HARVESTING TECHNICAL NOTE

HTN14-04
2022

Preliminary results of small-scale load dynamics testing

Summary

There is an average of about 20 injuries per year involving the throwing and tensioning of chains used for restraining logs on logging trucks. These injuries are either long-term repetitive injuries caused by chain throwing or physical contact injuring occurring during chain tensioning. At the same time there is a move to more debarking of export logs as an alternative to chemical fumigation as a phytosanitary treatment. This will likely result in increased transportation of slippery debarked logs. To address these issues, Forest Growers Research (FGR) has established a project to automate the chaining, tensioning, and monitoring of log loads on trucks. Part of the project is to improve the industry understanding of the dynamics of log loads. With this in mind, FGR are supporting Trinder Engineers Ltd of Nelson to embark on a series of tests of log load dynamics to better understand the tensions generated during the truck journey. This Technical Note provides an overview of the tests (which are at the small-scale to date) and the learnings from these tests.

Jared Silvester, Trinder Engineers Ltd

Friction Testing (unrestrained)

The small-scale testing was conducted on six K-grade logs cut into 2m lengths that were placed in a test bolster without chains as depicted in Figure 1.

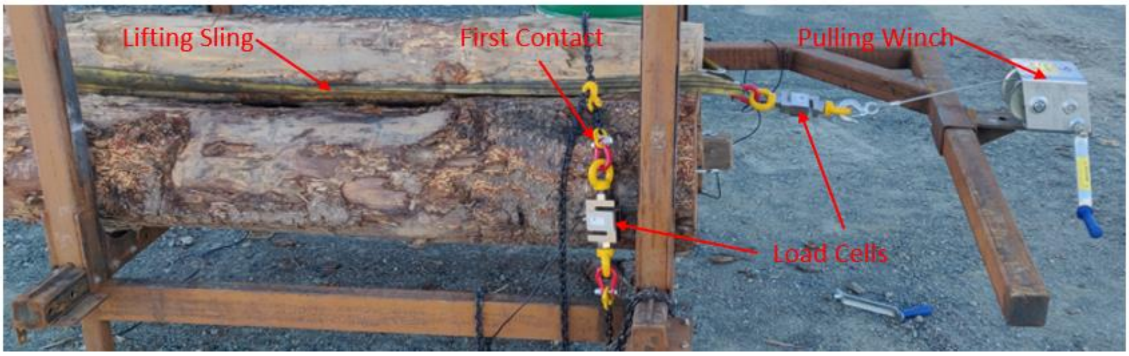

Figure 1 Restrained load testing set up

The first of these tests aimed to measure and compare the coefficients of friction for unrestrained logs (without chains) against the ones measured in earlier tests by TERNZ (P.H. Baas, 2004). The results are shown in

Table 1. Trinder's measurements for the mean static coefficient of friction for logs (0.70) are practically the same as that found by Peter Baas in the earlier tests (minimum 0.71).

Table 1 Results from friction testing.

Coefficient of friction	Mean	Minimum	Maximum
Static Peak	0.70	0.60	0.91
Dynamic Peak	0.78	0.61	1.02

What became clear from the unrestrained friction testing was that, in the majority of tests, while the log was in the dynamic region of the test (sliding) a second peak was present. This is depicted as the maximum force spike in **Figure 2**. Upon closer inspection it was found that this spike was likely caused by a pair of knots passing over each other, increasing the pulling force required to move the log.

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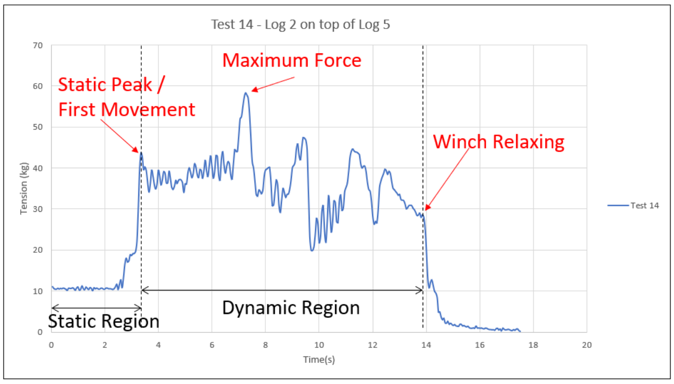

Figure 2 Friction testing force vs time graph.

After the completion of the unrestrained friction testing, the focus of testing shifted to evaluating the effect that a wedged log has on its security, see Figure 3 (unrestrained).

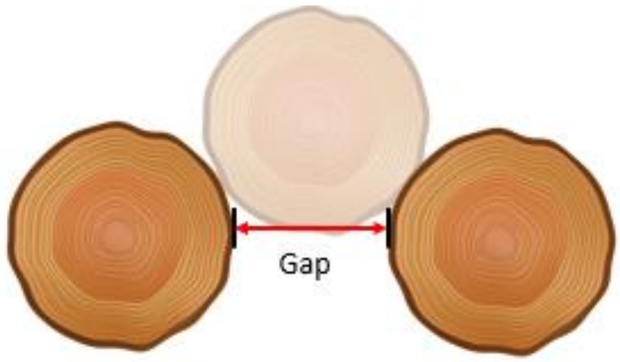

Figure 3 Wedged logs with a gap.

The results from this experiment showed that an exponential relationship exists between the static peak force (first movement) and the gap between the logs (**Figure 4**).

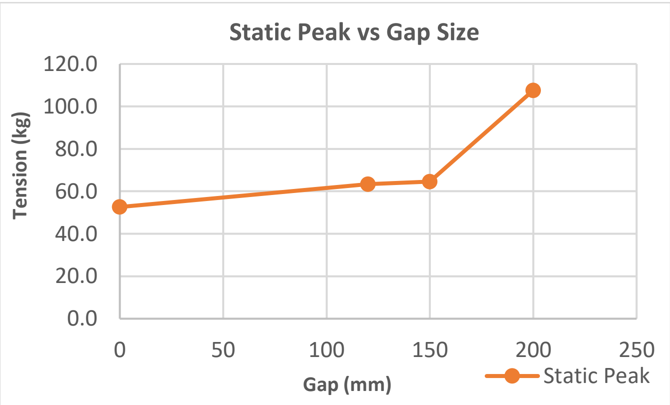

Figure 4 Tension vs gap size (80kg log, 230mm SED).

Inspecting the data point for a gap of 200mm revealed that a significant increase in force (of 48% compared to the no gap situation) was required to induce sliding.

Effect of Lashing Chains (restrained)

The final small-scale tests conducted were to evaluate the effect chains have on the security of a log. Logs were set up as per Figure 1 with chains and sliding was induced. While further testing is proposed to better understand the quantitative effects chains have on multiple logs, Figure 5 illustrates an example of the qualitative results of these tests.

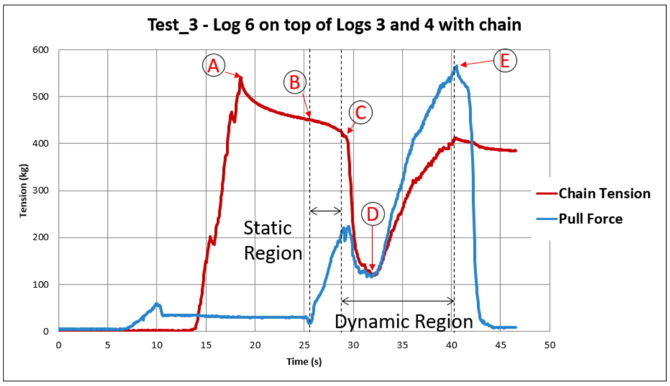

Figure 5 Restrained log test, rearward bias.

Looking at Figure 5 there are five key points on the chart to note:

A. The maximum load exerted by the chain winch.
B. The point at which the chain and logs settle, resulting in a drop in tension. The crowning log begins to be pulled.
C. Static friction is overcome and sliding occurs, resulting in a significant drop in both the chain tension and the pulling winch tension.
D. The lashing chain finds it's shortest path from the fixed side (slack) to the tensioner side (tight). Then the force in both lines begins to increase significantly as the chain transitions to a forward bias.
E. The pull force reaches the practical limit for testing and the pull force is relaxed.

Further testing of the positioning of the chains between a rearward bias (chain angled away from the direction of pull) and a forward bias (chain angled towards the direction of pull) revealed that the drop in tension from points C – D can be avoided by setting the chain to a forward bias at the start of the chaining procedure (as seen in Figure 6).

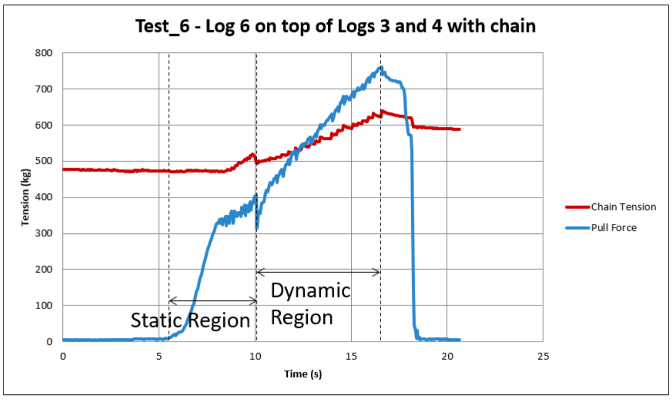

Figure 6 Restrained log test, forward bias.

A full packet of logs on a log trailer was studied with the aim to measure the difference in tension between the winch side and the fixed side. Figure 7 shows that

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the tests revealed two interesting points for discussion.

Firstly, as the winch engaged the next tooth, the tension spiked approximately 40% above the tension at the next settled point.

Secondly, the tension at the fixed side only achieved 30% of the tension at the winch side when first tensioned. That is, there was a 70% reduction in tension between the winch side and the anchor point.

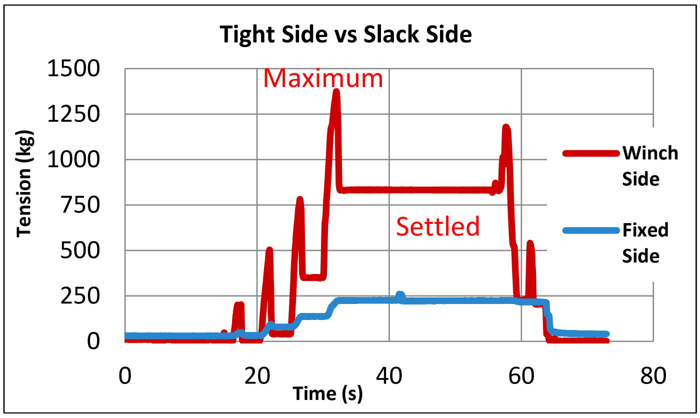

Figure 7 Winch side (tight) vs fixed side (slack), force vs time graph.

Next Steps

Further testing is planned to:

1. Explore how these tension measurements change when the truck is travelling.
2. Replicate the tests for debarked logs.
3. Undertake full-scale testing of loads on a logging truck.

For further details, or a full report on this small-scale load dynamics testing, please contact Jared Silvester at Trinder Engineers (Jared@trinder.co.nz).

Acknowledgments

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