Asia-Pacific
Economic Cooperation

2017/TPTWG/WKSP1/002

Cost of Overloaded Heavy Vehicles

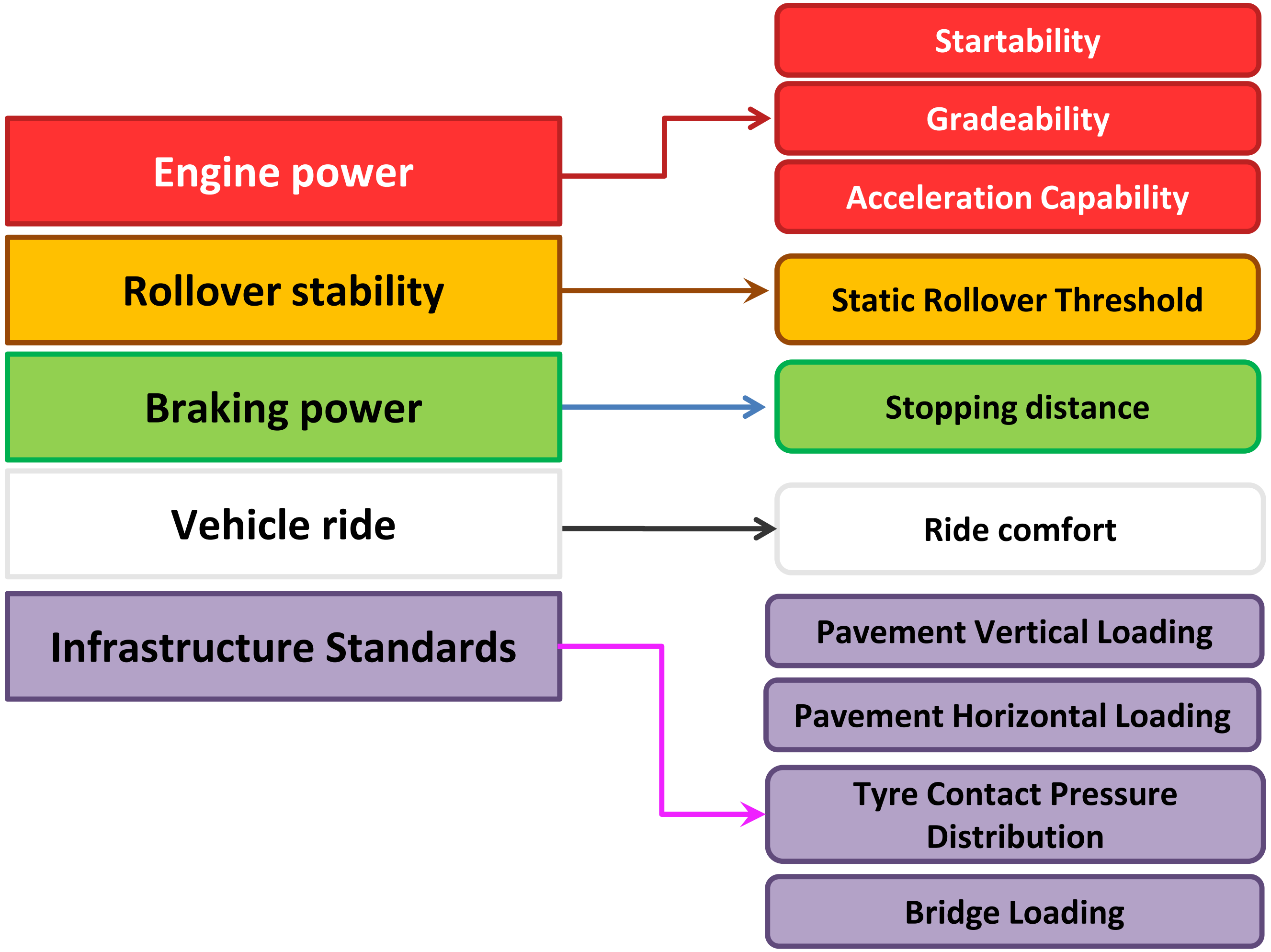
Submitted by: Australian Road Research Board

Workshop on Regulating High Mass Heavy Road Vehicles for Safety, Productivity and Infrastructure Outcomes
Brisbane, Australia
3-6 April 2017

arrb AUSTRALIAN ROAD RESEARCH BOARD

The cost of overloaded heavy vehicles

Effect on vehicle Performance



Engine power

Maximum gross mass permitted with one or two drive axles

Road access level	One drive axle	Two drive axle
Level 1	35 t	75 t

- Impacts of overloading
  - Inability to climb grades
  - Damaging the road surface
  - Delaying traffic
  - Increased overtaking crash risk

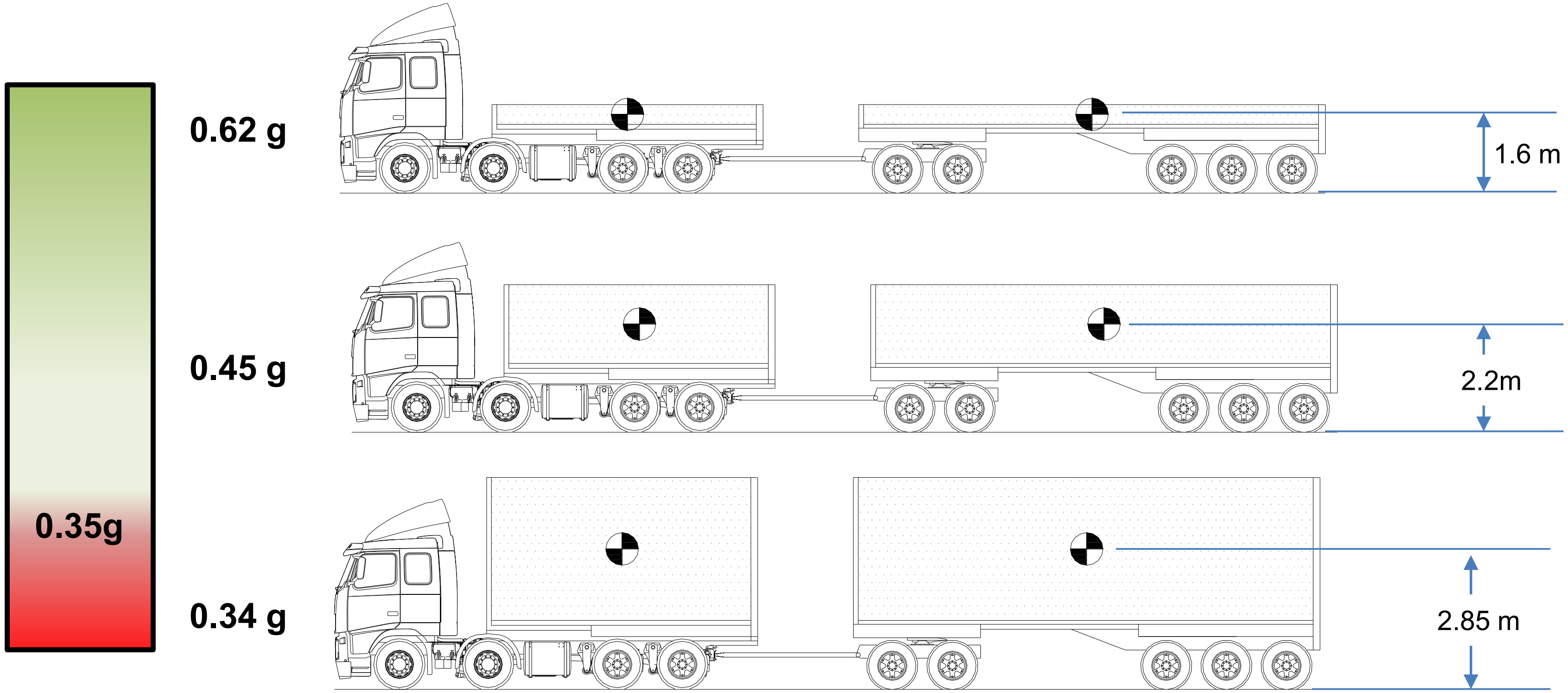
Engine power related

- Impacts of overloading on the vehicle:
  - – Exceed engine duty cycle and warranty
  - – Overloading of drive axles and differentials
  - – Increased fuel and maintenance
  - – Over heating of engine
  - – Failure engine repair/replacement

Roll stability

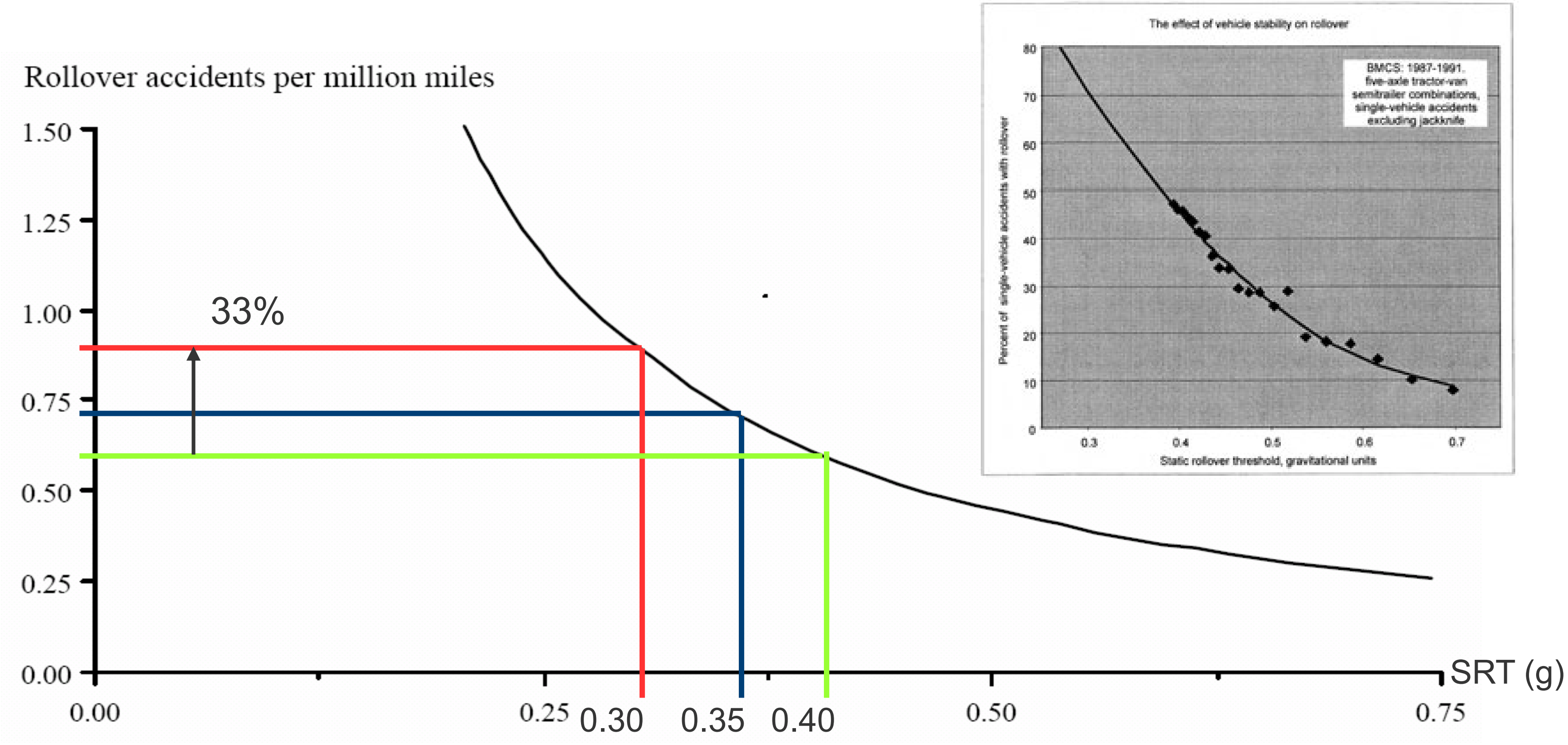
Rollover stability

- Increased risk of rollover
- Increased COG height



Rollover risk

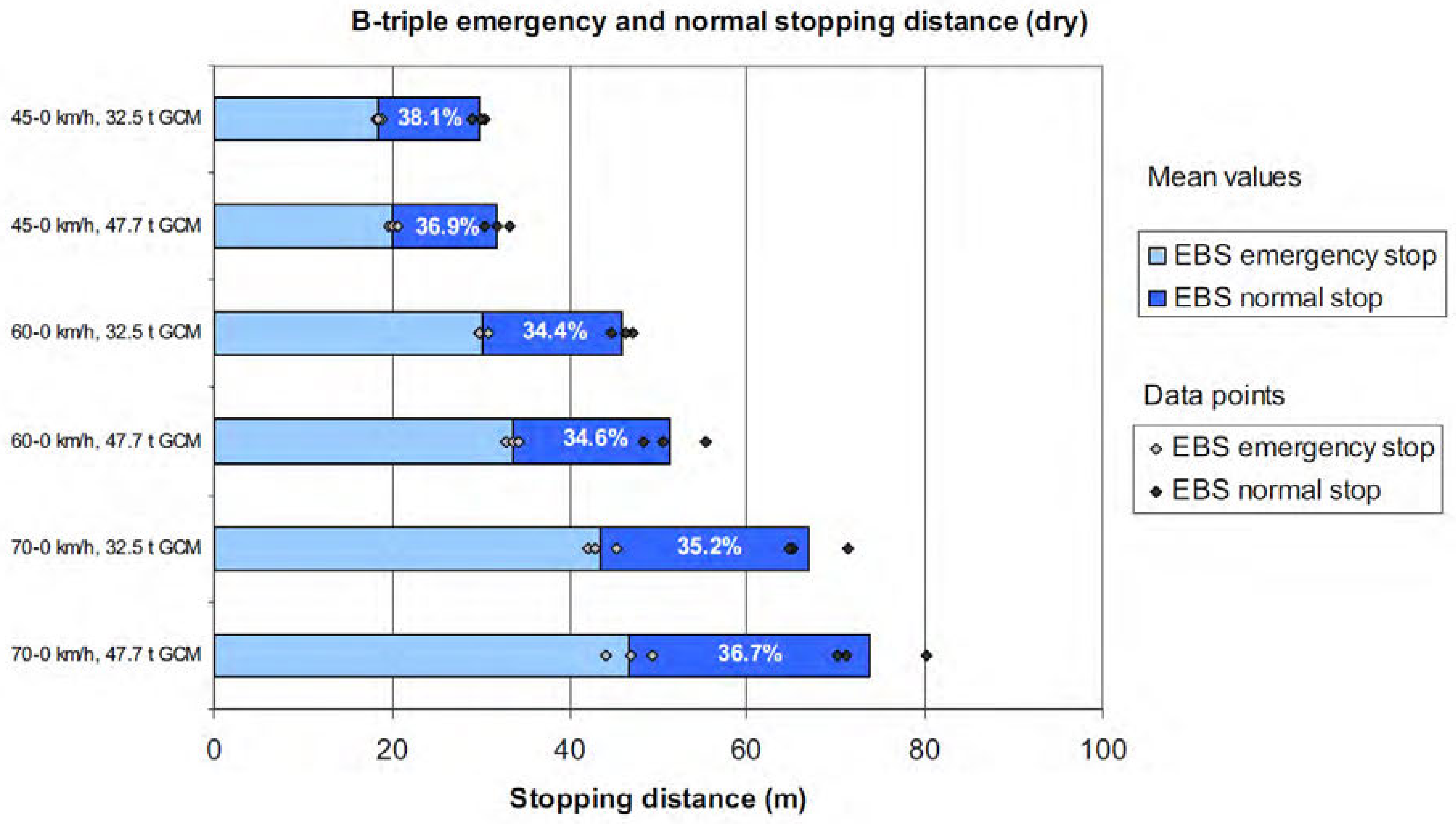
- SRT is about safety – minimising the risk.
- Strong link between SRT and crash rates.



Braking power

- Heavy vehicles require increased braking power
- The heavier the vehicle the more axles are required

Stopping distances



Source: Austroads Report AP-R347/09

Braking power related

- Impacts of overloading
  - Longer stopping distance
  - Increased risk of rear-end crashes
  - Over heating of brakes
  - Brake failure
  - Increased tyre wear – wheel lock ups

Vehicle ride and comfort

Vehicle ride and comfort

- Impacts of overloading
  - Increased cabin vibrations
  - Increased driver fatigue
  - Component failure
  - Chassis cracking

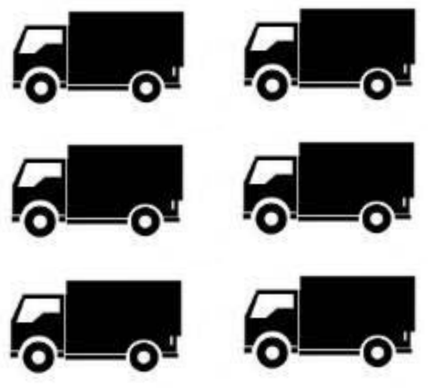
Heavy vehicle policy

- Encourage good practice
  - Vehicle fit for purpose
  - Chain of responsibility
- Provide incentives for more productive vehicles
  - New, longer and heavier with more axles
- Matching vehicles with roads
- Enforce correct loading of vehicles

Quantifying the benefits

- What is the value of more productive vehicles?
- How much does an overloaded vehicle cost?
- Who are the winners and losers?
- What should the limits be?
- What is the capacity of the network?

Quantifying the costs



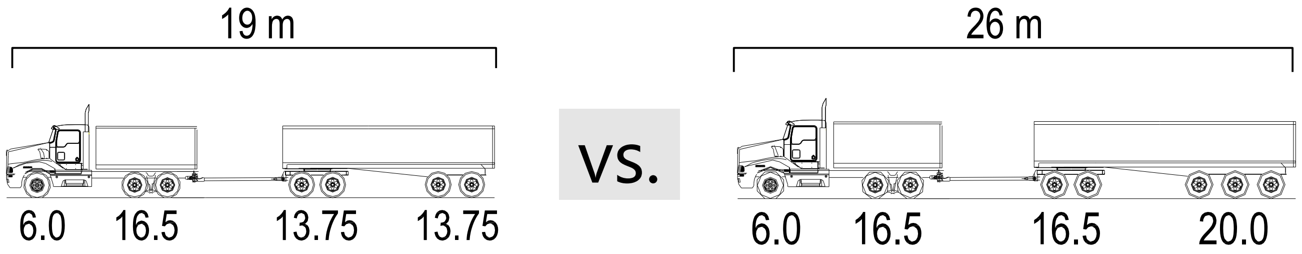
Freight task

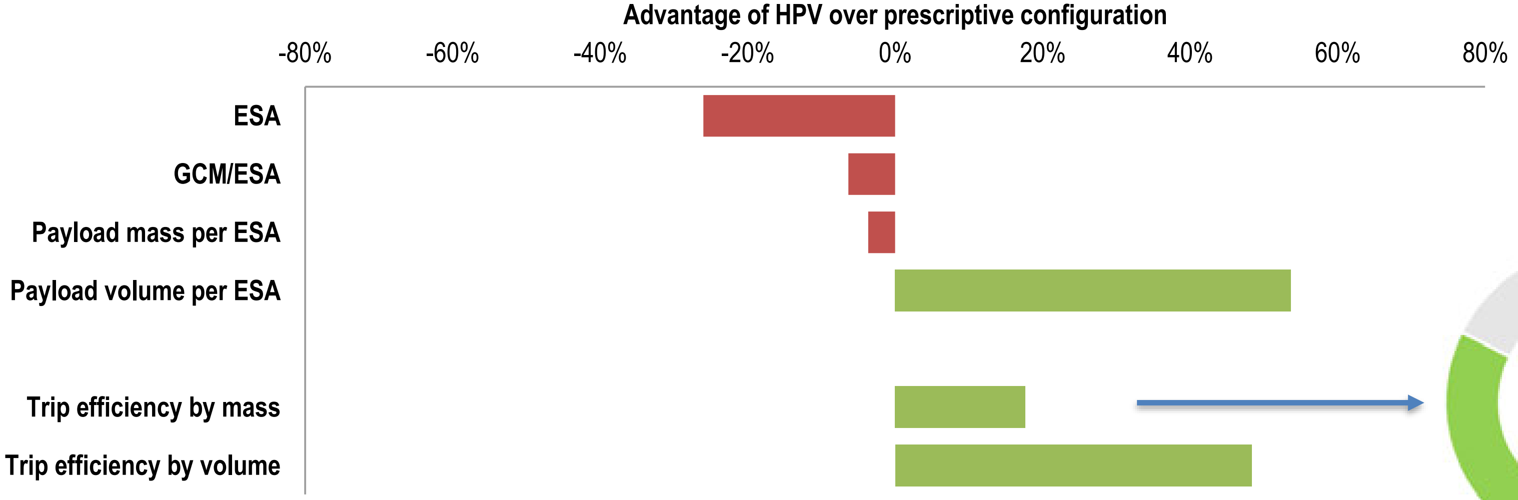
- ✓ Productivity gains
- ✓ Safety improvements
- ✓ Environmental advantages

New assessment method

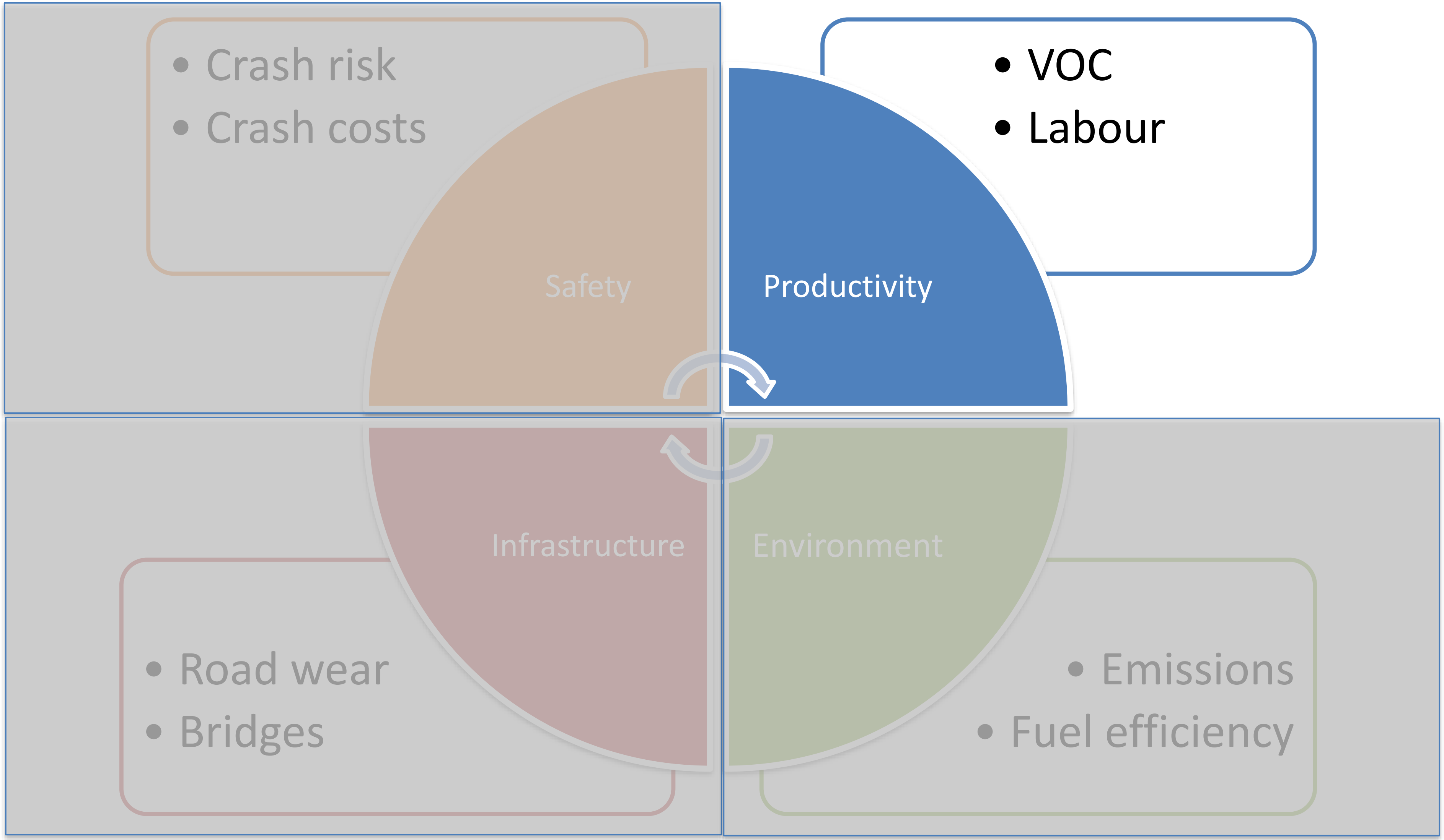
Comparing vehicle options

Fewer trips due to greater capacity





Quantifying the costs



Quantifying the productivity costs

- Vehicle operating costs (VOC)
  - fuel, oil, tyres, repairs and maintenance, depreciation (through new vehicle prices)
  - VOC models
- Labour and freight delay costs
  - vehicle occupants and freight delay per vehicle type

Quantifying the productivity costs

$$\mathrm{VOC} = BaseVOC \times \left(k1 + \frac{k2}{V} + k3 \times V^2 + k4 \times IRI + k5 \times IRI^2 + k6 * GVM\right)$$

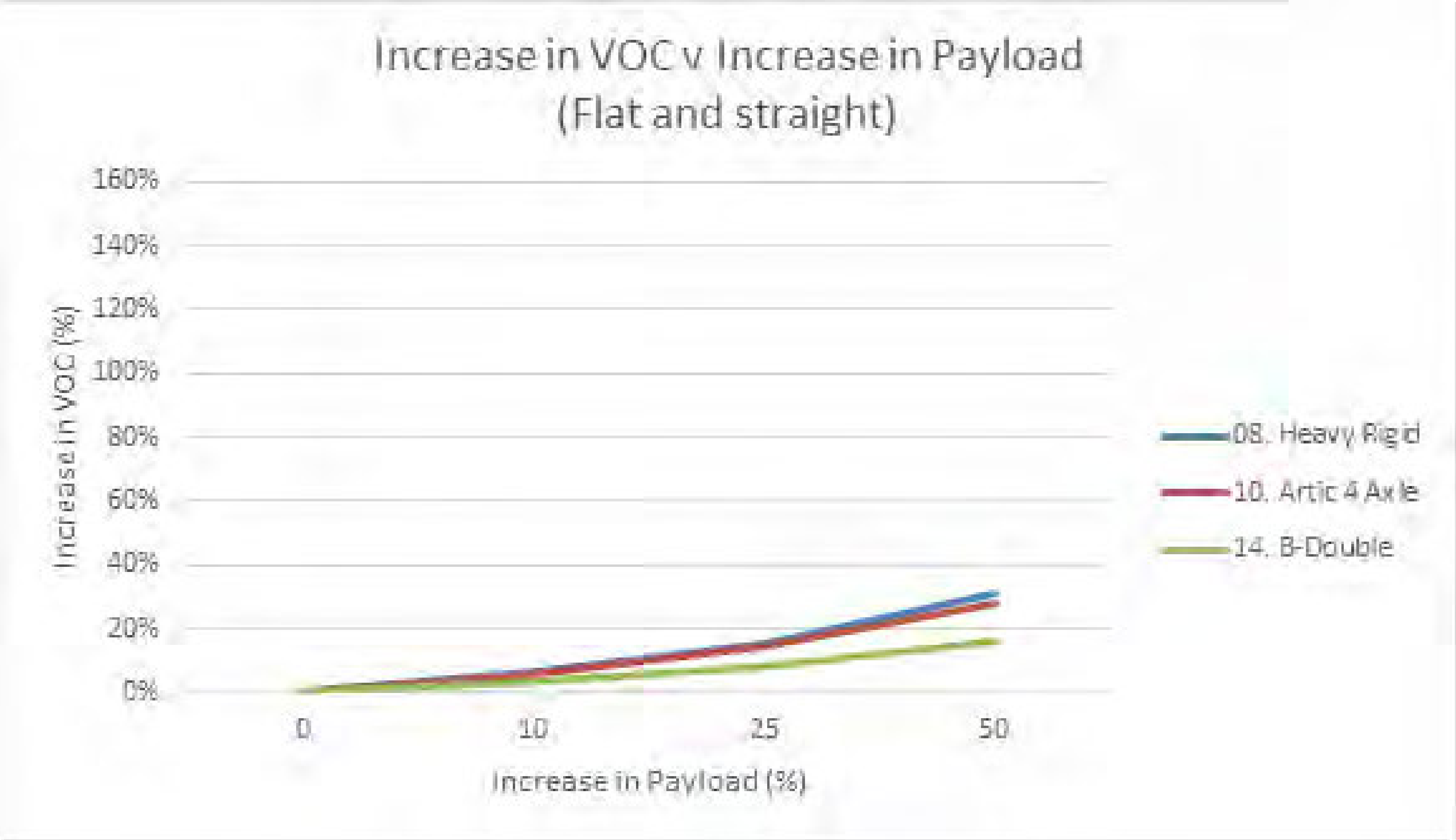
$$\mathrm{VOC} = 109.69 \times \left(0.507 + \frac{7.403}{80} + 0.001 \times 80^2 + 0.0812 \times 3.1 + 0.0001 \times 3.1^2 + 0.0039 * 59\right)$$

$$\mathrm{VOC} = 109.69 \times [1.26] = \mathbf{138.4}$$

Vehicle type	Base VOC (cents/km)	K_1	K_2	K_3	K_4	K_5	K_6
12. Artic 6 Axle	103.6022	0.491922	8.586421	2.8E-05	0.085237	0.000367	0.004082
13. Rigid + 5 Axle Dog	109.6991	0.507333	7.403231	2.75E-05	0.081194	0.000107	0.003943
14. B-Double	121.4093	0.483655	7.876344	2.41E-05	0.091051	0.000148	0.003567
15. Twin steer + 5 Axle Dog	120.4225	0.501057	7.606813	2.45E-05	0.085776	0.000191	0.003593
16. A-Double	146.9991	0.477559	7.54018	1.95E-05	0.096147	8.86E-05	0.002989
17. B Triple	170.3634	0.488334	7.864302	1.58E-05	0.097835	0.000332	0.00258
18. A B Combination	166.3673	0.475805	7.006039	1.75E-05	0.09811	-5.2E-05	0.002671
19. A-Triple	186.8652	0.480136	6.884288	1.56E-05	0.099253	-2E-05	0.002393
20. Double B-Double	189.7076	0.479935	6.579042	1.57E-05	0.098984	-0.00013	0.002361

Vehicle Operating Costs

- Impact of overloading increased VOC



Vehicle Operating Costs

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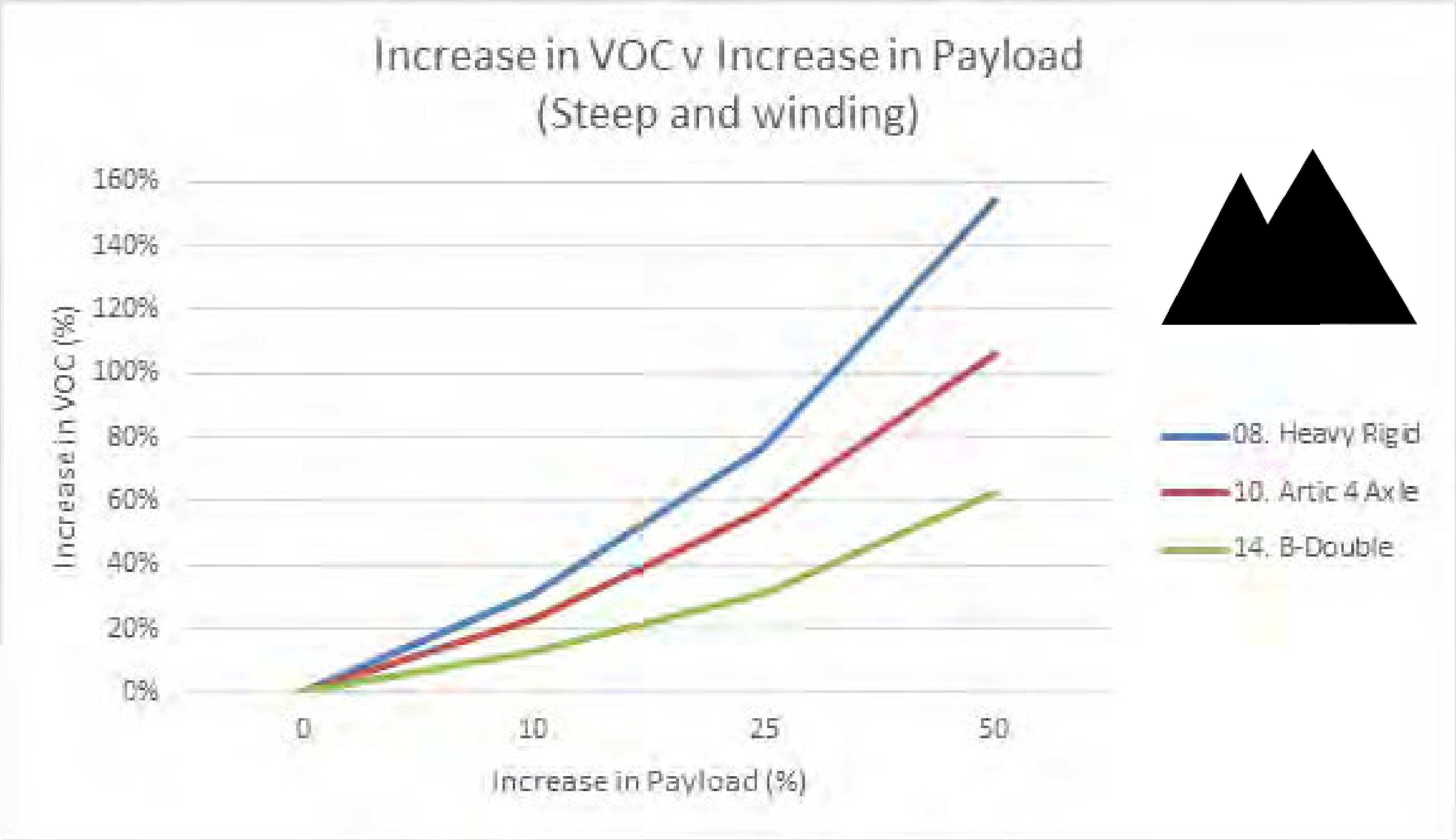
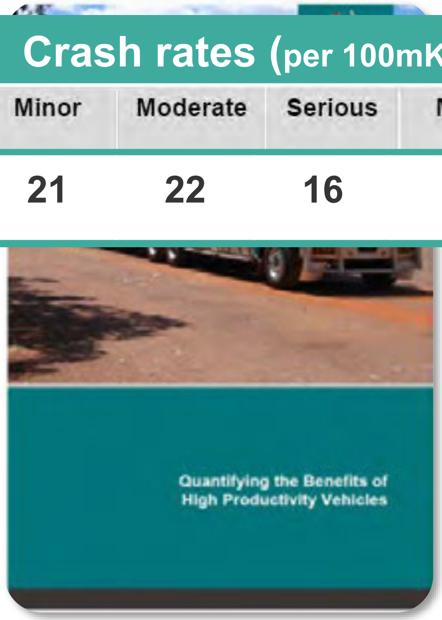


Quantifying the safety benefits

= crash rate (Austroads, 2014) x crash costs (ATAP, 2016)

=



Crash rates (per 100mKm)

Minor	Moderate	Serious	Major
21	22	16	13

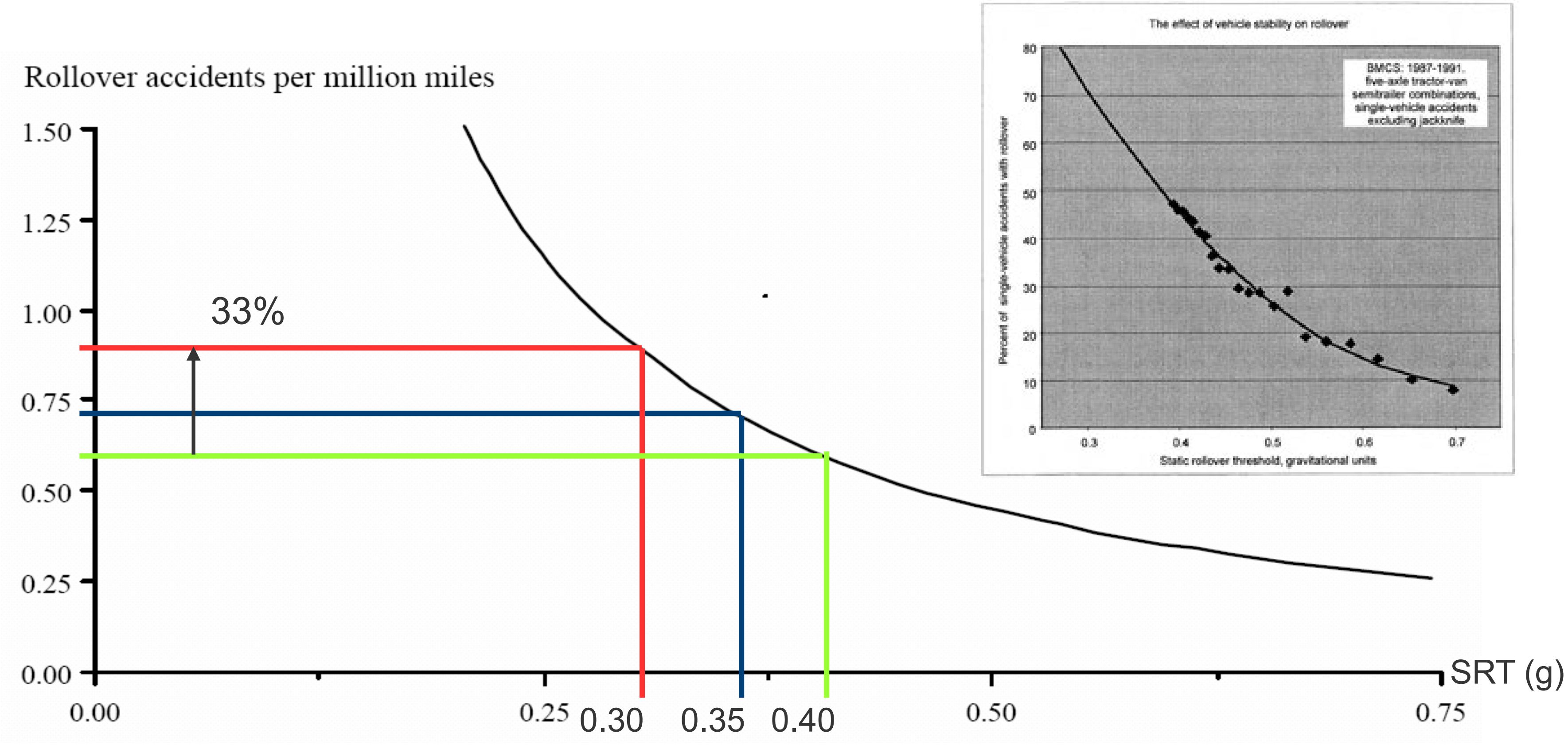
x

Minor	Moderate	Serious	Major
<$5K	$5K-$15K	$15K-$50K	>$50K
$2,500	$10,000	$32,500	$50,000

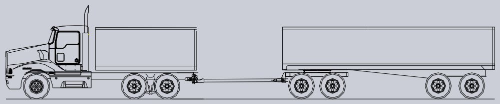
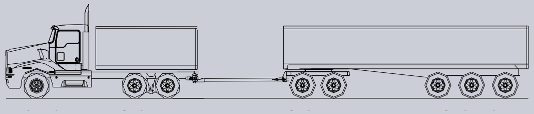
Other	Serious	Fatal
$20k	$500k	$2.2m

Rollover risk

- SRT is about safety – minimising the risk.
- Strong link between SRT and crash rates.



Quantifying environmental benefits

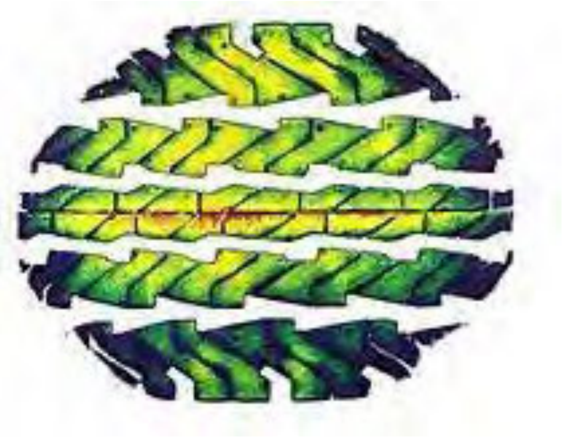
	Reference	HPV
Configuration/Load (t)		
Gross combination mass	50.0 t	59.0 t
Tare mass	17.3 t	19.3 t
Maximum payload mass	32.7 t	39.7 t
Fuel (L) per 1000 tkm	$51/32.7 \times 10 = 15.6$	$55/39.7 \times 10 = 13.9$
CO_2 (kg) per 1000 tkm	$15.6 \times 2.6712 = 41.67$	$13.9 \times 2.6712 = 37.13$
	$41.67/1000 \times 24.15 = \$1.01$	$37.13/1000 \times 24.15 = \$0.89$

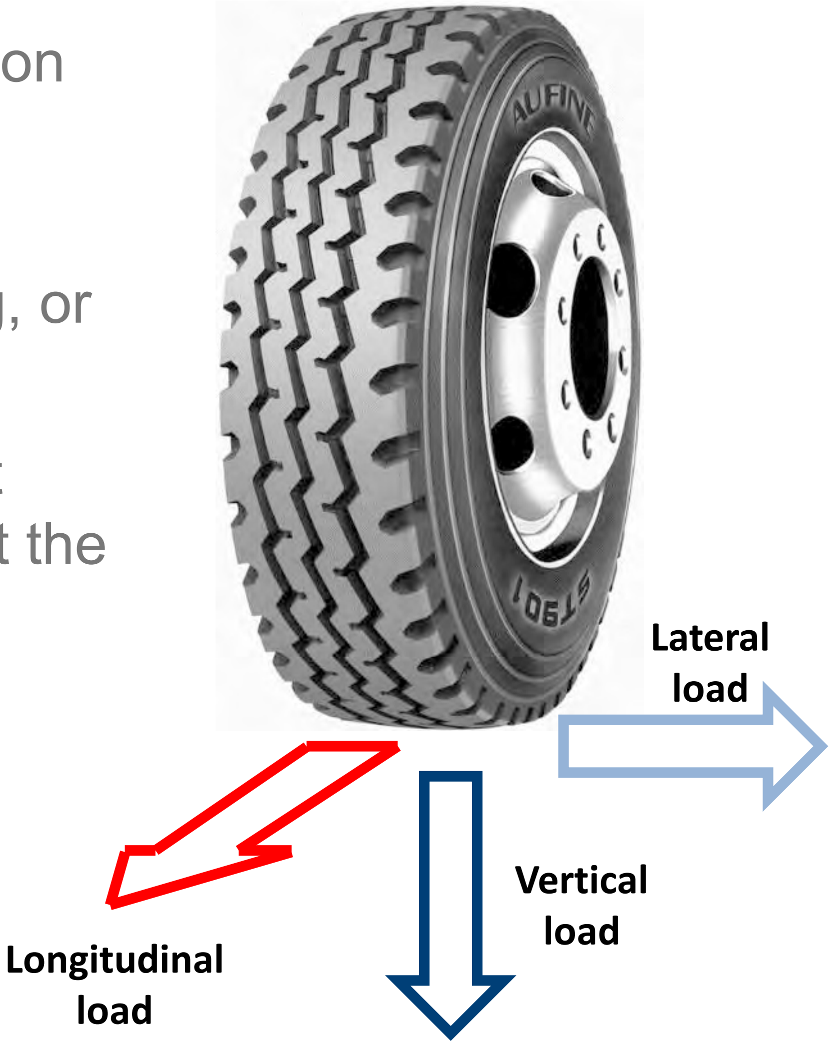
No particulates in this version.

HPV results in 12 cents saving per km

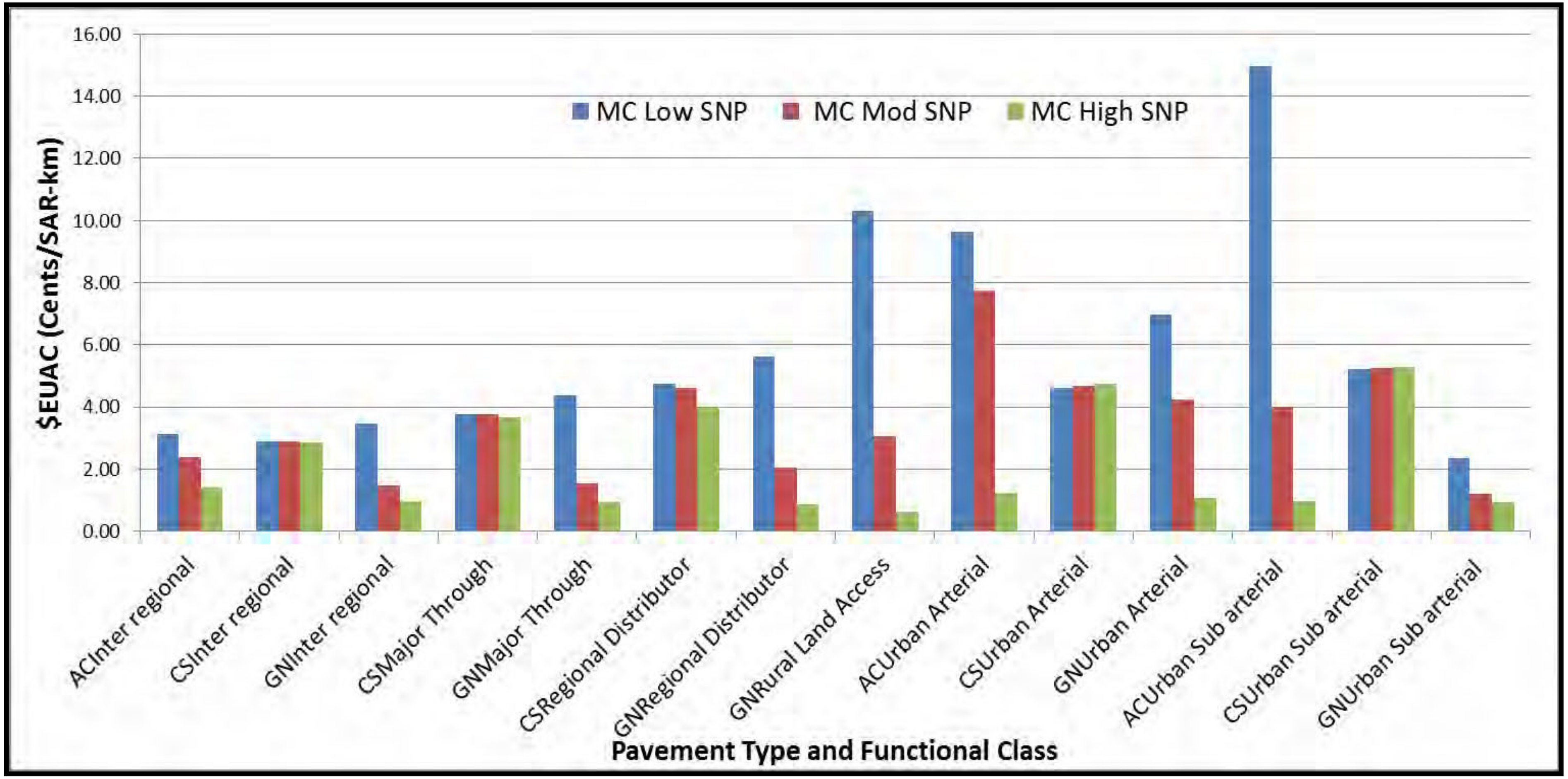
Pavements and surfaces

- Three main areas of consideration:
  - **Pavement vertical loading** (limit the stress on pavement layers)
  - **Pavement horizontal loading** (to limit road wear/damage due to scrubbing when turning, or accelerating or climbing a grade)
  - **Tyre contact pressure distribution** (to limit road wear/damage by controlling the force at the contact patch





Cost for road types



Pavement vertical loading

- Pavement rutting can be the result of:
  - Improper or poorly-controlled vertical loads
  - Poor pavement construction
  - Environmental factors

Seal surface broken

- Surface 15-25mm thick
- Base is sufficiently strong if surface is unbroken

Culverts

- Provide for water flow under road
- Decrease both run-off area and shoulder width
- Headwalls protrude above road surface
- Pre-fab sections cause sub layers to weaken

Resulted in rollover

Session summary – key points

- Vehicles must be fit for purpose
- Roads must be fit for purpose
- Matching vehicles to roads
- Promote good practise
- Encourage productivity through innovation
- Longer, heavier vehicles better equipped.