Australian Government
Civil Aviation Safety Authority

AIRWORTHINESS BULLETIN

AWB 25-034 Issue 2 – 24 April 2020

Helicopter Rescue Hoist Wire Rope – Wear, Fatigue and Failure

1. Effectivity

All operators, pilots, crew or maintenance personnel involved with operation or maintenance of multistrand wire rope winch/hoist systems.

2. Purpose

To emphasize the care, attention and proficiency required to safely operate and maintain winch/hoist systems that lift/lower personnel and loads.

Multistrand wire ropes herein referred to as cables, form a potential single point of failure within a winch/hoist system. Incorrect operation, inspection, maintenance, cable handling, contamination, weathering and age can cause internal and/or external damage that may go undetected leading to catastrophic defects.

3. Background

An AS350 helicopter and crew had completed ‘live’ winching of personnel and were carrying out winch cable maintenance. Whilst under load, the cable failed approximately 8mm from the hook assembly. The cable had completed 617 cycles. The manufacturer recommends for this system, cable replacement after 1500 cycles. No injuries or aircraft damage were sustained. See Figure 1, 2 and 3.

Image courtesy of ATSB

Figure 1. Failed Hoist Assembly (Winch, Bumper and Hook)

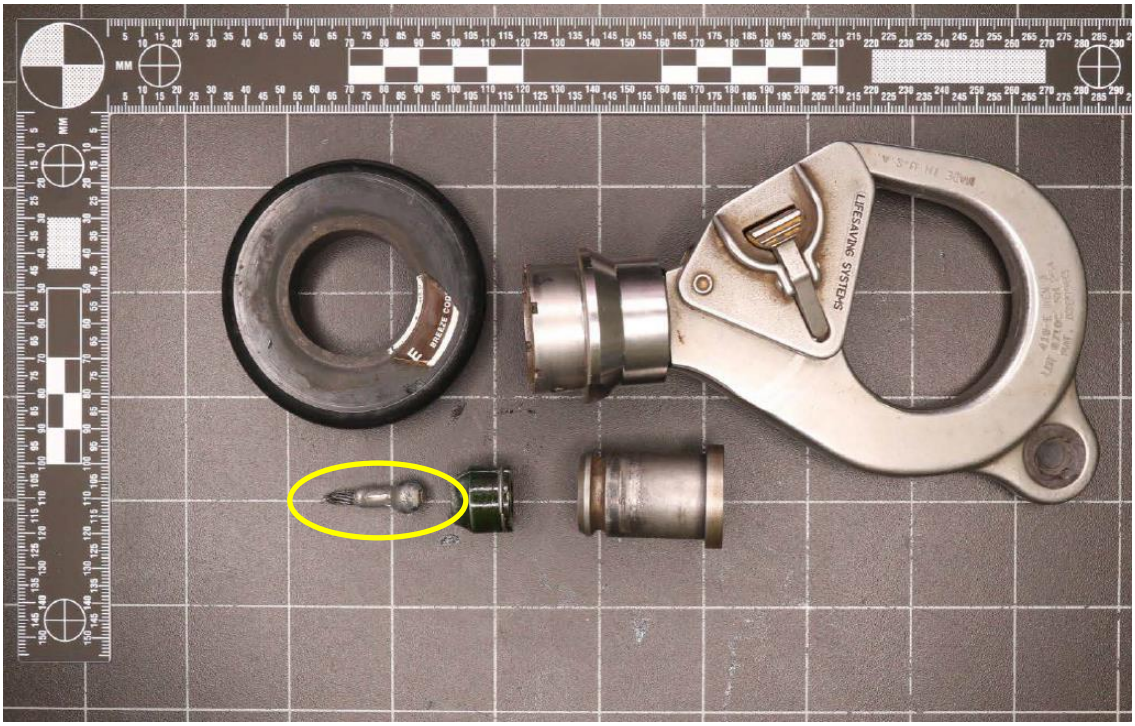

Image courtesy of ATSB

Figure 2. Disassembled Hook (showing swaged (Ball) end)

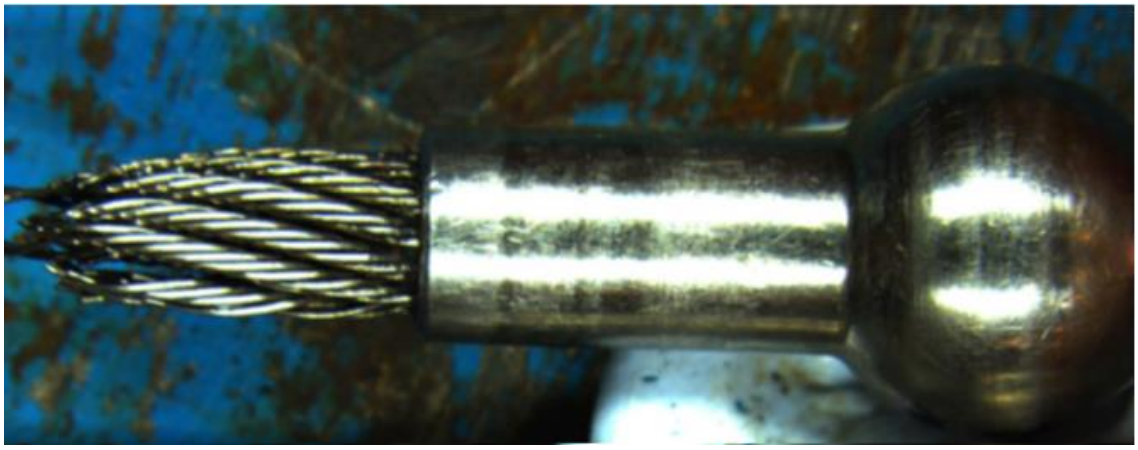

Image courtesy of ATSB

Figure 3. Swaged (Ball) end of failed cable

The failed cable is an aviation winch grade Type 1, 19 x 7 configured cable. Made from austenitic stainless steel (MIL-DTL-83140), each strand contains 7 wires. The strands are then spun into inner and outer wire ropes. The inner wire rope contains 7(strands) x 7(wires), covered by an outer rope of 12(strands) x 7(wires). See Figure 4.

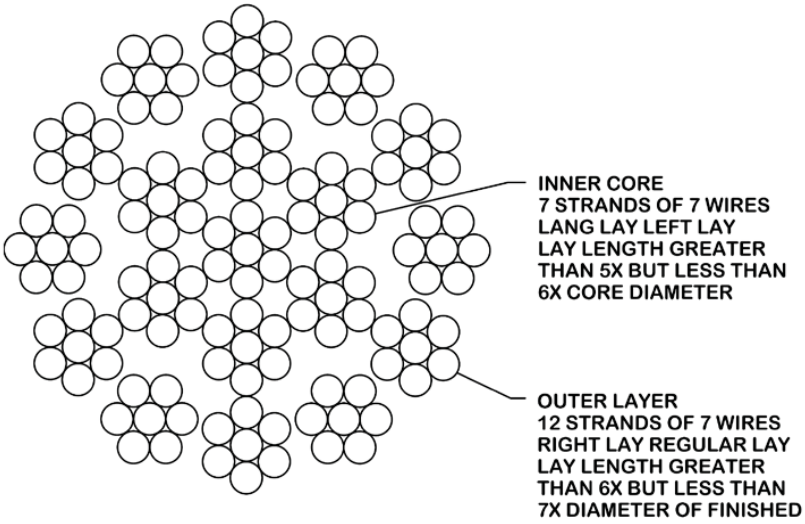

Figure 4. Type 1, Wire Rope Construction

As part of normal winch cable maintenance, a ‘conditioning’ procedure was being carried out. Conditioning, also known as salvaging, seasoning or load cycling, is an activity to rebalance or tighten cable strands after they become unwound or loose due to unbalanced loading on the inner and outer strands. See Figure 5.

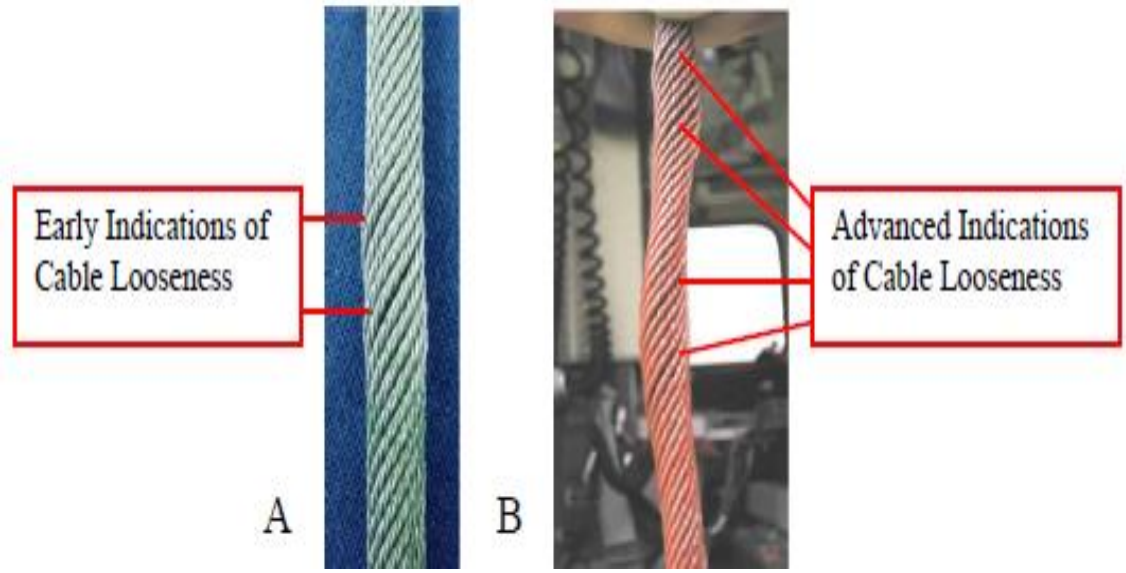

Image courtesy of Breeze-Eastern, LLC

Figure 5. Examples of Wire Rope Cable Looseness

Cable looseness is typically observed near the hook following multiple small length deploy and retrieve cycles or no-load cycles. Further no-load cycles can occur during inspection and maintenance activities. For this system, conditioning requires fully deploying and fully retrieving the cable 5 times with an attached weight equal to the rated load of the winch/hoist. Or removal and storage of the cable for several days. If looseness remains following conditioning or storage, the cable must be replaced IAW the manufacturers requirements.

On initial investigation, ATSB inspections revealed no corrosion or any significant debris within the cable strands. The ATSB indicated two potential sources that may have contributed to the failure. Firstly, mechanical wear on the inner surfaces of the outer strands. See Figure 6.

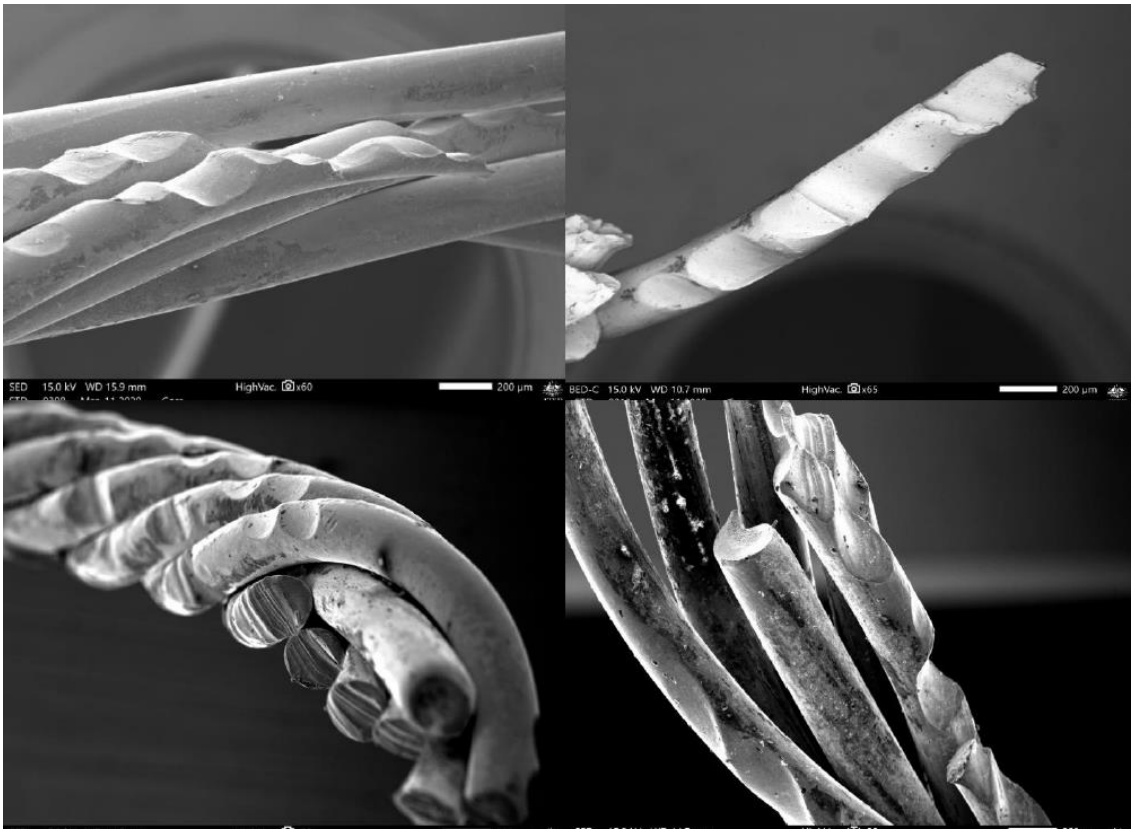

Image courtesy of ATSB

Figure 6. Internal mechanical wear to the wire strands

Secondly, the inner strands are believed to have prematurely failed due to wear and vibration fatigue. Both failure mechanisms are indicative of a hook that has not been correctly ‘homed’ after operations. Homing, is a procedure that ensures the hook assembly abuts up against a specified part of a winch or hoist. In this system, the hook is correctly homed when the ‘full in’ limit switch stops the winch

and the bumper spring is compressed sufficiently. Required spring compression can be verified by measuring the height from the top of the bumper spring retainer to bottom of the bumper spring. See Figure 7. If the measurement is outside limits, the 'full in' limit switch must be adjusted and tested OEM.

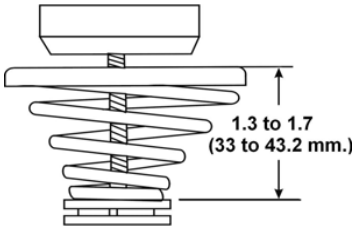

Image courtesy of Breeze-Eastern, LLC

Figure 7. Spring compression (homed hook)

A second operational cable was supplied to the ATSB by the operator for disassembly and inspection. External observations before disassembly showed local 'necking' in the same area as the failed cable. Necking, can visually indicate the onset of a serious defect such as worn or broken internal wires and strands. The subtle changes in diameter associated with necking could also be felt when handling the cable during a physical inspection. See Figure 8.

A detailed internal inspection of the second cable confirmed that the inner wire strands had also started to significantly wear. Necking in the vicinity of the ball end requires immediate replacement, in accordance with manufacturer data.

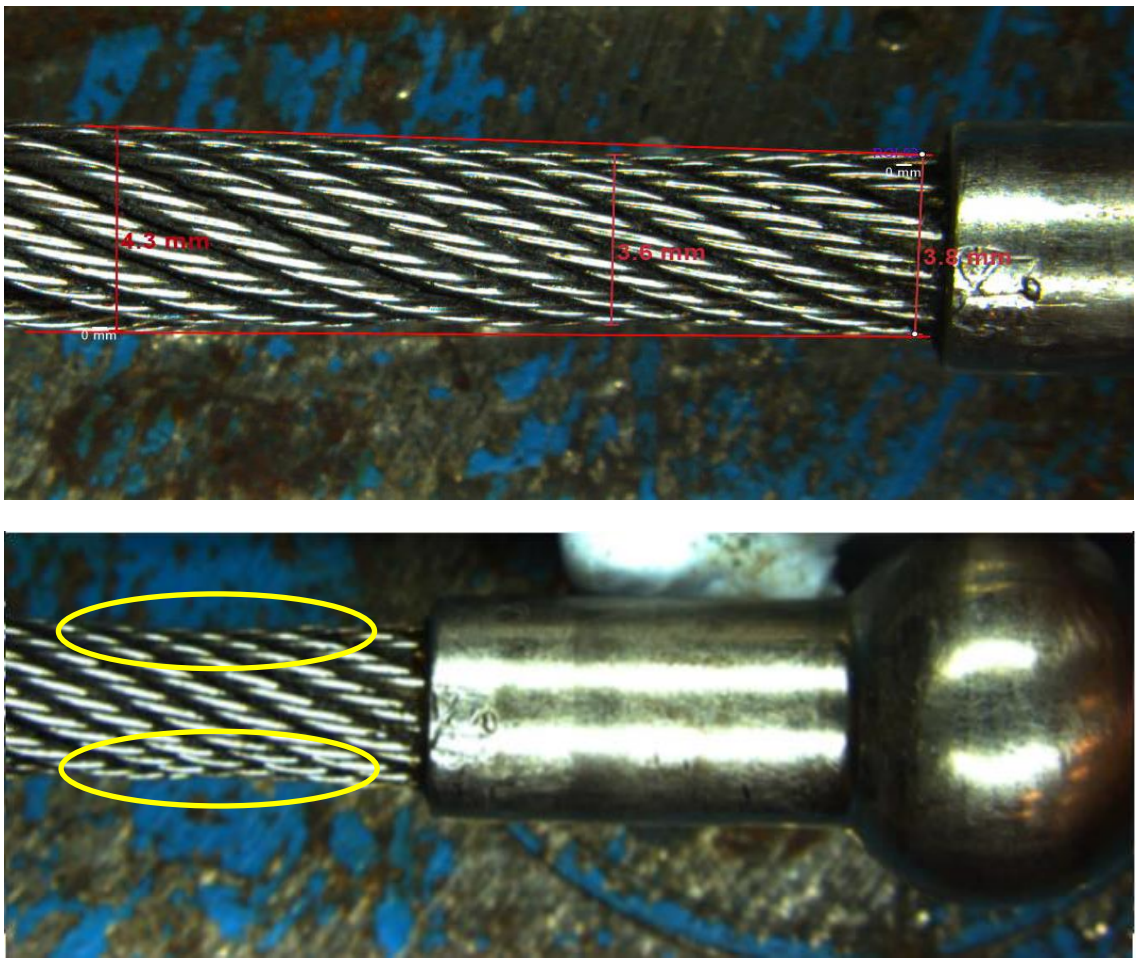

Image courtesy of ATSB

Figure 8. Operational cable with local necking and measurements

4. Recommendations

- Operate and maintain hoist/winch systems in accordance with approved data.
- Review and highlight acceptance and rejection criteria in accordance with winch/hoist manufacturer requirements.
- Ensure inspections are completed methodically and thoroughly.
- Always ensure the hook has been homed securely, as per approved data. This will prevent the hook causing premature cable fatigue.
- Winch/hoist system cycle counters cannot be used to replace physical and visual system inspections. These cycles are based on fatigue life determined in laboratories. Many winch/hoist operations consist of much shorter deploy and retrieve cycles, than a counter may show. Additional inspections may be warranted.
- Environmental and operational factors may require recommended maximum hoist cable cycles be reduced.

5. Related Information

- CASA Airworthiness Directives – Supplementary Equipment (including Rescue Hoists)

- AD/SUPP/10 - Breeze-Eastern Hoists

- CAB-100-30 - Customer Advisory Bulletin, Alert Advisory Bulletin – Rescue Hoist Load Cable and Hook/Bumper Stowage Inspection

- SIL 14 Maintenance - Breeze-Eastern Service Information Letter 14 - Rescue Hoist Maintenance and Flight Line Inspection for BL-29700 Series

- AWB 25-006 - Rotorcraft Underslung Loads

- AWB 25-017 - Goodrich Hoist Cable Cutter Wiring Inspections

- AWB 25-025 - Rescue Strops (Clarifies Australian Technical Service Order (ATSO) C1003)

- AWB 25-030 - Helicopter Personnel Winching - Human External Cargo (HEC) Operations

- CASA CAO 29.11 - Winching and Repelling operations

- CASA CAO 29.6 - External sling loads

- ATSO - C1003 - Helicopter External Personnel Lifting Devices

- ATSO - C1001 - Dispatchers Restraint Strap

6. Reporting

All incidents involving winch, hoist or cable system failures should be reported to CASA via the Defect Reporting Service (DRS). Rejected components within a hoist or winch system should also be reported via the CASA DRS.

7. Enquiries

Enquiries with regard to the content of this Airworthiness Bulletin should be made via the direct link email address:

AirworthinessBulletin@casa.gov.au

or in writing, to:

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