SESSION 8

Paper (b)

LOG LOAD SECURING DEVICES ON TRUCKS

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INTRODUCTION

There has been continuing concern about the safety standard of logging trucks in New Zealand. In order to obtain a better understanding of the function and behaviour of the log load securing devices, the Institute of Road Transport Engineers approached us (AIDD), to undertake a series of tests. An off-highway vehicle (fig. 1), driver, loading equipment and support staff were supplied by New Zealand Forest Products Ltd for a concerted test program which took place from 19 November 1982 to 26 November 1982.

The eight day test program was concluded with a field demonstration of dynamic strain measurement techniques, and an evening presentation of preliminary results and panel discussion. The demonstration and meeting were attended by IRTE members, representatives of the logging industry, Ministry of Transport, Department of Labour, Accident Compensation Commission and LIRA. The outcome was that a committee was formed "to establish safe and sensible working regulations for the securing of log loads on logging trucks and trailers". The work of the committee has already resulted in a clearer definition of specific terms and of the functions of log load securing device components. The committee will be making recommendations for revisions to the first draft of the Department of Labour Bush Code for "Bush Undertakings, Part II Transportation". It is also expected that there will be considerable benefit in the design and operation of these devices.

This paper will briefly describe the test work which was undertaken in November 1982. Further work has since been undertaken; in particular KLC have performed tests to investigate the effectiveness of load securing devices in the event of severe braking. These tests also looked at whether the strops should be loose or tight. Testing of a highway logging trailer is planned for late June - early July.

TEST EQUIPMENT

The test vehicle used for these trials was a Kenworth W924R logging truck with a Road Runner off-highway jinker trailer.

The test program called for the loading and unloading to be undertaken with a variety of loaders, and for this a CAT 966 front end loader, a large Wagner log stacker, and a grapple log loader were used.

In order to measure the loads present in the trailer and log load securing device, electrical resistance strain gauges were used. These gauges were carefully glued to the surface of the component, at positions where they would respond to the strains placed on the structure. Gauges were placed at the positions indicated in figure 2. Strop tensions were measured by inserting strain gauged tension links into the strop lengths, which were specifically constructed for this project. These links were designed to produce a uniform stress in their centre portion where the gauges were attached. The Appendix briefly describes the operation of the links and of strain gauges.

For our tests, the strain gauge signals were amplified and filtered before being recorded onto a special purpose 8-channel tape recorder. The strain gauges which were placed at other parts of the structure acted in the same manner as the tension links although there the stress field was more complex.

The strop tension links and the gauges for the wrap around strop tensions were calibrated by applying a known load with a wrecker truck. The other gauges were calibrated in terms of strain onto the tape recorder. During the testing, strains and tensions were recorded on seven of the eight channels of the recorder, the eighth channel being used for a voice commentary.

TEST PROGRAM

1. The gauges 1,2,3,4,5 and 6, as numbered in figure 2, were monitored as the truck was loaded by the CAT 966. The CAT driver was asked "not to be too gentle". Gross vehicle weight was targeted at 48.0 tonne for all of the tests, which gave a payload weight of 32.5 tonne.

2. The vehicle was parked sidewards on a slope, and anchored from tipping over with wire ropes attached to two other logging trucks. The throw-over strops were connected, and the wrap-around strops released. The resultant change in tensions were recorded as the logs tried to fall off.

3. The rig was cleared, and reloaded with the Wagner log stacker while gauges were being monitored.

4. The throw-over strops were reconnected very loosely and stanchions tripped.

5. The rig was then driven to a gang site, and reloaded with the grapple loader. The grapple loader driver was asked to be fairly rough particularly when dragging logs around the stanchions, and hitting the stanchions. When loading was complete, the belly strop was attached.

6. On the return trip to the mill, recordings were made on rough unsealed road, tarsealed road and during the normal manouevring in the yard.

7. After the truck had been repositioned, as in 2 above the drop stanchions were released with the belly strop attached.

8. The rig was reloaded, and drop stanchions released with two "KLC" webbings, positioned at approximately 1/3 log length from each end, used as belly strops.

9. The above test was repeated for a third time, using on this occasion a high breaking strain chain with hammer lock connectors.

10. With a loaded rig, low speed turns and figure eight turns were performed on a hard seal area. Vehicle speed was then increased for high speed turns up to a maximum at which the driver still felt safe.

11. The next test was to drive the rig on a typically rough off-highway metal road containing a variety of hills, corrugations, turns etc. At one stage, the vehicle was driven at steady speeds between 10 kph and highest safe speed (50 kph) in 10 kph steps.

12. The above test was repeated, on tarsealed roads with a portion of the driving at steady speeds between 40 kph and 100 kph.

13. At the end of the road run, the load was unloaded by splitting in a reasonably rough manner using a CAT 966 loader.

14. The truck was then reloaded, and unloaded by splitting using the Wagner stacker. Again the driver was asked not to be too gentle.

RESULTS

The tape recorded signals were analysed by replaying the signals onto a high speed chart recorder. Figure 3 is an example of chart recording. Portions of the tape recordings were also analysed on a computer in order to investigate fatigue behaviour. The following is a brief summary of the main points which came out of the testing.

1. Tensions of up to 2.8 tonnes were measured in the throw-over strops when the drop stanchions were released by disconnecting the wrap-around strops. This simulated a wrap-around strop failure.

2. Tensions of up to 13 tonnes were recorded in a specially constructed belly strop when the load fell off the vehicle during a simulated wrap around strop failure test. Conventional strops and a trial synthetic webbing both failed to contain the load in a bundle.

3. The above results suggested that throw-over strops should be used on drop stanchion rigs as a safety back-up in the event of a wrap-around strop failure. For fixed stanchion rigs, belly strops or throw-over strops could be used as their primary function is to prevent the load from sliding or bouncing off. (The KLC braking test in May investigated the effectiveness of strops to stop the load from sliding or bouncing).

4. Stresses of up to 209 MPa and 286 MPa were calculated from the strain measurements on the stanchions and bolsters respectively. This indicates that these components are very highly stressed, and care must be taken with their design, construction, modification and condition during use.

5. The rough loading and unloading tests showed that the log grapple loader tended to produce higher stresses on the stanchions and tensions in the wrap-around strops than the Wagner stacker or CAT 966 loader. The Wagner stacker was the most severe on the bolsters. The differences however were small.

6. The forces measured during driving and yard manoeuvring were similar in magnitude to the loading and unloading forces on this vehicle.

7. An attempt was made to fit the experimental results to a simple loading model which could be used for design calculations. These

"design loadings" will be tried against the stresses and tensions measured on other logging trucks in order to check whether they will be suitable as a basis of design.

CONCLUSION

The test work which has been described above has given a much clearer understanding of the loads imposed on, and the functions of log load securing devices. Many of the issues are being resolved by the continuing test program. By the time the Bush Code is finalised at the end of the year, we hope it will be greatly improved as it should be based more on discussion of objective information rather than historical information.

This project has involved considerable effort and cost. New Zealand Forest Products Ltd provided a truck and trailer unit, driver and more than four support staff for the 8-day test program; KLC have similarly provided a vehicle and staff for the severe braking tests; LIRA have coordinated the activities of the committee and undertaken some research; the committee members have contributed time in attending meetings and have been involved with background work; and DSIR have to date devoted approximately 15 man-weeks of work.

In our opinion the project has been well worthwhile because it has been coordinated and focussed. The willing cooperation of many organisations has been essential to the success of the work. An industry group which develops, understands and polices its own codes of practice responsibly in this way encourages the most effective use of all resources. Safety and efficiency must benefit by this. There have been additional benefits from the project to specific organisations such as NZFP who are now as an example, gaining expertise in strain gauging for their own design and failure investigations.

Cooperative research which has been drawing on DSIR's skills in measurement and methodology, LIRA's research coordination, the industry's expertise, enthusiasm and equipment, and Ministry of Transport and Department of Labour's knowledge and responsibility for public safety is proving to be a very effective combination.

Figure 1. Test vehicle. Hard cornering test.

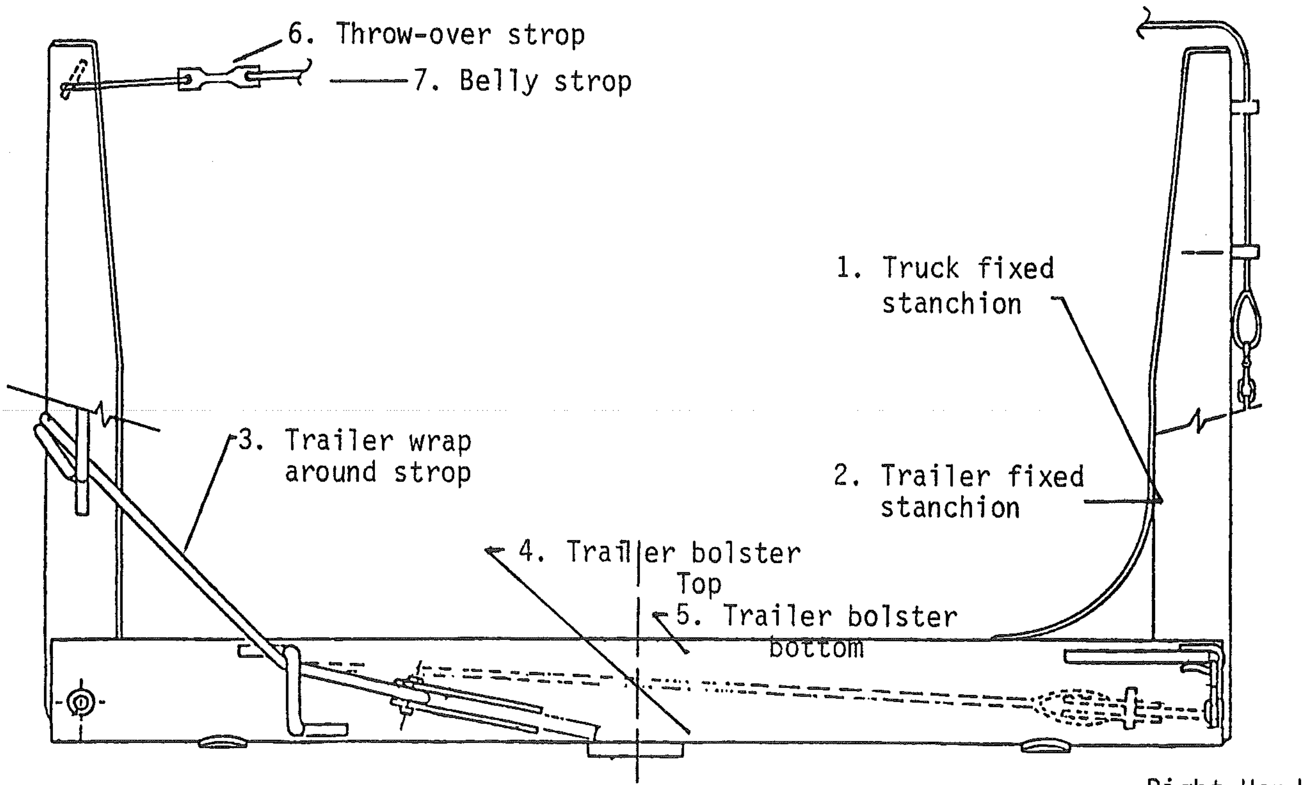


Figure 2. Measurement positions.

Figure 3.

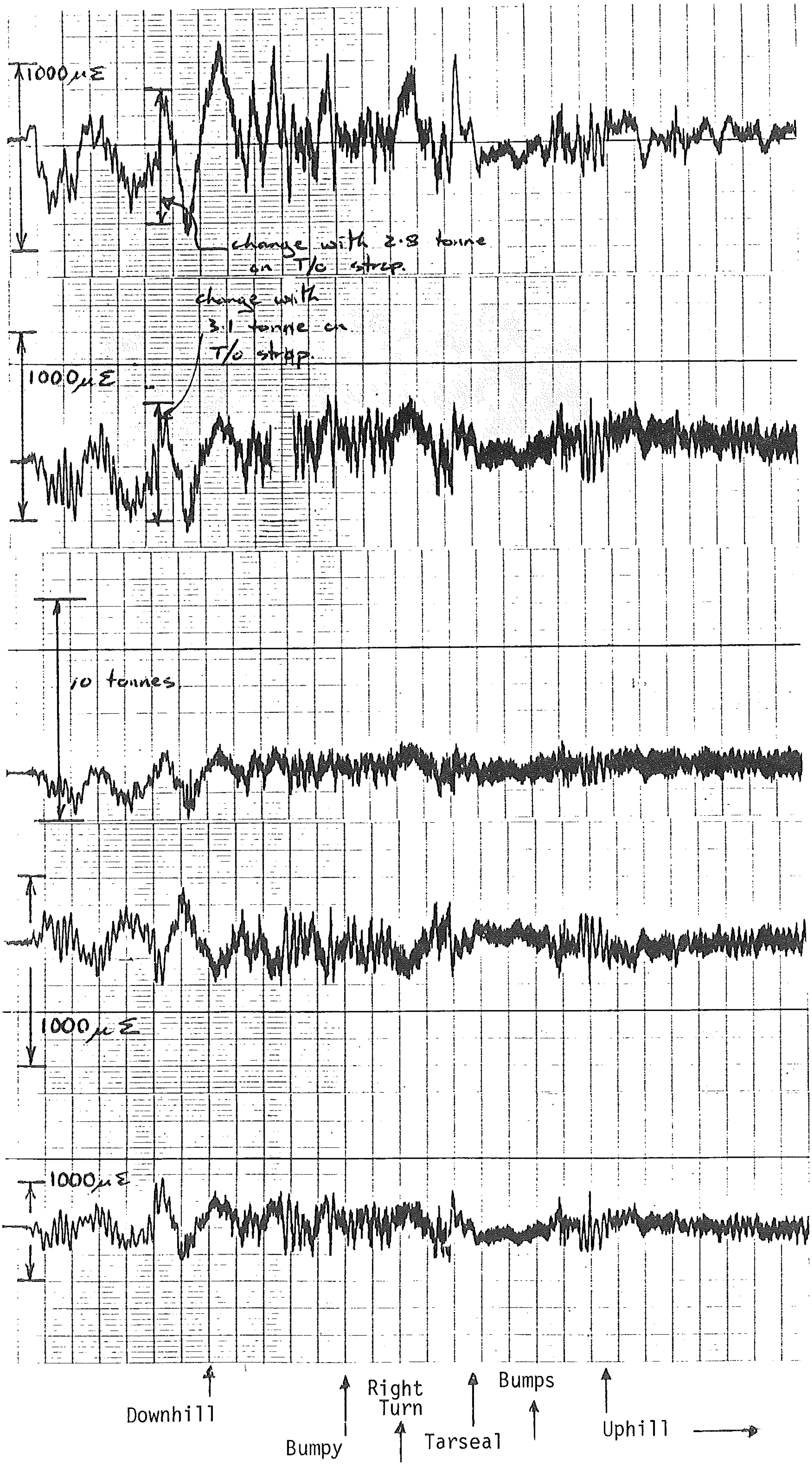
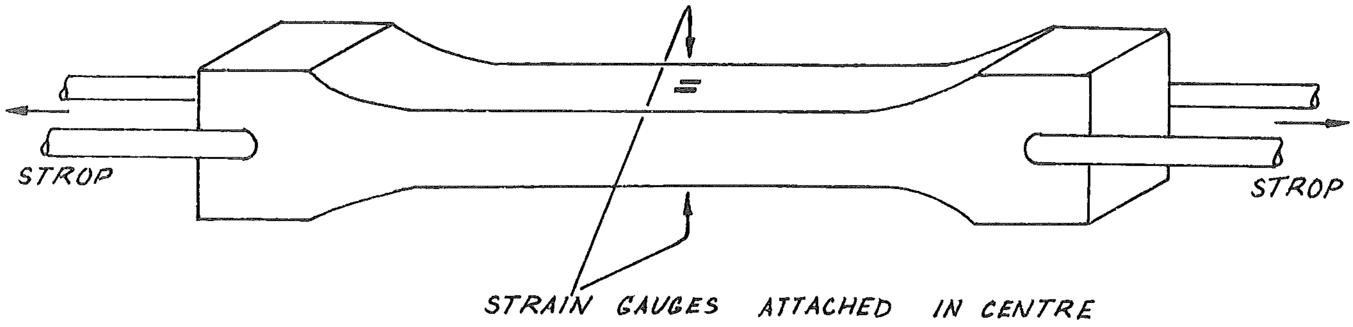


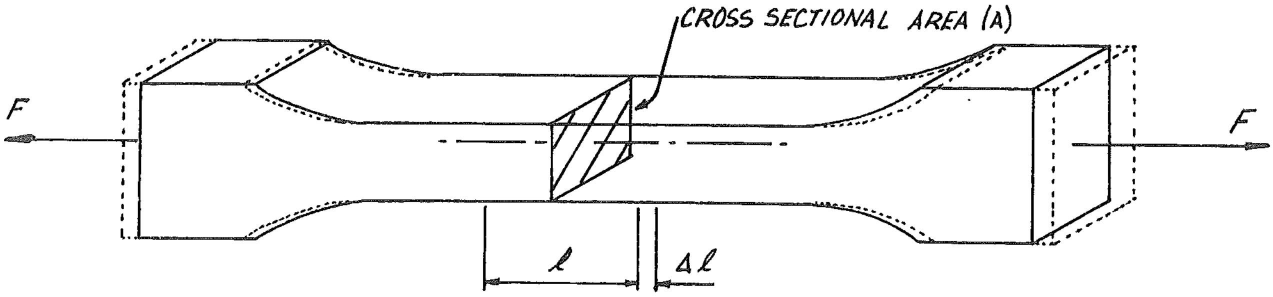
Figure 8 Sample of Road Run Recording

Strain Gauged Tension Link

Material: Mild Steel



When a load is applied to the link, its length increases.

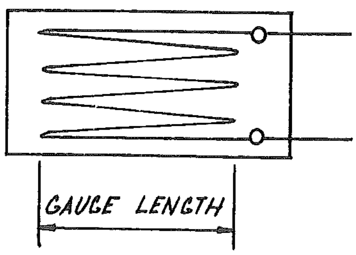


This change in length is referred to as engineering strain and is defined as $\frac{\text{change in length } (\Delta l)}{\text{original length } (l)}$

Stress is the $\frac{\text{force } (F)}{\text{cross sectional area } (A)}$

$\frac{\text{Stress}}{\text{Strain}}$ is equal to E, Youngs Modulus, a constant for the material.

Strain gauges consits of a precision grid of "wires".



If the gauge is firmly attached to the link, as the link changes length when a load is applied, the gauge must also change its length. This change in length alters the electrical resistance of the "wire" grid. By connecting the gauge to suitable electronics this change in resistance can be converted into an electrical signal.