Re-investigation of Roadside Risk Factors Associated with Run-off-road Casualty Crashes in Victoria, Australia

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Abstract

This paper examines the road side design features related with run-off-road collisions on rural undivided roads in Victoria, Australia. Run-off-road casualty crashes comprise around fifty percent of all single vehicle crashes that take place in rural roads with a speed limit 80km/h or above in Victoria. Five-year crash and road design inventory data from Victoria were analysed. A poisson regression modelling approach was adopted to estimate run-off-road crash frequency. Modelling results indicated that narrower hazard offset (clear zone) increased the likelihood of run-off-road casualty crashes. Tight road curvature was a strong and consistent predictor of run-off-road casualty crashes. Findings from the study can lead to more effective safety countermeasures that can substantially reduce the injuries and fatalities associated with run-off-road collisions.

Background

Run-off-road casualty crashes comprise around fifty percent of all single vehicle crashes that take place in rural undivided roads with a speed limit 80km/h or above in Victoria, Australia. Approximately fifty percent of these crashes result in fatalities and serious injuries.

Previous study shows that curves, obstacles and time and amount of clear roadside space contribute to run-off-road crashes and their severity (Montella & Pernetti, 2010 and Petegem & Wegman, 2014). The magnitude of these risk factors is not well documented, particularly in the context of Australia. Previous Australian research quantified the key relationships but was limited by limited data (Jurewicz et al., 2014, Doecke & Woolley, 2011). The current roadside geometry design guidance is largely based on US evidence and had limited validation of its safety in Australia and New Zealand. Greater understanding is needed of the effects of design elements such as curvature, roadside hazard offsets, and roadside barriers on the risk of run-off-road casualty crashes on high speed rural undivided roads.

This paper uses Big Data management and advanced regression analysis techniques to re-examine how road and roadside design features were related to frequency of run-off-road casualty crashes on high-speed rural undivided roads in Victoria. The paper aims to contribute in developing proactive road safety policy to reduce run-off-road injury risk in Australia.

Methodology

Five-year casualty crash and road design inventory data from Victoria were analysed for a sample of 16784 km of rural undivided roads, representing almost the entire state road network

of this kind in Victoria. Advanced GIS-based data-basing techniques were used to prepare set of 100 m long road segments containing information about individual roadsides. All crashes into these roadsides were matched with available road and roadside information provided by VicRoads (ANRAM data sets as per Austroads, 2014).

Preliminary analysis was conducted to determine the potentially significant variables to be considered for modelling purpose. The effect of road side hazard offset, curvature, road surface condition and shoulder type were all studied to ascertain the influence each of these has on run-off-road crashes. A poisson regression modelling approach was adopted from different alternatives to estimate run-off-road crash frequency. In addition, a zero-augmented model was also applied to address the zero inflation in crash database. The Akaike information criterion (AIC), the ratio of the 'residual deviance and residual degrees of freedom' and the overall model p-values are used to assess the model fit.

The model purpose was to identify and quantify the key design variables which contribute to run-off-road casualty risk. Validity of crash prediction was a secondary consideration.

Results

The modelling results are presented in Table 1. As zero-inflated model did not improve the overall model's capacity statistically significant findings estimated from Poisson regression model are interpreted here.

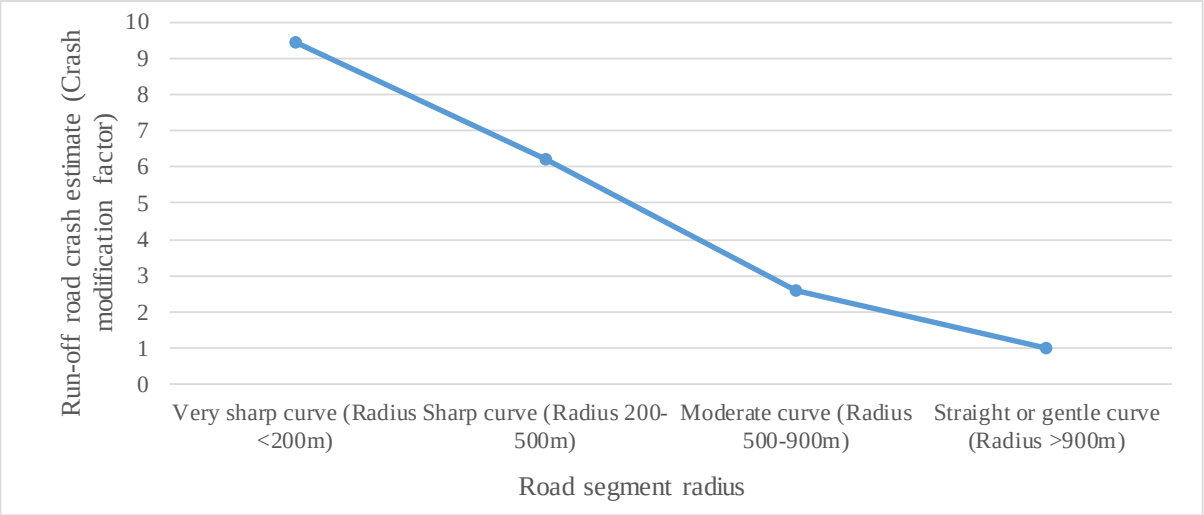
Table 1: Run-off-road casualty frequency CMFs

Predictors		CMFs(Exp(B))	S.E.
Shoulderrumblestrips	Not present	1.23***	0.05788
	Present	1.0	
Curvature	Moderate (R 500-900m)	2.60***	0.05201
	Sharp (R 200-500m)	6.19***	0.06996
	Very sharp (R <200m)	9.42***	0.17367
	Straight or gently curving (R >900m)	1.0	
Road surface condition	Medium	1.10*	0.05729
	Poor	.93	0.20178
	Good	1.0	
AADT		1.42***	0.01989
Roadside hazard distance	(5 to < 10m)	1.14**	0.06521
	(1 to < 5m)	1.68***	0.05682
	(0 to < 1m)	1.22	0.14016
	(>= 10m)	1.0	
Paved shoulder	Not present	1.09*	0.04487
	Present	1.0	
Intersection type	Roundabout	1.24	0.57909
	Other	1.66***	0.05931
	Not present	1.0	

*** = p < 0.01, ** = p <0.05, * = p <0.1

Higher traffic flows increase the frequency of run-off-road casualty crashes. Doubling of AADT leads to 1.4 times higher crash estimate. Curvature is a strong and consistent predictor of run-off-road casualty crashes.

Figure 1 illustrates the relationship between the road segment radius and the run-off-road casualty crash modification factor (CMF, a risk factor).



* All road segments were 100 m long, hence a single curve could comprise several segments

Figure 1: Impact of road segment radius on run-off-road casualty crashes

Absence of shoulder rumble strips increased crash estimate by a factor of 1.23. Medium pavement condition was associated with higher frequency of crashes, compared to good pavement condition. As there were very few cases of 'poor' pavement condition, this effect was not significant.

A narrower road side hazard distance increases the likelihood of casualty run-off road crashes. Figure 2 shows the significant results for run-off-road casualty CMFs. There were few instances of hazard offsets in the 0-1 m range, hence the results were not significant for this category.

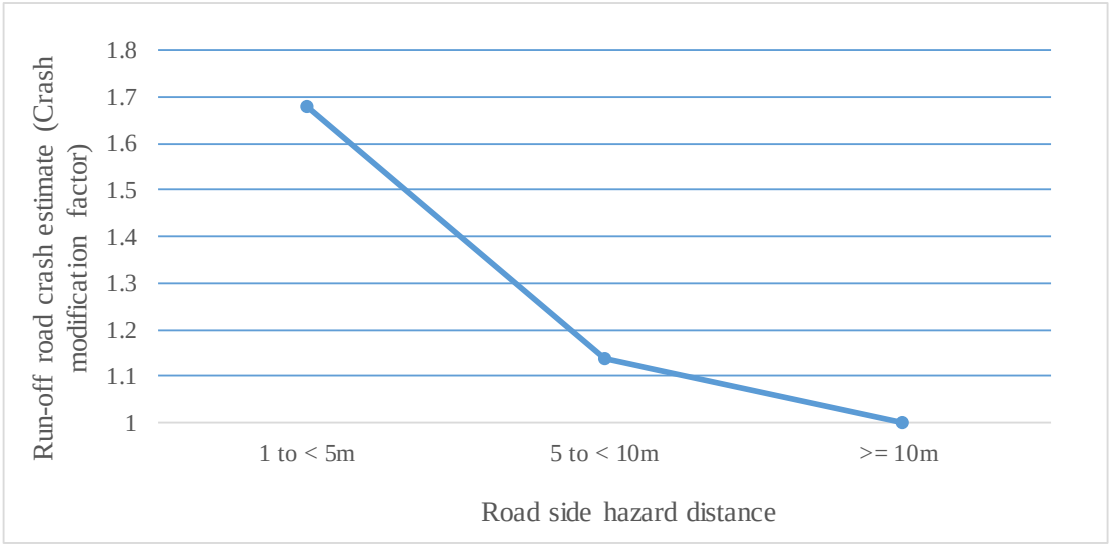


Figure 2: Impact of roadside hazard distance on run-off-road casualty crashes

Presence of a sealed shoulder reduced crash estimate by 0.9. Presence of an at-grade intersection other than a roundabout increased crash estimate by 1.7. Roundabouts were shown to also potentially increase risk, although this finding was not statistically significant.

Other available road variables were tested for their contribution to the run-off-road casualty crash estimate but were found to have any statistically significant effect (e.g. the prevailing type of roadside hazard).

Conclusion and policy relevance

The findings have improved the understanding of the roadside features that contribute to run-off-road casualty crashes on rural undivided high-speed roads. The results may contribute to the review of design practices. Given the cross-sectional nature of the findings, they could be used in mass-action road safety plans such as network-wide standard upgrade programs. The expectation is that such actions would translate to observed reduction in vehicle run-off-road casualty crashes and a consequential decrease in fatal and serious injuries.

References

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