

## AXLE SPACING AND ROAD WEAR

### ACKNOWLEDGEMENT

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Figure 1 - Close Spaced Axles



Figure 2 - Wide Spaced Axles

### BACKGROUND

On a two-axle log trailer wide-spaced axles incur higher Road User Charges than close axles, for the same axle loads.

This implies that wide-spaced axles cause greater road wear, however, under the Axle Weight Limit Regulations, they are allowed to carry greater loads - why?

This topic was discussed but not fully explained at the recent LIRA Log Transport and Log Loading Seminar. The aim of this report is to explain why greater loads are allowed on wide-spaced axles and why the Road User Charges are higher on these.

## AXLE WEIGHT LIMITS

A public roadway is an engineered structure designed to carry loads. Excessive loads can extensively damage them, therefore, restrictions are made on the loading allowed.

New Zealand roadways include bridges, culverts, and roads, all of which are structurally different. On particular road classifications (e.g. a Class 1 route) the Ministry of Works and Development aims to have the structural strengths of the bridges, culverts, and roads matched.

When a road structure is loaded a stress pattern is set up at the contact point between the road and the wheel. Components of the roadway structure, whether steel beams ( e.g. bridges) or layers of rock, will fail if the stress becomes too great. For two close axles and two wide-space axles, *Figure 3* illustrates the respective stress patterns set up in the road structure.

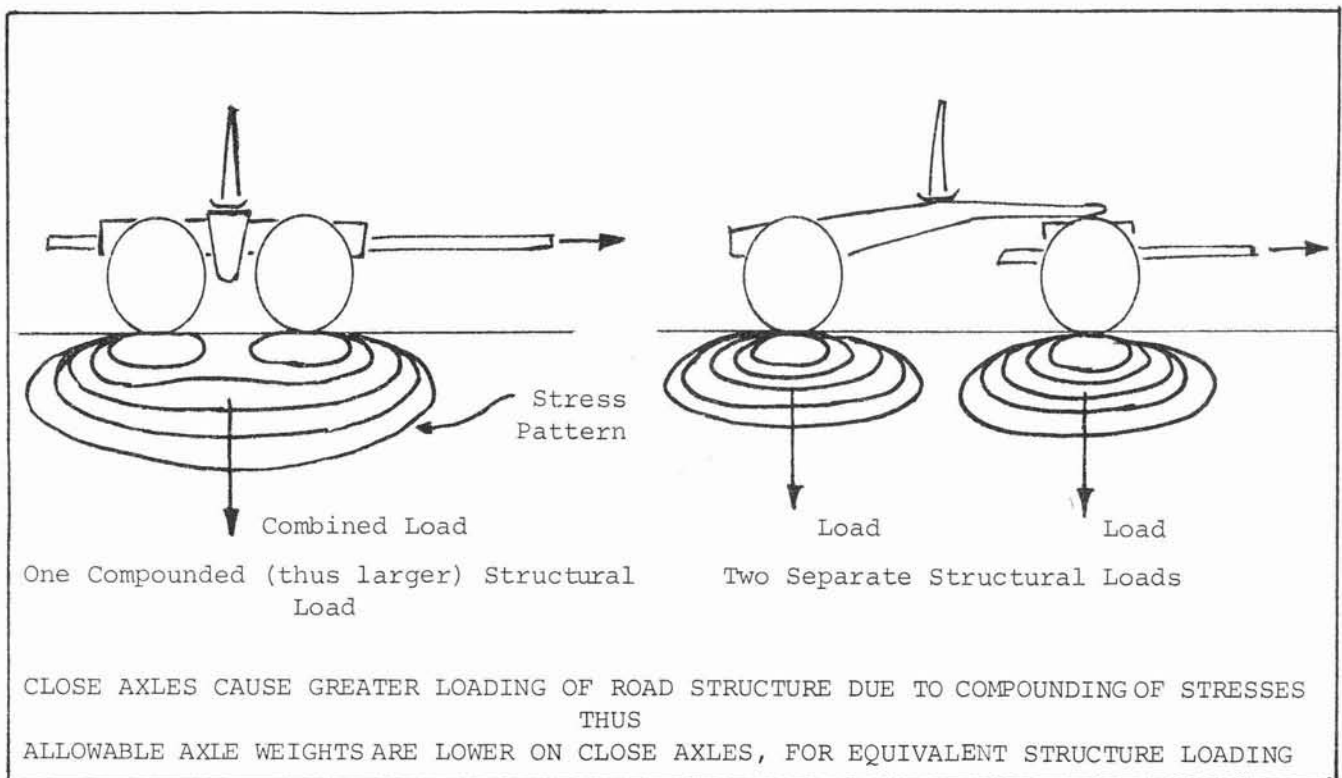


Figure 3. Road Loading

With two close axles the stress patterns from the separate axles combine and this creates a higher net loading on the roadway than occurs with two wide-spaced axles.

Because close axles cause a greater net loading on roadway structures, the allowable axle weights on them are lower than on wide-spaced axles. The following table shows axle weight limits for two-axle log trailers. These limits are there to protect roadways from structural damage.

Two-Axle Log Trailer Axle Spacing (metres)	Maximum Two-Axle Trailer Gross Weight (tonnes)	
	Class I Road	Class II Road
Less than 1.8	14.5	12.5
1.8 to 2.4	15.5	13.5
2.4 or more	16.4*	14.6*

(\* Limited by axle weight and not gross weight)

## ROAD USER CHARGES

A vital component of roadways is the pavement or surface section of the road. It is the pavement that is in direct contact with the wheels and which provides for traction and smoothness of vehicle ride. Like anything that is subject to continual use, roadway pavements do incur wear. Maintenance is thus required to sustain the pavement quality, and the Road User Charges system has been introduced to recoup the road wear costs from the road users so that funds are available for roadway maintenance.

The pavement is generally the top 7.5 cm of the roadway, whether it is sealed or unsealed, and this is the major consideration for road wear.

Under any vehicle's wheel (whether moving or stationary) the pavement deflects or bends slightly, the extent of bending being determined by the axle load. It regains its original shape once the wheel moves on. A bending cycle is thus created in the pavement with each pass of a wheel, and like a piece of fencing wire, continual bending cycles eventually result in the weakening of the item until it wears out and breaks through fatigue. For two close axles and two wide-spaced axles, *Figure 4* illustrates the respective bending patterns set up within the roadway pavement.

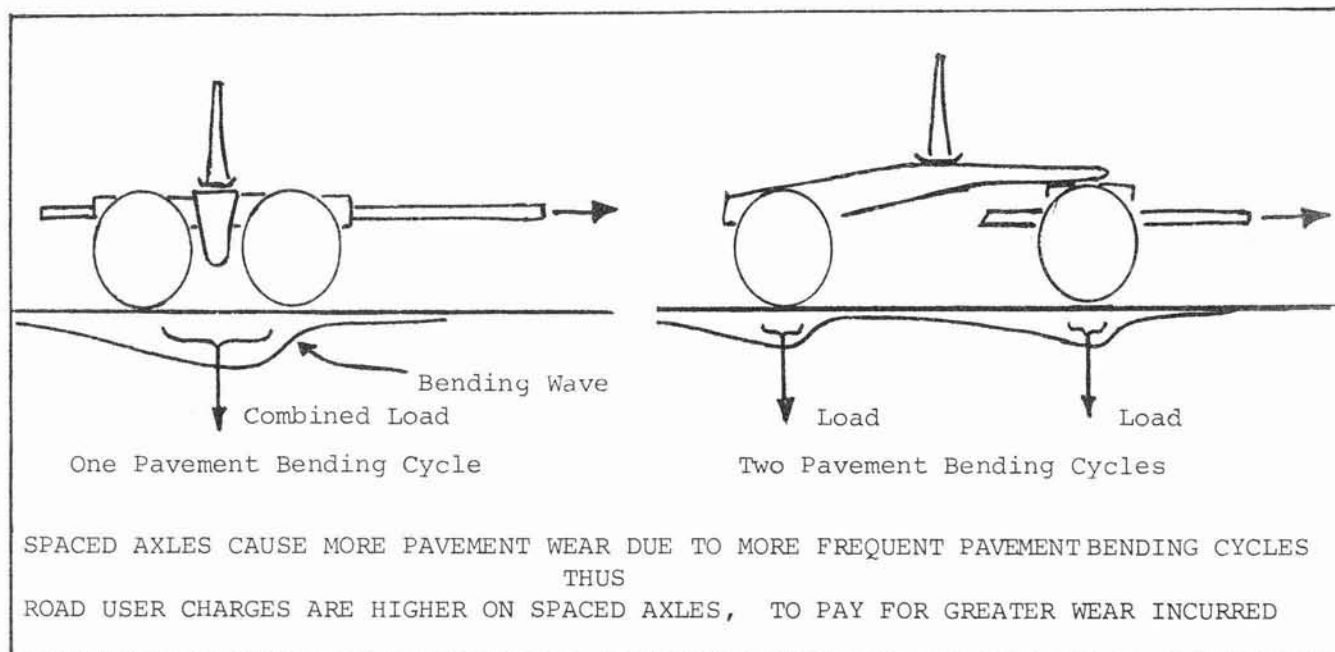


Figure 4. Road Wear

With two close axles the pavement bending from the separate axles combines, which results in a single bending wave rather than two separate bending waves.

Hence when two close axles travel over a roadway the pavement is only subjected to a single bending cycle compared to two bending cycles as with two wide-spaced axles. The extra bending cycles cause more rapid wearing (through fatigue) of the pavement. Thus higher road wear costs are charged to the wide-spaced axles than to the close axles. This results in the following current Road User Charge rates for two-axle log trailers:

Two-Axle Log Trailer Axle Spacing (metres)	R.U.C. Licence Category	R.U.C. Rate on Two-Axle Trailer (Dollars/1000 km)				
		13 tonnes	14 tonnes	15 tonnes	16 tonnes	17 tonnes
Less than 1.8	17	29.75	38.17	48.45	60.89	75.80
1.8 to 2.4	17	29.75	38.17	48.45	60.89	75.80
2.4 or more	16	34.83	44.98	57.44	72.53	90.62

These rates are imposed to pay for wear incurred on the roadway.

## CONCLUDING COMMENTS

Public roadways are an expensive but necessary asset to New Zealand. The logging industry uses them extensively for the cartage of logs, so their protection and maintenance is vital to their continued usefulness to our industry.

The axle weight limits imposed on public roadways are there to protect the roadways from structural damage, whereas the Road User Charges system ensures that the road user pays for the pavement wear he causes.

It is an unfortunate but unavoidable fact that wide-spaced axles offer advantages in terms of weight limits, while close axles offer advantages in terms of Road User Charges. This makes it more difficult to readily identify the best logging truck layout in terms of axle configuration for highway use.

An overall economic analysis, taking into account the total truck and trailer operating costs, the obtainable legal pay-loads, and the anticipated utilisation in terms of loads carted over a period, will identify the best axle configuration under current costs and regulations. An exercise on this is currently being done by LIRA. Regulations and costs, however, are not necessarily constant with time, thus considerable caution should be exercised in choosing a log truck layout on economics alone.

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