely, photo by P. Schubert

I loaded the ropes with my body weight and made as big pendulums as possible, within the bounds of safety. The result: no rope broke (Figure 12); I did the same with twenty-, thirty-, thirty-six- and thirty-nine- year-old ropes, but no rope broke, only the sheath was damaged a little bit, the sheath of the thirty-nine-year-old rope broke completely (Figure 13). Then I did the same with new and old half ropes, but no rope broke. I continued with an 8 mm accessory cord, but no breakage, only the sheath was broken. - In my opinion the reason for the rope failure in this accident could not be normal rope use, only contact with polyamide aggressive contamination, with acid or something similar.

All rope failures in the table since 1979 were investigated by me. The reason for all was a sharp rock edge, nothing else.

During my work for the DAV (German Alpine Club), during 32 years, I investigated many old ropes from time to time, when I received them from climbers and mountaineers, who wanted to know whether their rope was still good. Some of these ropes were 15, 20, 25 and even 30 years old. They were tested by a UIAA-approved test laboratory. The result: All ropes hold minimum one fall on the Dodero-test-machine, most of them more than one fall; and no rope broke in the knot, always at the orifice.

My resume: Because the fall on the Dodero-test-machine is much stronger than in practice, it is not possible (in practice no rigid falling mass, no strictly static belay) for a rope which holds one fall on the Dodero-test-machine to break in practice - not in knot, not in the running belay, not at the belaying device, only when the rope is loaded over a sharp edge, normally a rock edge. And this happens as the table shows very, very seldom.