OPTIMISATION OF NEW ZEALAND'S HEAVY VEHICLE FLEET

John de Pont

Neon Taramoeroa

TERNZ
TRANSPORT RESEARCH

Aims

- Benchmark NZ vehicles against those from other countries
  - Pavement Wear
  - Bridge Wear
  - Road Space
  - Safety
- Identify opportunities for improvement

TERNZ
TRANSPORT RESEARCH

Scope -Geography

- Five Countries
  - Australia (Au)
  - Canada (Ca)
  - New Zealand (NZ)
  - Southeast Asia (SEA)
  - United Kingdom (UK)

TERNZ
TRANSPORT RESEARCH

Scope – Transport Tasks

- Six Transport Tasks
  - Passenger Coach (PC)
  - Bulk Liquids (BL)
  - Bulk Materials (BM)
  - 40 foot Intermodal Containers (IC)
  - Livestock (LS)
  - Refrigerated Goods (RG)

TERNZ
TRANSPORT RESEARCH

Vehicle Configurations

- Weights & Dimensions
  - Based on respective National Regulations
  - SEA Same as UK which is based on European.
- Payload Spaces
  - Elliptical Tanks – Liquids
  - Rectangular Cuboids

TERNZ
TRANSPORT RESEARCH

Task ID	Country				
	Au	Ca	NZ	SEA	UK
PC	50p, 12.5m, 19.75t, 3-axle	55p, 14m, 21.68t, 3-axle	50p, 12.6m, 19.75t, 3-axle	44p, 12m, 17.62t, 2-axle	52p, 13.8m, 20.46t, 3-axle
BL	26m, 68t, 9-axle, B-double	19m, 46.5t, 5-axle, semi	20m, 44t, 8-axle, truck trailer	7.54m, 24t, 3-axle, truck	16.5m, 40t, 5-axle, semi
BM	19m, 42.5t, 6-axle, truck trailer	16.5m, 46.5t, 6-axle, semi	20m, 44t, 7-axle, truck trailer	6.84m, 24t, 3-axle, truck	16.5m, 40t, 5-axle, semi
IC	16m, 43.3t, 6-axle, semi	17m, 43.6t, 6-axle, semi	16m, 39t, 6-axle, semi	15m, 34t, 4-axle, semi	15.5m, 42.86t, 6-axle, semi
LS	26m, 68t, 9-axle, B-double	20m, 39.5t, 5-axle, semi	20m, 44t, 8-axle, truck trailer	7.54m, 21t, 3-axle, truck	16.5m, 40t, 5-axle, semi
RG	26m, 68t, 9-axle, B-double	20m, 39.5t, 5-axle, semi	18m, 44t, 8-axle, semi	7.54m, 22t 3-axle, truck	16.5m, 40t, 5-axle, semi

Methodology

- Vehicles simulated using Yaw-Roll multi-body simulation software originally developed at UMTRI
- Performance measures were evaluated using the Australian PBS specifications
- Compound performance measures were developed to produce ratings for comparison

TERNZ
TRANSPORT RESEARCH

Pavement Wear Performance

- Derived from
  - Standard Axle Repetitions (SAR)
  - Payload (PLD)
  - Axle Group Weight (w)
  - Reference Axle Group Weight (W)
  - Number of Axle Groups (N)

$$Pavement\ Performance = \frac{1}{SAR} \times PLD, \text{ where } SAR = \sum_{n=1}^{N} \left(\frac{w_n}{W_n} \right)^4$$

TERNZ
TRANSPORT RESEARCH

Bridge Wear Performance

- Derived from
  - Peak Bending Moment (PBM)
  - Payload (PLD)
  - Reference Span of 12.5m
  - Simply-Supported Metal Girder
  - Axle Loads modelled as Point Loads

$$Bridge\ Performance = \frac{1}{PBM^3} \times PLD$$

Road Space Performance

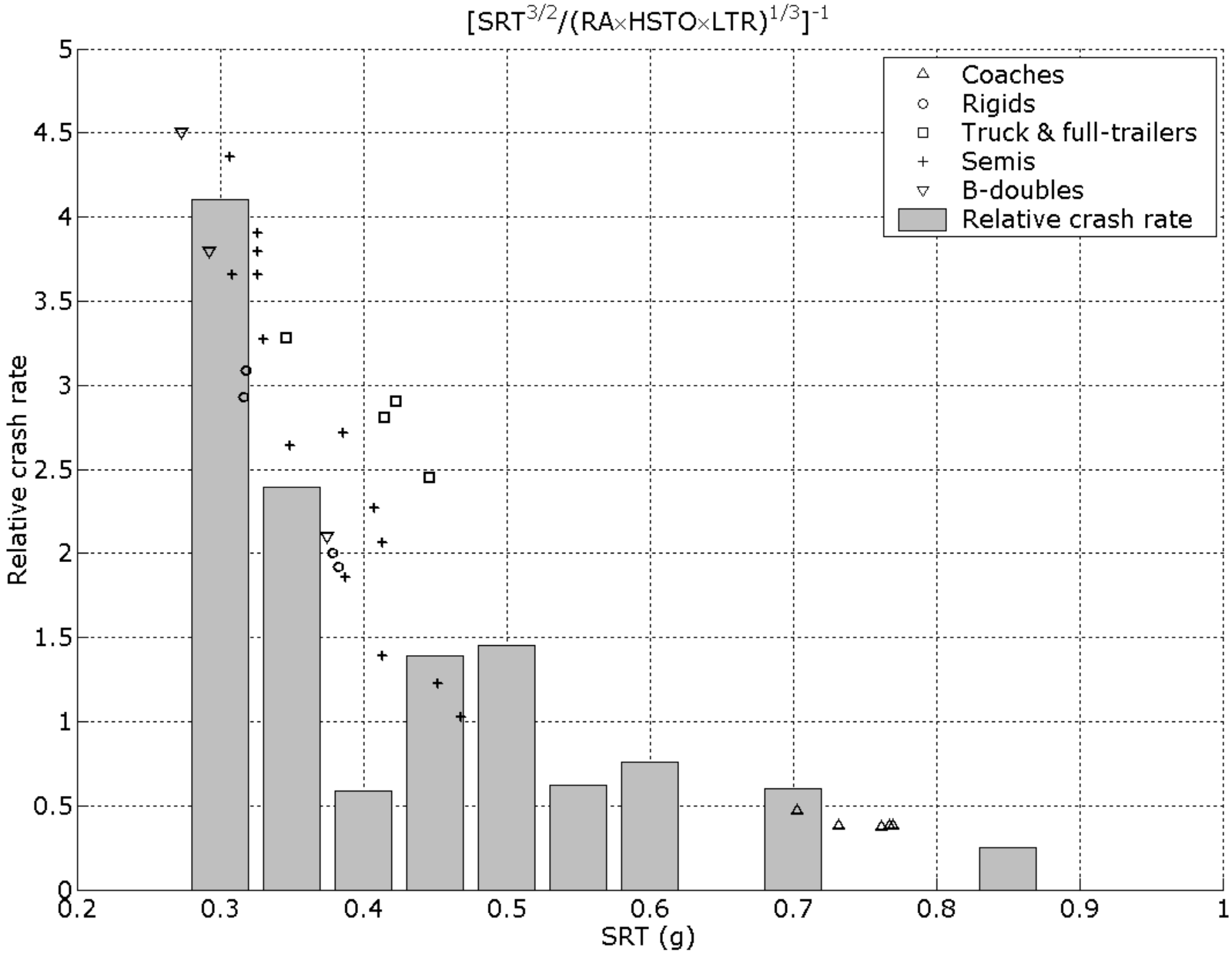
- Derived from
  - Low-Speed Offtracking (LSO)
  - High-Speed Offtracking (HSO)
  - Payload (PLD)

$$Road\ Space\ Performance = \frac{1}{(LSO \times HSO)^2} \times PLD$$

Safety Performance

- Derived from
  - Rearward Amplification (RA)
  - High-Speed Transient Offtracking (HSTO)
  - Load Transfer Ratio (LTR)
  - Static Rollover Threshold (SRT)
  - Payload (PLD)

$$Safety\ Performance = \frac{SRT^{3/2}}{(RA \times HSTO \times LTR)^{1/3}} \times PLD$$



reciprocal of the compound safety measure multiplied by PLD.

General Results

- With respect to pavement wear performance, NZ vehicles are the best, … while SEA and UK vehicles are among the worst.
- With respect to bridge wear performance, NZ and Au vehicles are among the best, … while SEA and UK vehicles are among the worst.

General Results

- With respect to road space performance, NZ and UK vehicles are among the best, … while Ca and SEA vehicles are among the worst.
- With respect to safety performance, Ca vehicles are among the best, … while SEA vehicles are the worst.

Optimising NZ Heavy Vehicles

- Most widely used combination is 4-axle truck towing 4-axle full trailer at 20m and 44t.
- For BL, for example, this vehicle ranks first for pavements, bridges and road space but only 4th for safety.
- Increasing weight to 50t and length to 23m improves safety while maintaining no 1 ranking for the other three aspects.

TERNZ
TRANSPORT RESEARCH

Conclusions

- The study has developed heuristic composite performance measures for comparing categories of performance.
- This enables a more general comparison of vehicle performance between jurisdictions.
- Generally NZ vehicles performed well compared to their international counterparts.

Acknowledgements

The work described in the paper was part of a research project funded by the New Zealand Transport Agency.

The full report is available online at

http://www.nzta.govt.nz/resources/research/reports/387/docs/387.pdf