Some implications from the in-depth study and simulation modelling of road departure crashes on bends on rural roads

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Abstract

Previous work by the authors has questioned the philosophy of reliance on clearzones, rather than barriers, for rural road safety. In-depth investigation and simulation modelling of a sample of real world crashes has highlighted that even if clearzones of 10 metres could be achieved throughout the rural road network, there are certain vehicle control mechanisms that are not adequately accommodated when a vehicle departs the road. This paper extends this work based on 64 investigated crashes on rural roads at bends and nine computer simulations of these crashes. Bends are over-represented in rural crashes yet the provision of clearzones tends to mimic that of straight sections of road in practice. The study summarizes the characteristics of the investigated crashes in the context of departures and vehicle control mechanisms and discusses the implications of the findings on the provision of safety features on rural roads. The provision of roadside barriers is also discussed including location relative to the bend and offset from the edge of the traffic lane.

Extended Abstract

In South Australia, 40% of injury crashes on high speed (80km/h and above) rural roads between 2001 and 2010 occurred on a horizontal curve. This study examined the nature of vehicle departures on curves to provide guidance on the extent of clear zone necessary to achieve a safe system and to examine if barrier protection was required in addition to clear zones.

The data for this project were obtained from the Centre for Automotive Safety Research's (CASR) in-depth crash investigation database. To the end of January 2010, 415 rural crashes had been investigated, of which 64 involved single vehicle departures on curves. These 64 crashes were analysed with regard to factors important to clear zones and barriers. Computer simulation of a selection of the departures was used to provide a detailed understanding of the instantaneous speed of a vehicle during the road departure manoeuvre. Computer simulation also allowed testing of the relative merits of various clear zone and barrier combinations. From the 64 crashes, nine were selected as representing the most common types of departures on curves. These cases were reconstructed using simulation software. The exact geometry of the road surface, including super-elevation and shoulder cross-fall was modelled from an engineering site plan produced by the crash investigators. From the edge of the shoulder, the terrain was modelled as a flat horizontal plane. A barrier was placed in the simulated environment to investigate the injury potential of roadside barriers. The barrier was moved progressively further away from the roadside in order to understand the implications of the lateral placement of the barrier.

The most common type of departure was a single yaw on a right bend. This involved a driver losing control, either on the sealed surface of the road or on the left unsealed shoulder, and consequently yawing over the centre line and departing the road on the inside of the corner. Almost half of the vehicles departed the road after the bend, having initiated the departure within the bend. This highlights the need to also consider the inside of curves and lengths of exit tangents to curves when providing clearzones or barriers. Of the 64 crashes on curves, 27 resulted in a rollover. Possible reasons for rollover included the change in height between the natural terrain and the edge of road formation, a propensity for vehicles to yaw after leaving the road as the driver attempted to recover and steep slopes and embankments in the vicinity of curves in hills environments. Modelling suggested that factors other than excessive speed may have been more important in the sample of crashes investigated.

A 10 metre design objective is often specified for clearzones. Many of the vehicles in the sample collided with fixed objects within 10 metres of the roadway. Approximately 20% of vehicles traversed at least 10 metres and had an occupant who sustained injuries requiring transportation to a hospital. Of those six cases where no fixed object was struck, only two came to rest within 10 metres of the roadway and three travelled further than the maximum clear zone recommended for a curve. The simulations indicated the distance vehicles travelled if a hazard was not struck. More than 80% of vehicles travelled further than 10 m laterally and more than half travelled further than the maximum recommended clear zone for a curve (Austroads 2009). The speed at which the vehicle was travelling when it struck a hazard 10 m from the road was above 30 km/h for 13 of 18 simulations and in seven cases the vehicle was travelling at more than 60 km/h. The simulations suggested that on the basis of safe system impact speeds, the closer the barrier is to the edge of the road the lower the severity of the impact. Further work is continuing on modelling the mechanisms of rollover in clear zones.

References

Austroads (2009) Guide to road design part 3: geometric design, Sydney, Austroads.