

Summary

From Austroads "Pavement Design" 2012, axles with super single tyres cause more pavement wear than axles with dual tyres, for the same axle load.

Yet legal maximum axle loads and Road User Charges do not differentiate between super singles and dual tyres, at least for tri-axles and quad axles.

For pavement design wear is calculated in terms of a power law, eg 4th power for empirical design, and 5th (asphalt cracking), 7th (rutting and shape loss) and 12th (cracking of bound) power laws for mechanistic design.

The New Zealand Transport Agency has Weigh-in-Motion data, but this data does not differentiate between dual tyres and super single tyres. MWH developed an Excel based tool to analyse the WiM data. This data was analysed assuming varying proportions of the trailer fleet had super single tyres.

The analysis showed that for New Zealand's current truck fleet, widespread use of super single tyres could increase pavement wear by 60% (empirical design) and 180% (rutting in mechanistic design), relative to dual tyres.

It is noted that WiM data does not currently differentiate between super single and dual tyred axles. Thus the damaging effect of heavy vehicles maybe being significantly under estimated in pavement designs.

Background

For pavement design to Austroads, the damaging effect of axle loads on pavements is calculated in terms of a power law. For empirical design the 4th power law is used, while for mechanistic design 5th, 7th and 12th power laws are used

From Austroads Pavement Design (2012), axles with super single tyres cause more pavement wear than axles with dual tyres for the same axle load.

Legal Axle Loads and Road User Charges

For trailers with tri-axle and quad-axle configurations, axles with super single tyres have the same legal maximum axle loads and the same Road User Charges as axles with dual tyres.

Weigh-in-Motion Data

The New Zealand Transport Agency (NZTA) has Weigh-in-Motion (WiM) data in their Traffic Monitoring System, and produces annual WiM reports. The authors have analysed the raw WiM data, for the Drury Site on the Auckland Southern Motorway. The author's paper includes a summary from approx. 17,400 data records from February 2012 for the Drury WiM.

Analysis of the WiM data reveals that the Drury site accounts for almost half of the total number of heavy vehicles at all six of the NZ WiM sites. Approx. 55% of all heavy vehicles (> 3.5 tonne gross) have 6 or more axles, and just under 50% have 7 or more axles.

It is important to note that the WiM sites do not capture tyre configurations. The WiM data does not differentiate between super single and dual tyred axles.



B Train. B1233 Pat Type 951.

Example

B Train B1232

Pat Type 851:



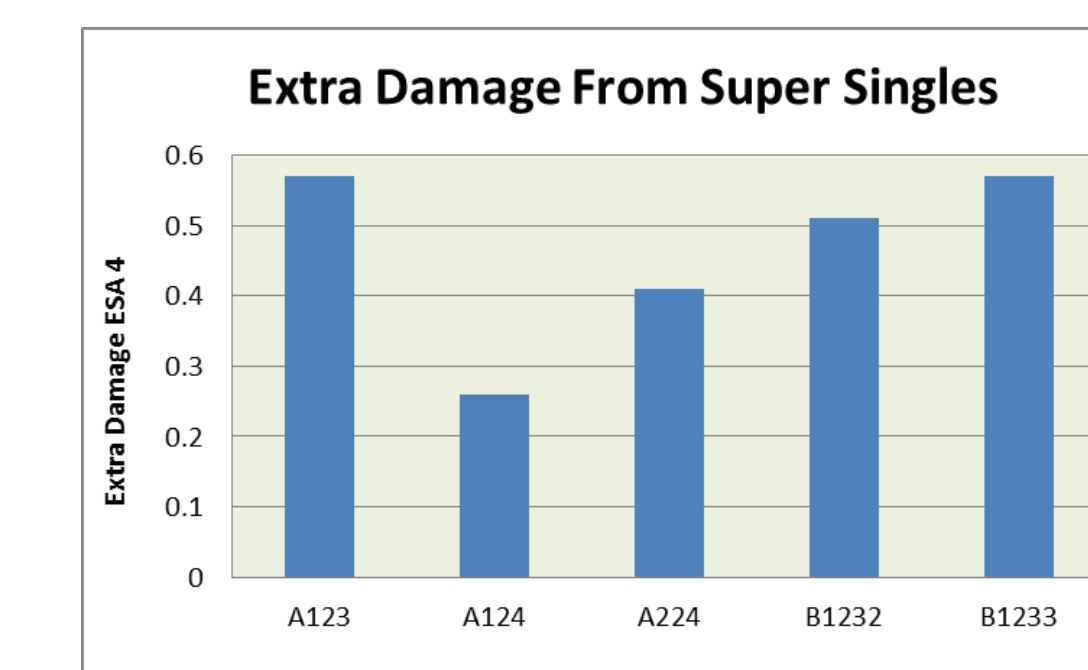
Number of WiM records for B1232 from Drury in February 2012.....866.

B Trains B1232 comprise approximately 20% of the 8 axle truck passes over the Drury WiM.

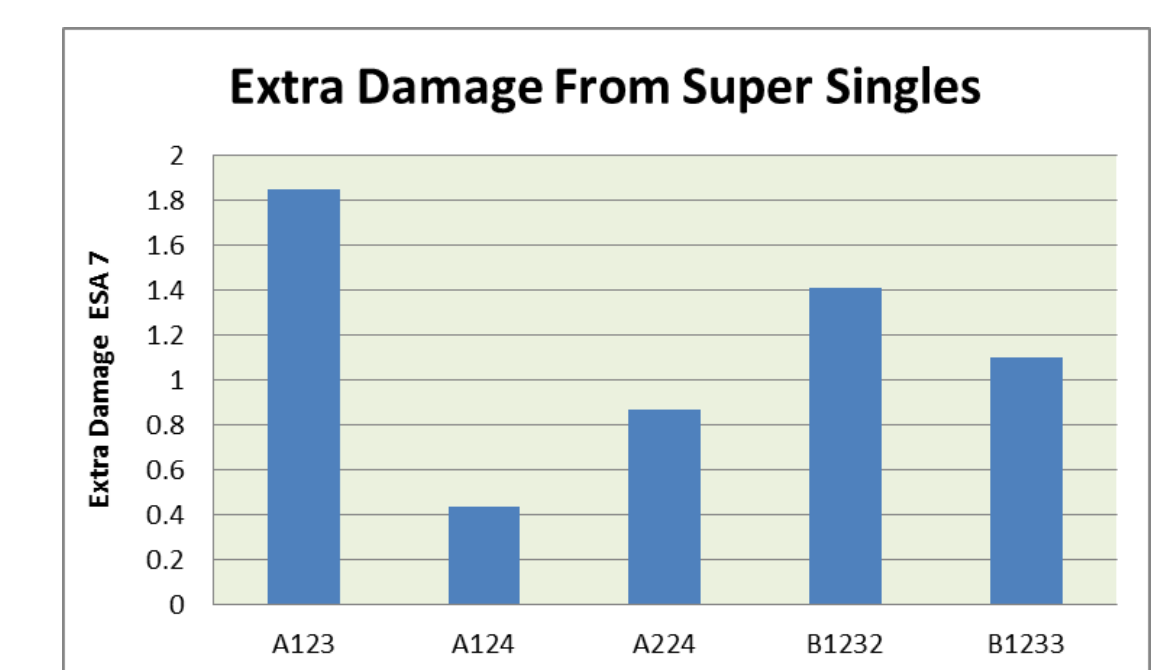
	Average Damage per Truck		
	Assume all Trailer Axles have Dual Tyres	Assume all Trailer Axles have Super Singles	Extra Damage from Super Singles
4 th Power Law	1.66	2.51	51%
7 th Power Law	1.38	3.33	141%

From WiM Data: Extra Damage from Super Singles

From analysis of the New Zealand WiM data, the pavement wear from 6, 7, 8 and 9 axle trucks has been calculated assuming all trailer axles were dual tyred, and assuming varying percentages of the trailer fleet had super single tyres. The results are summarised in the graphs below for the 4th power and the 7th power laws.



Extra Damage from Super Single Tyres over Damage from Dual Tyres. 4th Power Law.



Extra Damage from Super Single Tyres over Damage from Dual Tyres. 7th Power Law.

Conclusions Include:

Applying the 4th power law for empirical design to trucks with ≥ 6 axles, if all trailer axles had super single tyres, pavement wear from these trailers would be up to 60% higher than if all were dual tyred.

Applying the 5th power law for cracking of the asphalt to trucks with ≥ 6 axles, if all trailer axles had super single tyres, pavement wear from these trailers would be up to 86% higher than if all were dual tyres.

Applying the 7th power law for rutting to trucks with ≥ 6 axles, if all trailer axles had super single tyres, pavement wear from these trailers would be up to 180% higher than if all were dual tyres.

Pavement designers may well be significantly under estimating design loadings by this lack of recognition of the damaging effect of super singles.

Recommendations

Pavement designers recognise that the lack of specific identification of super single tyres may result in significant under estimation of pavement design loadings.

Research and data capture is needed to determine what percentage of the truck fleet includes super single tyres.

NZTA consider capturing tyre configuration, differentiating between super singles and dual tyres, with their WiM data.