Anatomy of a wire rope safety barrier impact

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Abstract

Carriageway departure crashes make up a significant proportion of fatalities and serious injuries in regional Victoria. Wire rope safety barrier (WRSB) is a proven countermeasure, eliminating 80-90% of serious trauma when fully installed. To demonstrate its life-saving benefits, the TAC staged a 'typical' fatigue-related crash on a public road under controlled conditions, driving a passenger vehicle into a WRSB at 87km/h at a 7-degree angle, while filming and making measurements. The vehicle was effectively contained by the WRSB, disengaging at 46km/h with decelerations well within tolerable levels. The test demonstrated the effectiveness of WRSB and will be used to validate future simulations aimed at improving WRSB design.

Background

From 2012-2016, an average of 78 vehicle occupants were killed and 520 hospitalised annually in run-off-road and head-on crashes in regional Victoria, equating to half of road fatalities and one-quarter of serious injuries in country areas. Wire rope safety barrier (WRSB) is a proven Safe System solution to this issue (Candappa, Corben, D'Elia and Newstead, 2011), eliminating 80-90% of fatalities and serious injuries when installed on both sides and centre of the road.

Under Victoria's *Towards Zero Strategy and Action Plan 2016-2020,* a large-scale rollout of WRSB was planned for Victoria's most high-speed, high-risk roads. To demonstrate its life-saving benefits, the TAC recreated a 'typical' fatigue-related carriageway departure crash with a car being filmed driving into WRSB under controlled conditions for a public education campaign.

Method

A 2012 Ford Territory was driven along a centerline barrier-equipped section of the Midland Highway near Shepparton. The four-wire section (2m post spacing) was 760m long, with impact 200m from the west end. The driver directed the vehicle into the barrier at 90km/h and 7-degree impact angle, representing typical rural fatigue crash conditions from MUARC real-world studies. Upon impact, the driver took his foot off the accelerator and allowed the vehicle to run for 2s before braking to rest.

Three load cells were fitted on the top, second and fourth wires to measure wire tension during the impact. Triaxial accelerometers were mounted at the centre-of-mass of the vehicle and on the driver's helmet.

The event was captured with seven cameras at 100-800 fps (4-32x actual speed).

Results

Initial barrier contact occurred at 24.2ms^{-1} (87.2km/h). The vehicle collapsed 17 posts before disengaging at a speed of 12.8ms^{-1} (46.1km/h), 36m and 2.25s later (Figure 1). Mean deceleration for the event was 5.1ms^{-2}, peaking at 8.5ms^{-2}.

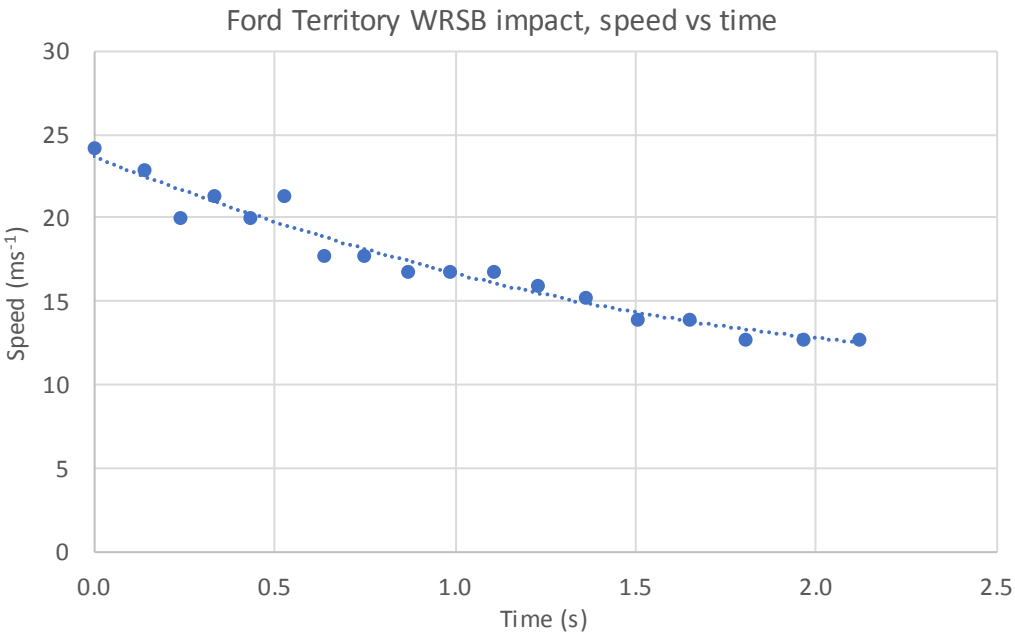

Figure 1. Vehicle speed vs time from barrier contact to separation

The barrier successfully captured the vehicle, with only 600mm lateral excursion. The centre brake light was seen to activate throughout, indicating stability control intervention, with the braking forces applied by the ESC likely increasing the overall deceleration rate. Against instructions the driver had steered gently into the barrier for visual effect. The camera showed a quarter-turn of steering from 0.29s until 1.16s. He stopped 1.5m laterally off the barrier. Vehicle damage was largely superficial, with a fluid leak and the engine not able to be restarted after the test. The passive safety systems were undeployed.

The barrier wires were tensioned to around 25kN pre-test as recommended by the Ingal representative. During the event, bottom wire tension peaked at +6.7kN (at 0.12s). The corresponding figures for the middle and top wires were 4.2kN (0.16s) and 3.6kN (at 0.26s).

The acceleration time series collected from the vehicle and driver had some anomalies that are still to be investigated.

Conclusion

This test clearly demonstrated that WRSB was highly effective in containing a modern vehicle of typical mass and ride height at a speed and impact angle commensurate with a fatigue-related carriageway departure crash. An associated PhD project will use this experiment as a validation sample for a model being developed to facilitate the simulation of a wider range of barrier impacts and provide guidance for improving WRSB design.

References

Candappa N., D'Elia A., Corben B. and Newstead S., 2011. Wire Rope Barrier Effectiveness on Victorian Roads. *Proceedings of the Australasian Road Safety Research, Policing and Education Conference*. 1-2 September, Melbourne.