BRITISH MOUNTAINEERING COUNCIL

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TECHNICAL COMMITTEE MEMORANDUM TCM 13/01

Broken rope: University of Leicester Mountaineering Club

Incident Ref. 01/13/B.HUL

SUMMARY

A climbing rope broke during top-roping use at a climbing wall on Tuesday 29th January 2013. The incident led to a fall of 6-7 m and the injured climber was taken to hospital.

The broken rope pictured below, has been examined by TWI Ltd, acting in a *pro bono* capacity on behalf of the BMC. The damage is consistent with contamination of the rope by acid, specifically sulphuric acid.

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Approved for issue by the EIP:		

1. INTRODUCTION

A description of the incident, and BMC's preliminary response to it, are given in three appended documents:

1. Incident report by the University of Leicester Mountaineering Club
2. EIP incident report, issued by the Mountaineering Club to the BMC
3. BMC's preliminary response to the incident, dated 13th Februrary 2013

The information in these documents is taken as read, and the remainder of this memo details the work carried out by TWI Ltd on behalf of the BMC Technical Equipment Committee to identify the cause of failure of the rope.

2. EXAMINATION

The broken rope arrived at TWI on or shortly before 7 March 2013. The shorter length of rope (3-4m long) was labelled 'rope attached to climber', whilst the longer portion was labelled 'rope attached to belayer'. There were no obvious signs of wear to the outer sheath, or damage other than the complete failure shown in the photo. A turquoise thread, assumed to be a certification tracer, can just be seen on the right-hand side.

BMC has encountered incidents of this type before (see refs. 1 and 2) and attributed them to contamination by acid. Most climbing ropes are made from nylon, which is highly susceptible to loss of strength on exposure to acids (see ref. 3). TWI staff considered this to be a credible hypothesis, particularly in view of the unknown history of the rope, and also believed sulphuric acid (perhaps from a spilt car battery) to be a possible contaminant. Consequently, some simple laboratory tests were carried out to establish whether or not acid contamination, and specifically contamination by sulphuric acid, could have occurred, as follows:.

1. The pH of a clean jar of deionised water was measured using both indicator papers and a pH meter (TWI ref. QIS2), calibrated against buffers of known pH4.0 and pH7.0. This confirmed the pH of the water to be neutral, ie between 6.9 and 7.1, as would be expected.

2. The broken end of the shorter length of rope (labelled 'attached to climber'), including the coloured sheath, was then immersed in the water and the pH re-measured as around 2.3, ie significantly acidic.

3. The far end of the longer piece of rope (as far as possible from the broken area if the rope is assumed to be completely extended) was immersed in a clean jar of deionised water, first in its intact form, then with the end cut off using clean scissors and the sheath pushed back to expose the cut core. pH was around 5.2-5.3, with no change when the core was exposed.

4. The rope was removed from the two solutions cited above and barium chloride added. The acidic solution (pH=2.3) in which the broken rope had been immersed immediately appeared turbid. This cloudy appearance is caused by precipitation of barium sulphate, and is a standard qualitative test for sulphates, thus confirming that the acid involved is sulphuric acid. No such precipitation was observed in the second container (pH around 5), confirming the earlier supposition that the far end of the rope is uncontaminated by sulphuric acid within the detection limits of the barium sulphate test (although the slight decrease in pH would suggest that some lower level of acidic contamination is still present). The identity of this contamination has not been further pursued.

CONCLUSIONS AND RECOMMENDATIONS

The tests carried out so far show that the broken area of the rope had been contaminated by sulphuric acid, and that the area remote from the break was not contaminated by that acid. It is not clear when and how the contamination occurred, and of course the tests carried out to date do not directly link the failure to the presence of the acid. The issue of whether the weight of the climber could have caused failure (given contamination by acid) could be addressed by mechanical testing, for example tensile testing to failure of both clean and contaminated rope, and a comparison of failure loads. TWI Ltd does not have the specialist rope-testing grips that would be required for such an exercise, but it is assumed that a rope manufacturer would.

To date, the manufacturer of the casualty rope has not been identified. The findings of this report should be widely publicised to increase user awareness of the importance of the care and storage of ropes, and in particular their protection from acids.

3. REFERENCES

1. Technical committee memorandum TCM09/01 September 2009 (https://www.thebmc.co.uk/bmcNews/media/u_content/File/equipment_advice/Technical_reports/TCM%200901.pdf)
2. Technical committee memorandum TCM 05/01, March 2007 (https://www.thebmc.co.uk/bmcNews/media/u_content/File/equipment_advice/Technical_reports/tcm05_01.pdf.pdf)
3. http://www.marlowropes.com/technical/physical-properties.html

4. ACKNOWLEDGEMENTS

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