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POTENTIAL CAUSES OF TOWER COLLAPSES

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Figure 1 - Tower collapse because of inadequate guyline placement

ABSTRACT

LIRO inspected current rigging practices used in seven hauler operations in New Zealand to check compliance with recommended procedures. The following discrepancies which had the potential to cause a tower collapse were found:

- *anchor stumps - too low, decaying or too small*
- *notching techniques - too deep or not in lead with the tower*
- *inadequate safe working load (SWL) of shackles*
- *SWL not stamped on shackles*
- *guyline shackle pins not secured*
- *worn and deteriorated rigging*
- *incorreci guyline placement*
- *legs of straps around stumps unevenly supporting the tension from the guylines.*

INTRODUCTION

While hauler towers have been collapsing in New Zealand for a number of years, no thorough investigation identifying recurring factors has been published. The Logging Industry Research Organisation (LIRO) identified the need for this type of investigation

which prompted a three part study. The first surveys rigging practices, the second reviews recent hauler collapses in New Zealand (Fraser, 1996), and the third formulates a hauler guyline and anchor check list.

LIRO researchers conducted a snapshot inspection of seven haulers to assess their current rigging practices. The objectives were:

- to assess the guyline and anchor arrangements
- to identify the aspects of rigging practices that need emphasising in a guyline and anchor set-up check-list.

From this investigation, LIRO hoped to gain some insight into how many recommended procedures were not being adhered to.

Attention was directed to the following features:

- guyline anchor placement relative to the tower and lead direction
- characteristics of the anchor stumps selected
- characteristics of the notches cut in stumps
- method of attaching guylines to the stumps
- relative size, type and condition of guylines, straps and extensions used
- size, type and condition of shackles/connectors used.

Rigging practices were evaluated according to :

- the LIRA Cable Logging Handbook (Liley, 1983)
- the Department of Labour, Occupational Safety and Health Service (OSH) - Safety Code for Bush Undertakings - Part 2 - Cable Logging
- operator handbooks (S. Madill, Ross Corporation).

FINDINGS

The following discrepancies to the recommended procedures were found:

(1) Stumps too low

- When stumps are too low, several problems can occur. The first is that the chainsaw operator is forced to cut the notch very close to ground level. At this level, the tree is often buttressed, forming the main supporting roots. The notch can often sever these main roots, reducing the holding ability of the stump. However, a compromise is necessary because, if the guyline is attached too high on the stump, greater leverage is created. This may cause the stump to rotate forward and up-root.

- The guyline choking the stump can impose an upward force which, in turn, can cause the stumps to slab or shear. Smith and McMahon (1995) have shown that the higher the stump above the notch, the less likely it is to slab, and the slower the stump will shear. They suggested at least 30 cm of stump should remain above the notch.

- There is insufficient stump height to lead the notch to the tower. Ideally, the notch should be sloped toward

the top of the tower and then gradually levelled off as it goes around the back of the stump. The intention of this is to distribute the lifting force on the stump over the circumference, rather than concentrating it at one spot where the guyline turns a sharp corner into the notch.

(2) Decaying stumps

Four of the seven haulers were working in settings where the surrounding areas had been previously logged. Stump age, after felling, varied from a few months to one year. The small structural roots provide a major proportion of the holding ability of a growing tree or fresh stump. As the stump gets older, these roots decay impairing the stump's holding ability. If possible, fresh stumps should be used and harvest plans should accommodate this.

(3) Stumps too small

The ability of a 30 cm stump to secure a medium to large hauler is questionable. Yet, in one instance where bigger stumps were not available, riggers did just that. The use of a tie back, where several stumps are used to anchor one guyline, is a quick and effective means of increasing anchoring capacity in this situation. There are also situations where the riggers must decide that deadmen are the only secure option.

A rule of thumb for the holding ability of stumps is that holding power increases approximately with the square of the stump diameter (Liley 1983). That is, a 60cm stump ($60^2 = 3600$) will hold approximately four times as much as a 30cm stump ($30^2 = 900$). Smith and McMahon (1995) found that over the range of stump sizes they tested, anchorage capacity increased with diameter at breast height. However, there was considerable variation in anchorage capacity for stumps of the same size on the same site. Stump selection skills acquired through experience of what has been sufficient in the past can therefore be unreliable.

(4) Notches too deep

Two examples of stump notching resulted in reducing the cross-sectional area of the stump diameter by up to 50%.

In New Zealand, the Safety Code for Bush Undertakings Part 2 - Cable Logging requires the depth of notches to be 1.5 to 2 times the diameter of the rope to be inserted into the notch. Cutting the notch deeper only reduces the cross-sectional area and strength of the stump, and often hinders the riggers when trying to remove the guyline or strap.

(5) Inadequate SWL of shackles

Of the seven haulers, four were using shackles which had a SWL less than the guyline they were attached to. This puts a 'weak link' in the system, reducing the overall strength of the guyline configuration.

The Safety Code for Bush Undertakings Part 2 - Cable Logging requirement is: "shackles, rigging screws and turnbuckles which may be used in the rigging or guylines shall have a breaking strength of not less than 1.5 times that of the guyline to which they are rigged".

(6) SWL not marked on the shackle

If there is no SWL stamped on the shackle, the user can only assume its strength by comparing it to a shackle that has its SWL marked. This can be very misleading because the relative size and SWL of different brands of shackles varies immensely depending on the materials used and how the shackle was manufactured. For example, cast shackles are larger than forged shackles of equal SWL.

The Safety Code for Bush Undertakings Part 2 - Cable Logging requirement is: "shackles shall be tested and marked with their SWL".

(7) Shackle pins not secured

Four of the seven hauler operations did not secure shackle pins from unscrewing. The Safety Code for Bush Undertakings Part 2 - Cable Logging requirement is that: "shackles which may be used in the rigging or guylines shall have their screw threads positively prevented from turning or unscrewing".

(8) Worn or deteriorated rigging

Three occurrences of worn shackles, shackle pins or stranded rope were found. The actual strength of these components will be less than that of new components.

(9) Guyline placement

The following individual discrepancies of guyline placement were found:

- One guyline was positioned so that it was taking almost all the reactive force of the working ropes
- The guyline angle was too steep (greater than 45°)
- The crew had set up the hauler, positioning the guylines in a compromise position so that the whole setting could be logged without re-arranging the guylines. The first and last corridors to be logged were outside the allowable lead angles.
- The front snap guys were not placed as far forward as the manufacturer recommended.

The spacing of guylines will determine how evenly they share the loading and subsequently their overall effectiveness. Each model of hauler has instructions for positioning guylines. These instructions include limits of how the guylines must be spaced to ensure the maximum stability of the tower. The Safety Code for Bush Undertakings Part 2 - Cable Logging requirement is: "guylines shall be rigged in accordance with the manufacturer's instructions".

(10) Legs of the straps not sharing the load

Where a strap is wrapped one-and-a-half times around the stump, friction can prevent the strap from sliding. This can cause overloading of one of the legs.

In one operation where this occurred, the crew were reliant on the strap being doubled to obtain the required SWL relative to the guyline SWL. This was not achieved and the crew continued working, probably oblivious that one guyline had only half of the holding capacity it should have.

DISCUSSION

These findings are a result of a combination of casualness creeping into operations and a lack of understanding of the issues. Any one of those examples could have been in an accident report subsequent to a tower collapse.

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