Overload protection in lifting gear

Mines safety bulletin no. 179 | 14 March 2019

What happened?

A maintenance fitter suffered multiple injuries when a hoist he was using fell on him when the upper hook detached from the rest of the assembly. The chain hoist—installed within a dragline house—was being used to attempt to lift a 2.6 tonne segment of a large ring gear. The hoist had a working load limit (WLL) of 4 tonnes and itself weighed approximately 200 kg. (See Figure 1)

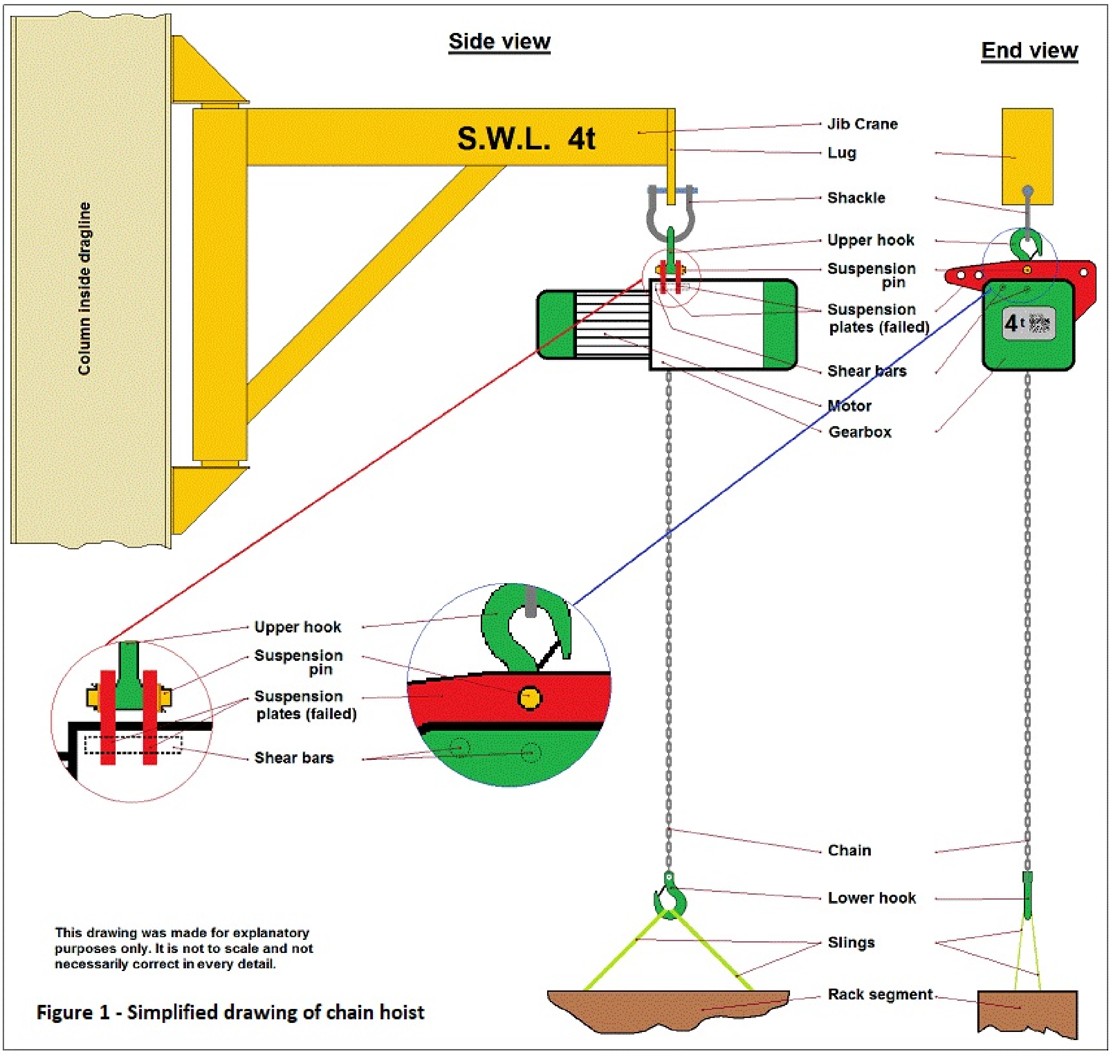

Figure 1 - Simplified drawing of chain hoist

Closer examination revealed that the suspension pin holding the hook had pulled through the sides of the suspension plates. (See Figure 2)

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Figure 2 - Ductile facture in suspension plates due to shear overload

Findings

Upon investigation it was found that:

- The suspension plate was made of good quality material. It failed in a ductile manner and was overloaded in a shear mode.
- All components in the load path were capable of carrying the 4 tonne WLL (working load limit) with a safety factor of at least 3x.
- For this incident, the main components of the 'load path' are defined as:
  - upper hook
  - suspension pin
  - suspension plates
  - shear bars
  - gearbox body (Including shafts, gears and chain wheels)
  - chain
  - lower hook
- The hoist gearbox and motor were capable of lifting 16.2 tonnes.
- The gear segment being lifted got stuck and allowed the load to increase to about 13.5 tonnes. At this point, the suspension plates failed.
- The hoist was not fitted with a device to protect it from being overloaded.

Recommendations

1. **Designers, manufacturers, importers and suppliers must ensure that:**
   a) all components in the load path are designed and manufactured to withstand any potential force generated by the motor and gearbox, regardless of the value of the WLL.
   b) the lifecycle of the equipment is considered in the design. As it is being used, the component materials are subjected to fatigue cycles which may lead to failure under a load that is lower than the original load capacity. Hoists operating in a corrosive environment could suffer a similar fate.
2. **Purchasing:**
   Purchase orders for hoists, cranes or other lifting equipment should specify that overload protection be fitted. (If *AS 1418.1 – 2002; Cranes, hoists and winches; Part 1: General requirements* is used as part of the purchasing specification, clause 8.8.8.1 requires fitting of a load limiting device.)

3. **Testing:**

Users of lifting equipment should have measures in place to ensure overload protection devices (OPDs) are installed and functional:

- before commissioning
- on an ongoing basis.

Note for users on site: For Recommendations 1 to 3 above, it may be difficult to determine whether an effective OPD had been ordered or installed without disassembling the item. Even then it may be difficult to determine at what load it will activate.

One method that will practically overcome this problem is to allow the equipment to pull to full WLL against an anchored and calibrated load cell. The load at which the OPD activates is verified and compared to specifications. This methodology will also allow the detection of lifting equipment on site not fitted with any OPD. Figure 3 shows how this was done within a load frame in the laboratory.

In the field it can be done with another structure that is suitable, available and of sufficient capacity. If a load cell and anchor is not available, similar results can be achieved by using calibrated weights. Care should be taken not to damage the OPD or other components during this test.

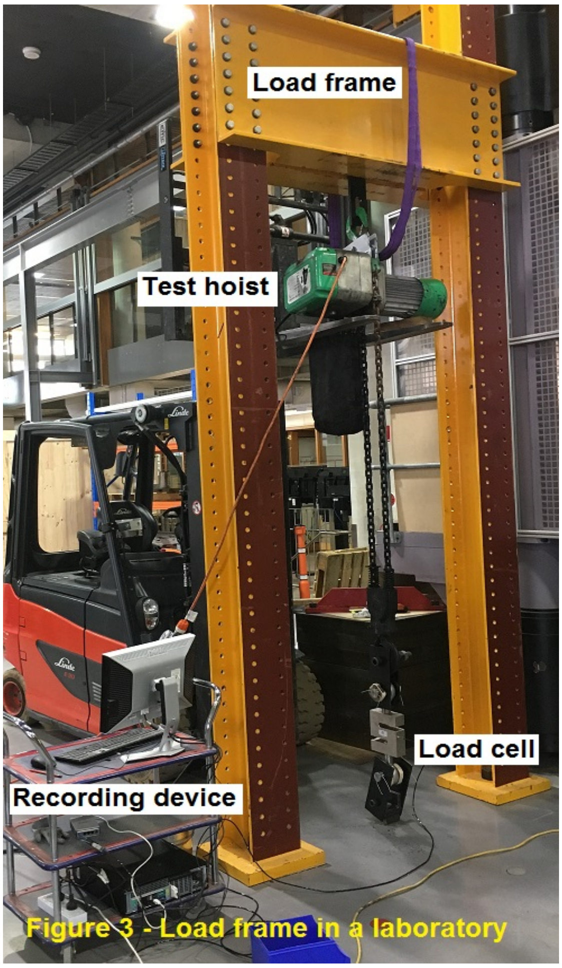

Figure 3 - Load frame in a laboratory

4. **Accounting:**

Measures should be in place that will ensure that all relevant lifting equipment on site is accounted for and is included in an inspection and maintenance plan.