Central Tyre Inflation and Harvest Planning Issues.

Arriving at the decision to move to Central Tyre Inflation

Neil Wylie
LIRO

Abstract

The topic of Central Tyre Inflation and the benefits than can be obtained by operating vehicles with lowered tyre inflation pressures has been thoroughly researched. Here the content of previous LIRO papers and selected North American research results has been condensed. Current New Zealand CTI operators experience is recorded, along with two Canadian forest companies with fleets equipped with CTI. It examines why the widespread use of CTI is yet to occur, and the reason for the current trend of fitting CTI to the drive zone only. This paper also looks at the possibility of the forest company sharing some of benefits they receive with the transport operator to encourage additional instillations.

Introduction

LIRO has been involved with CTI since 1988 when the first paper was published titled 'Truck Tyre Pressures Effects On Truck and Road" [1] This project examined the impact of operating over inflated tyres have on forest roads. As reliable commercial CTI systems were not then available, it examined the benefits of reducing tyre inflation pressures from their normal operating pressures of 90 - 110 psi range, to 80 psi. As road user charges can be reduced from 25% of vehicle operating costs for a six axle vehicle combination, to around 20% for an eight axle vehicle combination many operators have fitted extra axles, thus reducing the load per tyre to around 70% of the tyre manufactures rating. At a 70% load, in order to obtain the optimum highway loaded tyre deflection of 10 - 14%, (figure 1) the tyre manufacturers load and inflation tables recommend reducing the inflation pressure to around 70PSI. The conclusions of this project showed that annual savings on a spur roads only could amount to $1,640 per vehicle.

Since then LIRO has had two further CTI projects, and published two further reports. The first of these reports was in 1991 "Central Tyre Inflation The United States and New Zealand Experience" [2]. In this project LIRO assisted in developing a CTI system. The reliability of the equipment left much to be desired, as did the vehicles compressor's ability to provide clean, dry air in the volumes required. However despite the equipment's failure, this project was useful in confirming overseas experience, and the manner vehicles interact with the road surface, and the benefits that can be obtained by using CTI. The traction and gradeability tests demonstrated on sandy soils a 34% increase in peak drawbar pull is possible, with a 17% increase on saturated clay soils. A 17% increase very roughly translates into an additional 2% gradeability.

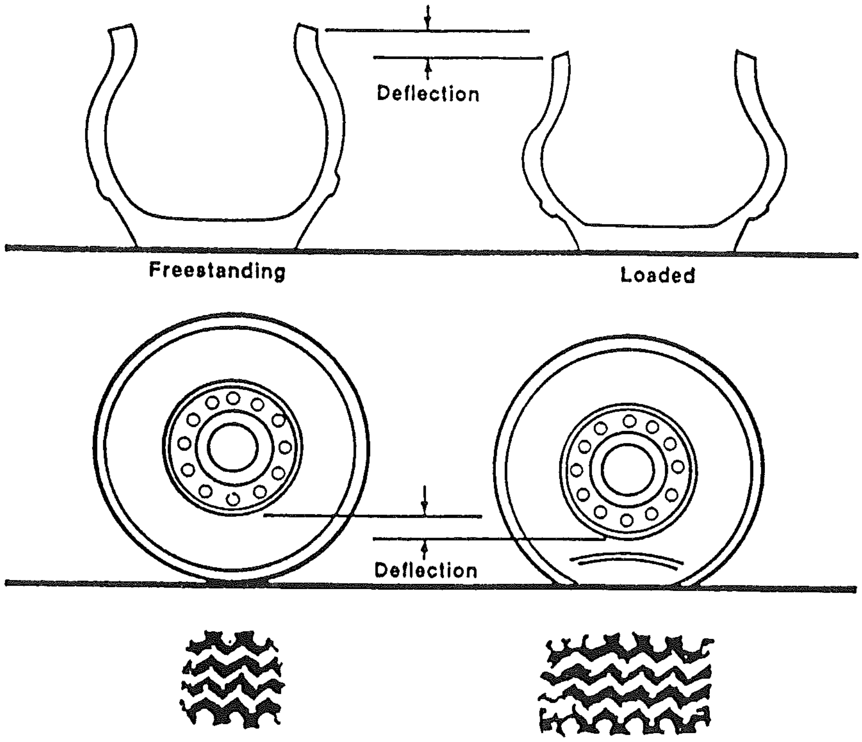

Figure 1 Freestanding and loaded tyre showing its deflection (Taken from Gililland, 1989).

$$\textit{Deflection} = {}^{\Delta}/_{H} \times 100\%$$

where : ***Δ = the change in section height from freestanding to loaded***
H = the freestanding section height

The American experience reported on here was from three major projects. The first project in 1984 being a proof of concept tests in San Dimas Equipment Development Centre. [3]

Stage one of the test involved 320 passes with the logging truck's tyres inflated to 24PSI. This compacted loose material from previous blading and the road surface improved in all dry sections, there was no wash boarding,

and the truck demonstrated good stability.

Stage two required the tyre pressures to be inflated to 100PSI. After only 5 passes wash boarding began to appear, cobbles were exposed in the road, small scuffs appeared in the tyres, and stones were being caught between the duels.

The drivers also noticed a rougher ride. Two culverts on the road had ruts form on either side that required reconstruction and after 100 passes.
Stage three saw the truck tyre pressures reduced to 24PSI again. The wash boarding was smoothed out after just 12 passes. The exposed cobles were not affected in any way, and the

driver comfort was reported to be greatly improved.

The conclusions were: The tests concluded that low pressure tyre inflation is completely safe, stable, and the truck ride and wear is greatly improved when using lower pressures.

The second test was a structured test at the Nevada Automotive Test Centre (NATC) [4]

This testing was conducted using two 18 wheel logging trucks operating over a specially constructed, 2km two lane course with a number of pavement surfaces, gradients, and alignment. Tyre inflation on one truck was 90PSI, while the second trucks tyres were set at a constant 21% deflection. On the drives and trailer tyres this was probably around 30-35PSI. The vehicles completed 4,000 circuits around the track, half of them loaded and the other half unloaded. Finally the trucks travelled a further 6,100km of high speed highway running with all the tyres at 90PSI. The following data was obtained:

1) The low pressure tyre truck had 15% less tyre wear.
2) The high tyre pressure truck had a 3% fuel consumption advantage
3) Truck repairs and maintenance was eight times higher for the high tyre pressure truck
4) Higher impacts occurred on the high tyre pressure truck
5) Greater aggregate loss occurred on the aggregate surfaced curves for the high tyre pressure truck
6) Wash boarding formed by the high tyre pressure truck was ironed out by the low tyre pressure truck
7) Better ride comfort in the low pressure tyre truck

The third test and second phase of structural testing was conducted by US Army Corps of Engineers at the Waterways Experimental Station. [5]

Tests were conducted here to quantify the effect low tyre pressures would have on road surface deterioration and pavement thickness requirements. A 5km special test track with 11 different surfaces varying from a thin chip seal with an asphalt surface, to earth roads. Special sections were constructed with pot holes and rutting. A series of tests were conducted which involved 3,000 loaded, and 1,200 unloaded passes using 18 wheel log trucks. One vehicle had tyre pressures of 100psi with a 7% deflection, while the other had tyre pressures of 30psi with tyre deflections of 21%.

The summary of the findings showed that:

1) The failures or distress in the high-tyre -pressure lane of the asphaltic concrete (AC) sections were more pronounced than in the low -tyre pressure lane.
2) When failures occurred in both lanes of the same AC section, the ratio of low tyre pressure to high tyre pressure traffic to initial failure ranged from 1.5 to 21
3) More raveling was observed in the low tyre pressure lane in the horizontal curves of the AC sections than in the high tyre pressure lane.
4) Considerable maintenance was required on aggregate surfaced grades receiving high-tyre-pressure unloaded traffic because of severe wash boarding. This type of distress was not a factor under low-tyre-pressure traffic.
5) There was no appreciable difference in the performance of aggregate-

surfaced horizontal curves due to different tyre pressures.

6) The performance of the straight and flat aggregate sections was considerably better in the low tyre pressure lane as compared to the high tyre pressure lane.

From this research an equation was developed to estimate the aggregate thickness required for unsealed roads using rut depth as the failure criteria. This equation (now considered to be conservative) shows, if vehicles lower their tyre inflation pressures to obtain a tyre deflection of 20%, then for unsealed roads it is possible to reduce aggregate thickness by approximately 25% when compared to normal design criteria where only vehicles with high tyre pressures are considered.

Since these tests, several other tests have been conducted all of which have been well documented. All the reports come to the conclusion that there are advantages to be gained by operating vehicles with low tyre inflation pressures.

The New Zealand Experience

The New Zealand experience to date has been equally as convincing. Almost all of the companies after purchasing one system to trial, have subsequently gone onto fit additional systems. Systems installed to date are:

Smith & Davies

New Zealands first vehicle fitted with a commercial CTI system was a three zone system on 6x4 Mercedes truck and three axle trailer working for C.H.H. in the Northland region. C.H.H. have been monitoring the vehicle closely, and as a result of the benefits they have observed are now asking their regular contractors to have CTI installed in the near future.

Pacific Haulage

The second CTI instillation was a two zone system on a Kenworth 6x4 truck and trailer owned by Pacific Haulage LTD of Gisborne. Pacific Haulage have since fitted another six systems although they are all only single zone systems. These vehicles work predominantly for Juken Nissho's Patenamo forest and Rayioner's Mangatu forest. Pacific Haulage now have a policy that all their new vehicles, and vehicles that they extensively rebuild will have CTI fitted to the drive zone. Two other operators in the East Coast area, after observing the added traction benefits of Pacific Haulage's CTI equipped trucks have also fitted CTI to the drive zone of their vehicles.

Doug Robertson

After six months of operating a CTI equipped vehicle in Taneatua, Doug reported:

1) At Taneatua, my trucks with CTI, eliminated corrugations and wash boarding caused previously by other trucks. When metal trucks began using the road, after one week these corrugations began to form again. After they finished their work it took us about another week for my trucks to eliminate the corrugations caused by these trucks. Their must be dramatic savings in road wear if all trucks had CTI fitted.
2) I have noticeable savings in tyre wear, and I hope to obtain extra caps out of my casings.
3) The driver comfort has improved dramatically, it is similar to the ride improvement on vehicles fitted with air suspension. As a result of the

enhanced vehicle ride I expect a reduction in vehicle maintenance.

4) I had a tare weight advantage, as I no longer have to carry spare tyres. If a tyre does get punctured the system keeps the tyre inflated allowing the tyre to be changed later, eliminating down time.
5) The CTI system allows allot more traction, an added safety bonus is that we now have more control on greasy tracks especially when going down hill.
6) There is a definite advantage in having it fitted to the trailer zone as well as the drive zone.

Stewart Drummond

Stewart Drummond has fitted CTI to both the drive and trailer zones on two new vehicles working for TFL in the Nelson region. These vehicles are being closely monitored with the early results looking promising. The vehicle owner and drivers are very happy with the performance to date.

McCarthy Wilshier Transport Rangiroa

Warwick Wilshier fitted one of his vehicles with CTI on both the drive and trailer zone. He has since fitted CTI to another truck and trailer, with a third to be fitted early next year.. Warwick uses these vehicles predominantly to cart from woodlots where he considers the added manoeuvrability of these vehicles will regularly allow them to operate on occasions when they would normally be unable to operate. This, and the other operator benefits he receives should cover the increased cost. However, he is quick to point out that in a normal log truck fleet operation working on well formed forest roads where the conditions generally are not that challenging, he finds it difficult to justify fitting CTI to his vehicles, although their may be a case for fitting it to the drive zone.

Rotorua Forest Haulage

Rotorua Forest Haulage has CTI fitted to drive zones only on their two trucks carting full length logs for Forestry Corporation. While their are some benefits to be had in this operation, with the axle loads in the 12-13 tonne range, the ability to lower their pressures is limited..

The Canadian Experience

We contacted two uses of CTI in Canada, they are Alberta Pacific Forest Products (ALPAC) and Riverside Forest Products. Both companies are impressed with the added traction ability of the vehicles using low tyre pressures and are convinced of the savings in both road construction and maintenance costs, often using them to "pack-in" green roads. They estimate CTI extends their haul season by 15%, particularly as the roads begin to freeze or during the thaw.

ALPAC made it a requirement that all of their regular log haul contractors operating approximately 100 vehicles have CTI fitted to all zones. They started by paying their operators a CTI premium of $3 per hour, with the intention of ceasing that payment when the reached the capital cost of the equipment. After three years of experience, they are so pleased with the results and the benefits they receive they are continuing to pay the $3 per hour premium.

Riverside Forest Products have 20 contractor trucks. Two years ago they picked the trucks where they would receive the most benefit by having CTI fitted, and are now working through the fleet as they come up for replacement. They pay their CTI equipped trucks an additional $0.12 per tonne hour which represents a 4.2% increase on their self loaders, and 5.1% increase on their conventional six axle loggers.

The New Zealand Potential

With the overwhelming evidence in favour of CTI, why has it taken so long for forest companies to request their transport contractors to install CTI on their vehicles? and why have transport contractors also been slow to fit CTI?

The reason may be because answers have yet to be found for the following questions:

1) How big is the advantage?
2) Who gets the advantage?
3) Who should pay for the advantage?

A fear of many of the contractors is that if they fit CTI to their vehicle, they will get all the cartage from the more challenging areas where they will suffer from increased vehicle maintenance costs, while the easier runs are given to the vehicles with poorer off road performance. Operators are willing to fit CTI to their vehicles (or any other technology for that matter) provided they get a return on the additional capital they are required to invest. Another factor is, if it is left to the operators to fit CTI without inducement from the companies they work for, then they will only fit it to the drive zone which is where they receive the benefits. The New Zealand experience to date is already showing this trend, unfortunately the roading and environmental benefits that can be obtained by operating CTI equipped vehicles are only half of what they could be if CTI equipment was fitted to the trailer zone was as well.

Conclusion

With the experience gained in CTI both in New Zealand and overseas, and now that reliable commercial systems are available harvest planners can now have the confidence to design roads for CTI equipped vehicles with grades steeper than previously considered, and with reduced sub grade thickness. A system will need to be developed where some of the savings both in road construction and road maintenance can be shared with the transport contractor. Perhaps it is time that the forest companies started becoming more involved in the vehicle specifications operating on their roads with the aim being to reduce the impact. It would be relatively simple to nominate things like tyre size, road friendly suspensions, and CTI. With known equivalent standard axle loads (ESAL), and the effect this technology has in reducing ESAL's it is possible to calculate savings and to offer a package where the transport contractor becomes willing to fit this equipment, knowing he will receive an adequate return on the additional capital invested. Until this occurs the introduction and use of CTI and other road friendly equipment will only occur in a haphazard manor, and will only be fitted to the zones where the transport operator receives the benefit.

References

Goldsack, R. (1988): 'Truck Tyre Pressures Effects on Truck and Road". LIRA Report Vol 13, No8.

Jones, G. and Smith, M. (1991): 'Central Tyre Inflation: The united States and New Zealand Experience". LIRO Report Vol 16, No 9.

Della-Moretta, L (1985): 'Proof of Concept Tests for Central Tyre Inflation". USDA Forest Service, ED&T 4E31L58.

Anon. (1987): 'Final Report-Central Tyre Inflation" Nevada Automotive Test Centre.

Grau & Della-Moretta (1991): 'Effects of Variable Tyre Pressure on Road Surfacings". Transportation Research Board, Transportation Research Record 1291, May' p313-328