Mechanical Failure on Hauler Spar



Investigation undertaken and Report Prepared by Brady Clements on behalf of Robbins Contracting Ltd



Incident Details

Date: 10/10/2019

Time: 2:00 pm

Crew: RCL Hauler

System Used: Shot gun system with an extension shackled into the skyline onto the tractor mobile tail hold, around 500 metres of skyline was out across the gully.

Hauler Information: The hauler was a Madil 071 tower hauler which has three guy rope drums and three working drums. The tower certification was in date on the tower and the cab had been re-certified in July 2019. The hauler operator had undertaken the required daily checks for the hauler and the guy line angles where the guy lines are attached to the dead men were documented. These angles were under 45° which is the angle industry recommends having guy line angles at. (Image 1)

Background Information: The hauler was pulling in a drag which consisted of two medium sized stems. As the drag was being extracted to the landing the drag picked up another stem with the rootball still attached. The stem with the root ball was not hooked on with the chain like the other two stems but has been caught around the chain where it has been hooked onto one of the stems in the original drag. The stem with the rootball still attached, was a in 300mm in diameter and was approximately 15m in length. The drag has continued to be extracted to the landing by the hauler, the breaker outs saw the other stem get picked up by the drag but thought it would be fine as the original drag was light. The drag has become stuck during the inhaul, when the drag has become stuck it has caused a shock load on the system, this shock load has travelled up the skyline to the hauler.

Description of the Incident: When the shock load occurred, it triggered a mechanical failure on an integral component on the hauler. One of the D-shackles that attached the guy line block to the top of the tower failed. This particular shackle has cracked and was compromised, breaking on one side, which resulted in the shackle stretching out of shape and rupturing completely (refer to images 2,3). The failure of the D section of the D-shackle has resulted in the guy line block releasing from the top of the tower and dropping towards the ground, causing the left-hand guy line to go slack. The guy line block did not fall all the way to the ground as the safety strop that was attached to the top of the spar through the guy line blocks worked and caught the block. Slack from the guy line, however dropped 8 meters and landed on the ground beside the hauler.

The failure of the left-hand guy line resulted in the weight supported by this guy line transferring to the two remaining guy lines on the hauler. The two-remaining supporting guy lines: the middle guy line located directly behind the hauler spar and the right-hand guy line located on the cab side of the spar, now supported the entire weight of the hauler. Due to the loss of the left- hand side guy line this weight was now unevenly distributed across the hauler and the remaining two guy lines were inadequate to provide comprehensive restraining support. This caused the hauler to pivot from the centre of the track frame towards the right-hand guy line, the hauler rotated on the ground. (Image 4) Please note:

during this rotation of the hauler the skyline remained taut, suspended across the gully while the failure has occurred at the hauler.

Further Events Following the D-Shackle Failure: When the shock load has occurred combined with the hauler pivoting towards the right-hand guy line the dog spike that slots into the notches on the middle guy line winch set has dropped out slightly. (Image 5) It remains unknown as to why this has occurred, during the investigation engineers whom deal with haulers and tower certifications have been spoken to regarding this and they are unable to shed any light on why the dog spike would have dropped out. The dog spikes are held in place via a spring system and with air pressure. The dog spike has not dropped out completely but has dropped enough to compromise the working capability.

When the hauler has stopped pivoting the weight of the skyline has pulled the tower forward. The weight applied the middle guy rope would have substantial due to this guy line being located right behind the spar and the skyline. The middle guy line has taken the majority of the force from the shock load given the location of this guy line, directly behind the skyline. With the skyline suspended in the air across the gully and the weight of the drag and shotgun carriage the hauler spar has continued to be pulled forward. This resulted in further mechanical failures on the hauler.

The pendant guy which is a guy line that is attached to the hauler base and attached to the spar, used as a safety device when the hauler is being moved with the spar up. This guy rope prevents the hauler spar falling forward, this guy line is always attached. When the added weight has been applied this guy line has failed. (Image 6) It is unknown as to why this has occurred as the pendant guy line was within specification for rope diameter and breaking strain. Once the pendant guy line had broken the middle guy line drum mechanisms have started to fail. (image 7) The dog spike has slipped out of the first notch and the guy line has started to unwind off the drum. The dog spike has still been held in against the notches but due to the dog spike dropping out slightly and the mechanism being compromised the guy line drum up has failed under the weight the internal gears have been shorn and destroyed. The guy line has continued to unwind allowing the hauler spar to fall forward due to the weight of the skyline across the gully.

It is important to note the condition of the guy line drum and the notches where the dog spike slots in. This indicates that the dog spike was still in place however for the reason unknown it has dropped out slightly and allowed the drum to unwind. The condition of the notches where they are worn where the dog spike has been making contact indicates that the dog spike still had force behind it holding it in place. If the dog spike had dropped out completely then there would have been very little wear to the notches on the guy line drum. (Images 8,9) It is thought that the weight applied to this middle guy was so great that the mechanical components failed. The tower has continued to fall forward until the second pendant guy which is located on the right and side of the hauler by the cab has pulled tight. This pendant guy has stopped the spar falling right to the ground. (Image 10)

Following the Incident: When the hauler spar came to rest out the front of the hauler the hauler operator has got out of the cab and climbed down the ladder off the hauler. His initial reaction was to ensure no crew members were injured as there were two other crew members working on the landing. The crew member driving the excavator clearing the chute was still in the machine and the crew member unhooking had run up the road out of the way when he heard the bang. The crew member unhooking recalls hearing a loud bang and the left-hand guy line going slack, at this point he moved away from the hauler to a safer location.

The crew radioed Greg the crew owner and informed him of what had happened. The scene was frozen and the crew knocked off for the day. Greg then rang the crew health and safety facilitator to inform him of what had happened.

Doug Mecloud the Work Safe inspector for forestry in the Nelson Marlborough region was called to inform him of what had occurred. Doug was phoned on the 10/10/2019 at 5:20pm. The situation was explained to Doug as to what had occurred, and we were informed that it wasn't a notifiable incident in regard to Work Safe. It was discussed with Doug that Robbins Contracting would be undertaking an internal investigation on the incident and they would be appointing Brady Clements to undertake the investigation on their behalf.

Angela MacKenzie from MacKenzie Management Ltd, the forest manager was also called on the 10/10/2019 to inform them as to what had occurred.

Investigation Process: On the 11/10/2019 Brady Clements from Forest Safety Management the Health and Safety Facilitator for Robbins Contracting met Greg on site to go over what had occurred. Photos of the scene and the hauler were taken for use in the report. Notes were taken as to what had occurred, crew members were interviewed in a non-formal manner in order to ascertain the turn of events.

When talking with the hauler operator during the investigation process and retracing the turn of events from in the hauler cab it become very clear that this all happened very fast. The hauler driver recalls feeling the hauler spar lurch forward slightly then hearing a loud bang and the left-hand guy line becoming very loose. The hauler has then pivoted towards the right-hand guy line and the spar has started falling forward. He said the spar didn't fall forward quickly but just gradually fell forward, he said it happened in one motion and he was not able to react by trying to lower the skyline. The hauler spar continued to fall forward until the right-hand side pendant guy pulled up tight and held the spar, the top section of the spar was 1m from the ground with the rope sheathes just off the ground (Image 11) He recalls hearing all manner of noises which sounded like steel bending and flexing as the hauler spar has fallen forward. These noises would have been from the various steel structures bending as the spar has been moving forward. (Image 12)

Darren Hall from Hauler Engineering was also interviewed over the phone regarding the incident to get his thoughts on what had occurred.

What were the Causes? And Actions Taken to prevent Incident Re-occurring

The main cause of this incident was a mechanical failure of one of the d-shackles that attach the guy line blocks to the top of the spar. This failure happened as a result of the shock load that occurred when the drag was being extracted to the landing by the hauler. As outlined earlier in this report the hauler had a current tower inspection certification.

It is unclear what has caused the shackle to fail on the hauler spar, on inspection there is a very small crack on the shackle where it is rusty. Given the age of this hauler it is estimated that the hauler is around 40 years old the steel shackles could have been weakened over time. When talking to Darren Hall about the age of the shackles that hold the guy line blocks on the hauler spar, he stated that he thought these shackles could well be the original shackles. Darren stated that the shackles were however still in specification. When the hauler spar was brought out to the Hauler Engineering workshop and the dismantling process was underway in order to strip the required items off the spar to start the rebuilding of the spar. The two remaining guy line block shackles had to be gas cut off the hauler in order to get them off the spar, Darren stated that this indicated the shackles were very old.

The hauler had been set up within the required specification the guy lines were spread evenly and the angle of the guy lines when attached to the dead men were all under the required maximum of 45°.

In order to prevent an incident of this nature happening again in the future changes to tower certifications need to be made. Discussing this point with Darren Hall outlined some good points that need to be considered across the industry in relation to tower haulers.

Every seven years the guy lines are required to be replaced on tower haulers, however there is no mention of the replacement of the shackles that attach the guy line blocks to the hauler spar. On old machines such as the Madil 071 of Robbins Contracting the shackles that hold the guy line blocks on the spar could be very old. Darren Hall stated that every seven years when the guy lines are replaced, the guy line block shackles should be replaced as well.

Learnings from this incident across the forest industry could prevent a similar incident happening in the future. It is hoped that it will generate discussion regarding the age of guy line block shackles and whether there is cause to make changes to the guidelines for hauler tower inspections.

Effects of guyline angle on tension

Vertical angles

For a given load (skyline tension), the tension in the guyline increases as it gets steeper. *Examples*:

If the guyline is horizontal (vertical angle is 0°), the tension is equal to that of the skyline

If the guyline is steepened to 45° , the tension is now 14 tonnes

If the guyline is steepened to $60^\circ,$ the tension increases to 20 tonnes





Guyline angles should be as flat as possible to avoid extreme tensions. An angle of less than 45° is recommended. However, this may not always be possible. In this situation, the **Approved Code of Practice for Safety and Health in Forest Operations** states that an addition guyline shall be installed to appose the haul line.

Guying above the tower can cause an upward (lifting) force on the tower. This occurs if the working rope(s) are angled above the guyline angle. If however, the working ropes angle below the guyline, a downward force is generated in the tower.

Horizontal angles

As the horizontal angle between load bearing guylines increases, tension in those lines increases.

Examples:

If a 10-tonne force is placed on the skyline, with two guylines equally spaced at 30° , with a vertical angle of 45° , the tension shared in those guylines is 7.3 tonnes.

If the angle between the guylines increases to 100°, the tension in each guyline increases to 11.1 tonnes.

If the angle between the guylines is further increased to $130^\circ\!,$ the tension in each guyline is now 16.7 tonnes.



Image 1: This image is taken from the *Cable Logging Best Practice Guide for Forest Harvesting* it states that the recommended angle where the guy line attaches to the dead man is recommended to be less than 45°



Image 2: Shows the two ends of the shackle that the D section has broken out of, the pin and two sections are still attached to the hauler spar.



Image 3: Shows the broken section of the shackle pieced together this indicates the stretch in the shackle when it broke. This image indicates one end of the shackle has broken and stretched the D section of the shackle out of shape, which has then caused the other end of the D section to break.



Image 4: This indicates where the hauler has pivoted when the left-hand guy line has failed. The red line in the image indicates where the hauler has moved to. The hauler has been dragged back into position in order to get the vehicles past post incident.



Image 5: This shows the dog that drops into the notches on the guy line drum, this holds the drum in place and prevents the drum unwinding. This is the dog that has dropped out slightly as referred to in the report.



Image 6: Shows the end of the pendant guy which has failed in the incident due to the shock load.



Image 7: shows the internal mechanisims that have failed on the middle guy line drum. The intenal drive motor system has been destroyed and collapsed.



Image 8: Shows the wear on the notches of the guy line drum where the dog has dropped out slightly. Not the wear on the notches as the dog has been held in against the notch but it has still been unwinding.



Image 9: Shows a non-worn guy line winch drum, if the dog spike had dropped out completely the drum would have looked like this as there would have been no resistance on the drum from the dog in the notches.



Image 10: shows the pendant guy located on the cab side of the hauler that has pulled up tight and prevented the spar from hitting the ground.



Image 11: Shows where the spar has come to rest out the front of the hauler, note the pendant guy that has pulled tight has prevented the spar hitting the ground



Image 12: shows the various steel structures on the hauler that have bent while the spar was coming forward on the hauler.