HARVESTING TECHNICAL NOTE

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Current Methods of Log Securement for Road Transport

Summary

Securing logs onto a truck by throwing chains remains a very physical and time-consuming task for log truck drivers. It is also a known risk for injury such as sprain/strain to the shoulder for the throwing task, and blunt force injury when tensioning. An evaluation of log securement in the field was completed to obtain a more detailed understanding. Nineteen trucks in total were observed and nine of the drivers interviewed on aspects of the task at a site in Canterbury. Using 6mm gauge chains together with ratchet winches and twitches (where needed), the drivers secured two log packets in an average time of 4.9 minutes, and three packets in 7.5 minutes (excluding delays). The element of load securing that took the most time was organising the chains and tossing them over the load(s) and the least amount of time was taken to tension the chains. Four of the nine drivers interviewed had previous injuries relating to chain throwing or tensioning however were comfortable with the securement system in its current form. All interviewed drivers elaborated on aspects of good (or poor) engineering design which influence job risk. Any new, automated system would need to prove itself to drivers as being robust in a work environment that is subjected to repeated knocks and stresses.

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Introduction

Log securement for road transport has been a focus of FGR research and development efforts in New Zealand in recent years. The chain and ratchet winch method used to secure loads of logs from movement during transport continues to challenge drivers when log packets are springy or slippery, and the method is also known to result in injuries from throwing and tensioning the chains. For these reasons the industry has sought to improve the current system without radically increasing truck tare weights or cost.

The need to change how logs are secured is well established. A study by Log Transport Safety Council (Mackie and Ashby 2011) reported 38% of drivers suffered stress-strain injuries from chain throwing, and 35% of drivers suffered a mix of stress-strain and 'struck by' injuries from twitching.

"While some drivers seem to have no problems with throwing and tensioning chains, a significant proportion of drivers are likely to be affected in some way, especially given the age profile of log truck drivers in NZ. The extent of these issues may widen in the future as the driver workforce ages further."

Various solutions were proposed in the LTSC report, including reducing chain weights, using equipment to place the chains over the load or throwing a lightweight leader rope to pull the chain over. If retaining the current chain throwing and ratchet system, solutions included reducing time-pressure, ensuring a dedicated flat area for chaining loads and limiting excessive load heights.

Rotorua Forest Haulage Ltd previously conducted a trial of ultra-high molecular weight polyethylene (UHMWPE) ropes which is approximately 15% of the mass of chains or steel cables. The result was an unsatisfactory lifespan of the ropes.

A study by Jokai (2020) supports the claim of high deterioration rates, especially fibre ropes without the protection of a polyester jacket. The recommended either a larger diameter, or

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jackets installed to protect the fibre core from abrasion and contaminants. Over six months of use, unjacketed ropes deteriorated to approximately 35% of original tensile strength, while jacketed ropes retained on average 50% of their strength. One consideration worth noting is the effect of multiple freeze-thaw cycles in the workday in Jokai's Canadian test. Ropes would adsorb wet road spray while travelling to the forest, where it would freeze in winter, get tensioned on site, then thaw again on the loaded section of the trip, to lower elevation. The changing conditions during the load cycles may have accelerated the deterioration.

While steel chains are heavy, the material has a long lifespan if consistently loaded below its fatigue limit, which is why it remains a popular choice.

Some interventions have been adopted including dedicated chaining-up areas where possible. Innovations to the manual load securement method have also progressed, for example the horizontal twitch and Borlase Bellcrank chain tensioning system (Figure 1). This system was developed by Borlase Transport Ltd in the Tasman region to direct the twitch bar away from the body if the bar released uncontrollably, previously a significant source of serious injuries to truck drivers.

Figure 1: Horizontal twitch and Borlase Bellcrank chain tensioning system. Source: Wild Tomato 2016.

Another innovation comes from Timberlands in the CNI region with the trailer-mounted chain lifter for eliminating the need to throw chains over the log packets, and thereby eliminating throwing-related injuries to drivers (Figure 2).

Figure 2: Timberlands' chain placement system uses a trailer mounted hydraulic lifting arm to deliver chains to the other side of two log packets with minimal effort.

Fully automatic log load restraints are available internationally, with the ExTe COM 90® a notable solution, developed in Sweden and now on trial in New Zealand (Figure 3).

Figure 3: ExTe automatic log load restraint system. Source: www.exte.se

Shetty (2021) reported on an interview with the NZ installer, Evans Trailers. Evans Trailers noted that the device enables the doubling of productivity (loads per day) in very short turnaround port operations, while on-highway operations result in somewhere between 30-60 minutes of time saved, daily. Servicing of the wear components is necessary with the system every 3000 cycles and loader operator must be particularly careful not to damage them during loading/unloading. A clear consideration is the cost to install and maintain, which is significant in comparison to the simple and robust bolster, stanchion and chain system currently employed by most operators in NZ.

With FGR-funded projects to develop automatic chain tensioners and chain

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placement systems in progress, innovations and trials have improved aspects of log securement and allowed industry to advance knowledge, however throwing and manual tensioning with ratchet winches and twitches remain commonplace across NZ. This report details a study by University of Canterbury final year Forest Engineering students, Max Gomez and Johny Royds to establish baseline data for the current methods through a structured time-of-motion study and interviews of log truck drivers in the Canterbury region.

Time-of-Motion Study

The time study for chain throwing activities took place over three days. In that time, 19 trucks were observed being secured, 15 of which were loaded with two log packets and the remaining four had three log packets loaded. The site was Chaney's plantation near Christchurch, 2km south of the Waimakariri River and 2km east of State Highway 1. The site was flat, with minimal hinderance for the drivers.

Each driver was timed from when they exited the cab until all chains were secured around the log packets. The securing process was divided up into steps with the time of each step observed. These steps were:

1) Organising & throwing
   Removing the chains from the vehicle, coiling them and throwing them over the log packet.
2) Repositioning & securing
   Whipping the chains across the log packet to be on the correct side of each bolster &/or in line with the tensioning device (ratchet winch or twitch).
3) Tensioning
   Installing the chains into each tensioning device and setting the correct tension.
4) Delay
   Any time spent not actively securing the load; to be removed from the time-of-motion dataset.

For each load, an observation was made about the log load as this influenced the number of chains used to secure the packet(s) and therefore total time spent securing. The number of chains thrown could vary from 4 to 9, depending on the logs carted. The technique used to throw the chains was planned to be compared, however all drivers used the same side-arm technique.

The element of the load securement task that took longest to complete was removing the chains from the chassis, coiling them and throwing them over the load (Task 1). This took on average 2.1 minutes for two log packets and 3.3 minutes for three packets, but with wide variation for the two-packet trucks (Figure 4).

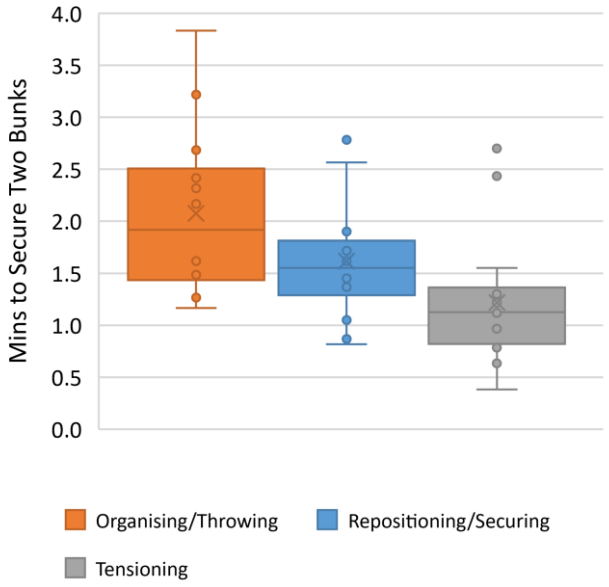

Figure 4: Elemental time study of securing 2 log bunks (14 trucks observed).

The task that took the least amount of time to complete was manual chain tensioning, taking on average 1.2 minutes and 2 minutes for two log packets and three log packets respectively. This was again subject to some variation in time as shown in Figure 5.

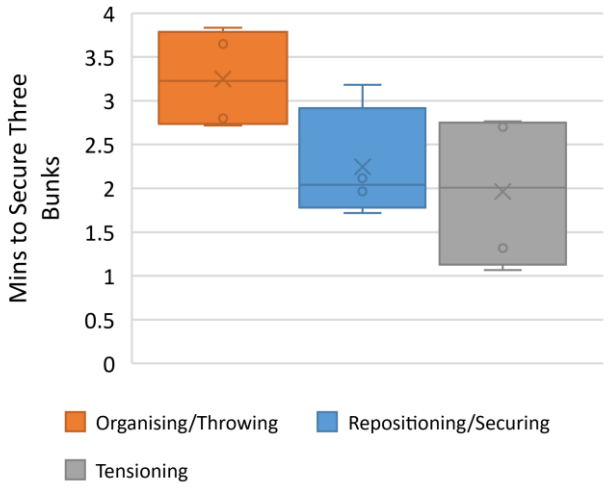

Figure 5: Elemental time study of securing 3 log bunks (4 trucks observed).

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The current system, using the side-arm side-arm technique (Figures 6 to 9) to throw a 6mm gauge chain over the load and tension with ratchet winches or twitches took on average 4.9 minutes to complete for two log packets, and 7.5 minutes for three log packets.

Photographic illustration of the sidearm throwing technique

Figure 6: Step 1 of the side-arm technique: removal of the chain from its storage position and the subsequent attachment of it.

Figure 7: Step 2 of the side-arm technique: Coiling/reeling of the chain to concentrate its mass and throw it all over.

Figure 8: Step 3 of the side-arm technique: The "loading" of the throwers arm, the start point in the throw where the throwers arm and shoulder are both at full extension.

Figure 9: Step 4 of the side-arm technique: the final point in the throw of the chain, the release of the mass.

Driver Interviews

A survey was completed with nine drivers. This allowed insight into the drivers' history with chain throwing as well as their opinions of manual chain throwing and alternative securement methods. Seven questions were asked of the drivers:

1) Have you or others in your line of work had injuries caused by chain throwing?
2) If so, has this caused you financial strain?
3) Do you know anyone that has faced early retirement due to chain throwing injuries?
4) Would there be more log truck drivers if chain throwing was eliminated from the process?
5) How frequently have you experienced a chain coming loose?
6) Is your ability to chain throw a point of pride for you?
7) How long have you been driving for?

Of the nine drivers, five recounted having no previous injury, while the remaining four (44%) reported having injuries over their careers. The previously injured drivers had muscular-skeletal shoulder injuries, mainly due to wear and tear over time, but most did not have any time off work. Painkillers were used to reduce the pain throughout the day during the recovery period. One driver did require some time away from work to recover from a shoulder injury.

One driver noted that as he aged, his throwing technique changed. He has done this to ensure that injuries do not happen. He now focuses on flicking the chain over the loaded logs instead of using force. One driver knew of a log truck driver who had a shoulder injury from the

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repetitive nature of chain throwing. Because of this, he was given a rope to throw over the logs, referred to as the leader-rope method. This rope was attached to the chain, so it was easier for the driver to throw the lighter rope than the heavy chain.

Shock loads and crushing injuries tend to result in immediate and serious injuries for the drivers. Drivers reported that worn ratchet winches not properly gripping the chains, shackles not correctly aligned prior to tensioning (Figure 10) or twitch bars slipping/springing open are the most common, dangerous situations that can readily lead to injury. In terms of frequency, just one in nine drivers had experience with an injury of this nature.

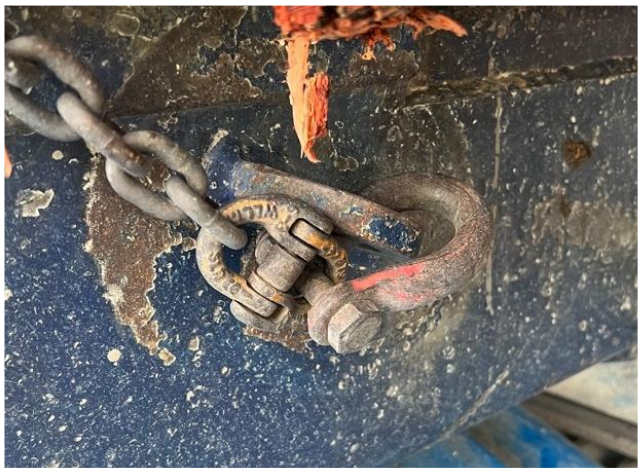

Figure 10: Misalignment of the D-shackle on the trailer eye prior to tensioning can cause the shackle to slip/spin under load, rapidly slackening the chain and destabilising the driver tensioning the assembly.

Engineering solutions are possible, such as the shackle mount shown in Figure 11, the secure end on the power bar used to close the twitch (Figure 12), or the Borlase Bellcrank (as discussed earlier and illustrated in Figure 1) to reduce or eliminate the chance of shock load-type injuries through design.

All nine drivers in the study noted that the chain throwing process has become significantly easier since adopting lighter 6mm gauge chains. All the trucks surveyed were equipped with 6mm gauge chains, as opposed to the 8mm chains previously used.

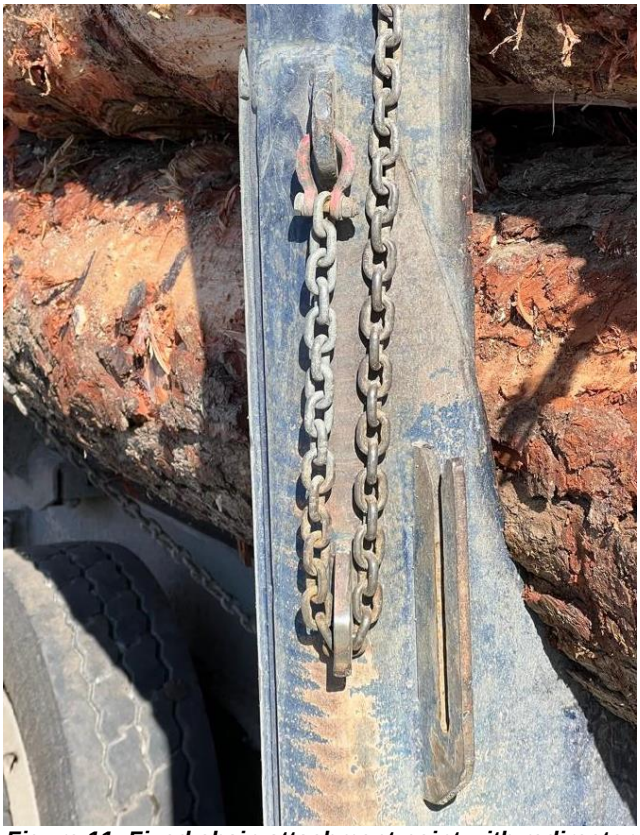

Figure 11: Fixed chain attachment point with redirector to potentially eliminate shock loads from shackle misalignment.

Figure 12: Multi-use power bar, used for increasing leverage over the twitch bar and now designed to hold securely onto the twitch to reduce incidences of slipping while levering the unit closed.

The drivers were largely unconvinced about the proposed automated systems, warning that robustness was critical in an environment where bolsters are regularly knocked by loading and unloading. Current bolster designs are rugged and come at a perceived much

lower cost. The drivers felt that added complexity could make them prone to damage and difficult to replace.

The summary views from the drivers were that with good technique, injuries from throwing chains are preventable. When the drivers have poor technique and try too hard to throw the chains over the log stack, they are likely to injure themselves. Alternatives are available where drivers are having issues with the heavy chains, like the leader rope method, but these are exceptions to the norm.

Conclusions

This study has established benchmark times for the current system of manual load securement, using the side-arm technique to throw a 6mm gauge chain over the load and tension with ratchet winches or twitches. For two log packets the average time was 4.9 minutes to complete, and 7.5 minutes for three log packets. These times can be used to compare time savings associated with new load securement systems.

Engineering innovations and safety training are improving the probability of log truck drivers coming home uninjured at the end of the work week. Automated log securing systems while clearly eliminating a potential source of injury, need to prove themselves to drivers in a market where tare weight and costs (both initial capital costs and ongoing operating costs) are critical in remaining competitive.

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