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TECHNICAL COMMITTEE MEMORANDUM TCM 17/01

DMM Single rope, broken during sea cliff fall

Incident Ref. 12/16/B.MOO

SUMMARY

Following a lead climbing fall on a sea cliff pinnacle, the single dynamic rope broke resulting in a ground fall and lower leg injuries. No chemical contamination was found, and the characteristic mixture of sharply cut and bulbous fibre ends strongly suggested that the rope had failed after cutting under load, most probably against a sharp rock.

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Approved by the Technical Committee	Philip Tootill

1. INTRODUCTION

The rope was sent in for investigation by the injured lead climber, after it unexpectedly failed. The rope broke during a lead fall on a sea cliff pinnacle, on a route graded XS 4c. Whilst resting, a foothold broke leading to a fall, during which the top runner also failed. The remaining pieces of gear held, but unfortunately the lead rope broke and the climber fell to the ground sustaining lower leg injuries which are expected to take at least one year to recover from.

2. EXAMINATION

A portion of the rope including both broken parts was sent in, along with photographs describing the fall length and circumstances behind it.

The rope is a green DMM Shorty 10mm single dynamic rope to EN892 and appears used but in otherwise good condition.

An inspection of the entire rope portion sent in for examination found no evidence of any manufacturing defects or obvious prior damage from use, such as sheath wear or distortion due to core damage.

The broken area is quite localised, with no obvious sign of sheath melting or scoring, and no visible evidence of previous damage or chemical degradation. Inspection of the broken core bundles found that several were broken abruptly around the same length, with a similar number partly cut around the same length but then with the remaining strands longer and more variable in length (see Fig1).

Inspection by microscope of the broken strand ends found that the shorter ends seemed to mainly be fairly cleanly terminated, with longer strands having what looked to be more rounded, bulbous ends of the strands (see Fig2 and Fig3).

Fig1: Cut core bundles of similar length with longer strands alongside

Fig2: Cleanly cut strands on bundle with strands of similar short length

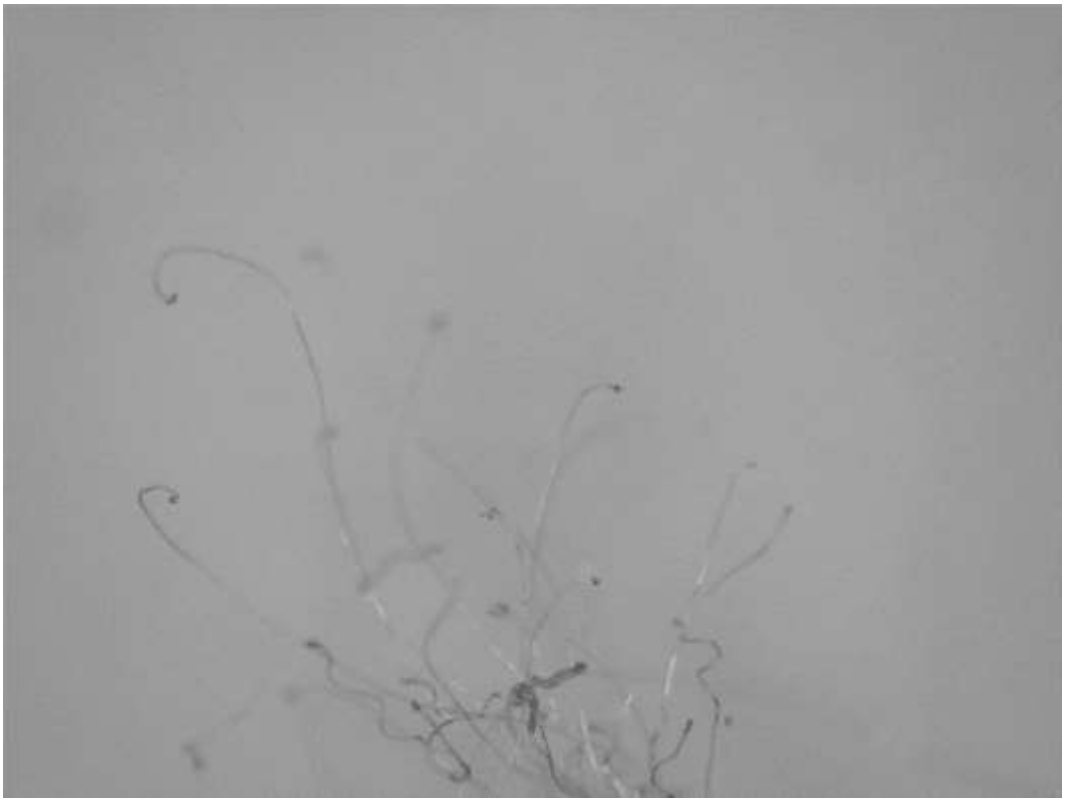

Fig3: Rounded ends on longer, variable length strands

Although there was no obvious indication of chemical contamination, the rope was checked for this using a simple test. Some distilled water was poured into a clean beaker and the pH measured using a digital meter. The broken rope end was washed in the distilled water and then the pH was measured again. This was repeated using the unbroken end of the rope for comparison.

The results were:

pH distilled water	= 6.5
pH water, broken rope	= 7.0
pH water, unbroken rope	=7.3

3. ANALYSIS

The localised nature of the damage strongly suggests that the rope was cut by contact with a sharp rock whilst under load. This may have been the broken foothold hitting the rope, or more likely may have occurred after the fall, leading to the climber loading the rope against the rock.

Looking at the microscopic evidence, the presence of a mixture of cleanly cut fibre ends along with bulbous ends is commonly associated with cutting by a sharp object under load. [1] The cleanly cut fibres have likely been cut by the rock, with the remaining fibres stretching under the load of the falling climber, and breaking at high speed as they are unable to withstand the load. It is estimated that around half of the core bundles were cut, which would dramatically compromise the ability of the rope to withstand the force of a fall.

Estimating the fall factor using information from the climber suggested that around 6m of rope was out, with a fall around 3m before the rope broke but including the top runner failing. A fall factor of 3/6 = 0.5 would usually be considered moderately severe and would not be expected to damage the rope.

The lack of any signs of chemical degradation such as discoloration and physically weak material, combined with a failure to detect any measurable acidic residues by pH testing rules out chemical contamination by acids as a possible cause of the rope failure. The small change in pH is likely due to the rope containing salt after use on a sea cliff, sea water has a normal pH = 8 so it would be expected that the pH of the distilled water would rise slightly after washing the rope in it.

4. CONCLUSIONS

Normally a fall of such moderate severity would not be expected to damage the rope. The evidence suggests that several core bundles were severed with the remainder failing at high speed under load. No evidence of chemical degradation or contamination with acid was noted.

5. RECOMMENDATIONS

The route was graded XS 4c, which implies a serious and potentially quite dangerous climb, with risk of loose rock and poor protection. A common risk mitigation strategy when climbing on loose terrain is to employ double ropes, as it is very unlikely that both ropes will be cut in the event of a fall or by rock fall.

6. REFERENCES

[1] Atlas of Fibre Fracture and Damage to Textiles p.400
J. W. S. Hearle, B Lomas, W D Cooke