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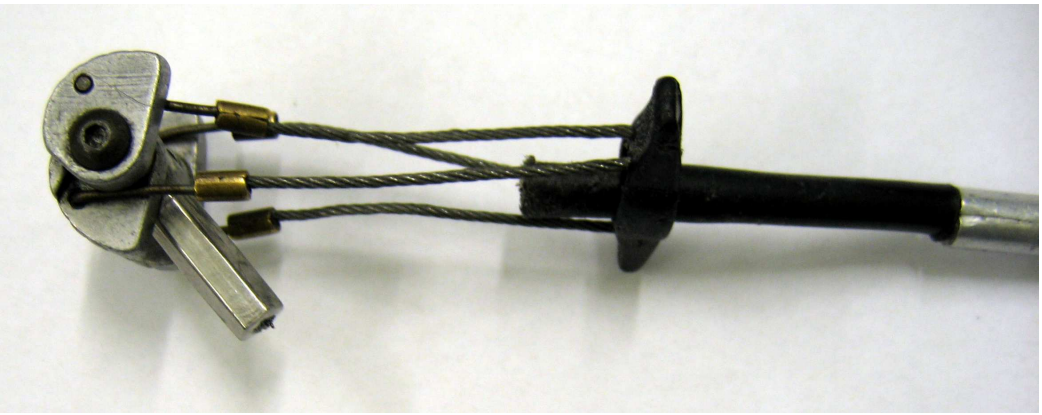
TECHNICAL COMMITTEE MEMORANDUM TCM 07/03

ROCK EMPIRE CAM, SNAPPED WIRE CABLE

Incident ref: 07/10/I.SAR

SUMMARY

The wire cable snapped during a fall, fortunately not leading to any serious injuries. Fatigue failure of the cable caused by repeated bending was found to be the likely cause. The design of the sleeve and the specification of cable were felt to be contributory factors. The difficulty of detecting broken wires in the cable was felt to be a flaw in the design, given that in all other respects the unit appeared to be in good condition, albeit well used.



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1. INTRODUCTION

Whilst climbing at Bosigran in Cornwall, the user fell from about 2m above his last piece of protection. This protection was a Rock Empire cam, size 1, placed in a parallel-sided crack. The stem of the device was orientated in line with the expected load. The device failed, leading to a fall of approximately 16m. Very fortunately, no major injuries were sustained as a result of the fall. The head of the unit was retrieved, still in place in the crack. The sling and stem part were found, still attached to the climbing rope, on the ground.

Following the incident, the user sent the unit to the BMC for investigation, reporting that the device was 5 years old and in good condition as far as they were concerned. There are some similarities with a previously reported failure of a device with a similar design.[1]

2. EXAMINATION

The orange sewn-in sling was marked with the manufacturer (Rock Empire), the notified body (CE0123) and the number 1731 or 1781 on a white tag. The white tag was also marked with the number 1, giving the size of the unit.

The initial impression when examining the unit was that it was well used, but generally in a good condition for its reported age.

Examination of the cam surfaces revealed minor surface scratching but no major deformities. The other metal components such as the trigger wires and solid stem also appeared to be in good condition, with no evidence of corrosion or a general lack of care by the user. The cams rotated freely about their axle, and were smoothly returned to their original position by their springs.

The wire cable was broken fairly cleanly at the junction between the cable and the solid stem. The wire cable shows no evidence of corrosion or damage other than at the break. Viewed end on, the remaining wire is located centrally and evenly inside the stem. No wire strands appear to have come free from the swaged socket.

Looking in more detail at the wire cable, it has a nominal diameter of 4mm, and appears to be manufactured from a stainless steel alloy. The cable specification is 7x7 (6/1) RH OL SWC. This means that each strand contains 7 individual wires, and in this construction 6 strands are wrapped around a seventh used as a central core.

The black plastic sleeve covering the wire stem was indented and scuffed. The orange sewn-in sling was in a good condition.

3. ANALYSIS

The examination of the camming surfaces indicates that it is very unlikely that the unit has sustained a major load prior to the failure of the wire cable. The condition of the plastic sleeve does suggest that the stem has been loaded horizontally on numerous occasions, causing rock to scuff and indent the plastic.

The nature of the break strongly suggests that the wire cable has failed as a result of bending fatigue, caused by repeated flexing of the cable.

4. DISCUSSION

The method of construction results in bending forces being concentrated at a single point; the plastic stiffening sleeve prevents the wire from bending too much when, for example, the trigger is activated, but concentrates any bending at the junction between the sleeve and the solid stem.

A 7 x 7 metallic centre specification is used when flexibility is not a consideration, and is commonly employed to limit elongation. [2] The cable diameter is rather small compared to that used in the construction of other similar single-stem camming units. A larger diameter cable would have an improved resistance to fatigue failure; a wire cable specification with more wires per strand would also achieve this. [3]

Fatigue failure in wire cables is a well-known phenomenon, and is known to usually be detectable as progressive mechanical failure of the wire strands occurs. Unfortunately, the black plastic sleeve hinders the ready examination by the user in detecting broken wire strands, making it extremely difficult for the user to make an informed judgement regarding retirement of the device.

5. CONCLUSIONS

The design of the stem concentrates bending stresses at the eventual point of failure of the wire. Using a thicker and stiffer cable would give improved fatigue resistance. In addition, the bending stresses could be more evenly distributed if the plastic stiffening sleeve did not butt up against the stem/cable junction, but overlapped the junction area.

Using a clear plastic sleeve would greatly assist the user in being able to detect damage to the cable before final failure could occur, with the design found here this is almost impossible.

Failure of the wire cable in other units of the same manufacture could lead to serious injury or worse to the user. With the design employed, it appears that this may occur in other units, which on inspection by the user appear to have plenty of life left in them.

6. RECOMMENDATIONS

The manufacturer should be contacted and given the opportunity to respond to the report. In particular, they should be asked how to determine whether to discard or retire other units of this type, specifically in order to avoid this mode of failure.

No response was received from the manufacturer, after they were sent a copy of this report. In the light of this, it was decided to publish the report to alert users of similar devices to the problem.

7. REFERENCES

1. BMC Technical Report TCM02/06 WC Friend
2. Wire Engineering www.inventionfactory.com/history/RHAwire
3. Criteria for Selecting Wire Rope www.safetysling.com/wr1.htm