Proposed Australian/New Zealand AS/NZS 3845.2 Standard for Truck Underrun Barriers: Design, Testing and Performance Requirements

Raphael Grzebieta[a] and George Rechnitzer[a,b]

[a]Transport and Road Safety (TARS) Research Centre, University of New South Wales ,
[b]George Rechnitzer & Associates Pty Ltd

Abstract

Each year around twelve fatalities occur as a result of truck rear underruns in Australasia. The injuries are usually horrific. Given Australia has adopted a 'Safe System Approach' road safety strategy, all such foreseen fatalities need to be addressed if a design countermeasure can be implemented. This paper presents details of practical test requirements set out in the draft Australian New Zealand standard AS/NZS 3845.2: Road Safety Barrier Systems and Devices which is now out for public comment. Brief details of the crash test matrix and the basis on which requirements were established is presented.

Background

Rear underrun car crashes into heavy vehicles with rear overhangs where the truck structure intrudes into the impacting vehicle's occupant compartment represents the most extreme example of system incompatibility between heavy vehicles and passenger cars. Figure 1 (a) shows some real world crashes where people have died as a result of such horrific crashes in Australia (Rechnitzer & Foong, 1991). Any car impact protection devices such as crumple zones, frontal airbags, or pre-tensioning belts are completely negated by the obvious mismatch between the truck's rear and car's crashworthiness systems as shown in Figure 1 (b) (Rechnitzer & Grzebieta, 1991, Grzebieta & Rechnitzer, 2001). This type of crash often causes severe or fatal injuries to car occupants due to the mismatch in mass ratio, stiffness ratios, compartment intrusion, and importantly interface geometry (Rechnitzer & Grzebieta, 2001, Grzebieta & Rechnitzer, 2001).

Haworth and Symmonds (2003) estimated that rear underrun crashes in Australia account for some 10 or so fatalities and around 150 serious injuries every year. Despite this, there currently is no legislation or Australian Design Rule (ADR) requiring crash testing of underrun barriers. The US Insurance institute of Highway Safety has also identified that truck underrun fatalities and serious injuries are occurring as a result of inadequate truck underrun barriers and the lack of a crash performance test standard (IIHS, 2014).

Truck Underrun Barriers (TUB's) can be thought of as a barrier or a crash cushion that prevents the vehicle from underrunning the truck, and hence injuries, as shown in Figure 1 (c) & (d). TUBs are permanently fixed to the rear of any truck or trailer. A considerable amount of research work has been completed into establishing what is a suitably crashworthy TUB (Rechnitzer, Powell & Sayer, 2001, Zou, Rechnitzer & Grzebieta, 2001, Rechnitzer, 2003). Readers are referred to that material because of the word restriction in this Extended Abstract.

Proposed Standard

To address this shortcoming in the ADR, a new Australian Standard AS/NZS 3845.2: Road Safety Barrier Systems and Devices (Standards Australia, 2016) now specifies an underride crash test based on US MASH crash testing protocols for Australia and New Zealand for regulators and operators who wish to have crashworthy TUBs fitted to trucks that operate within or deliver materials to a road works/maintenance site. These performance criteria can be equally applied to any truck or trailer of an articulated truck that operates on any public road and are used to protect the occupants in a vehicle that runs into the back of the truck or trailer.

Table 1 shows the crash test matrix that underrun devices are required to comply with. Tests are based on the United States (US) Manual for Assessing Safety Hardware (MASH) protocols where a 1500 kg sedan car (1500A) and then a large 2270 kg sports utiliity vehicle (2270P) are impacted into the truck underrun barrier at a speed of 70 km/h in a centred and a 30% offset configuration. The barrier must meet certain crashworthiness criteria (C, D, F) detailed in MASH. The research work by the Authors referred to above have established that all criteria can be readily met by well designed TUB. This would be elaborated on in the presentation and in an expanded 10 page paper.

References

American Association of State Highway and Transportation Officials (AASHTO), (2009). Manual for Assessing Safety Hardware (MASH). See: (http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/ctrmeasures/mash/)

Insurance Institute of Highway Safety (IIHS), Status Report, Vol. 49, No. 7, October 9, 2014. http://www.iihs.org/iihs/sr/statusreport/article/49/7/1 http://www.iihs.org/iihs/news/desktopnews/new-crash-tests-underride-guards-on-most-big-rigs-leave-passenger-vehicle-occupants-at-risk-in-certain-crashes

Grzebieta, R.H., Rechnitzer, G.R., 2001. Crashworthy Systems – a paradigm shift in road safety design (part II), Transport Engineering in Australia, IEAust, Vol. 7, Nos. 1&2, Dec.

Haworth, N., Symmonds M., 2003. A Cost-Benefit Analysis of Heavy Vehicle Underrun Protection, Proc. Australasian Road Safety Research, Policing and Education Conference, http://acrs.org.au/files/arsrpe/RS030141.pdf

Rechnitzer, G., 2003. The Improvement of Heavy Vehicle Design to Reduce Injury Risk in Crashes with Other Road Users, PhD Thesis, Accident Research Centre and The Department of Civil Engineering, Monash University. https://www.filesanywhere.com/fs/v.aspx?v=8b6a69875e67767ca2a4

Rechnitzer, G., Foong C.W., 1991. Truck Involved Crash Study: Fatal and Injury Crashes of Cars into the Rear of Trucks, MUARC Report No. 26, Monash University, Clayton, Australia. http://www.monash.edu.au/miri/research/reports/muarc026.pdf

Rechnitzer, G., Grzebieta, R.H., 2001. Crashworthy System – a paradigm shift in road safety design (part I), Transport Engineering in Australia, IEAust, Vol. 7, Nos. 1&2, Dec.

Rechnitzer, R.G., Powell C., Sayer, K., 2001. Performance Criteria, Design and Crash Tests of Effective Rear Underride Barriers for Heavy Vehicles, Proc. 17th International Technical Conference on the Enhanced Safety of Vehicles**,** Amsterdam, Netherlands, 4-7 June. http://www.georgerechnitzer.com.au/wp-content/uploads/2013/09/ESV-2001-Rear-Underrun-GR-2001.pdf

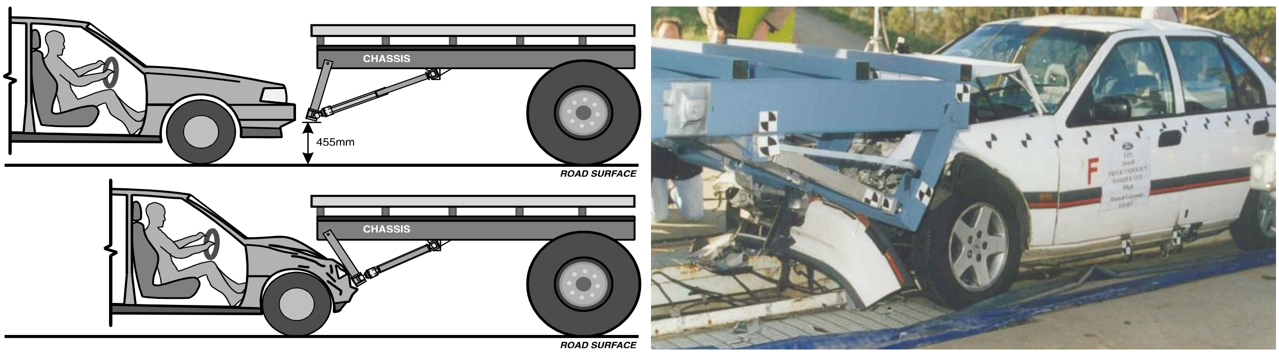
Standards Australia, 2016. AS/NZS 3845.2: Road Safety Barrier Systems and Devices, Standards Australia, Sydney.

Zou, R., Rechnitzer, G., Grzebieta, R.H, 2001. Simulation of Truck Rear Underrun Barrier Impact, Proc. 17th International Technical Conference on the Enhanced Safety of Vehicles, Amsterdam, Netherlands, 4-7 June. www-nrd.nhtsa.dot.gov/pdf/esv/esv17/Proceed/00225.pdf

(a) real world fatalities *(after Rechnitzer & Fong, 1991)*

(b) underrun mechanism *(after Rechnitzer & Grzebieta, 2001)*

(c) rigid barrier design *(after Rechnitzer, Powell & Sayer, 2001)*



(d) energy dissipating barrier design *(after Rechnitzer, Powell & Sayer, 2001)*

Figure 1: Underrun crashes and barrier crashworthiness

Table 1. Test Matrix for Truck Underrun Barriers from AS/NZS 3845.2: Road safety barrier systems and devices bashed on MASH crash test protocols.

Test Level	Feature	Test designation	Impact conditions			Impact point	Evaluation Criteria (see Table 5.1 of MASH)[c]
			Vehicle	Nominal Speed[a] (km/h)	Nominal Angle[a] θ deg.		
2	Truck Underrun Barrier	2-51	2270P	70	0	(b)	C,D,F
		2-52	2270P	70	0	(b)	C,D,F
		2-54	1500A	70	0	(b)	C,D,F
		2-55	1500A	70	0	(b)	C,D,F