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## Safety of raised platforms on urban roads

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### Key Findings

- raised platforms at pedestrian crossings (wombat crossings) lead to a casualty crash reductions of 63%;
- platforms at midblocks reduce casualty crashes by 47%;
- raised priority controlled intersections reduce casualty crashes by 55% (p = 0.1),
- raised platforms also lead to speed reductions; 85<sup>th</sup> percentile speed reductions ranged between 5 km/h and 8 km/h for all platform types.

### Abstract

A recently concluded Austroads study identified effective and innovative countermeasures for improving safety outcomes on urban arterial roads. Included in the study were raised platforms at priority controlled intersections (raised intersections), midblock and pedestrian crossings (wombat crossings). While these treatments have been widely applied overseas and, to an extent, across Australia and New Zealand (especially wombat crossings and at midblock sections on local and collector roads), a measure of effectiveness in mixed use and high volume environments in an Australian context was required. Using available speed and crash data from across Australia, this paper applied Poisson regression analysis in a retrospective quasiexperimental study to determine the effect of raised platforms on crash occurrence and severity. The results showed that

overall, raised platforms are effective in improving road safety on urban roads. The effectiveness differed by platform type; platforms were most effective in reducing casualty crashes at wombat crossings. Casualty crashes fell by 63% at wombat crossings, 47% at midblock platforms and an indicative 55% reduction at priority controlled intersections. Furthermore, 85<sup>th</sup> percentile speed reductions of between 5 km/h and 8 km/h were observed at the different platforms. While this study provides an effectiveness measure for raised platforms on urban roads in Australia, most sites were high order collector roads. Further work is required to determine when and where on the urban arterial network platforms are most and/or least effective, the effect of design and implementation considerations on effectiveness and overall effectiveness in different conditions and different road users.

## Keywords

Wombat, Platforms, Crashes, Speed, Intersection, Traffic calming

## Introduction

### Background

This paper presents the findings of a recent Austroads study aimed at identifying Safe System treatments for managing urban arterial speeds, including those that help to achieve Safe System levels. As part of this project, raised platforms were identified as a potential measure for managing speeds and reducing severe crashes on urban roads of different functions, speed and use, while maintaining traffic flow.

A literature review indicated safety benefits from raised platforms at intersections (raised intersections), midblock locations (traffic calming devices) and at pedestrian crossings (wombat crossings). These findings were from applications in the UK (Gordon 2008, 2011), the Netherlands (Schermers 1999 and Van der Dussen 2002) and the US (PEDSAFE 2004, Watkins 2000). Research from Australia and New Zealand evaluated trial applications of wombat crossings in New South Wales and the Australian Capital Territory (ACT) and raised intersection in New Zealand (Austroads 2008, Department of Territory and Municipal Services 2006, Hawley et al. 1993).

### Raised Intersection

Raised intersections are an innovative speed management and safety device generally used on local roads, with some examples on arterials through activity centres. The entire intersection acts as a form of speed hump aimed at

reducing vehicle speeds to 50 km/h or less (Austroads 2010). Alternatively, raised stop lines can be used in advance of the intersection. The height of the intersection is often equal to that of the surrounding pavement, which can facilitate pedestrian crossing movement. They can be painted or paved to raise driver awareness of the intersection as illustrated in Figure 1. An extensive review of existing literature indicated that raised intersections are most common in Europe, especially the Netherlands. Trials have also been completed in the United States and on local and collector roads in Australia and New Zealand.

Austroads (2011) assessed raised intersections as a part of a review of trials in Australia and New Zealand. The study found a 1.1 km/h reduction in 85<sup>th</sup> percentile speeds at an intersection on Mahoe Street in Hamilton, New Zealand. In addition to a raised intersection, median islands and a chicane were also installed.

Watkins (2000) assessed raised intersections at two sites near schools and activity centres in Cambridge, Massachusetts (USA). The raised intersections were implemented in an attempt to make intersections safer for pedestrians. The study found reductions in 85<sup>th</sup> percentile speeds of 8 km/h (5 mph) and 6.4 km/h (4 mph) respectively, with the percentage of drivers exceeding the 40 km/h (25 mph) limit dropping from 57% to 17% at one site, and from 39% to 14% at the other. The raised intersections tripled the number of drivers yielding to pedestrians at crossings.

Van der Dussen (2002) studied the effectiveness of raised platforms at 10 intersections in Gelderland (the Netherlands) with traffic volumes of 3000–6000 per day. The study concluded that raised platforms reduced the number of crashes by 70%. The platforms were especially effective at reducing the severity of crashes, with casualty crashes reduced by 80%, while property damage only crashes were 60% lower. Schermers (1999) outlined the Sustainable Safety program in the Netherlands and the role that raised intersections could play. The study recommended the use of raised platforms where arterial roads intersected with dedicated cycle paths, in order to alert drivers to the presence of other road users.



Surf Coast Shire, Victoria

**Figure 1. Raised platform at intersection**  
(source: VicRoads)



**Wombat crossing**



**Raised platform at midblock**

**Figure 2. Wombat crossing and raised platform at midblock (source: Austroads, 2016a).**

### Raised Platforms at Midblock and Wombat Crossings

Raised platforms at midblock sections are typically used to maintain lower speeds along a route. In high pedestrian activity areas, raised platforms at midblock generally include pedestrian crossing facilities. The raised pedestrian crossings, typically termed wombat crossings in Australia, have a similar profile and speed reduction effect as flat top speed humps but they differ in that they give priority to pedestrians rather than motorists (Austroads 2016a). When designed with appropriate signs, markings and lighting, this adds a pedestrian mobility and safety element to the speed management objectives. Figure 2 shows both a wombat crossing (left) and a raised platform at midblock (right).

Hawley et al. (1993) analysed the speed reduction associated with installations of platforms in Australia. Across the seven study sites, the initial average 85<sup>th</sup> percentile speed between platforms was 66 km/h. After the platforms were installed, the speed dropped to 49 km/h, a 26% reduction. The study also found that the speed across the platform was lower with higher ramp gradients and with shorter platform lengths.

The UK Mixed Priority Routes Demonstration Project included raised intersections in several of their study sites. These sites were located in areas with high traffic volumes but relatively low speeds due to the mixed-use nature of the area. Across the four sites that included either a speed table or speed hump, there were casualty reductions ranging from 0%–41%. Mean speeds were reduced by between 5% and 19% and 85<sup>th</sup> percentile speeds by between 5% and 17% (Gordon 2011).

A series of wombat crossings were trialled in NSW from 1991 to 1992. At the five study sites, the 85<sup>th</sup> percentile speed was 34%–43% lower at the device after the installation of wombat crossings compared to a 10%–12% reduction at the control sites (Hawley et al. 1993).

Three wombat crossings, along with two chicanes and a speed platform, were installed on two collector roads in the ACT (Department of Territory and Municipal Services 2006). The aim of the scheme was to reduce the speed and volume of vehicles using these collector roads. The study found that mean speeds between devices fell by between 3 km/h and 11 km/h. Eighty-fifth percentile speeds fell by between 5 km/h and 9 km/h; however, they remained above the 50 km/h posted speed limit on both roads. Traffic volumes were around 12% lower on one road while remaining unchanged on the other road. In addition, there was an increase in crashes at one intersection in the study area; however this was not directly adjacent to any of the wombat crossings.

### Aim of Study

While the literature review identified safety benefits of raised platforms at intersections, midblock and at pedestrian crossings, there were concerns regarding the transferability of these benefits to an Australian and New Zealand context. The concerns included differences in design standards, operating environments (e.g. traffic and road user mix, speed limit, surrounding land use, etc.), and the expected magnitude of benefits; some of the research did not account for underlying trends nor the presence of other treatments. Furthermore, most of the raised platforms in Australia and New Zealand were on local or low volume collector roads (Austroads 2011, Department of Territory and Municipal Services 2006 and Hawley et al. 1993). To obtain a comprehensive measure of the safety effectiveness of raised platforms on high volume and high order roads in Australia and New Zealand, evaluations of applications at intersections, midblock locations and at wombat crossings across jurisdictions were undertaken. The evaluation aimed to provide insight into the speed management effectiveness of the different platform types and to determine whether they have an effect on crashes (frequency and severity) and traffic volumes.

Data was obtained on raised platform applications across Australia and New Zealand. Only sites with sufficient after periods were included in the crash analysis. The excluded sites were reserved for future evaluations and monitoring. This paper outlines the evaluation process and findings.

## Method

A quasiexperimental retrospective matched comparison approach was used in this evaluation. To determine whether reductions or increases in crashes at treatment sites were statistically significant, Poisson regression with a log-link function was applied. The assumption was that crashes follow a Poisson distribution (1):

$$\Pr(y|\lambda) = \frac{e^{-\lambda}\lambda^y}{y!} \quad (1)$$

where = conditional probability function of  $y$  given  $\lambda$ ,  $y$  = the number of crashes and  $\lambda$  = the average and variance of the distribution.

To control for mild violations in distribution assumptions, robust standard errors were estimated. Tests for the most appropriate distribution were also conducted. These involved fitting both Poisson and Negative Binomial distributed models and comparing the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC) and the loglikelihood to determine the most parsimonious distribution.

Each treatment site was matched to similar untreated sites (comparison), on criteria outlined below. The comparison sites accounted for the effect of the underlying traffic, socioeconomic conditions and other road safety initiatives, excluding any effects from raised platforms. The treatment effects were therefore measured by comparing crashes before and after the implementation of raised platforms at treatment sites, while accounting for the underlying trends. The study was retrospective as there was limited time within the project to identify locations, install raised platforms and collect post-completion data.

## Data

### Site data

While the key gap in knowledge and the focus of this study was on urban arterial roads, it was evident that raised platforms were not widely applied on arterial roads. The site selection involved identifying treatments on higher volume collector roads with a traffic mix and function approaching that on arterial roads (high order collector roads). The selection of all sites depended on the surrounding land use, the traffic volumes prior to installation and road function.

Given the differing definitions of an urban arterial road, the definition used for this research was set broadly. Urban arterial roads were defined as higher volume roads, some of which may be designated as collector roads with typical speed limits of 60 km/h and above (for Australia) and 50 km/h and above for New Zealand.

The sites were classified into three treatment categories, depending on location and function; raised intersections (sites in this study were raised intersections only, and did not include raised approaches or stop lines at intersections), wombat crossings (i.e. platforms with pedestrian crossing facilities); and raised platforms at midblock locations. Overall, there were 10 raised intersections, 26 raised midblock sites and 14 wombat crossings (see Table 1).

**Table 1. Treatment sites by jurisdiction**

Treatment type	New South Wales	Victoria	Queensland	Total sites
Intersection	1	8	1	10
Midblock	5	19	2	26
Wombat crossing	-	14	-	14
Total sites	6	41	3	50

Traffic volumes ranged between 5,000 and 10,000 annual average daily traffic (AADT) for the raised intersections, between 2,000 and 10,000 AADT for raised platforms at midblock and between 4,000 and 9,000 AADT for wombat crossing sites. All sites installed from 2013 onwards were excluded from the evaluation as the after period was not long enough for an informative crash analysis. However, these sites were reserved for future evaluations.

For each of the treatment sites, three sites were selected as the comparison group. The comparison group included sites with similar attributes to the treatment sites in terms of speed limit, surrounding land use and geometric design. Where similar sites were not available in the same local government area (LGA), comparison sites were obtained from a neighbouring one. Care was taken to ensure that comparison sites had not received any interventions during the evaluation period.

The selection of the comparison groups ensured that:

- crash distributions in the before period were similar at both treatment and comparison groups
- the speed limit at the treatment and comparison groups was similar
- road geometry at the treatment and comparison sites was similar
- where possible, the traffic volumes at the treatment and comparison sites were matched as closely as possible, however, where traffic volumes were not available, the match was based on road function and the surrounding land use
- intersection layout was similar to the treatment site (for raised intersections)
- similar traffic control to match downstream and upstream of platforms (mainly for midblock and wombat crossings)
- comparable section length considered where platforms were a route treatment

**Table 2. Crash data**

Treatment type	Crash severity	Treatment sites		Comparison group	
		Before	After	Before	After
Intersection	FSI	1	1	28	29
	Non-FSI	12	6	35	47
	Total	13	7	63	76
Midblock	FSI	23	14	182	179
	Non-FSI	68	35	394	405
	Total	91	49	576	584
Wombat	FSI	16	5	62	58
	Non-FSI	26	13	94	121
	Total	42	18	156	179
Overall	FSI	40	20	272	266
	Non-FSI	106	54	523	573
	Total	146	74	795	839

- the evaluation period for the treatment and comparison groups was the same in order to avoid temporal bias.

### Crash data

Crash data for the treatment and comparison sites was obtained from the respective jurisdictions. For Victorian sites, crash data was obtained from the Road Crash Information System (RCIS) while data for Queensland and New South Wales was obtained from the Austroads crash dataset and the respective LGAs.

Crash data for intersections covered a 100 m radius from the centre of the intersection. For wombat crossings, crash data was obtained for 50 m upstream and downstream of the crossing. The data for midblock platforms depended on the length of each treated section of road.

Crash data covered five years before and after the treatments were installed. The data was grouped by severity, i.e. fatal and serious injury (FSI) crashes and non-FSI crashes (see Table 2). The five year period was selected as it was long enough to account for regression to the mean while being short enough to ensure any technological advances, traffic mix and other socio-economic trends remained as similar as possible in the before and after periods. To ensure both treatment and comparison groups had similar evaluation periods, crashes at the comparison sites were classified using the installation dates at the treatment sites.

One of the key issues in crash analyses is regression to the mean. Regression to the mean is a selection bias resulting from the selection of sites with high crash numbers in a short period of time. There is a probability that crash reductions may not only be due to the treatment installed but also due to chance or measurement error.

The effect of regression to the mean was minimised by using an evaluation period of five years before the raised platforms were installed. Preliminary analyses of crashes before the evaluation period at the treatment and comparison sites

showed no significant jumps in the crash trends, and similar crash distributions, reducing the risk of regression to the mean. Regression to the mean will also be reduced for most of the sites as it was evident that most of the treatments had been installed as part of a systemic approach to addressing crash risk rather than prior safety performance.

### Evaluation period

The before period was defined as five years prior to the installation start date, up to the calendar month before the installation start date, and the after period was defined as the period one calendar month after the installation end date onwards. The implementation period covered a month before and after the installation start and end dates (rounded to calendar months). The implementation period was designed to account for changed traffic conditions before, during and after installation, allowing for an adjustment period following the implementation.

### Speed data

Eighty-fifth percentile speed data before and after raised platforms were installed was obtained. Eighty-fifth percentile speed is defined as the speed at or below which 85% of all vehicles are travelling. The evaluation focused on 85<sup>th</sup> percentile speeds as more detailed data was not available. The 85<sup>th</sup> percentile speed was used as a proxy for high end speeding and an indicator of driver behaviour. Due to the retrospective nature of the evaluation, complete data was not available for all sites, therefore the evaluation was restricted to those sites with available data in both the before and after periods. The data was obtained from different LGAs and where the treatments were on arterial roads, from the state road authorities. The analysed data was collected using pneumatic tubes and in some cases, radar. Speed data for neighbouring similar roads or sections of road for use as comparisons was also collected. The use of comparison sites accounted for the underlying trends outside of the treatment effect.

Speed data was available for 21 sites, eight raised intersections, eight platforms at midblock and five wombat crossing sites (see Table 3).

**Table 3. Treatment sites with speed data by speed zone**

Treatment type	40 km/h zone	50 km/h zone	60 km/h zone	Total <sup>a</sup>
Intersection	-	2	6	8
Midblock	-	2	6	8
Wombat crossing	1	4	-	5
<b>Total</b>	1	8	12	21

<sup>a</sup> table outlines sites with complete data only.

## Statistical Analyses

The Poisson loglinear analysis was conducted to assess the significance of differences in casualty and FSI crash changes as well as pedestrian crash changes. The model for each individual treatment type was specified as outlined in (2):

$$\ln(y_{pgs}) = \alpha + \beta_{ps} + \gamma_{pg} + \delta_{pgs} + \varepsilon_{pgs} \quad (2)$$

where  $y$  = cell crash count (casualty or FSI crash count),  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$  = model parameters to be estimated,  $\varepsilon$  = error term,  $p$  = evaluation period index,  $g$  = treatment or comparison group index,  $s$  = site index.

The interaction term was modified to estimate the average crash effects across all sites within the treatment and comparison groups and to estimate the crash effects within each site, time period and treatment group combination.

The overall crash effectiveness, accounting for comparison site crashes, was defined as (3):

$$\text{Percentage change} = 100 \times (1 - \exp(\delta_{111})) \quad (3)$$

where  $\delta_{111}$  = the parameter for the after installation period at treatment site 1.

The student's t-test was conducted to determine the statistical significance of differences in 85<sup>th</sup> percentile speeds before and after the platforms were installed.

**Table 5. Estimated crash changes by severity**

Treatment type	Severity	Estimated casualty crash reduction (%)	Significance	Lower 95% confidence level (%)	Upper 95% Confidence limit (%)
Intersection	FSI	-	-	-	-
	Non-FSI	62.8	0.0712	-8.9	87.3
Midblock	FSI	38.1	0.1764	-24.1	69.1
	Non-FSI	49.9	0.0016	23.0	67.4
Wombat	FSI	66.6	0.0438	3.0	88.5
	Non-FSI	61.2	0.0099	20.3	81.1
Overall	FSI	48.9	0.0195	10.2	70.9
	Non-FSI	53.5	<0.0001	34.1	67.2

## Results

### Overall Crash Effect

The evaluation showed a statistically significant casualty crash reduction of 53% for all sites regardless of platform type. However, given the differences in conditions, design and expected impacts, this value was used for indicative purposes only. There was a reduction of 47% in casualty crashes at raised platforms at midblock and 63% at wombat crossings as shown in Table 4. These reductions were statistically significant. At the same time, there was no statistically significant change in casualty crashes at raised intersections. This may be attributable to the small sample size and the number of crashes at both treatment and comparison sites.

**Table 4. Estimated casualty crash changes**

Treatment type	Estimated casualty crash reduction (%)	Significance	Lower 95% Confidence level (%)	Upper 95% Confidence limit (%)
Intersection	55.4	0.1059	-18.7	83.2
Midblock	46.9	0.0011	22.1	63.8
Wombat	62.6	0.0012	32.5	79.3
<b>Overall</b>	52.6	<0.0001	35.7	65.1

There were statistically significant reductions of 49% and 54% in FSI and nonFSI crashes for all platform types, respectively. FSI crashes at wombat crossings fell by 67% and nonFSI crashes by 61%. At the same time, there was a reduction of 50% in nonFSI crashes at midblock platforms as shown in Table 5.

### Speed Changes

The speed analyses were based on 85<sup>th</sup> percentile speed data for 60 km/h speed zones at raised intersections and midblock platforms and 50 km/h speed zone for wombat crossings. There were statistically significant reductions of 7.5 km/h and 5.4 km/h at raised intersections and midblock platforms, respectively. Wombat crossings led to a 6.5 km/h



reduction in 85<sup>th</sup> percentile speeds as shown in Table 6.

**Table 6. Estimated 85<sup>th</sup> percentile speed changes**

Treatment type	Speed reduction (km/h)	Significance	Lower 95% confidence level	Upper 95% Confidence limit
Intersection	7.5	<0.0001	5.9	9.0
Midblock	5.4	0.0012	2.6	8.1
Wombat crossings	6.5	0.0048	2.7	10.3

## Discussion

The evaluation of raised platforms at intersections, midblock and pedestrian crossings on urban roads across Australia showed overall crash and speed reductions. The crash reductions varied by treatment type and severity. The study identified a significant casualty crash reduction of 63% for wombat crossings. This finding was consistent with the 65% reduction in injury crashes in Elvik et al. (2009). However, other international research provides a more conservative estimate of 40% to 60% casualty crash reduction (Harms & Turner, 2013; Vaa, 2006). The evaluation also showed a significant 47% reduction in casualty crashes for raised platforms at midblock. There is limited research on the effectiveness of raised platforms at midblock, with one study showing a 60% reduction in serious and minor injury crashes (Elvik et al. 2009). The indicative reduction at raised intersections highlighted the need for further trials of this treatment in order to obtain the effectiveness measure in an Australian and New Zealand perspective.

Raised intersections and raised platforms at midblock in 60 km/h speed zones and wombat crossings in 50 km/h speed zones were associated with reductions in 85<sup>th</sup> percentile speeds ranging from 5 km/h to 8 km/h. Raised intersections lowered 85<sup>th</sup> percentile speeds by 8 km/h. The speed reduction is consistent with Watkins (2000). Watkins (2000) assessed the effectiveness of raised intersections at two locations in Cambridge, Massachusetts (USA). The results showed a 5 mph (8 km/h) and 4 mph (6.4 km/h) reduction in 85<sup>th</sup> percentile speeds at the two sites. The 7 km/h reduction in 85<sup>th</sup> percentile speed was consistent with Hawley et al. (1993), PEDSAFE (2004) and Department of Territory and Municipal Services (2006). These studies reported 85<sup>th</sup> percentile speed reductions between 6 km/h and 8 km/h at wombat crossings. On the other hand, the 5 km/h reduction at midblock platforms was at the lower end of changes identified in research (Hawley et al. 1993).

While the study provided evidence on the effectiveness of raised platforms at different locations across Australia, it highlighted the need for further research into the following:

- Trials on arterial roads – there is a need for widespread trials and effectiveness evaluations of platforms on urban arterial roads across Australia and New Zealand.

The trials will provide information on implementation issues e.g. when and where to install platforms, the ideal dimensions for different locations and traffic mix, ideal traffic volumes and speed and environmental impacts. Austroads (2016b) outlines implementation issues and considerations for different platform types.

- Monitor and assess raised platforms in different speed zones – there is limited evidence on the effectiveness of raised platforms in different speed zones. Evaluating trials in different speed zones will improve the information on where different platform types are most effective.
- The effect of raised intersections on crashes – more widespread applications of raised intersections are required in order to identify the safety effect. At the time of the evaluation, further trials of raised intersections were underway. An evaluation of these trials will add to the evidence base.
- Traffic migration – there is a need to assess the impact of raised platforms on traffic volumes on adjacent routes. Traffic volume data was available for some of the treatment and comparison sites before and after the implementation of raised platforms. However, this was limited and generally excluded data from adjacent routes. This information could be obtained from further onroad trials.

## Conclusions

The use of raised platforms at intersections, midblock and pedestrian crossings across Australia led to associated reductions in crashes (both casualty and FSI crashes) and 85<sup>th</sup> percentile speeds. There was a 63% reduction in casualty crashes at wombat crossings, 47% reduction at midblock platforms and an indicative 55% reduction at priority controlled intersections. These reductions were consistent with international research. Further, raised intersections lowered 85<sup>th</sup> percentile speeds by 8 km/h, 7 km/h at wombat crossings and 5 km/h at midblock platforms. While the evaluation provided a measure of effectiveness for raised platforms in an Australian context, the effectiveness of each application depend on the design (e.g. platform height and length), the speed environment and road function. The study also highlighted the need for further onroad trials on urban arterial roads and the subsequent monitoring and evaluation. These will add to the existing evidence base and used to support the widespread use of raised platforms as a measure for achieving Safe System outcomes on urban arterial roads.

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## Speeding in urban South East Asia: Results from a multi-site observational study

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### Key findings

- There is a high prevalence of speeding in three large cities in Southeast Asia
- Motorcycles were speeding at >50 km/hr over posted speed limits in Bandung
- Speed prevalence was highest during the weekends in all three cities.