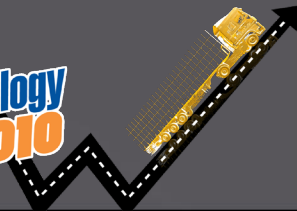


The effect of multiple axle combinations on the road

David Hutchison

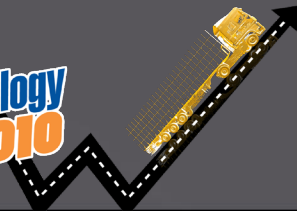
Chief Civil Engineer

Downer NZ



Axle Weights and Repetitions

- ▣ Pavement performance is affected by
 - Type of axle (axle group)
 - Number of repetitions of axle pass
 - Tyre pressure
 - Axle weight
- ▣ Pavement design is done on basis of
 - The Equivalent Standard Axle (ESA)
- ▣ “Average heavy vehicle” has
 - 2.4 Axle Groups
 - 0.6 ESA per Axle Group
 - i.e. $2.4 \times 0.6 = 1.44$ ESA per heavy vehicle



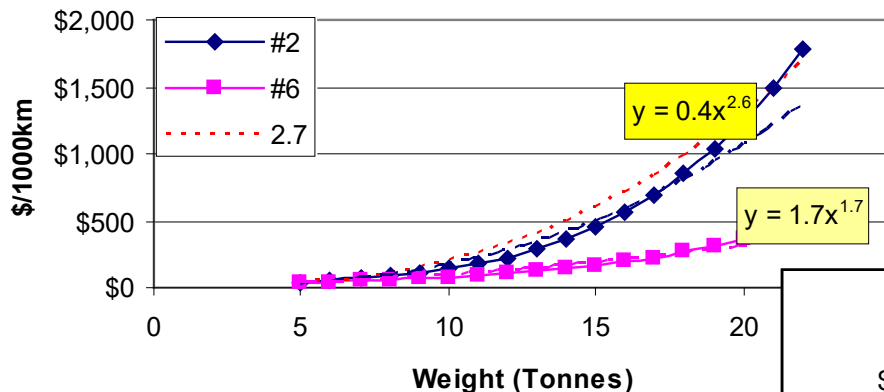
Effect of Axle Weight

- ▣ The “4th Power Law” declares that the wear effect of an axle (axle group) on a pavement is proportional to the 4th power of its weight
- ▣ Thus, for example, a 12 tonne axle has
 - $(12/8.2)^4 = 4.6$ times the wear effect of an 8.2 tonne axle
- ▣ The road will wear out in 25% of the time
 - But this “law” is not at the forefront in the design process

Axle Grouping and RUC

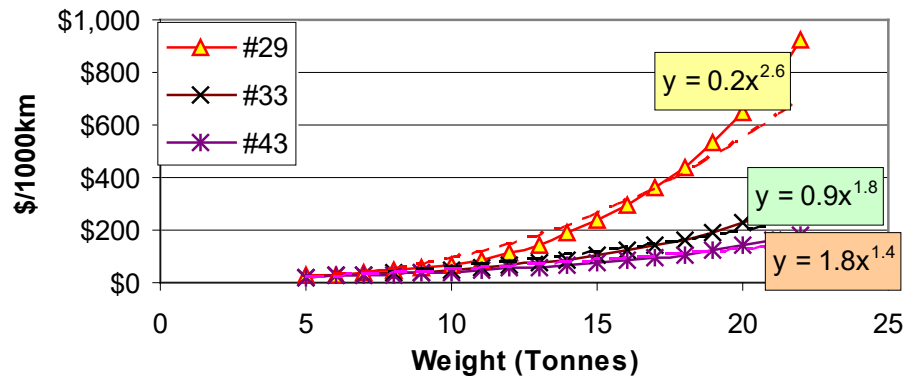
- Are these influenced by the “4th power law”?

RUC for Selected Axle Groups



- The basis of charge is less severe

RUC for Selected Axle Groups



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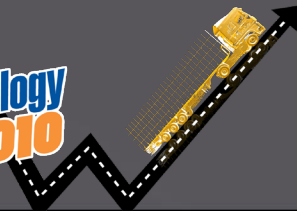
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How do Pavement Structures Fail?

- ▣ Thin-surfaced pavements fail through rutting
 - Potholes result from cracks in the surface and ingress of water
- ▣ Structural asphalt pavements may also fail by rutting
 - Either as a result of the asphalt tiring OR
 - Because of settlement of the base and subgrade
- ▣ Foamed bitumen pavements are considered to fail in the same manner as thin-surfaced pavements

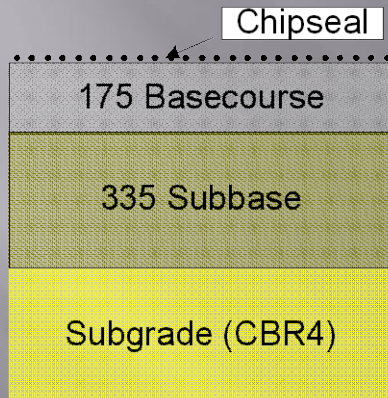
The Pavement Environment

- ▣ Sometimes a good pavement structure will fail because of reduction in its support at edge
 - A lack of “buttress”
- ▣ Asphalt pavements often show rutting at slow-speed locations
 - Intersections
 - Roundabouts
- ▣ This is because conventional bitumen is not good at resisting slowly applied loading
 - It creeps

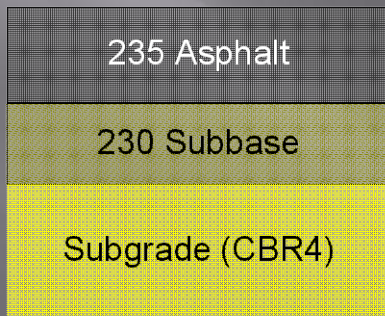


Pavement Structures Examined

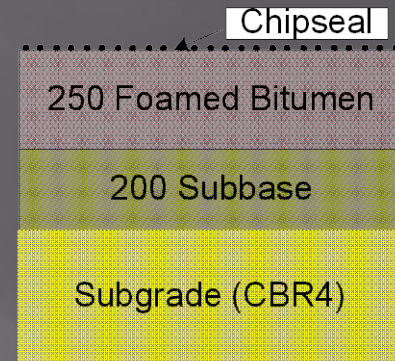
- ▣ Three pavement structures have been examined
- ▣ Thickness influenced by ESA approach



Unbound Granular Pavement



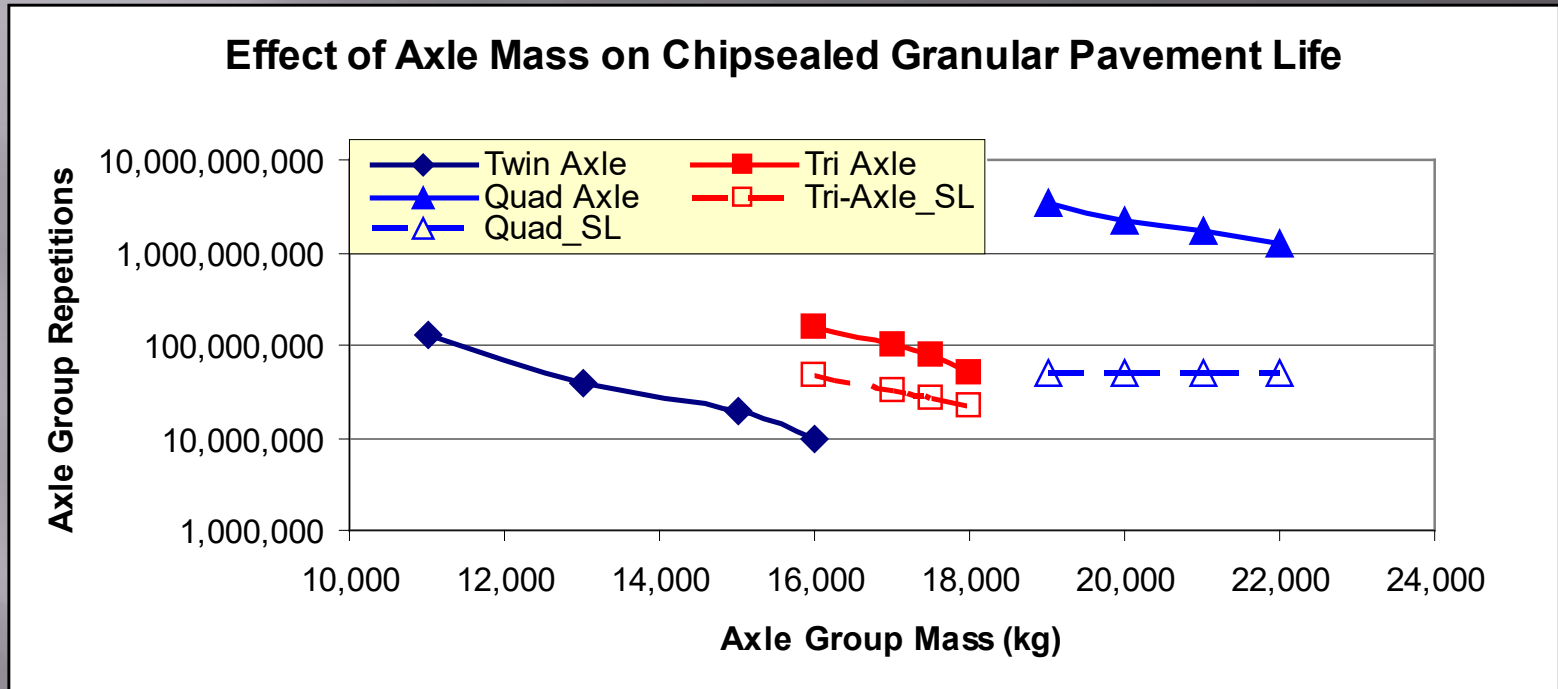
Structural Asphalt Pavement



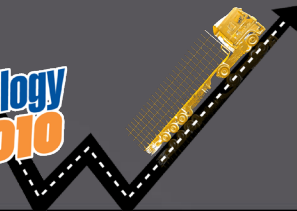
Foamed Bitumen Base Pavement

- ▣ What is the effect of different axle groups?

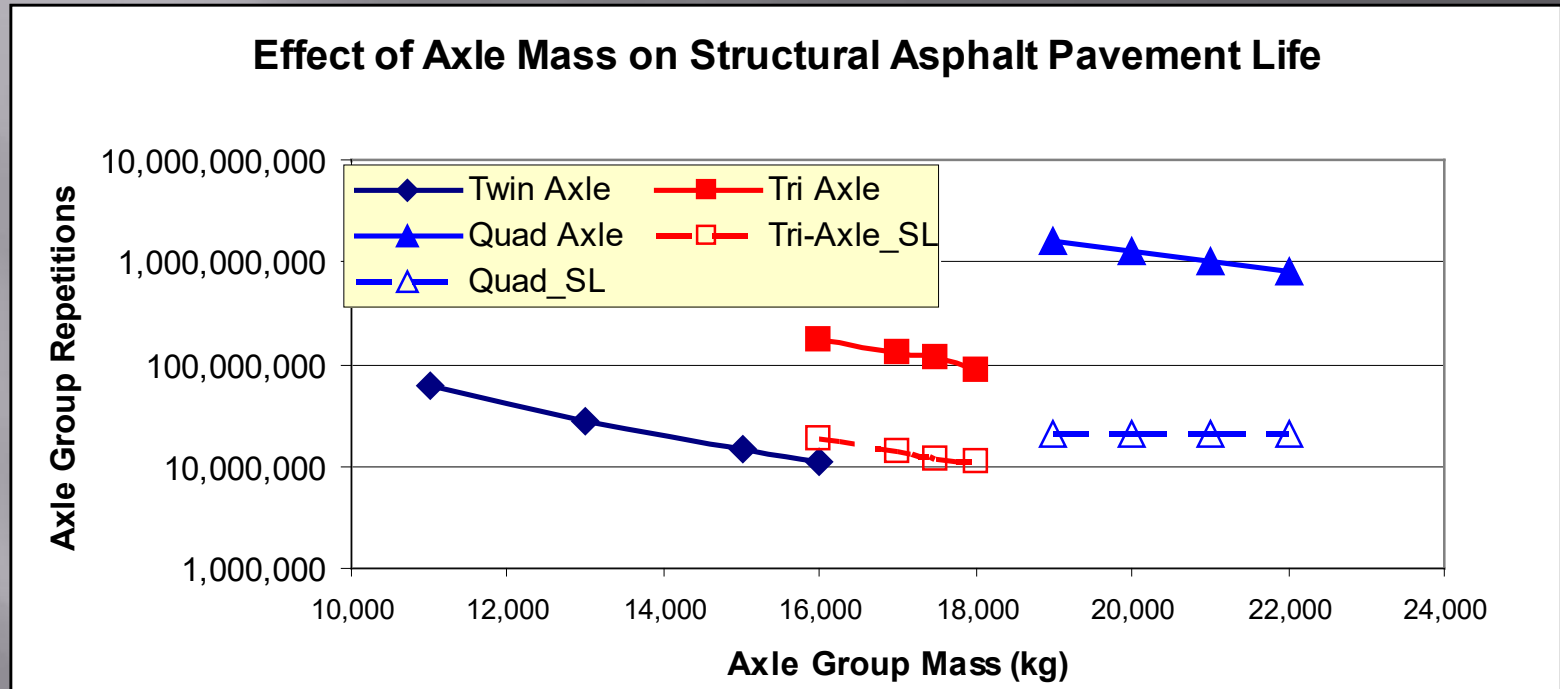
Chipsealed Pavement



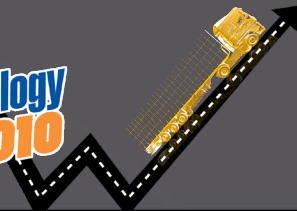
- More repetitions can be sustained from larger groups
- SL tyres somewhat disadvantage the group



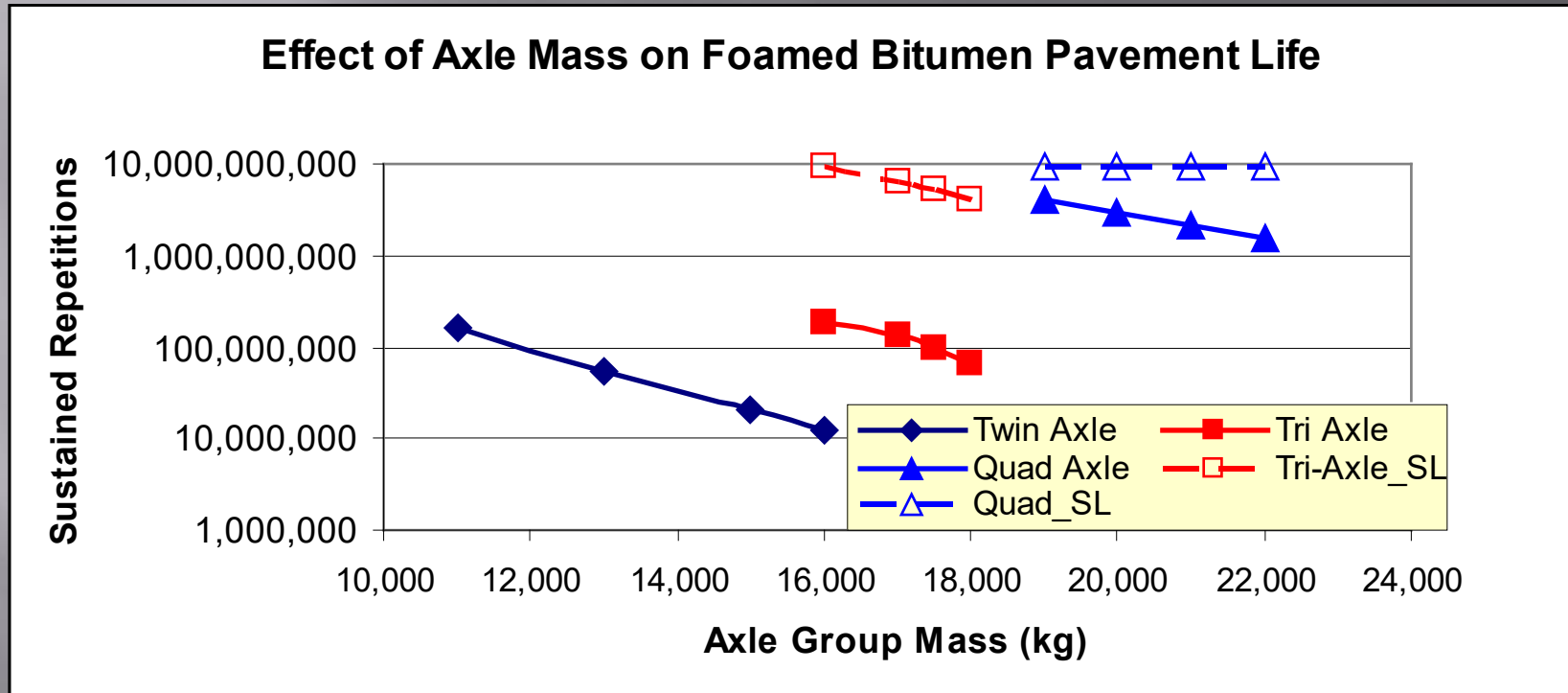
Asphalt Pavement



- The more axles, the more gentle the effect
- But SL tyres are more hard on this form of pavement



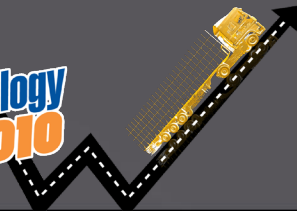
Foamed Bitumen Pavement



- The quad axle is very “kind” to the pavement structure
- SL tyres are no disadvantage to this type of pavement

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What Can We Learn?

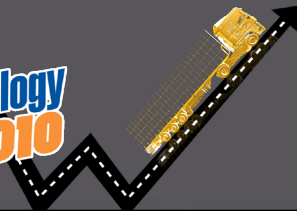
- ▣ For a given mass, an additional axle leads to a significant increase to the life of a pavement
- ▣ For most pavement types, the single large tyre is harder on the pavement than the dual set
- ▣ Additional axles on trucks have potential to
 - reduce ongoing road maintenance costs
 - reduce thickness of newly-constructed pavement
- ▣ Over time, RUC could reduce
 - 30% of NZTA revenue is from RUC

What Can We Learn?

- ▣ At present, the trucking fleet is diverse
- ▣ Therefore, we are unable to design solely on multi-axles
- ▣ There is a trend with the Roads of National Significance, for NZTA to require more conservative pavement structures than has been the case in recent years
 - This should lead to a reduced rate of maintenance intervention

The Pavement of the Future?

- ▣ Its structure will be strengthened with bitumen and/or cement
- ▣ Its surface will be asphalt
- ▣ Asphalts will have better fatigue and better rut resistance
- ▣ More of maintenance will be machine-controlled, cover wider areas and be less labour-intensive
- ▣ More work will be done at night



The Truck of the Future?



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