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HAULER TOWER COLLAPSES

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ABSTRACT

LIRO reviewed 13 tower collapse accident reports to determine the key factors contributing to the collapses. Incorrect guyline placement and the use of guyline anchors of insufficient strength were the most frequent factors causing tower collapses. Other factors were: operator error, structural failure, stump failure, deadman failure, poor communication, deteriorated rigging, overloaded skyline and inadequate deflection.

INTRODUCTION

There is considerable concern within the logging industry at the frequency with which hauler towers have collapsed. These incidents result in considerable expense to many parties, as well as presenting a threat to the safety of workers on the site.

A study of 15 tower collapses was made by The Workers' Compensation Board of British Columbia (Ewart, 1978) which revealed that poor guyline rigging was the cause of all but two of the accidents. Some of these accidents resulted in injuries and fatalities. The failures studied resulted from:

- poor guyline placement and/or tensioning
- poor stump selection
- failing to tie back stumps
- failing to inspect stumps under tension
- worn guylines
- failure of blocks, shackles or other rigging
- improper securing of the guyline drum.

Many of these failures were attributed to inadequate attention or inspection.

Ewart (1978) found that the most common error with guyline systems was poor placement of lines. Poor guyline placement results in the creation of three conditions which can lead to tower collapse.

The first condition occurs when an unacceptably high percentage of the guyline reaction (resulting from tension in the operating lines) is placed on one guyline causing it to fail. If the guylines are spaced properly, failure can be caused by uneven tightening, or by the slackening of a guyline transferring all of the load to another line when an anchor or stump loosens.

Secondly, unequally spaced guylines alter the stability of the tower. As the angle between two adjacent guylines approaches 180°, guyline tension increases rapidly and the tower becomes less stable. Ideally, with a six guyline machine, the guylines should be spaced at 60° intervals around the hauler. Should one of the guylines fail, the maximum angle between adjacent guylines becomes 120°. If the remaining guylines are properly anchored and pre-tensioned, the tower may remain standing, although its stability is drastically impaired.

The third condition is the result of excessive compressive stress in the tower. This can be caused by steep guyline angles or unnecessarily high tension in the side or front guylines.

STUDY METHOD

The Logging Industry Research Organisation (LIRO) reviewed the accident reports from the Department of Labour Occupational Safety and Health Services (OSH) and from forest companies of all tower collapses in New Zealand which occurred within the last two years.

Thirteen accident investigation reports were reviewed to determine the key factors which contributed to the tower collapses. Of these, four were selected to highlight typical factors which have contributed to tower collapses.

Case 1 - Incorrect Deadmen Installation

Hauler description - telescoping tower
Height - 47 feet (14 m)
Guylines - four

What happened

The hauler was highleading over a long haul distance. During inhaul, a drag became jammed behind a stump. As the increased tension from the mainrope came on to the tower and guylines, the two back quadrant deadmen slowly pulled out. The tower fell forward, landing in the chute area. The two side quadrant deadmen were partially pulled out as the tower fell.

Contributing factors

- The back quadrant guylines passed through the tower sheave and down at a very steep angle to the deadmen.

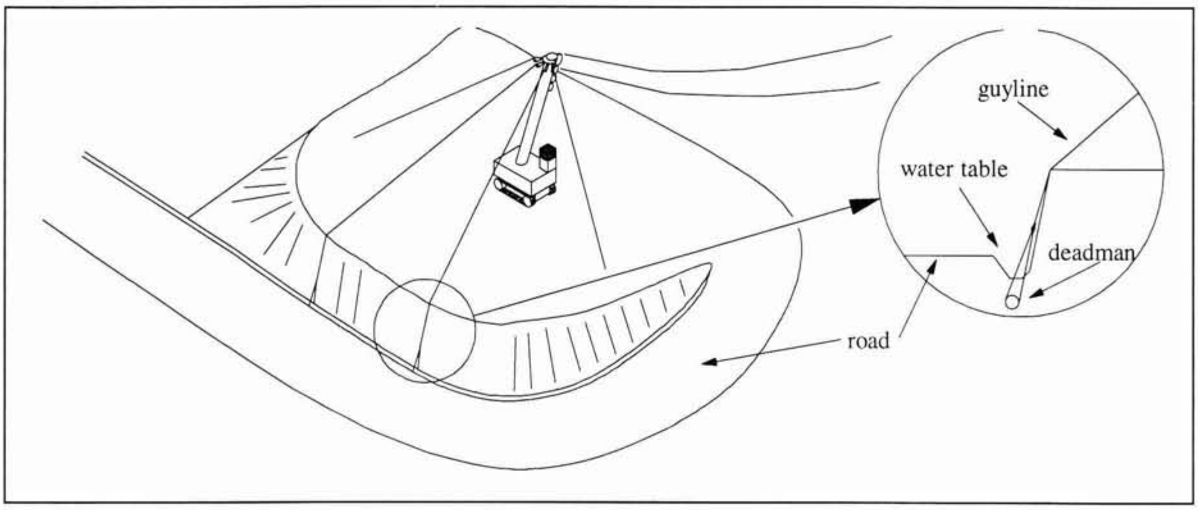

Figure 1 - Guyline arrangement before failure

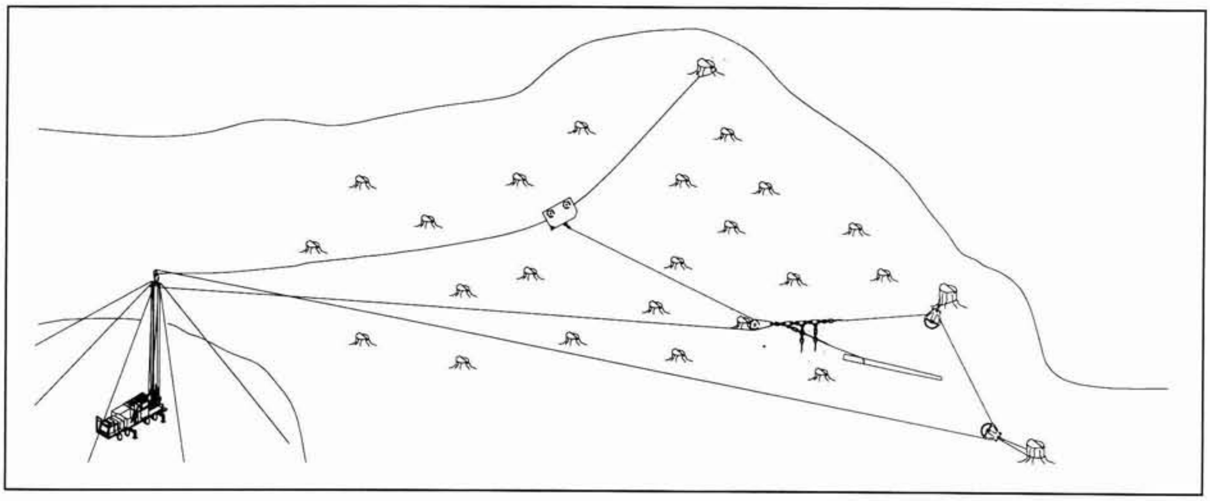

Figure 2 - Mainrope hung up on stump

- The lower part of the guylines passed over a cut batter then dropped at a steeper angle down to the deadmen (Figure 1). A "T" shape was not cut out of the side of the trenches to ensure the guylines were straight.

- The deadmen were buried in a water table.

- The extra forces from the jammed drag pulled the deadmen straight up and out of the trench.

Case 2 - Anchor Stump Failure

Hauler description - telescoping tower
Height - 100 feet (30 m)
Guylines - seven

What happened

The hauler was using the North Bend system in an area with very little deflection, bridling approximately 50m from the skyline. As the hauler attempted to break out a drag, the mainrope caught behind a stump (Figure 2). Before

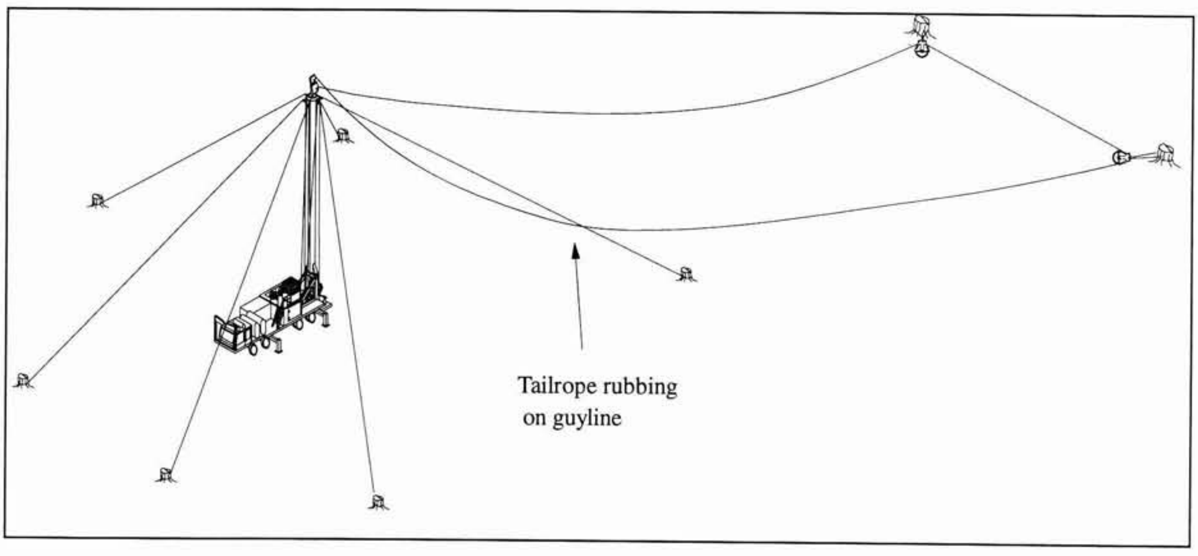

Figure 3 - Tailrope rubbing on guyline

the hauler operator could stop, two guyline stumps pulled out and another two shore off. The tower fell to the ground on its side.

Contributing factors

- When the mainrope first caught behind the stump, the breakerouts did not signal to the hauler operator to stop.
- The hauler operator continued to apply pull on the mainrope when the excessive tension being applied should have signalled the operator to stop.
- The guylines had not been shifted after a large change in the direction of pull. One guyline was in the direct line of pull; this was the first stump to fail.
- Heavy rain the previous day probably decreased soil strength.
- The roots of one stump were damaged from previous logging.
- The breakerouts had previously used radios for communication, but on this occasion were using the Talkie Tooter only.

Case 3 - Guyline Cut by Rubbing Tailrope

Hauler description: tower
Height - 90 feet (27 m)
Guylines - six

What happened

The hauler had finished working one corridor and was shifting the lines to the next. The guylines were not re-adjusted and the crew did not notice that the tailrope was touching one of the guylines. The tailrope cut through the guyline reducing the stability of the tower to such a degree that the tower collapsed.

Contributing factors

- The primary cause of this tower collapse was the guyline being severed by the tailrope. This was due to failing to prevent the guyline from touching the tailrope
- Had the six guylines been spaced evenly, the loss of one guyline would not have been enough to allow the tower to collapse.

Case 4 - Anchor Stump Failure

Hauler description - telescoping tower
Height - 100 feet (30 m)
Guylines - eight

What happened

The machine was operating a live skyline using a shotgun carriage. A drag was hooked on, one of the stems of which was under other logs and behind a rootball. The hauler operator started to break out the drag but the snagged stem showed no sign of moving. At this point, the guyline stumps sheared and the tower collapsed.

Contributing factors

- The primary cause of the tower collapse was insufficient stump height above the notches to sustain the loadings imposed
- This was possibly aggravated by an overloaded skyline which would have increased these loadings
- Uneven tensioning of the guylines may have contributed.

DISCUSSION

The key issues resulting from all 13 tower collapses were quite varied, but there were contributing factors that recurred. The most common factors were related to guylines. Manufacturers of haulers stipulate the range at which guylines must be distributed to maintain the stability of the tower.

Stumps are presently the most commonly used form of guyline anchor in New Zealand, because they are cheap and most readily available. It is critical that stumps are correctly prepared for use as guyline anchors. The relatively small piece size of new crop necessitates skilled notching techniques to prevent impairing stump strength. It may also necessitate an increased use of multiple stump anchors or deadmen rather than using single stumps.

Stumps and deadmen have failed after rainfall events because of unidentified changes in soil strength.

Guylines are often anchored in adjacent cutovers which imposes an additional hazard of using old deteriorated stumps, or stumps that are too low to provide adequate strength.

Structural failure was identified in three of the 13 collapses. This is a particularly difficult hazard to identify but highlights the importance of routine inspections and maintenance.

Another factor which became apparent was the lack of communication between the hauler operator and breakerouts. In almost all occurrences of tower collapse, the hauler was breaking out, or hauling in a drag. The drag became fouled, overloading other components, resulting in the tower collapsing. American breakerouts (choker setters) continually instruct the hauler operator during the inhaul phase. In effect, the breakerout controls the line speeds and subsequent drag ground clearance. The hauler operator just pulls the appropriate levers when signalled and watches the drums to ensure the ropes fleet correctly. More of this communication style needs to be adopted in New Zealand. At present, it seems that many breakerouts hook the logs on and think their job is done. The hauler operator is often left to haul the drag to the landing, relying on listening to the machine and watching line speed to determine what the drag is doing. The resulting shock load from a fouled drag is often too late to be useful as a warning to stop.

Three of the 13 accident reports stated that inadequate deflection was a possible contributing factor. Often contractors try to extract drags of the same payload regardless of the deflection available, possibly unaware that the ropes are being overloaded. Lower payloads must be expected where there is poor deflection, and this should be reflected by production expectations. It is also essential that the hauler operator has a full understanding of the relationship between deflection, payload and line tension.

Rope tension monitors enable hauler operators to monitor guylines and the skyline simultaneously. The percentage of safe working load can be read from a display screen positioned in the hauler cab, enabling the hauler operator to check line tensions at any time during a cycle. When combined with good communication with the breakerouts, the logging team can maximise payloads without impairing rope life through overloading.

The costs of hauler collapses vary with the degree of damage incurred to the tower and carrier, the length of down-time while being repaired and loss of personnel from injury or death. Some hauler operators have refused to continue operating haulers after the event of a collapse. This, in itself, can be a great loss to the contractor and the industry.

Repairs to haulers which have collapsed ranged from $7,000 to $50,000. Tower damage was the most expensive to repair.

"Down-time" while waiting for a hauler to be repaired, has been up to eight weeks. In some cases, the logging operation continued extracting timber with other available machines, but this was carried out at a very high opportunity cost.

Most of the tower collapses reviewed for this report could have been avoided had adequate training and control systems been in place. Logging crews should comply with the hauler manufacturer's guidelines. The whole crew should be aware of the allowable range of guyline placements to enable them to check and question the configuration at any time during operation. The LIRA Cable Logging Handbook (Liley, 1983) also describes the resulting tensions and forces of differing guyline angles. Operators should be aware of this information to understand more fully the reasoning behind manufacturers' specifications.

CONCLUSIONS

As a result of this study, LIRO has identified that incorrect guyline placement and using guyline anchors of insufficient strength are the causes of most tower collapses.

To eliminate these causes, guylines must be spaced within the manufacturer's specifications to ensure the loadings are shared evenly and attached to anchors which are sufficiently strong.

If correct guyline placement is followed and anchors of sufficient strength are used, in the event of the skyline or mainrope breaking, the tower should remain standing with guylines intact.

ACKNOWLEDGEMENTS

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