



**Asia-Pacific
Economic Cooperation**

2017/TPTWG/WKSP1/004

The Impact of Overloaded Heavy Vehicles

Submitted by: Australian Road Research Board

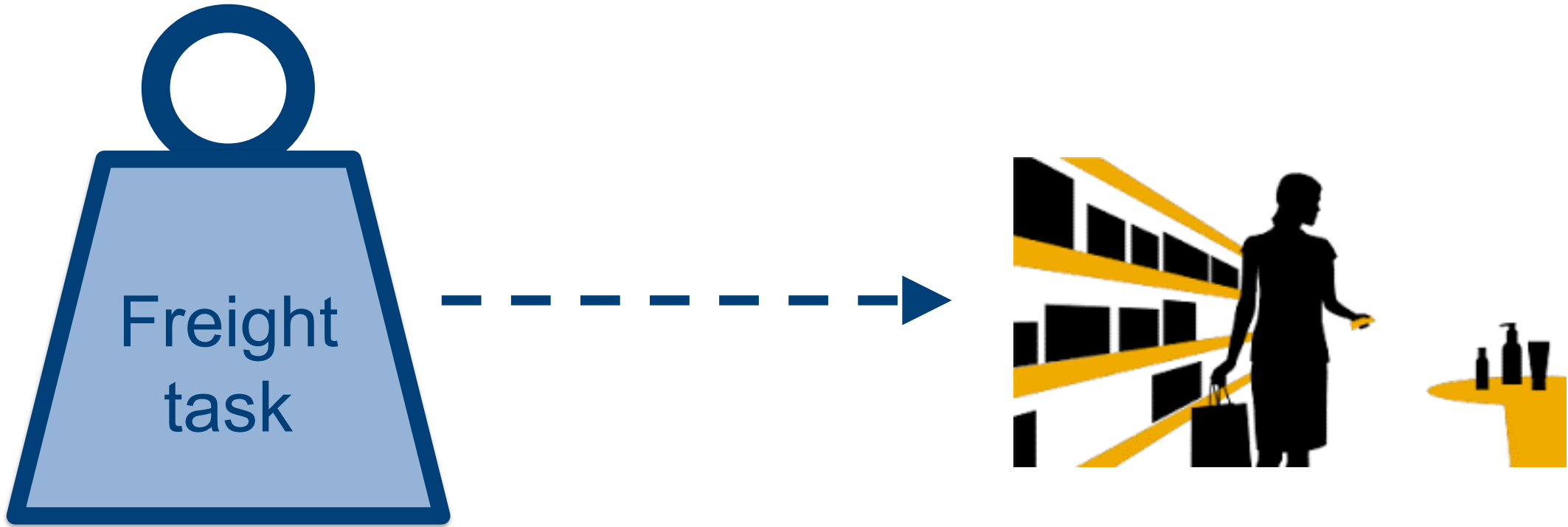


**Workshop on Regulating High Mass Heavy Road
Vehicles for Safety, Productivity and Infrastructure**

**Outcomes
Brisbane, Australia
3-6 April 2017**

The impact of overloaded heavy vehicles

The demanding freight task



Working together to deliver freight



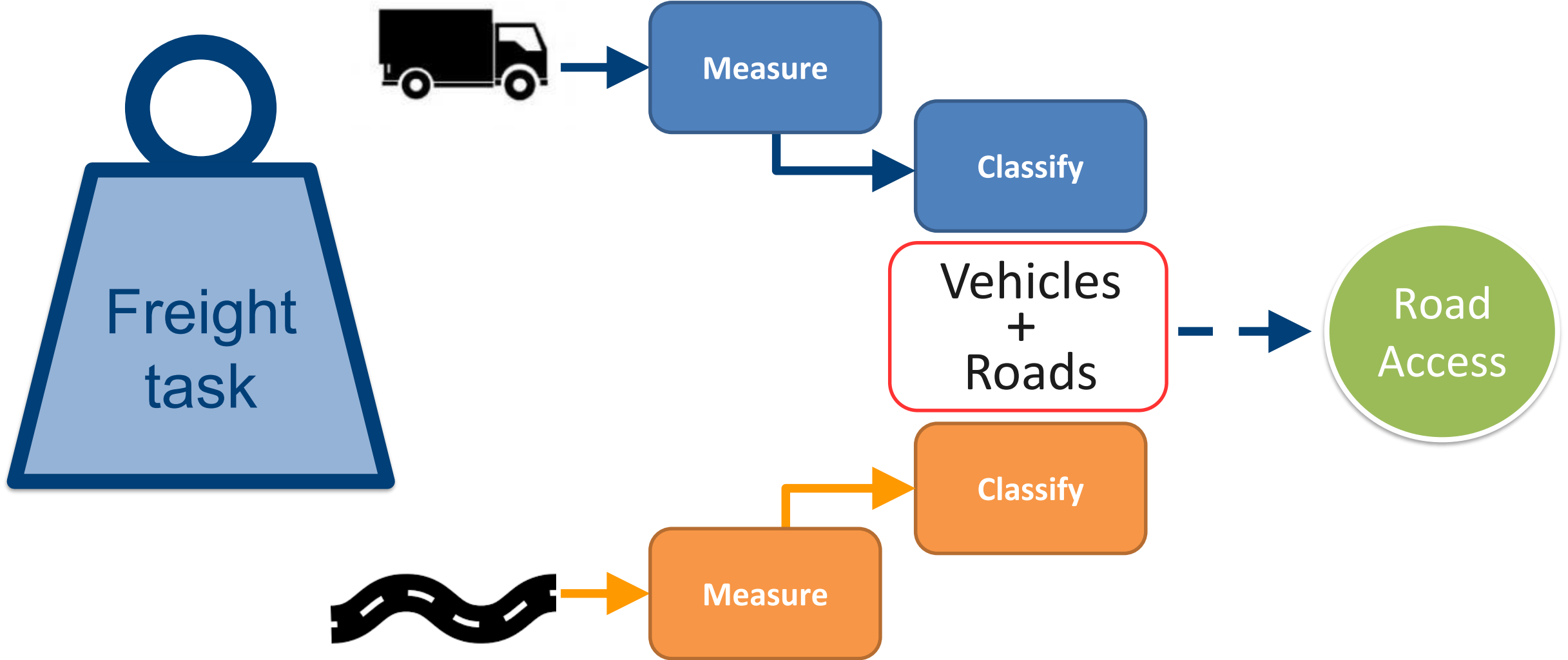
Vehicles



Roads

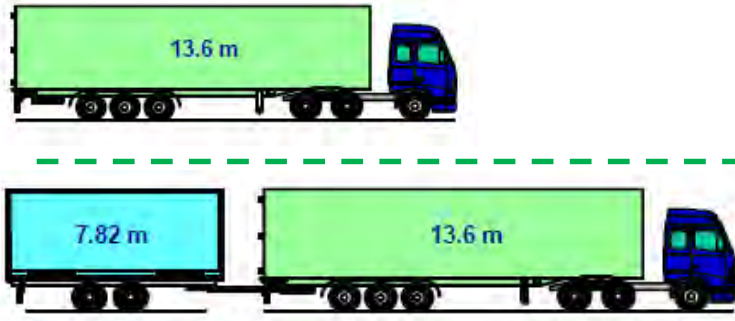


Matching the vehicle to the road

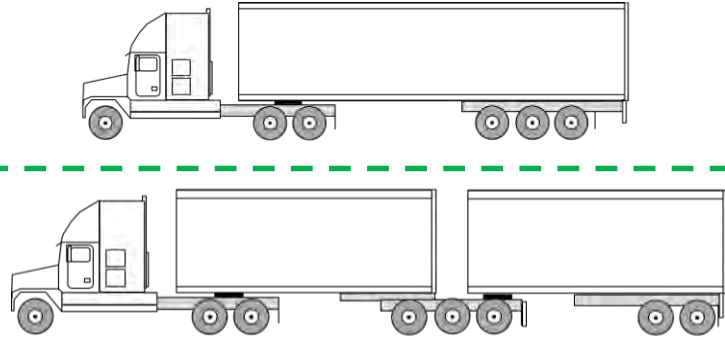


EU vs US vs AUS

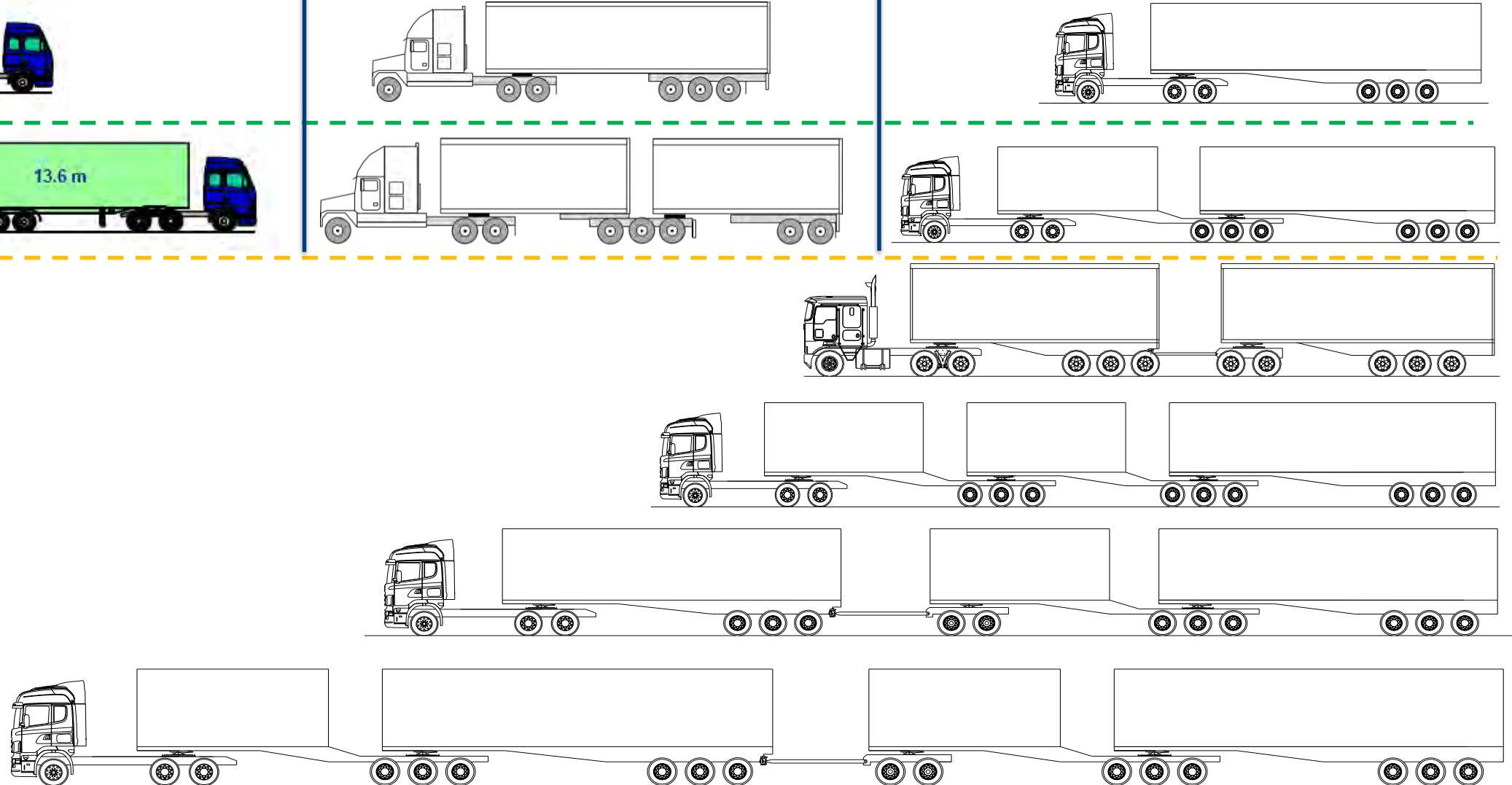
Europe



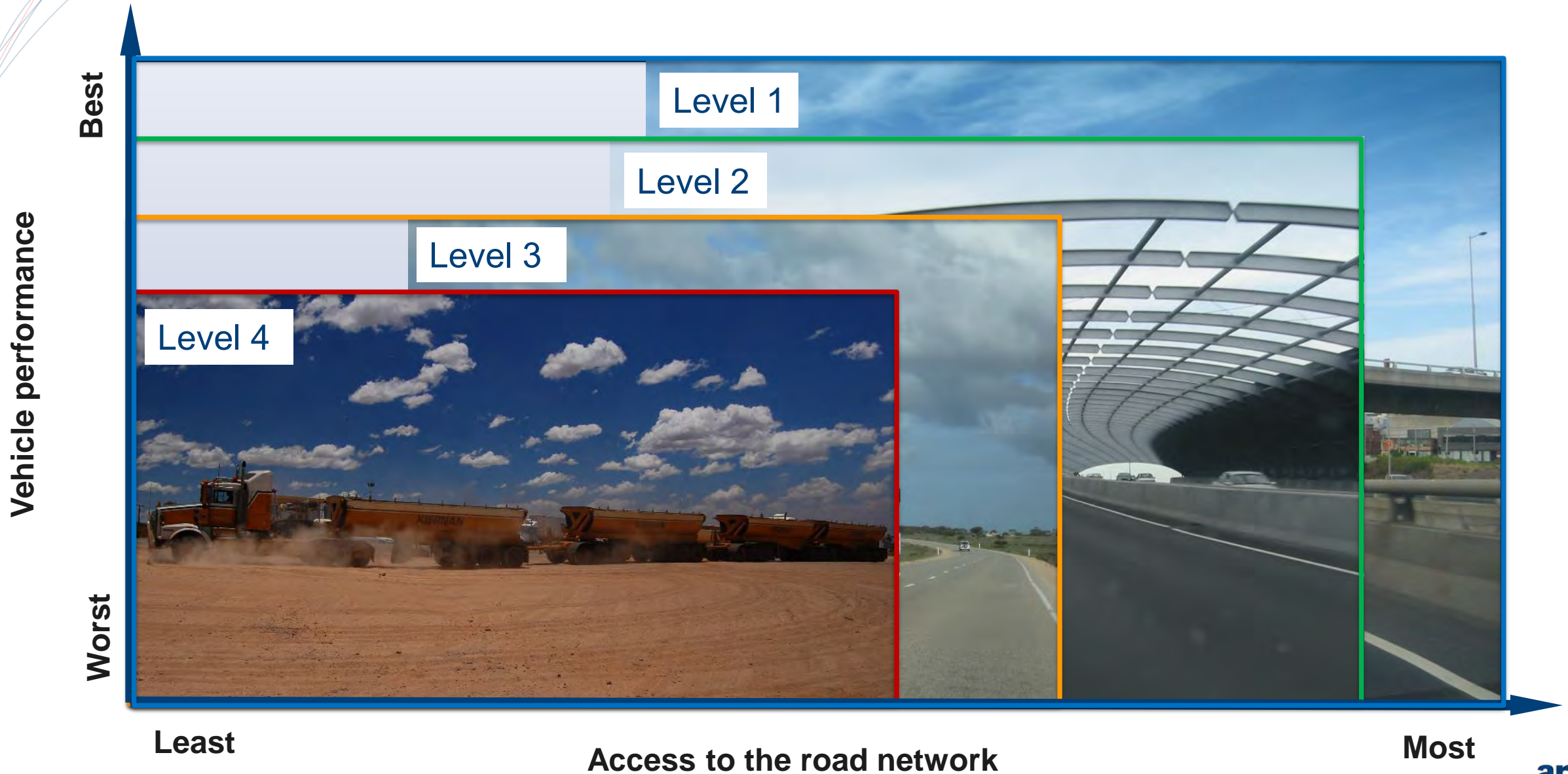
USA



Australia



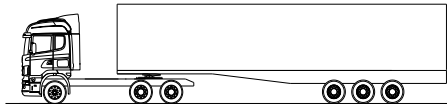
Road levels in Australia



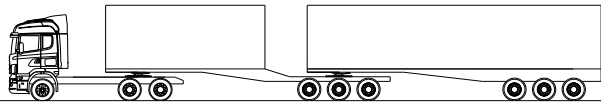
Road levels in Australia

- The road network is assessed for each Level 1, 2, 3 & 4.

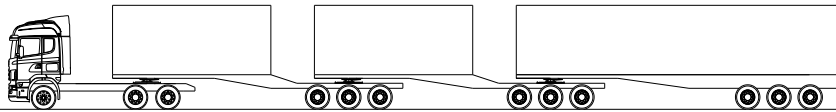
• L1 —



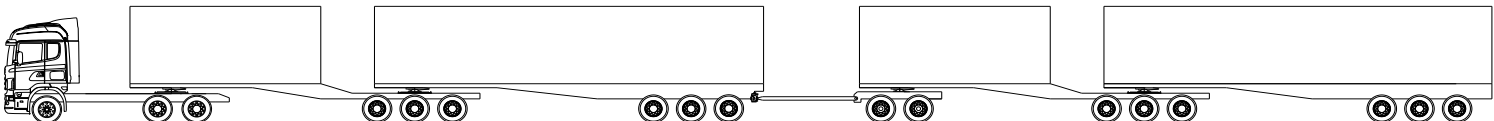
• L2 —



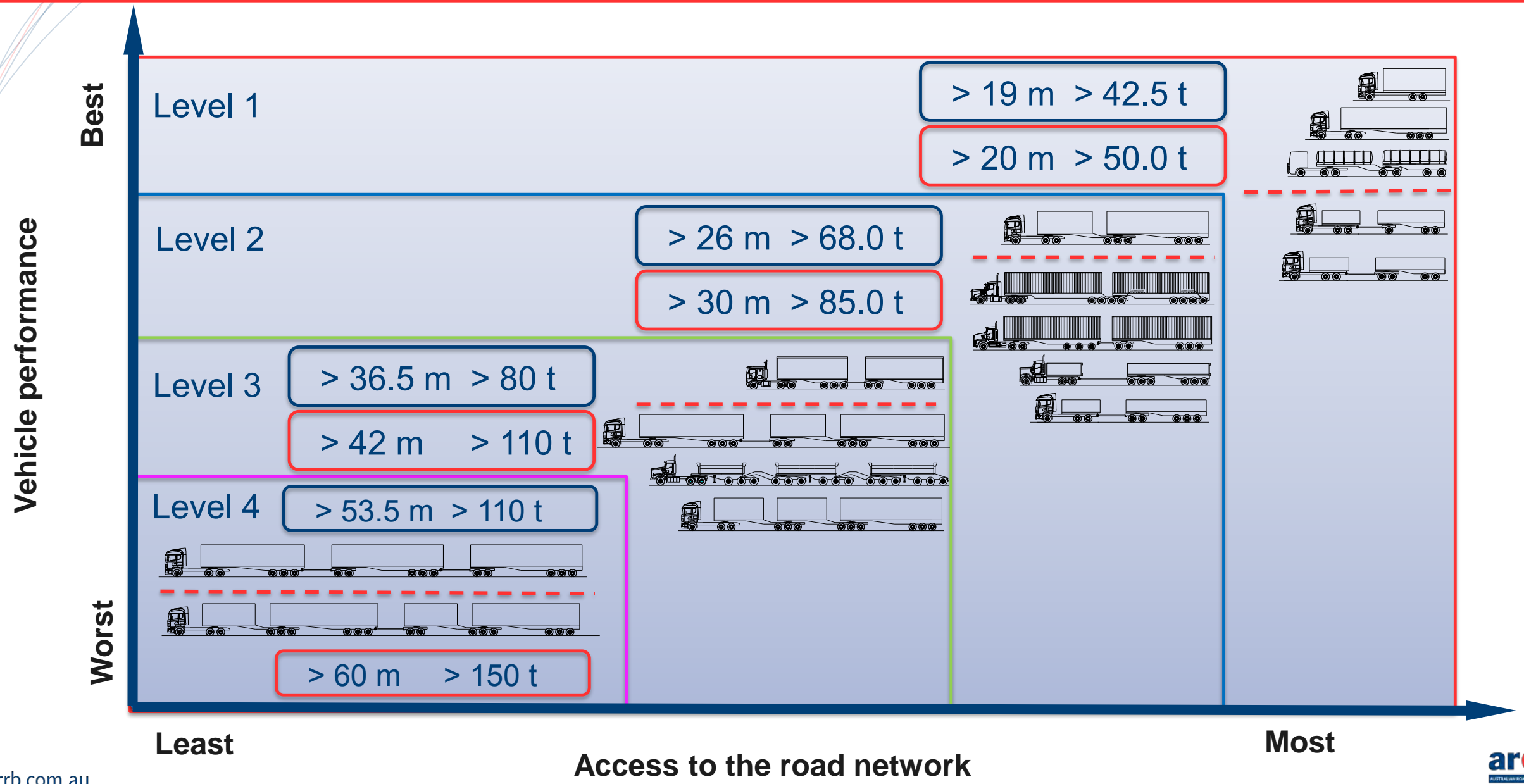
• L3 —



• L4 —



Increasing mass and length



Level 1 vehicle (unrestricted access)



Level 1 vehicle (unrestricted access)

Payload: Building materials
Length: 19.0 m
Gross mass: 48.5 tonnes



Level 2 vehicle (major highways)

Payload: Grain
Length: 23 m
Gross mass: 63 tonnes



22.5 t

17.0 t

17.0 t

6.5 t

Level 2 vehicle (major highways – port precinct)

Load: Containers
Length: 30.0 m
Gross mass: 77.5 tonnes
Access: Level 2



27.0 t

27.0 t

17.0 t

6.5 t

Level 2 vehicle (major highways – cotton harvest)

Load: Containers

Length: 30.0 m

Gross mass: 79.5 tonnes

Access: Level 2



Level 4 vehicle (remote areas)

Load: Mineral sands

Length: 37.5 m

Gross mass: 130 tonnes

Access: Level 4



Level 4 - Quad road train

Load: General freight

Length: 53.5 m

Gross mass: 130 tonnes

Access: Level 4



Level 3 – AAB Quad road train

Load: Sulphuric Acid

Length: 53.5 m

Gross mass: 160 tonnes

Access: Level 4



Axle group limits



Vertical loading of pavement

6.5 t

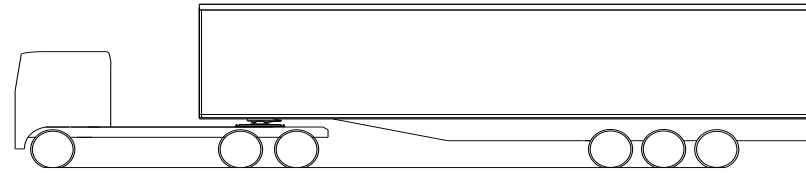


ESA = 5.4 t

ESA method – standard axles

Axle	Axle type	Reference load (t)
I	Single axle (single tyres)	5.40
I	Single axle (dual tyres or super singles)	8.20
II	Tandem axle (single tyres)	9.18
II	Tandem axle (dual tyres or super singles)	13.80
III	Triaxle (dual tyres or super singles)	18.50
III	Quad axle (dual tyres or super singles)	22.50

ESA calculation method



5.4
6.0

13.8
16.5

18.5
20.0

3 axles
4.9 axles

$$\text{Steer axle ESA} = \left(\frac{5.4}{5.4} \right)^4 = 1$$

$$\text{Steer axle ESA} = \left(\frac{6.0}{5.4} \right)^4 = 1.52$$

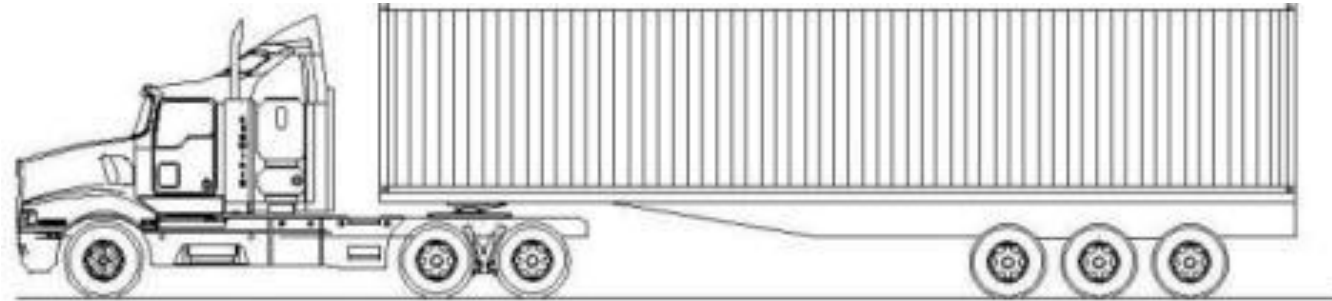
$$\text{Drive axle ESA} = \left(\frac{13.8}{13.8} \right)^4 = 1$$

$$\text{Drive axle ESA} = \left(\frac{16.5}{13.8} \right)^4 = 2.04$$

$$\text{Triaxle ESA} = \left(\frac{18.5}{18.5} \right)^4 = 1$$

$$\text{Triaxle ESA} = \left(\frac{20.0}{18.5} \right)^4 = 1.36$$

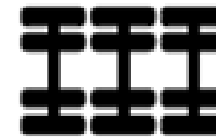
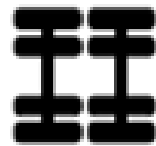
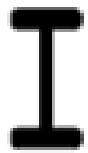
Conventional Australian heavy vehicles



6.0

16.5

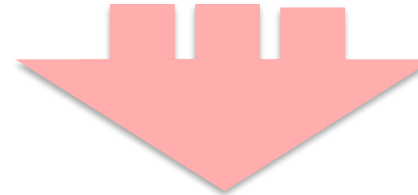
20.0



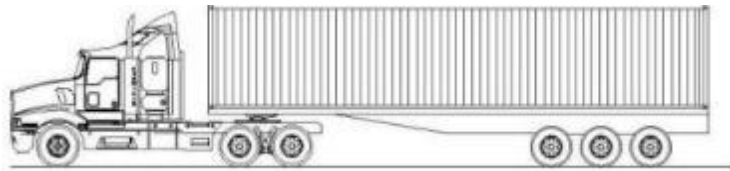
3.0

2.06

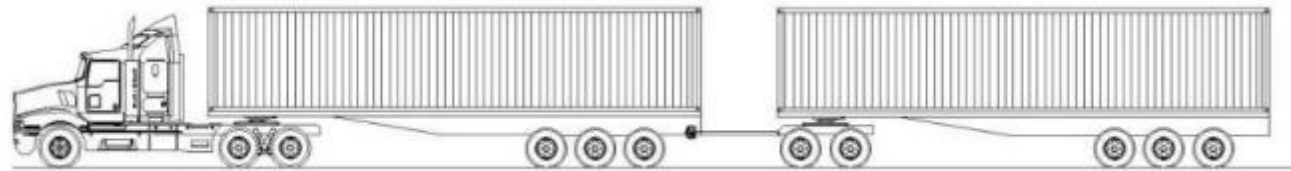
1.11 tonnes per tyre



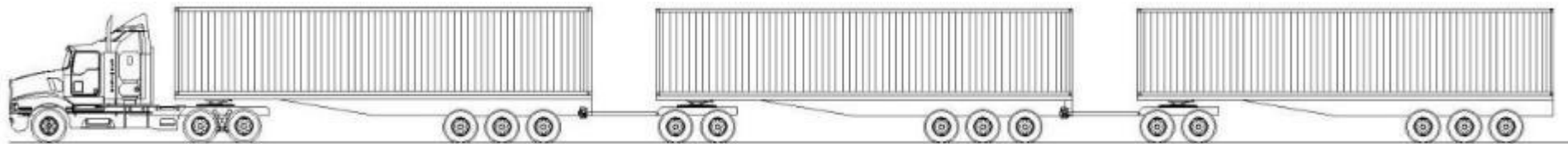
Conventional Australian heavy vehicles



6.5 16.5 20.0

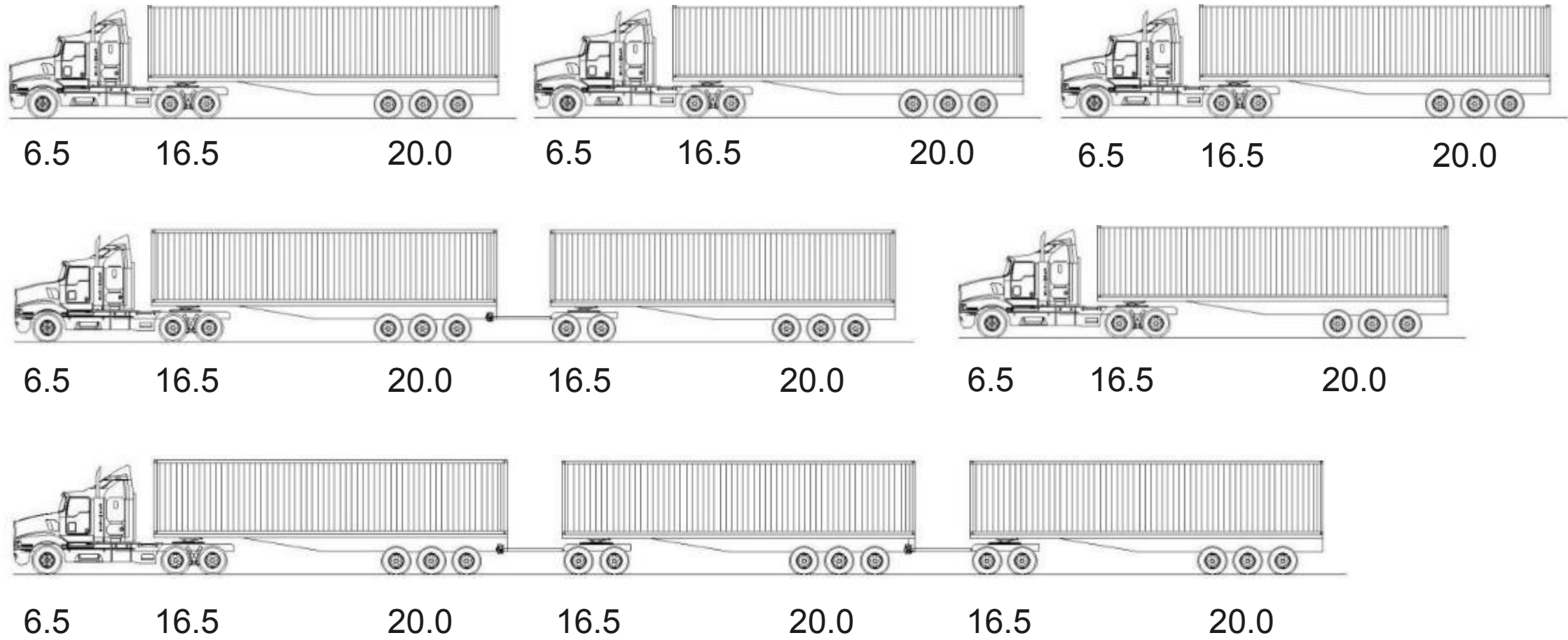


6.5 16.5 20.0 16.5 20.0

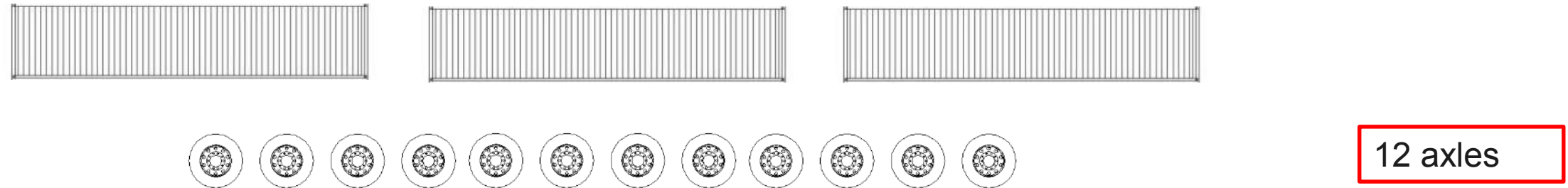
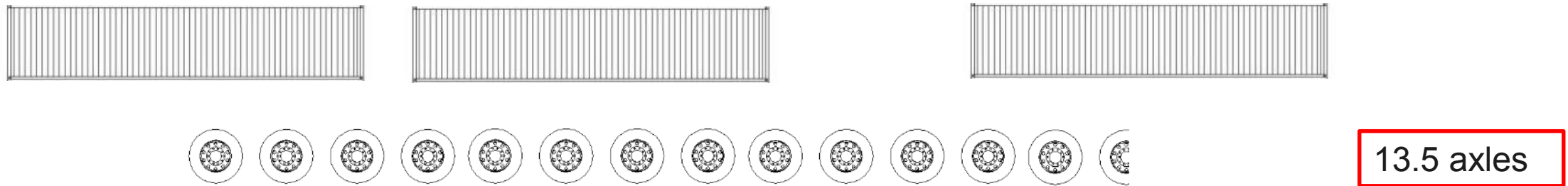
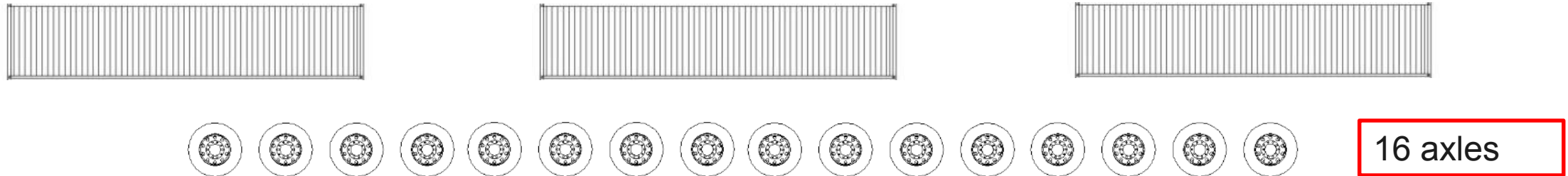


6.5 16.5 20.0 16.5 20.0 16.5 20.0

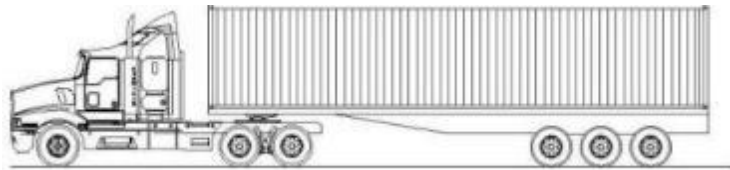
Conventional Australian heavy vehicles



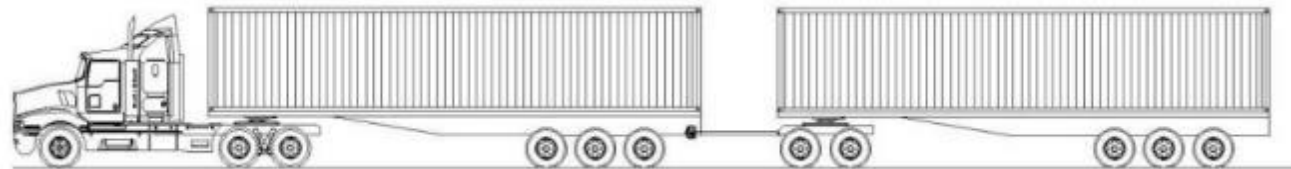
Conventional Australian heavy vehicles



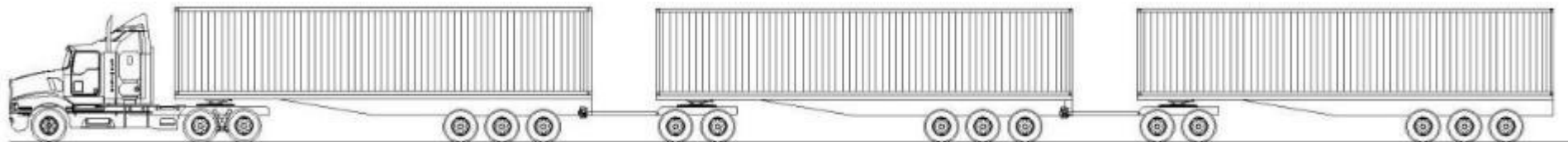
Conventional Australian heavy vehicles



6.5 16.5 20.0

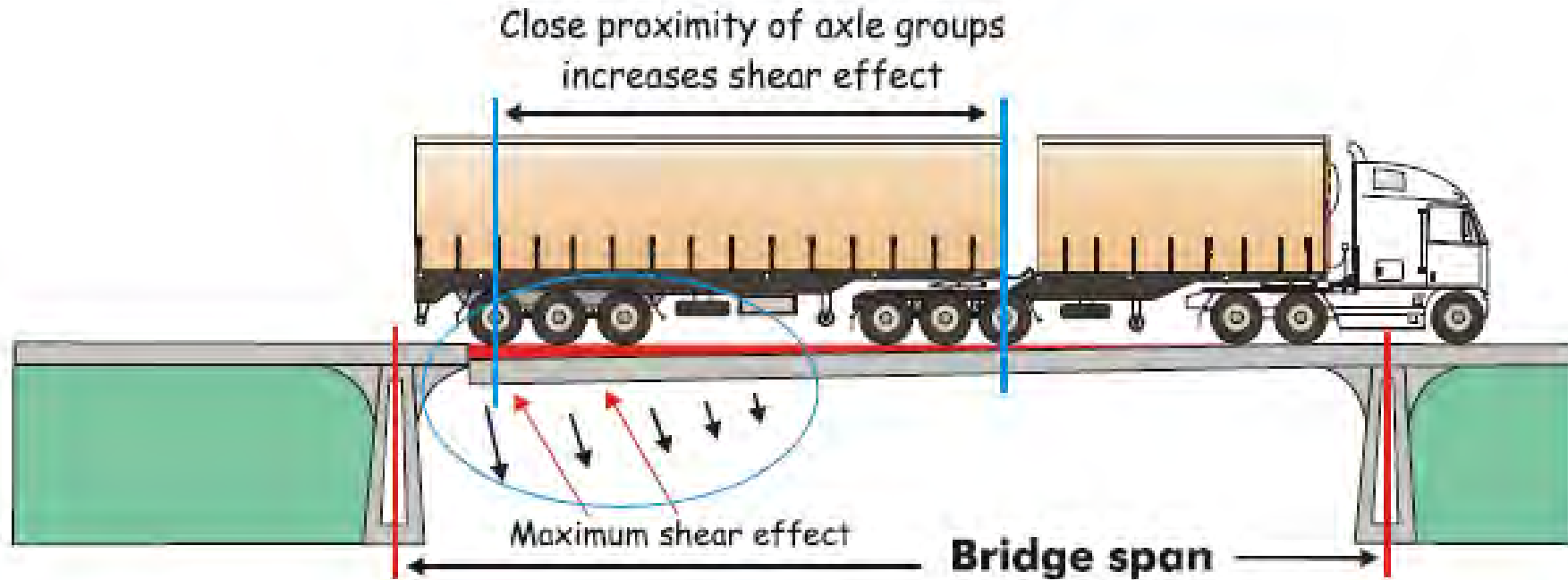


6.5 16.5 20.0 16.5 20.0



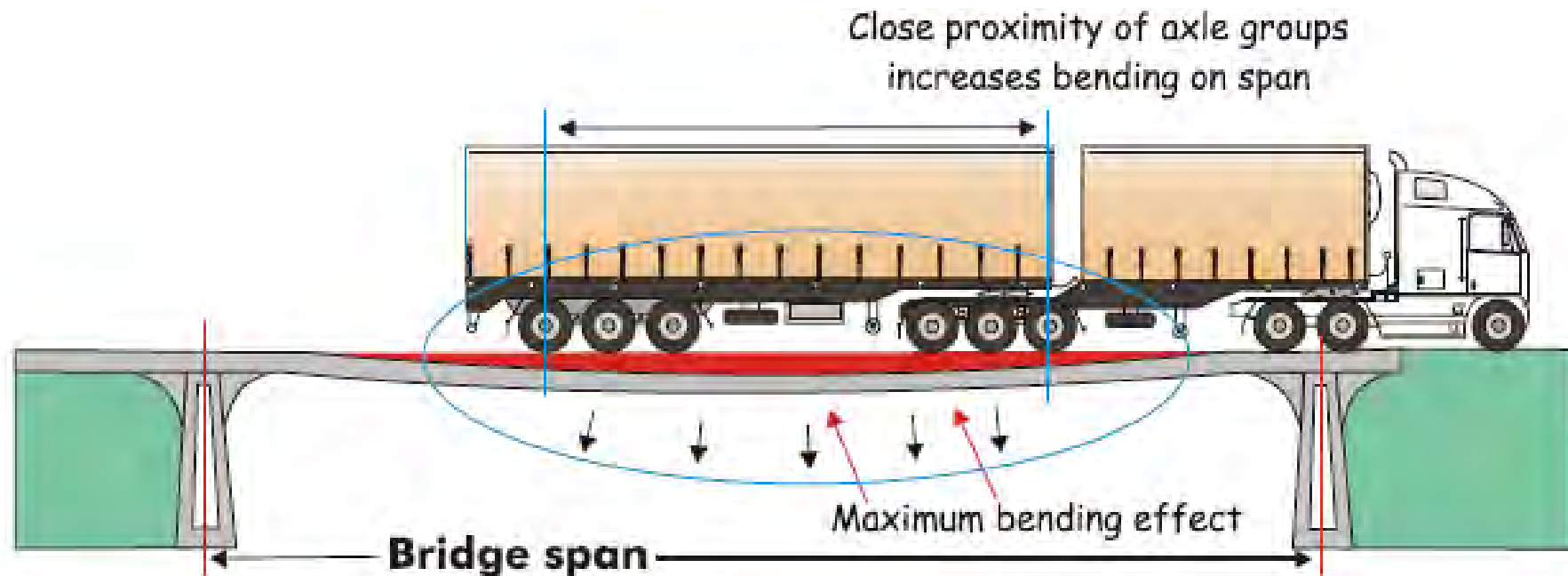
6.5 16.5 20.0 16.5 20.0 16.5 20.0

Impacts on bridges – shear force



Source: ARTSA (2003)

Impacts on bridges – bending moment



Source: ARTSA (2003)

Access to the PBS Level 1 road network

$$M = 3L + 12.5 \quad \text{for } M \leq 42.5 \text{ t; and}$$

$$M = L + 32.5 \quad \text{for } M \geq 42.5 \text{ t}$$

Access to the PBS Level 2 road network

$$M = 3L + 12.5 \quad \text{for } M \leq 46.5 \text{ t; and}$$

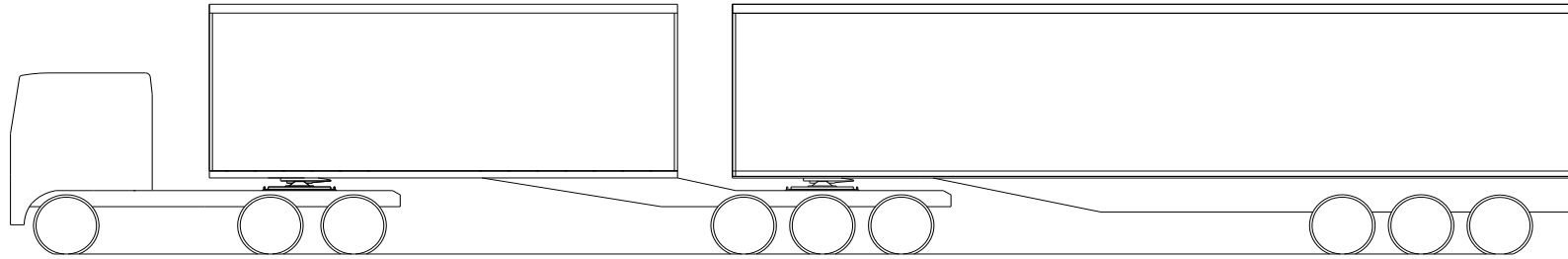
$$M = 1.5L + 29.5 \quad \text{for } M \geq 46.5 \text{ t}$$

Access to the PBS Level 3 and Level 4 road networks

$$M = 3L + 12.5 \quad \text{for all } M$$

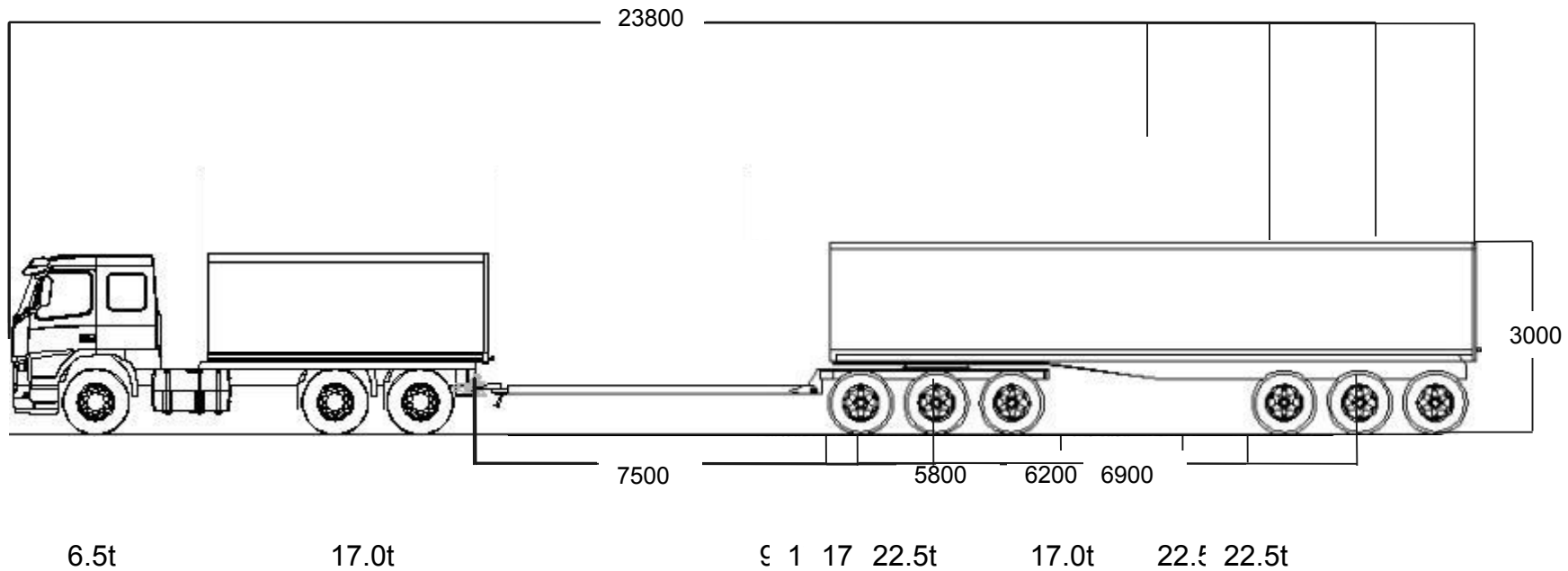
Source: NTC (2007)

Bridge formula



- ✓ Axles 1 to 3
- ✓ Axles 1 to 6
- ✓ Axles 2 to 6
- ✓ Axles 4 to 9
- ✗ Axles 2 to 9
- ✗ Axles 1 to 9

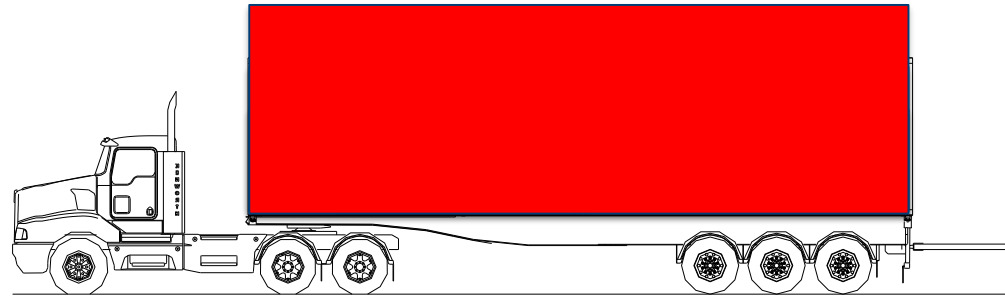
Bridge formula check



GCM: 68.5t

Efficiency gain = new payload/old payload
= ~~46.0 t~~ / 35.0t
= ~20% increase

Load calculations



Axle group mass (t)		Axle group mass (t)		Axle group mass (t)		Axle group mass (t)	
5.4	13.58	18.5	24.5	32.1			
6.5 t	16.5 t	20 t	43.0 t				
2.1	2.06	1.38	5.5 axles				
Axle group mass (t)		Axle group mass (t)		Axle group mass (t)		Axle group mass (t)	
7.0	18.5	22	42.0	47.5	42.0	+10%	42.0
2.8	3.3	2.4	8.5 axles	+35%			
7.5 t	20.5 t	25 t	53.0 t	+20%			
Axle group mass (t)		Axle group mass (t)		Axle group mass (t)		Axle group mass (t)	
3.7	4.9	3.4	42.0	34.0	34.0	+50%	34.0

Vehicle Manufacturer ratings

Specification	Vehicle 1	Vehicle 2	Vehicle 3
Application	Road train (tandem drive)	B-double	Truck and trailer
Make	Scania	Volvo	Mercedes
GVM	28,500 kg	27,700 kg	26,000 kg
GCM	130,000 kg	70,000 kg	55,000 kg
Steer axle capacity	7500 kg	6700 kg	7500 kg
Suspension capacity	7500 kg	6700 kg	7100 kg
Steer tyre capacity	8500 kg	7100 kg	7100 kg
Steer rims capacity	8500 kg	7300 kg	7300 kg
Front axle assembly rated capacity	7500 kg	6700 kg	7100 kg

Effect on vehicle Performance

