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TRUCK GRADEABILITY TRIALS

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INTRODUCTION

In planning the logging of some northern areas of Kaingaroa Forest, Tasman Forestry Limited staff at Murupara became aware that construction of steep roads (1 : 5) would offer a major saving in transport costs. Before further progress was made, it was necessary to complete some grade capability trials of the rigs likely to be used.

Since the location of the planned roads was on a new alignment, it was necessary to find an existing road with grades of about 1 : 5. A suitable road was chosen and reformed to give a consistent grade. Tests were completed after compaction of the pumice sub-base, again after compaction of the crushed gravel pavement and finally after the road had weathered for six weeks. Rig types used included; the Pacific Triple and Double Units and the new Mack Double Unit. These were trialled both up and down the grade. Trials were undertaken in October, 1986.

ROAD DESCRIPTION

The trial section was part of a straight access road through Compartment 543, just south of Wairere Road, Kaingaroa Forest.

Originally it was just an access track following the natural contour. Reforming was carried out to achieve a generally consistent grade by cut and fill. Compaction was carried out by vibrating roller and road grader. After trialling the compacted pumice surface, a gravel pavement of compacted Pekepeke quarry rock was constructed. On completion this pavement was also trialled. Compaction of the gravel could have been improved but not without addition of water. It was decided to allow the road to weather and thereby improve compaction by natural means before running final tests. The road was effectively dry for all trial runs.

The longitudinal profile of the road is shown in Figure 2. Cross-sections are not available but the road was generally level in the transverse direction.



Figure 1 - Pacific Triple unit partially loaded up 1 : 5 grade

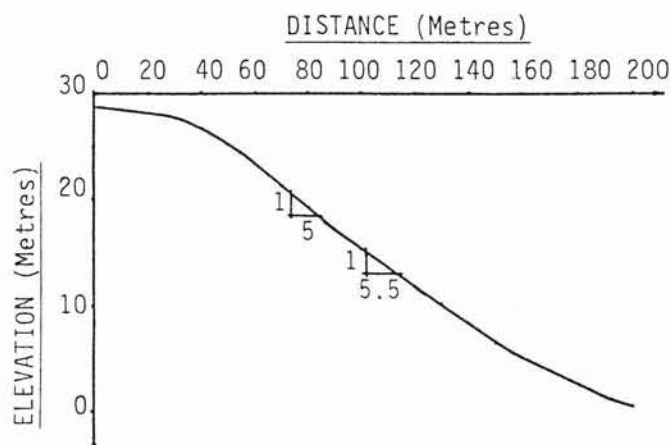


Figure 2 - Long section of trial road

Clegg Hammer readings for the freshly compacted pumice and Pekepeke gravel were taken. These readings give a measure of road strength by measuring deceleration of a falling weight as it contacts the road surface (Table 1).

Table 1 - Clegg Hammer Readings

COMPACTED PUMICE

SURVEY PEG POSITION	POSITION ACROSS ROAD		
	LEFT HAND SIDE	CENTRE	RIGHT HAND SIDE
160	13	16	16
140	15	14	13
120	15	16	14
100	13	14	10 *
80	12	13	14
60	14	16	13

* This spot appeared soft

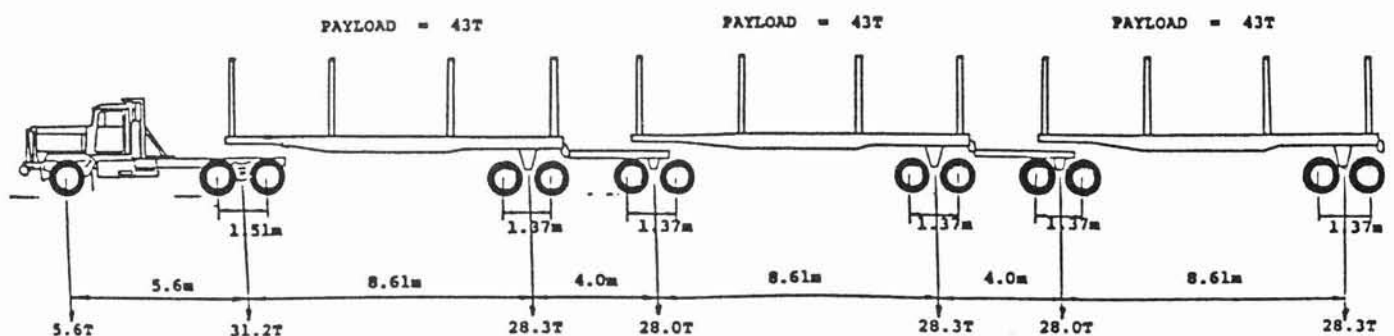
COMPACTED GRAVEL

SURVEY PEG POSITION	POSITION ACROSS ROAD		
	LEFT HAND SIDE	CENTRE	RIGHT HAND SIDE
160	14/24	*	*
140	18	*	*
120	20	14	22
100	12	19	16
80	20	18	17
60	20/15	15	*

* Not recorded

Double entries denote two readings from the same general location
 Artificial compaction with the Clegg Hammer achieved a reading of 22
 The high reading of 24 was caused by a relatively large piece of rock
 Road width was approximately one lane but truck path was slightly variable. there was effectively no truck tyre compaction by the end of the trials (i.e. no wheel tracks).

TRUCK RIG DESCRIPTIONS



*Figure 2 - Layout for Pacific Triple Unit
 (Loads show design limits, actual loads depend on product)*

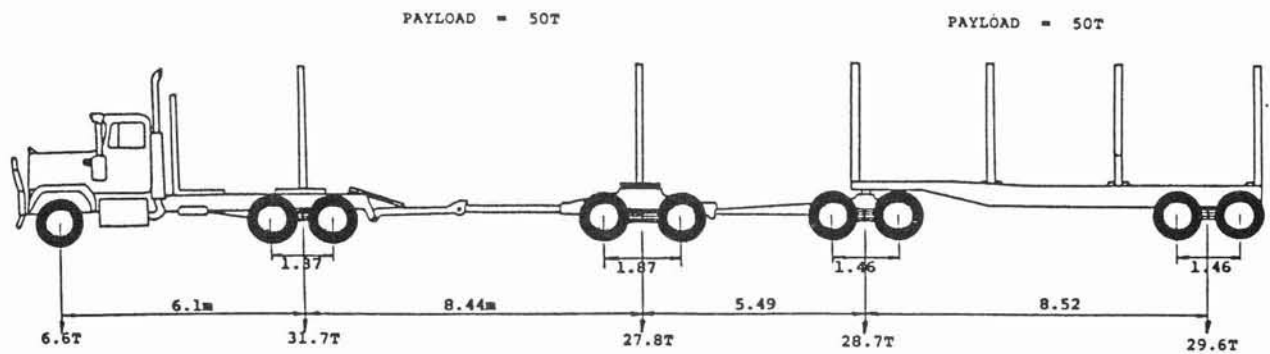


Figure 3 - Layout for Mack Double Unit
(Loads show design limits, actual loads depend on product)

Pacific Triple Unit

Tasman Forestry Limited log train to the familiar KLC specification :

	<u>Tare Weight</u> (Tonnes)
Truck : Pacific	14.41
First Trailer :	9.38
First Bogie and Second Trailer :	12.01
Second Bogie and Third Trailer :	12.78

Actual payload was between 25 and 30 tonnes per trailer loaded with Ponderosa pine used in the trial.

Pacific Double Unit

This is the same rig as the Triple above but with the second bogie and third trailer removed.

Mack Double Unit

This is the most recent off-road configuration commissioned by Tasman Forestry Limited at Kaingaroa. It consists of a Mack tractor unit followed by a jinker and a skeletal four axle full trailer. One of the special features incorporated is the ability to load the jinker on to the truck (hydraulically) for empty running, thereby increasing the drive axle bogie load and gradeability.

	<u>Tare Weight</u> (tonnes)
Tractor plus Jinker	16.11
4 Axle Trailer	8.38

Actual payload was approximately 35 tonnes for each of the jinker and the trailer.

A layout drawing is shown in Figure 3.

All trucks had sufficient gear reduction to be grade limited by traction rather than torque. Differential locks were fitted to all, but the Pacific's had individual axle locks, whereas the Mack was fitted with full cross locks giving lockup between drive axles as well as within each axle.

TRIALS AND RESULTS

Compacted Pumice Tests

- Empty Double Unit uphill in crawler gear

The rig travelled steadily at approximately 3.6 km/hr up to the 130 metre peg where it spun out. Failure was because of weak soil rather than loss of traction.

- Loaded Double Unit downhill

Payloads of 30.5 and 25.6 tonnes were applied to the first and second trailers respectively.

The rig braked from 20-25 km/hr (subjectively high) speed to a halt safely and without difficulty. Brake effort was sufficient to skid the front wheels of each bogie thereby creating a pile of pumice ahead of the bogie which appeared to improve retardation. Stopping distance was 32 metres.

- Loaded Triple Unit downhill

Payloads of 30.5, 25.6 and 26.5 tonnes were applied, i.e. 26.5 tonnes on the third trailer.

The rig braked from 15-20 km/hr to a halt safely and without difficulty. Brake force was reduced from test 2 most probably because of driver appreciation of the additional trailer. Stopping distance increased to 67 metres. This time the front wheels of each bogie continued to roll. Rear bogie wheels did lock up because brake reaction through the bogie suspension moved weight from the rear axle to the front axle of each group.

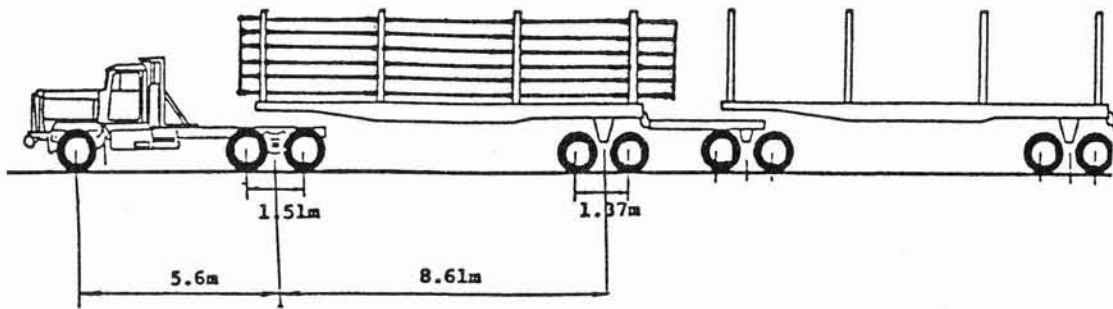


Figure 4 - Partially laden Double Unit

Compacted Gravel Tests

- Empty Double Unit uphill

The rig travelled steadily up the grade to the 90 metre mark at which point it spun out. This was caused by lack of pavement strength rather than loss of traction. Further compaction or natural weathering would be required to increase strength to the point where the tyres slipped on the surface.

- Partially laden Double Unit uphill

The first trailer was loaded with an estimated load of 25 tonnes. The layout is shown in Figure 4. The truck then climbed the full distance of the grade without excessive free slip. The rig appeared to be close to its traction limit for the prevailing conditions.

- Partially laden Triple Unit uphill

The first trailer was loaded with an estimated load of 25 tonnes and the truck then climbed the full distance of the grade without excessive free slip. The rig appeared to be close to its traction limit for the prevailing conditions.

- Loaded Triple Unit downhill

Total payload was estimated at 80 tonnes. It was not possible to weight the loads for tests 4 to 8 because the weighbridge was not operational but since the same rig was used and loaded from the same skid the estimate should be within 5% to 10%.

Thirty metres was required to stop the rig from 10 to 12 km/hr. This manoeuvre was completed safely and without difficulty.

- Empty Mack Double Unit uphill

The rig negotiated the grade quickly and without slip. Average speed over the grade was 9 km/hr. It was also reported that this rig could climb the original track before any improvements were made.

Compacted and Weathered Gravel

Despite natural weathering for six weeks no improvement was found in the Pacific Double

(spun out at 80 metre peg). Since this is a relatively short time, it is reasonable to expect that the road will improve with further weathering especially if it is also subject to logging truck traffic.

CONCLUSIONS

Transport of logs down 20% (1 : 5) grades can be carried out safely in dry weather with all three truck types used. Stopping distances are reasonably short and braking manoeuvres can be effected safely from relatively high speeds. Wet weather performance was not tested. Both trucks trialled were taken directly from normal service without any maintenance to the brake system.

Gaining access to skid sites up 20% grades is not possible by Pacific Triple or Double Units without partially loading the drive bogie. Such a procedure is obviously not acceptable for normal logging operations.

Performance from the Mack Double Unit showed that it could easily gain access to skids up 20% grades. In this trial, the main reason for its success was the increased drive bogie weight. On less consistent surfaces, the Mack could also completely lock up the differentials thus maintaining mobility for longer distances.

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