A trial of a reduced maximum speed for trucks on the Princes Highway between Melbourne and Geelong

Young, K[a]., Newstead, S[a]., Fridman, M[a]., & Truong, J[b].

[a] Monash University Accident Research Centre (MUARC), Melbourne Victoria, [b] Transport Accident Commission (TAC), Geelong Victoria

Abstract

Excessive speed is estimated to account for 36% of crashes in which the driver of a heavy vehicle was killed. In 2013, the Transport Accident Commission undertook, with assistance from the Victorian Transport Association and several heavy vehicle operators, a trial of reduced speed limits for trucks traveling along a 43.5 km stretch of the Geelong Freeway to evaluate the effects of speed reduction on speed behaviour, fuel consumption, travel times, and driver acceptance and attitudes. Six drivers of five trucks participated in the study. During the first 11 weeks, all trucks travelled up to the legal speed limit of 100km/h. In the following 10 weeks, three trucks reduced their maximum travel speed: two to 90 km/h, and one to 95 km/h. Two control trucks maintained the legal speed limit of 100 km/h for the entire trial. Evaluation methods included face-to-face interviews with drivers and operations mangers, an on-line survey of community attitudes, on-board video surveillance as well as analysis of truck speed data and fuel consumption data. The reduced maximum speed of travel was associated with reductions in fuel consumption, crash risk, and generally positive attitudes from the drivers, operations managers and other road users. Only small increases in average trip times at the reduced speeds were observed. Drawbacks included greater difficulty overtaking or changing lanes, tailgating by other vehicles and an increase in the number of safety-related events when other vehicles merged onto the freeway. These appeared more pronounced at the 90 km/h reduced maximum speed than at 95 km/h.

Introduction

Excessive or inappropriate speed remains one of the most common factors contributing to road trauma in Australia. In 2013, 1,310 people in Australia died as a result of road crashes (Bureau of Infrastructure, Transport, Regional Economics, 2012). Speeding is estimated to account for at least 30 percent of deaths on Victorian roads each year (VicRoads, 2008).

Speeding is also a major concern in the heavy vehicle industry. An evaluation study of the NSW 'Three strikes and you're out' scheme for heavy vehicles revealed that between January 2003 and April 2011, 12,107 heavy vehicles were issued at least one strike for speeding in NSW at or more than 15 km/h over the posted limit (Willis & Gangell, 2012). Further, a study of heavy vehicle driver fatalities in Victoria between 1997 and 2007 indicated that speeding was associated with 36 per cent of crashes where the driver of a heavy vehicle was killed (Brodie et al., 2009). Taken together, these statistics indicate that speeding represents a serious road safety issue for the heavy vehicle transport industry.

In response to concerns about the impact of speeding on heavy vehicle safety, in 2013 the Transport Accident Commission (TAC) undertook, with assistance from the Victorian Transport Association and several heavy vehicle operators, a trial of 90kph maximum travel speeds for trucks using the freeway grade section of Princes Highway West in Victoria between Melbourne and Geelong (the Geelong Fwy). The project aimed to evaluate the effects of the reduced maximum speed trial for trucks on multi-lane roads in terms of speed behaviour, fuel consumption, travel times and driver acceptance and attitudes. As part of the trial, the Monash University Accident Research Centre (MUARC) undertook a rigorous and independent evaluation of the trial outcomes. This paper presents the key findings from the evaluation.

Method

Trial Design

The trial involved six heavy vehicle drivers (driving 5 vehicles) from two heavy vehicle transport companies (referred to as Company A and Company B) who use the Geelong Fwy as a sole or regular transport route for at least part of their business. One company had four trucks and five drivers involved in the trial, while the other company had one truck and driver involved. Another company with 12 drivers was involved in the early stages of the trial, but withdrew before data collection started. Given time and budget constraints this company was not replaced.

For the purposes of the study, the Geelong Fwy comprised a 43.5 km section of the Princes Fwy West between the Kororoit Creek Rd Overpass and the Corio Rail Overpass. The drivers regularly drove the Geelong Fwy for the duration of the trial.

The trial ran for a period of 21 weeks, conducted over 3 stages:

- ***Stage 1 (Baseline):*** For the first 11 weeks, all six drivers (five trucks) drove the Geelong Fwy at the usual 100 km/h maximum speed limit.

- ***Stage 2 (Reduced speed):*** For the remaining 10 weeks, three of the six drivers voluntarily reduced their maximum travel speed on the Geelong Fwy; two drivers reduced to a 90 km/h limit, while one driver reduced to a 95 km/h maximum limit. The remaining three truck drivers drove at the 100 km/h maximum speed limit for the entire trial. For the first three weeks of the 10-week reduced speed period, no stickers advising of the reduced maximum travel speed for the truck were placed on the vehicles.

- ***Stage 3 (Reduced speed with a rear warning sticker):*** For the last 7 weeks, stickers were placed on the rear of the three trucks travelling at the reduced limit. These stickers read 'Limited to 90kmh' (or 95kmh). These stickers were designed to inform surrounding road users that the trucks were travelling at a reduced speed. The behaviour of other motorists in the vicinity of the trucks was compared using on-board video surveillance across the pre-sticker and sticker-on reduced speed stages to examine the impact of the stickers on other road users' behaviour towards the trucks travelling at the reduced speed.

The design of the Geelong Fwy trial, including all trial phases is represented in Figure 1.

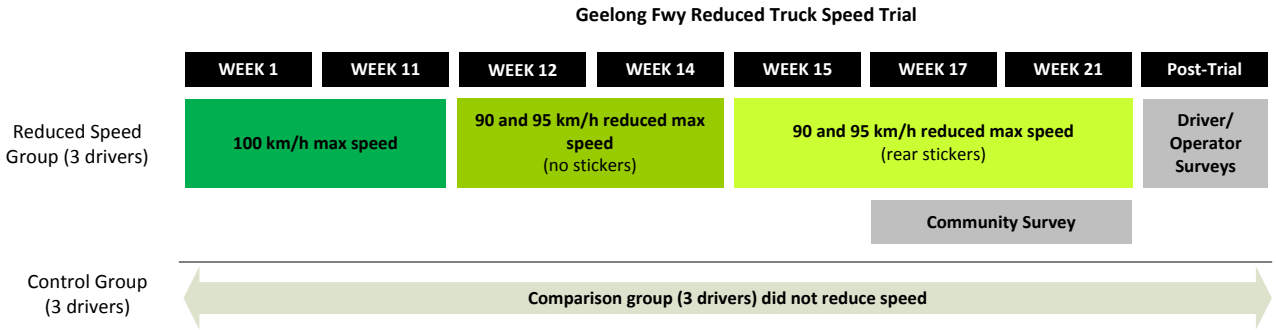

Figure 1 Geelong Fwy trial activity timeline

Driver and Operator Interviews & Community Survey

Post-trial face-to-face interviews were conducted with the six drivers and two operations managers (one from each truck fleet) to investigate experiences with the reduced travel speeds, including the benefits and any negative issues associated with the reduced speed. An on-line survey was also developed to examine the broader driving community's experiences with heavy vehicles on the Geelong Fwy during the trial, including the general driving behaviour of heavy vehicles, and their interactions (positive and negative) with the reduced speed trucks on the freeway.

Video Data of Roadway Events

Four of the trucks from Company B had videos cameras and a button for the driver to flag incidences of abuse towards them fitted to determine if the reduced maximum travel speed on the freeway changed the incidence of positive or negative/unsafe interactions with other road users (e.g. tailgating, driver abuse, or merging incidents). The cameras were fitted during the 10 week reduced speed trial periods only. The video data were examined manually by watching the video footage and noting down events of interest to determine if the reduced maximum travel speed changed the incidence of positive or negative/unsafe interactions with other road users (e.g. tailgating, driver abuse, or merging incidents). Four cameras (roadway forwards, rear and side views) were fitted to four of the trucks: one each that reduced speed to 90 and 95 km/h, and two that stayed at the 100 km/h maximum limit.

Two types of video coding were conducted:

1. A 6 minute window surrounding each of the logged driver abuse events was coded to determine the type of incident that occurred and the context in which it occurred (e.g. at a merging ramp, or on a bend, etc.); and

2. A randomly selected 5 minute window of every individual trip taken on the Geelong Fwy was coded to examine if driver interaction with other road users differed across the three trial speed phases.

Results

Driver and Operator Interview Results

Interviews were conducted with the six drivers and two operations managers (one from each truck company) to investigate experiences with the reduced travel speeds on the Geelong Fwy. Two of the three reduced speed drivers held positive attitudes about the reduced speeds and noted few safety issues with doing so. The other driver who reduced speed held a far less positive attitude and noted numerous safety concerns with the slower speed including tailgating and cutting in by other vehicles, disrupted traffic flow, increased stress and fatigue and perceived longer trip times.

Two of the three drivers who remained at 100 km/h during the trial were positive when asked hypothetical questions about lowering truck speed to 90 km/h on the Geelong Fwy and noted some perceived safety and fuel saving benefits of doing so. The other driver held a less positive attitude to the reduced speeds and noted some possible safety concerns including problems with merging vehicles, holding up other motorists who then become impatient, and increased boredom and concentration lapses for heavy vehicle drivers. This driver also noted that the reduced speeds may negatively impact on productivity by increasing trip times.

The operations managers from both companies believed that the reduced speeds would improve heavy vehicle safety; however, they also believed that it could create some safety issues for drivers such as difficulty overtaking and building up speed. One manager reported that these issues were

more pronounced at the 90 km/h limit. The managers also reported that their drivers had experienced a range of negative consequences at the reduced speeds, including other vehicles tailgating, difficulty overtaking and changing lanes, and issues with other vehicles merging onto the freeway. The managers reported that the reduced speeds had no effect on either productivity or work scheduling. They noted a marginal increase in trip times during the reduced speed period of the trial (estimated at typically 5 to 7 minutes per trip).

Community Survey Results

The survey examined the broader driving community's experience with heavy vehicles on the Geelong Fwy during the trial, including the behaviour of heavy vehicles in general, and their interactions (positive and negative) with the reduced speed trucks. A total of 118 respondents accessed the on-line community survey, with 114 providing complete data sets.

Around half of respondents reported that they had seen the reduced speed trucks on the Geelong freeway during the trial. The majority of these respondents had noticed the trucks because of their slower speeds, not because of the rear reduced speed stickers. It was unclear if respondents had seen the actual trucks participating in the trial. Survey responders were largely in favour of the reduced truck speeds, with around 60% stating that they believed the lower speeds would reduce crashes and near misses on the freeway and improve safety. A number of possible drawbacks of the slower truck speed were noted, however, including: other motorists being held up by the slower trucks, the slower trucks preventing vehicles from overtaking or increasing the time taken to do so, increased frustration from other motorists and reduced efficiency in the trucking industry.

Speed Reductions, Trip Times and Fuel Consumption Results

Specific outcomes considered from the logged truck data were trip duration, fuel consumption, speed profile and potential risk of crash involvement. The analysis was based on the trip records from the five trucks. Each trip comprised the same 43.5 km test corridor of the Geelong Fwy. Each of the outcome measures was summarised for each truck, study group and trial stage and the relative change in each measure between stages 1 and 2 and stages 1 and 3 between intervention and control groups calculated to give the net impact of the lower travel speed with and without accompanying signage on the measure. Although only 5 trucks were involved in the trial, this represented a large number of trips (2810 trips) and trip data.

Trip Duration

A standard Ordinary Least Squares (OLS) linear regression model was fitted to the trip duration data. Average trip duration times within each experimental group and trial stages estimated from the regression model along with 95% confidence intervals are given in Table 2. During Stage 1, where all trucks travelled at the normal 100 km/h speed limit, the average time taken to drive the test corridor was 27 mins. As expected there were statistically significant increases in trip times after the commencement of travel at reduced speed (90 and 95 km/h) in Stage 2. Also as expected, there was no change in trip time for the control trucks, which remained at 100 km/h in stages 2 and 3.

In the four Company B trucks, speed reductions of 5 km/h were associated with a 1 minute average increase in travel time ($p<0.008$), while reductions of 10 km/h were associated with a 1.7 minute average increase ($p<0.001$). The one Company A truck appeared to travel at a maximum speed of approximately 85 km/h in the intervention stages of the trial - slower than the assigned maximum speed of 90 km/h. The greater reduction in the speed of the Company A truck was associated with significantly greater increases in trip times: in stages 2 and 3 respective trip times were on average 2.0 and 1.3 minutes longer for the Company A truck than for the Company B truck in the same intervention group (p-values<0.001).

Table 2 Average trip duration times (and 95% confidence limits) for each group in the trial

Stages of the trial	100 km/h (control)		95 km/h (treatment)		90 km/h (treatment)	
	Company A (min)	Company B (min)	Company A (min)	Company B (min)	Company A (min)	Company B (min)
Stage 1 (100 km/h)	-	26.8 *(26.5 - 27.1)*	-	26.8 *(26.5 - 27.1)*	27.5 (27.3 - 27.7)	27.3 *(27.1 - 27.5)*
Stage 2 (reduced speed)	-	26.5 *(26.0 - 27.0)*	-	27.6 *(27.1 - 28.1)*	30.8 *(30.4 - 31.2)*	28.9 *(28.5 - 29.2)*
Stage 3 (reduced speed + stickers)	-	27.0 *(26.8 - 27.3)*	-	28.0 *(27.6 - 28.4)*	30.5 *(30.3 - 30.8)*	29.2 *(29.0 - 29.4)*

Risk of casualty crash involvement

Analysis of casualty crash involvement was based on the Company A truck speed data. Total risk estimates, as well as the method of calculation, are outlined in Table 3 and are derived by applying the relative risk curves of Kloeden et al. (2002) to the travel speed distribution of the truck in each phase of the trial to impute an expected change in crash risk. Applying these methods, the reduced maximum travel speed resulted in a reduced expected risk of a casualty crash on the Geelong Fwy of around 60%. The rear warning stickers appeared to provide no additional risk reduction benefits.

The estimates of relative risk in Table 3 should be heavily qualified. Greater than expected reduction in speed observed for the Company A truck during the intervention stages of the trial would result in overestimating the benefit of imposing a 90km/h maximum travel speed. Another limitation is that the equation for risk estimation was based on the results of a study of South Australian rural roads in speed zones of 100 and 110 km/h. The same relationship may not represent accurately the risks of a casualty crash at various travel speeds on the Melbourne-Geelong freeway. A large scale, long-term trial would be needed to accurately assess the crash effects of reduced truck travel speeds on this road.

Despite these limitations, a notable feature of Table 3 is that the lower travel speed for the Company A tuck resulted in no transgressions above the posted speed limit in Stages 2 and 3 of the trial. This is in comparison to a 2% transgression rate in Stage 1. This means that the lower maximum travel speed would reduce the chance of the driver being issued with a speeding infringement which may represent a further benefit to the driver and company.

Table 3 Risk of involvement in a casualty crash

Trial Stages	80-85km/h (RR**: 0.38)	86-90km/h (RR: 0.49)	91-95km/h (RR: 0.64)	96-100km/h (RR: 0.87)	101-105 km/h (RR: 1.24)	Risk estimation	Total Risk
Stage 1	1.0%	3.4%	19.9%	67.7%	2.0%	0.010*0.38 + 0.034*0.49 + 0.199*0.64 + 0.677*0.87 + 0.020*1.24	0.76
Stage 2	97.6%	2.1%	0%	0%	0%	0.976*0.38 + 0.021*0.49 + 0*0.64 + 0*0.87 + 0*1.24	0.38
Stage 3	70.5%	27.8%	0%	0%	0%	0.705*0.38 + 0.278*0.49 + 0*0.64 + 0*0.87 + 0*1.24	0.40

* Percentage of records per trip at indicated speeds
** Relative Risk

Fuel consumption

The evaluation of fuel consumption was based on Company A data only. It was assumed that the presence/absence of freight was responsible for an observed bimodal distribution of the fuel consumption measures (Figure 2). To accommodate this unknown, comparisons of fuel consumption between stages of the trial were conducted separately for each peak: peak 1 (truck assumed empty) and peak 2 (truck assumed to carry freight).

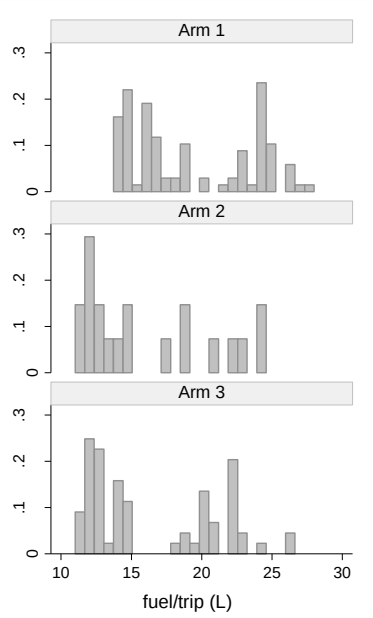

Figure 2 Distributions of fuel use (litres/trip) in each stage of the trial for the Company A truck

As displayed in Table 4, during the reduced speed stages, there was a highly significant decline in fuel use of 3.3 L/trip ($p<0.001$) when the truck was assumed to be empty, and a similar decline of 3.0 L/trip when the truck was assumed to be carrying freight ($p<0.001$). This represents a fuel saving of around 20%.

As noted previously, while the assigned speed limit for the Company A truck was 90 km/h, the average travel speed was closer to 85 km/h. This greater than expected reduction in speed would result in overestimating fuel consumption savings from a 10km/h reduction in the speed limit. A proportionately smaller fuel reduction would be expected at 90 km/h, theoretically between 2.6 and 2.9 litres per trip based on the relative fuel consumption difference between 85 and 90 km/h. This represents a reduction in total fuel consumption of between 4 and 15%. For a 15 km/h reduction in maximum travel speed, the fuel consumption reduction would be in the order of 12-20%.

Video Coding Of Driver Abuse & Safety-Related Events

Video data collected from four of the trucks in the trial were examined to determine if the reduced maximum travel speed on the freeway changed the incidence of positive or negative/unsafe interactions with other road users (e.g. tailgating, driver abuse, or merging incidents). Results revealed that the trucks that reduced maximum travel speed to 90 and 95 km/h were involved in fewer driver abuse events overall compared to the two trucks that remained at 100 km/h. Of the abuse events that were reported by drivers, many appeared to relate to the truck drivers' frustration with slower moving vehicles and not being able to change lanes, rather than safety-related events. A greater number of abuse events were reported for the 90 km/h reduced speed truck than the 95 km/h truck and was also the only truck that was involved in safety-critical events.

Table 4 Summary of fuel consumption measures (litres) for each stage of the trial

Fuel use summary measures	Stage 1 (L/trip)	Stage 2 (L/trip)	Stage 3 (L/trip)	Comparison between stages*
Fuel use range				
Peak 1 (empty)	14-20	11-15	11-15	---
Peak 2 (freight)	21.5 – 28	17.5 – 24	18-26	
Peak 1 (N=111)				
Mean ± sd	16.1 ± 1.7	12.8 ± 1.25	12.9 ± 1.2	F(2,108)=61.8;
Median [IQR]**	16 [15 – 17]	12.5 [12 – 13.8]	13 [12 – 14]	p<0.001
Peak 2 (N=74)				
Mean ± sd	24.3 ± 1.3	21.2 ± 2.5	21.4 ± 1.9	F(2,71) =26.4;
Median [IQR]	24 [23.5 – 25]	21.5 [19 – 23.5]	22 [20-22]	p<0.001

*ANOVA F-test. Degrees of freedom are in brackets.
**IQR = interquartile range.

A general observation made from viewing the random video segments was that the trucks travelling at the reduced speeds have less direct interaction with other road users on the freeway overall, as these faster moving vehicle travel past and away from the trucks. However, the 90 km/h reduced speed truck was involved in more safety-related events involving other vehicles merging onto the freeway than the other three trucks. These issues primarily involved the drivers of other vehicles not being able to judge the trucks' speed accurately, which resulted in them not being able to select an appropriate gap when merging onto the freeway. In many cases, the driver of the other vehicle would brake heavily and move in behind the truck, but in some cases the truck would also have to brake and/or change lanes to allow the vehicle to merge in front.

Discussion

The reduced maximum travel speed trial generated largely positive findings, with crash risk reduction, reduced over speed limit transgressions and fuel saving benefits expected from the speed reduction and generally positive attitudes towards the lower travel speeds from the heavy vehicle drivers, operations managers and the general driving community. More specifically, the trucks were found to be highly compliant with the voluntarily reduced maximum travel speed on the Geelong Fwy, with one truck driven at average speed below that requested (~85 km/h). Based on the observed reductions in travel speed during the reduced speed stages of the trial, the reduced 90 km/h maximum travel speed on the freeway was estimated to reduce crash risk by around 60%. A significant 15% reduction in fuel consumption was also found when maximum travel speed reduced to 90 km/h. Despite the reduction in maximum travel speed, trip times increased only marginally with increases less than 2 minutes estimated for each company. Moreover, the heavy vehicle drivers and operations managers noted that the reduced travel speeds did not negatively impact upon work scheduling or productivity.

There were a number of issues experienced with the reduced travel speeds, however. The heavy vehicle drivers noted that they found overtaking and changing lanes more difficult at the reduced speeds and one driver reported that travelling at the lower speed increased the incidence of tailgating and cutting in by other vehicles, disrupted traffic flow and increased stress and fatigue. These issues appeared to be more pronounced for the 90 km/h maximum travel speed than for the 95 km/h maximum travel speed. Analysis of the video data also revealed that the reduced speed limit was associated with an increase in safety-related events involving other vehicles merging onto the freeway. Again, this issue appeared more pronounced for the 90 km/h reduced limit.

A range of limitations with the trial design and truck data were noted and these impacted the analyses that could be performed. Data limitations included inconsistencies in the format and type of data provided by the two companies, missing data, and imprecise field specifications, such as no identifying trip information. Fuel usage records from Company B were also not specific to the road section defined for the study and thus were not included in the fuel consumption analysis. Finally, the trial included only a small sample of trucks on a defined section of freeway and, as such, the ability to generalise the findings beyond the specific study conditions is limited. Further research should examine the potential benefits of a reduced maximum travel speed for heavy vehicles in a larger sample and in a more diverse range of driving environments.

Overall, reducing the maximum travel speeds of heavy vehicles on the Geelong Fwy by 5 or 10 km/h is expected to yield a number of safety and fuel saving benefits, with minimal impact on travel time or productivity. While these benefits are expected to be larger for the 90 km/h reduced speed, this limit was also associated with a higher number of safety-related incidents with other road users as well as increased driver stress, compared to the 95 km/h maximum. A 95 km/h maximum travel speed for trucks on the Geelong Fwy may therefore represent a good compromise between safety benefits and driver acceptance for heavy vehicle companies looking to introduce a lower maximum travel speed for their fleet. While this study has provided promising results, by its nature, a small scale pilot study limits the conclusions that can be drawn from it. Further research using a larger sample of drivers and a wider selection of travel routes is needed to confirm the findings and provide an evidence base to inform future policy decisions on heavy vehicle speed.

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