LOGGING INDUSTRY RESEARCH ASSOCIATION

THE RELATIVE FUEL EFFICIENCY OF SUPER-SINGLE, LOW PROFILE AND STANDARD TYRES ON LOGGING TRAILERS

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ABSTRACT

This Report summarises LIRA Project Report No. 48 and presents the findings of a series of comparative fuel consumption tests carried out on a 4km stretch of straight sealed highway. The objective of the testing was to determine the relative fuel efficiency of trailers fitted with super-single, low profile and standard radial tyres.

The recorded fuel consumptions were adjusted for the different gross weights of the three trailers.

The results found super-single tyres to be 4% more fuel efficient than standard radial tyres.

There was no significant difference between low profile and standard radial tyres tested.

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INTRODUCTION

Research directed toward the improvement of all forms of energy consumption is in progress. Heavy transport is receiving considerable attention with refinements not only to the internal combustion engine but also to vehicle aerodynamic properties and tyre design.

Over the past few years the transport industry has progressively introduced larger, more powerful trucks that are capable of moving greater payloads faster, safer and more economically. This trend is particularly evident in the logging industry. These larger units and the roads they travel on place heavy demands on tyres, and, different tyre designs can influence performance.

Of immediate interest to transport operators is the opportunity to reduce fuel costs. With the cost of fuel accounting for as much as 18% of total costs, any reduction in this area needs further consideration.

One of the most cost efficient configurations for transporting short logs in New Zealand is an 8 x 4 truck and four-axle

trailer (Taylor, 1989). The author highlighted the importance of the relationship between repair and maintenance costs, road user charges and tare weight. Four-axle trailers for short log cartage are obviously the preferred option when buying road tax and typically return cheaper repair and maintenance costs. The major disadvantage of four-axle logging trailers however is their tare weight.

In an attempt to reduce road tax, tare weight and fuel consumption, Rotorua log cartage contractor, Dave Medlicott, designed and built a four-axle short log trailer on super-single tyres with a tare weight of 4520 kg.

In this study, the fuel efficiency of Medlicott's trailer was compared with two other four-axle short log trailers, fitted with low profile and standard radial tyres respectively. The trailers were loaded with the same payload and towed over a pre-measured stretch of sealed highway.

The towing unit in each case was a 283 kW 8 x 4 truck fitted with a DZL fuel flow meter to measure fuel consumption.

Super-single tyres are preferred over standard tyres because they allow the spring centres to be widened, improving stability. Also their unit weight is significantly lighter than a dual set. Low profile tyres have a low rolling resistance due to their lower aspect ratio which reduces scrubbing in the tread contact area. Their shorter sidewalls and wider belts reduce tyre deformation.

The objective of the trial was to determine the relative fuel efficiencies of the three different tyre types.

FACTORS AFFECTING FUEL CONSUMPTION IN LOG TRANSPORT

When transporting logs by truck, a number of resistances, which have a direct effect on fuel consumption, must be overcome. The major components are:

1. The rotation resistance of a truck's drive train.
2. Wheel and tyre rolling resistance.
3. Air resistance
4. Gradient resistance.

One consistent finding that has emerged in recent years is that radial ply tyres have less rolling resistance than crossply tyres and many steel wire belted tyres may have even less. Therefore, for high mileage main road vehicles, radial ply and steel belted tyres in particular are the preferred option, not only for their reduced rolling resistance but for their increased tread life and better retreadability.

TEST PROCEDURE

To determine the relative fuel efficiencies of low profile, super-single and standard radial tyres used in logging, three four-axle short log trailers each with different tyre types were loaded with the same payload and taken three times each over the same pre-measured section of highway. The fuel flow meter was connected in the fuel supply line prior to the vacuum float tank and after the primary filter.

A preliminary trial highlighted the need to have a test route of constant gradient to:

- make it easier for the driver to maintain the required engine speed
- enable the trial to be conducted with the engine under load and working close to its peak torque and thus fuel efficiency without increasing vehicle speed.

The trial section had a continuous 2.5% uphill grade, with only minor deviations, over the 4km distance. Therefore the results gained from this trial pertain to straight sealed highway running only.

The relative effect on fuel consumption of cornering and off-highway running were not measured.

Table 1 - Summary of Results of Fuel Consumption Trials

Brightwell Trailer (Standard Radial Tyres)	Trial 1	Trial 2	Trial 3	Average
Total Time (seconds)	434	434	435	434.3
Total Fuel Consumed (litres)	5.757	5.757	5.691	5.735
Temperature Variation	35 - 37°C	36 - 39°C	36 - 38°C	

Medlicott Trailer (Super-Single Tyres)	Trial 4	Trial 5	Trial 6	Average
Total Time (seconds)	430	433	434	432.3
Total Fuel Consumed (litres)	5.461	5.461	5.461	5.461
Fuel Temperature Variation	35 - 36°C	37 - 38°C	37 - 39°C	

Dicker Trailer (Low Profile Tyres)	Trial 7	Trial 8	Trial 9	Average
Total Time (seconds)	434	434	432	433.3
Total Fuel Consumed (litres)	5.757	5.691	5.724	5.724
Fuel Temperature Variation	36 - 37°C	38 - 40°C	38 - 40°C	

The fuel consumption tests of the three different four-axle shorts logging trailers were each done separately. The towing unit was loaded with a payload of 11490kg. The same 17230kg payload was loaded on each of the trailers for testing. The payloads were weighed by on-board electronic scales. Tyre pressures were checked prior to each test and were kept uniform as recommended by the tyre manufacturers.

RESULTS AND DISCUSSION

Fuel Consumption

The time taken, fuel temperature and total fuel consumed for each trial are summarised in Table 1.

The small variation in trial times increases the significance of the difference between

the fuel consumed per trailer. This small percentage change in time and therefore speed per trial indicates that the majority of the change in fuel consumed per trailer was due to either the variation in gross weight of each trailer or the rolling resistance of the tyres. There is only five seconds difference between the fastest trial, trial 4, and the slowest trial, trial 3. The mean time for the nine trials was 433.3 seconds. This indicates the degree of driver influence, causing error throughout the nine trials was 1.1%.

Fuel temperature fluctuated between 35°C and 40°C throughout the trials. The DZL fuel meter automatically compensates for any fluctuation in fuel temperature.

In fuel consumption tests such as these, unexplained variations are inevitable and closer analysis of trials 4 to 6 highlights this. While the fuel consumption over these three trials did not vary at all, the time taken to complete the three runs varied by .9%. While variations of this magnitude are not significant in terms of the overall result, an explanation of their source is difficult.

The time taken to complete the 4km test section was exactly 434 seconds in trials 2, 6 and 8. Analysis of the results have shown these three trials to be the most accurate. Table 2 shows the average fuel consumed per GVW over the 4km test section.

Table 2 - Average Fuel Consumed per GVW

TRIAL 2 *Brightwell Trailer* *(Standard Radial Tyres)*	*.62 l/km/tonne*
TRIAL 6 *Medlicott Trailer* *(Super-Single Tyres)*	*.59 l/km/tonne*
TRIAL 8 *Dicker Trailer* *(Low Profile Tyres)*	*.61 l/km/tonne*

Figure 1 represents graphically the relative fuel efficiency of the three tyre types. The fuel consumption data over the first 1000m was not accurate due to the requirement of the Husky Hunter fuel programme to average a number of pulses before settling down.

Other Considerations

Tyre wear and condition were similar in each case which raises the question of individual durability. Operator reports to date regarding super-single tyres have varied. At the time of testing, the trailer with super-single tyres had travelled in excess of 80,000km on the original tyres and were showing little sign of wear. The operator was expecting another 50,000km before retreading.

Other contractors with a higher percentage of unsealed running are less complimentary about super-single tyre durability and have made a conscious move away from these tyres on trailers. One contractor using super single-tyres on a Bailey Bridge in a close spaced tri-axle configuration got less than 45,000km out of the tyres before having to recap them. Apart from the higher proportion of off-highway running, poorly set up brakes and suspension as well as a soft tyre compound contributed to this poor performance.

The performance of standard radial tyres in logging is well known. These tyres are by far the most common tyre in use in log transport today. Tyre manufacturers are continually refining construction techniques and tread patterns to not only increase the fuel efficiency of this type of tyre but to also increase durability and traction qualities for working off-highway.

While low profile tyres lower the centre of gravity of the trailer, their performance in logging is largely unknown.

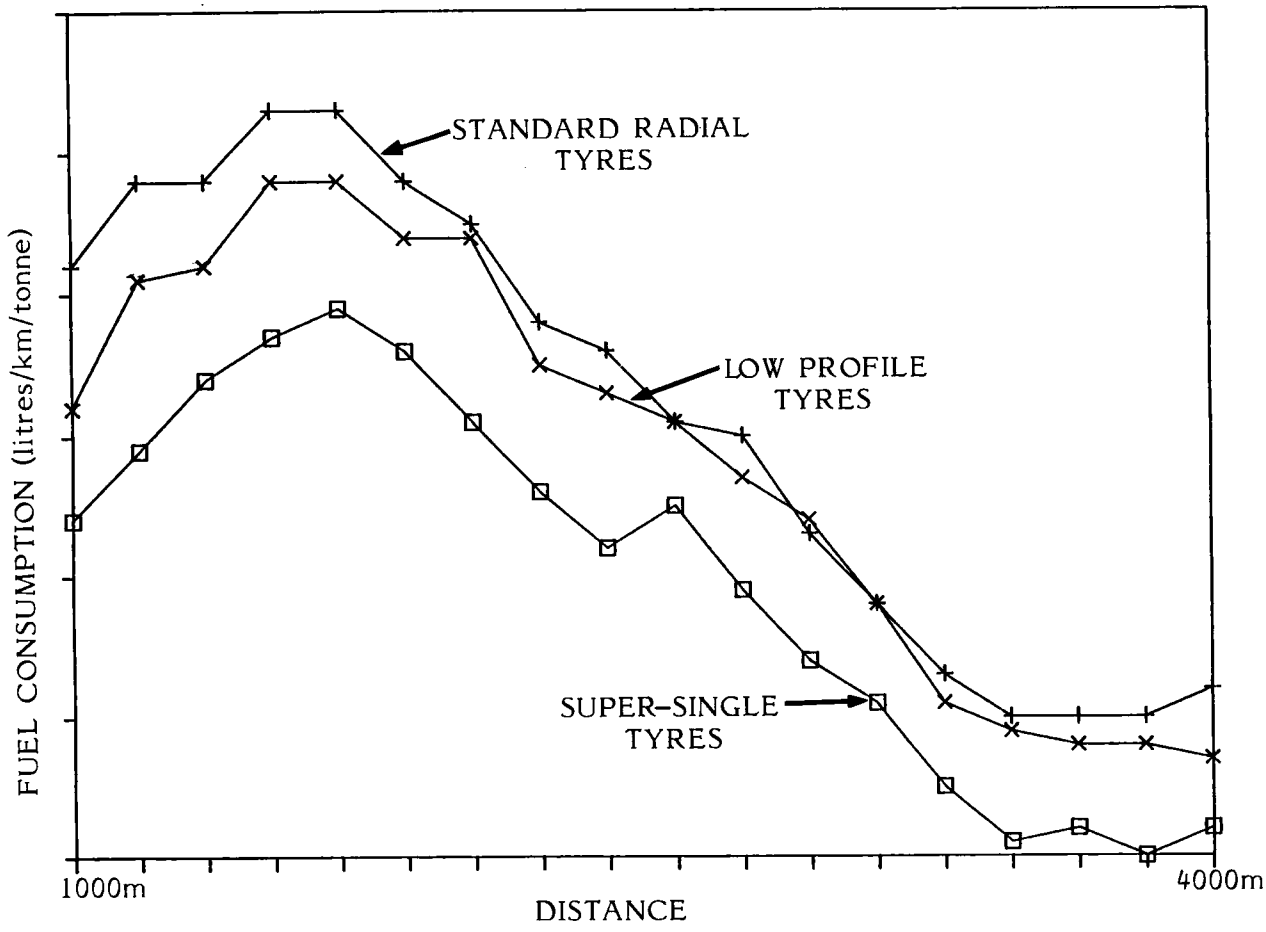

Figure 1 - Comparison of Relative Fuel Efficiency of Tyres (results adjusted for GVW)

CONCLUSIONS

The trial to determine the relative fuel efficiencies of standard radial tyres, super-single tyres and low profile tyres on straight sealed highway shows super-single tyres to be 4% more fuel efficient than standard radial tyres. There was no significant difference between low profile and standard radial tyres.

The full descriptive report of these trials is contained in LIRA Project Report No. 48.

REFERENCES

Taylor, Paul (1989) : "Log Truck Axle Layouts - 1989" LIRA Report Vol. 14 No.4.

Taylor, Paul (1989) : "The Relative Fuel Efficiency of Super-Single, Low Profile and Standard Tyres on Logging Trailers", LIRA Project Report No. 48.

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