

# JTRC Seminar

24 September 2007

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**Infrastructure and Access**

# What will I talk about?



- ❖ Vehicles – Les has covered that
- ❖ Pavements
- ❖ Bridges
- ❖ Access
- ❖ Pricing – Stewart will talk about that



# Key lesson

- ❖ With PBS we put too much time into vehicle safety and not enough into pavements and bridges.
- ❖ The custodians of pavements and bridges are passionate when it comes to protecting and funding them!!!

# Pavements

# Pavement Loading Standard



- This has turned out to be a real challenge. Policy position was:
  - no increase in the "wear and tear" of pavements
  - pricing was not to be part of PBS
- Australia already has a range of axle mass limits, eg triaxles or tridemms:

– General Mass Limits	20.0 t
– Concessional Mass Limits	21.0 t
– Higher Mass Limits	22.5 t
– Bulk Cargo Scheme (Western Australia)	23.5 t
– Indivisible loads (Western Australia and ?)	27.0 t

Access is limited for all bar General Mass Limits

## What to do with PBS vehicles?



# History



- ❖ In 2004 Australian Governments gave qualified approval to a set of performance standards and measures to apply under PBS.
- ❖ The Pavement Vertical Loading needed further work.
- ❖ In April 2006 Austroads\* delivered a proposal for a Pavement Vertical Loading Standard. Austroads also agreed to undertake research to test the impact of the proposed standard.

\* Like AASHTO



# First try at a standard

## ❖ The standard:

*“...vertical forces applied to the pavement by a PBS vehicle will be regulated through consideration of the total Standard Axle Repetitions of road wear (SAR12) caused by a single pass of the vehicle and calculated using a 12th power load damage relationship, divided by the Gross Combination Mass (GCM) of the vehicle in tonnes.”*



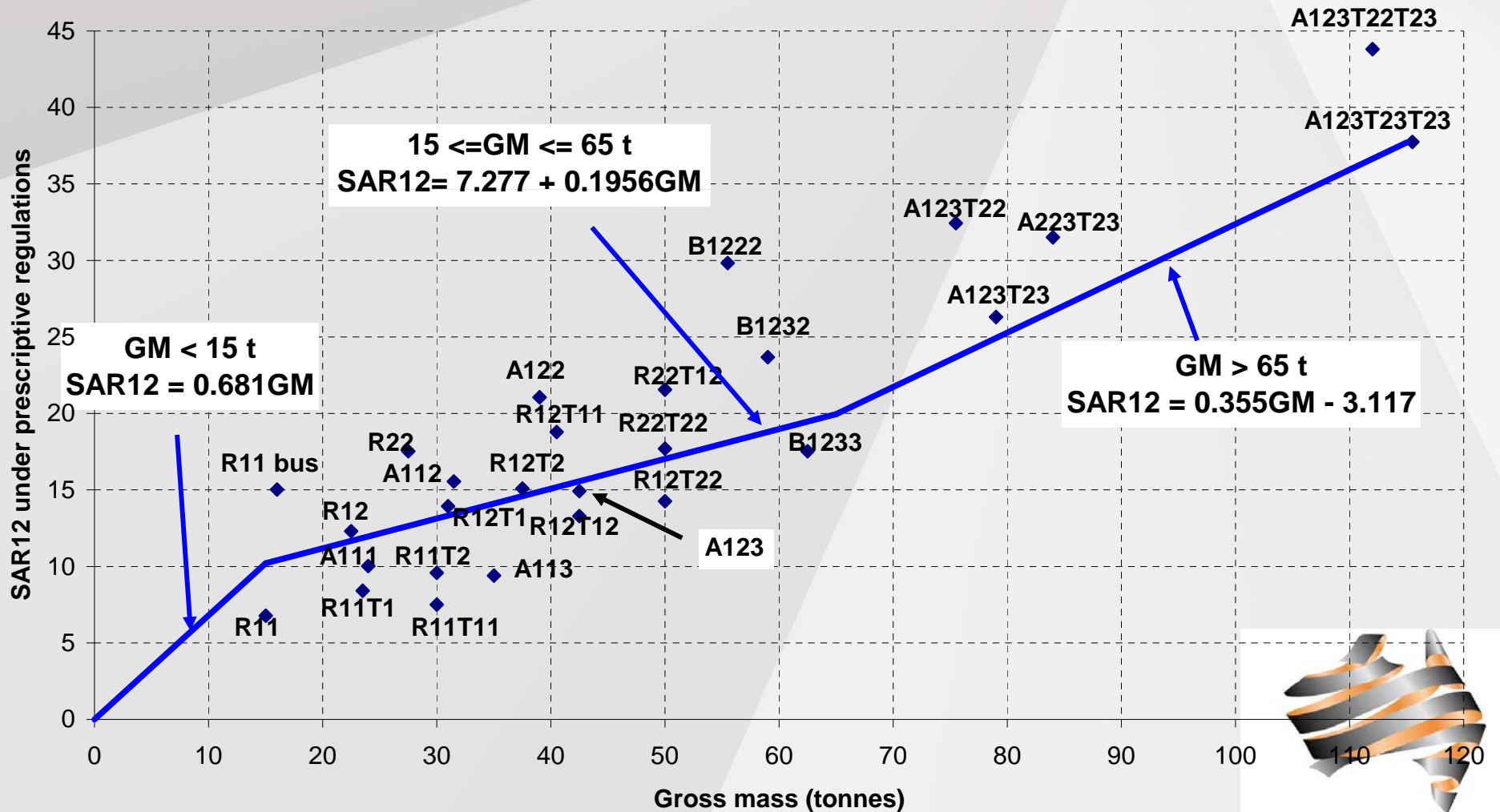
# First try at a standard

- ❖ 12th power used to protect vulnerable pavements
- ❖ many qualifications
- ❖ became known as the Blue Line
- ❖ good idea
- ❖ basically road wear limit set by the vehicle's gross combination mass



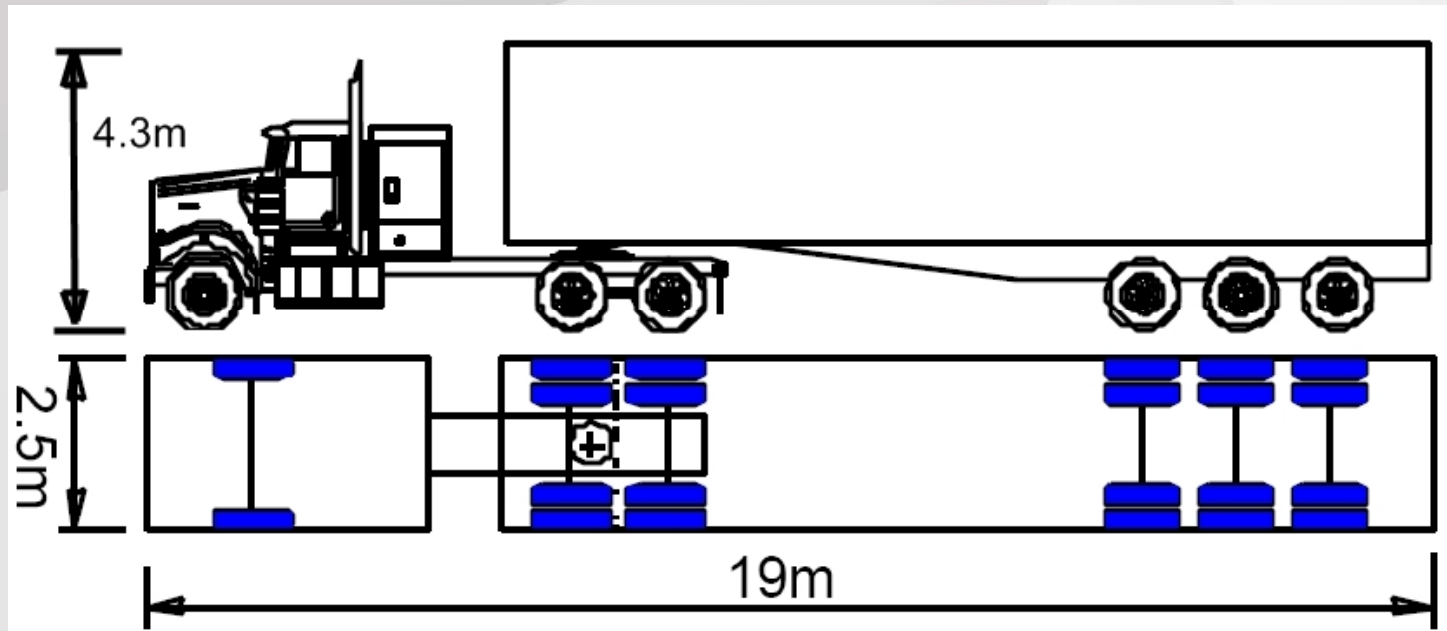
# The Blue Line

Weighted using 2004 SMVU national laden-km travel



# What did it mean:

A123



Present mass limits 6 t, 16.5 t, 20.0 t (GM of 42.5 t)

Under PBS 5.7 t, 15.9 t, 21.9 t (GM of 43.5 t)

# NTC



- ❖ The standard was not acceptable to the NTC/Austrroads PBS Project Team:
  - It was overly conservative – to ensure no more pavement wear,
  - It was impractical – lighter drive axles, axle mass limits to 0.1 t,
  - PBS mass limits that were at best equal to, or in most cases less than existing prescriptive axle mass limits.
  
- ❖ The subsequent testing of the standard by Austrroads showed that it protected pavements but did not deliver national benefits. This work also showed significant benefits were available from increased axle mass limits.



# Hold point!

- PBS was dead in the water without a standard that offered industry opportunities to innovate
- Pavement people ‘dug their toes in’ – no load increase unless funds came to maintain their pavements
- Pricing then became an acceptable consideration
- But something was needed – an acceptable Interim Pavement Loading Standard

# Interim Standard



This limits individual axle group loads for PBS vehicles to those that presently apply under (tridems shown):

- ❖ General Mass Limits (GML) – 20 t;
- ❖ Concessional Mass Limits (CML) – 21.0 t; and
- ❖ Higher Mass Limits (HML) – 22.5 t.

Total gross mass of the vehicle is not limited. However, Axle Spacing Mass Schedule (ASMS) {bridge strength} requirements must be met when operating under general access arrangements.



# Pavement Access?



Acceptance of this approach varies across Australia – from complete to largely!

Access is still at the discretion of the jurisdictions – the 6 states and 2 territories



# Key Issues!!

- Australian pavements are not all the same
- Some are 'perpetual' – if not loaded too heavily
- Some pavements are fragile – can bear many light loads or few heavy loads
- Some pavements are very strong - infinite light loads and many heavy loads
- Knowledge of real pavement loads (dynamic) and performance is small
- Increased axle loads will increase pavement construction and maintenance costs



# What next?



- ❖ The NTC and Austroads have agreed in principal to undertake a research project into the issue over the next two financial years.
- ❖ A \$400,000 research proposal is being developed to establish “Optimal Axle Mass Limits”. It is to be joint funded by the NTC and Austroads
- ❖ The Blue Line has made a difference – the possibility of paying for extra mass is now a real option

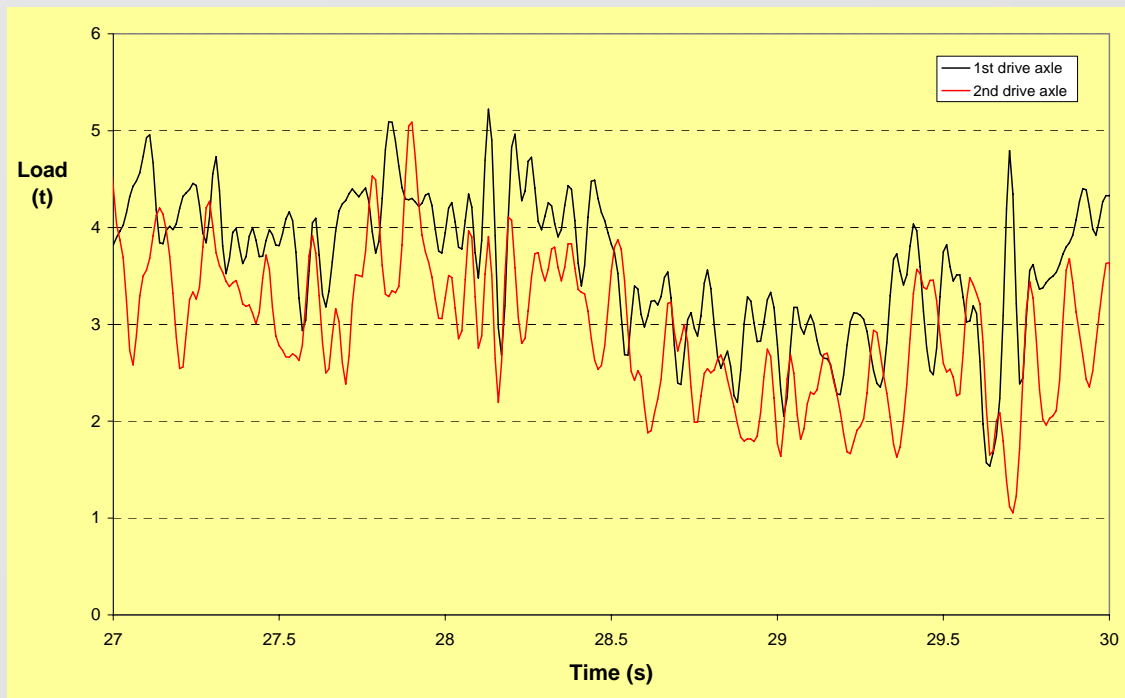


# The future

- ❖ Identify optimal heavy vehicle axle mass limits that reflect the future national freight task, minimise total transport costs and allow the infrastructure to operate at maximum efficiency.
  
- ❖ Austroads Pavement Loading Research
  - dynamic wheel loads
  - accelerated pavement loading with multi-axle groups

# Stop Press!

We have developed a tool to cheaply measure dynamic wheel loads. Tyre is the sensor – laser is the scale!



# Bridges

# The Standard



The bridge loading standard ... *ensures that a PBS vehicle does not induce effects on bridge structures that exceed accepted limits as specified by the bridge owner*



# Some thoughts

- Bridges are the same, yet radically different to pavements – elastic to some extent and then comes the fatigue zone
- A pavement failure worries a few engineers
- A bridge failure can make international headlines:
  - Quebec
  - Minnesota

# Bridges!!!!!!

Bridge capacity depends! Bridges are complex beasts!

- Simplistically most bridges are beams sitting on supports – some beams are continuously reinforced over supports.
- Some beams are short and some are long.
- Bridges have generally been built to meet the standard at the time, and at minimum cost.
- Some beams are also shallow, making them weaker than deep beams.
- Some bridges are in poor condition – rotting, poorly designed, cracking, not maintained, etc.
- Some bridges may have been heavily stressed for a long time and may fatigue fail.





# Tiered approach

Effort needed to assess bridges depends.

- A light PBS vehicle should be quickly assessed.
- A very heavy PBS vehicle may require careful consideration.
- A tiered approach to the standard was developed to recognise this.

# Tiers

## Tier 1 General Access or Restricted Access

- Must meet bridge formulae as listed.

## Tier 2 Special Access

- Must not cause more effects than those caused by existing commercial vehicles acceptable to the bridge owner.

## Tier 3 Specific Link Access

- Approval by the owners of the bridges to use all of the bridges on a specific link based on detailed individual bridge assessment.



# Tiers

Bridge assessment at three levels – Tiers

The effects (basically bending moments, shears, reactions) caused by a PBS vehicle on any bridge on the route/network requested shall be limited by either of the three 'tiers':

- Tier 1
  - low risk - straight forward assessment – lots of access
- Tier 2
  - medium risk - reasonably straight forward – limited access
- Tier 3
  - high risk - not straight forward – minimal access

# Assessment Requirements

## Tier 1

- Accredited PBS assessors must demonstrate that proposed vehicle designs satisfy the appropriate bridge formulae.

## Tier 2

- Assessment must be undertaken by a pre-qualified bridge engineer. The engineer must demonstrate that the vehicle will not cause bridge effects that exceed acceptable limits for the bridges on the network/route/link proposed for use by the vehicle.

## Tier 3

- This assessment should be undertaken by the bridge owner. Some authorities may be prepared to accept assessment by a pre-qualified bridge engineer using the authorities' bridge data.

# Bridge Access

PBS Road Network Level				
PBS Bridge Tier	1	2	3	4
1	$M = 3L + 12.5$ for $M \leq 42.5$ t; and $M = L + 32.5$ for $M \geq 42.5$ t	$M = 3L + 12.5$ for $M \leq 46.5$ t; and $M = 1.5L + 29.5$ for $M \geq 46.5$ t	$M = 3L + 12.5$ for all M	
	<b>Bridge Formulae</b>			
2	<b>Special Access – effects to not exceed existing commercial vehicles</b>			
3	<b>Specific Link Access – individual bridge assessments required</b>			

# Commentary

- Many heavy vehicles are not approved for general access to the Australian road network – they have restricted access.
- Australian bridges vary considerably in design strength and structural condition
  - many were designed for much lighter trucks than are the norm today and some are in a degraded condition.

# Research – ‘Bridge Loading Package’



Austrroads/NTC Project in 2007/2009 to address need to:

- invest more in **bridge strength databases** containing quality information on bridge load capacity;
- make greater use of **computer packages** to assess the response of links/networks of bridges to proposed trucks;
- have in place **compliance regimes** that assure bridge owners that vehicles inducing significant bridge effects do not overload or breach access conditions; and
- grant accredited **consulting bridge engineers** access to the bridge data.





# A plea!

- Don't skimp on bridge strength to save a few pennies in the design and construct phase
- The marginal cost of considerable extra strength is small – 5%?
- Cultivate chief bridge engineers who not only love bridges, but also see them in the national economic context.

# Access

# Summary

- Four levels of access from a safety perspective -  
Les
- Bridges – three tiers – straight forward if not heavy
- Pavements – no change from now – except lifting in most jurisdictions of gross mass cap

# Concluding thoughts

- Pavement and bridge capacity varies considerably – one size only approach to trucks is inefficient
- Huge benefits to be had by using the unused strength capacity in roads and bridges
- Need a system like PBS to help capture some of those benefits
- European and North American multilane motorways would be worth considering