

Replacement Windscreens – a serious vehicle and road safety issue

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Abstract

In modern vehicle design the car's windscreen is integral to a vehicle's safety and crashworthiness design. Australian Standard AS4739 (Standards Australia, 2002) for windscreen replacement stipulates the vehicle must be returned to the Original Equipment Manufacturer (OEM) standard but does not specify adhesive characteristics.

The quality of replacement windscreen installations and compliance to AS4739 is dependent on both the correct adhesive being used and that correct practice is being used by installers. However, from the experience of personnel involved in the replacement windscreen industry such as the Australian Autoglass Industry Alliance (AAIA), neither of these factors is assured as a matter of course. This Extended Abstract discusses issues associated with the after-market adhesives.

For the approximately one million windscreens being replaced in Australia each year it is a matter of good luck that a replacement windscreen is bonded with an after-market adhesive that meets the OEM specification.

This paper presents the issues regarding this situation and improvements required in the windscreen replacement industry to ensure vehicle safety is maintained.

Background – the Windscreen Replacement Industry

The windscreen replacement industry in Australia consists of more than 500 businesses that operate as large repair networks, independent businesses or sole traders. These businesses fit an estimated one million replacement windscreens per annum.

Australian Standard AS4739 (Standards Australia, 2002) for windscreen replacement stipulates the vehicle must be returned to the OEM standard, but it does not specify the adhesive characteristics.

Windscreen Replacement Industry associations such as the Australian Autoglass Industry Alliance (AAIA) and others (Rechnitzer, 2015, Call Kurtis Investigate, 2013) have raised major concerns with windscreens being improperly fitted and incorrect adhesives being used. Indeed, Murray (1994) highlighted this more than two decades ago in United States (US) Federal Motor Vehicle Safety Standard (FMVSS) 216 roof crush tests he carried out at Monash University for VicRoads (Murray, 1991, 1994). Both co-authors Rechnitzer and Grzebieta were involved in the FMVSS 216 tests at Monash University in 1991. In these tests, the Ford Falcon tested failed the US roof strength FMVSS 216 criterion because the windscreen was incorrectly bonded, and on retest with the correct windscreen adhesive being used, passed the US test. It should be noted that Australia then and now does not have an Australian Design Rule that requires minimum roof strength for passenger sedan vehicles.

Replacement of windscreens can be a 'safety lottery' for Australian car occupants where in the event of an collision or rollover crash, their windscreen may perform as the vehicle manufacturer intended or it may have been poorly installed and separate from the vehicle altogether.

‘Safety lottery’ is emotive language, but it is the AAIA’s contention after surveying members and non-members that there would be no windscreen repairer in Australia that would be able to locate the OEM adhesive specification for a range of common vehicles sold in Australia such as Toyota, Holden, Mazda, Mercedes, Ford. AS4739-2002 Direct Glazed Automobile Glass Replacement – Light Vehicles standard requires among other things that the adhesive sealant system ‘shall’ be equivalent to the vehicle manufacturer’s specifications. Yet there is no published document that outlines what these specifications are. In the absence of this information, repairers have come to rely on the general marketing claims of adhesive suppliers.

Relevance of the various vehicle tests for validating Windscreen adhesive performance

The Euro-NCAP 64 km/h frontal impact test is a consumer crash test that rates the injury severity risk to vehicle occupants and thus the crashworthiness of new vehicles. The testing has no relevance to windscreen retention but many aftermarket adhesive manufacturers market their product as meeting Euro-NCAP requirements.

On the other hand in the US FMVSS 212 Windshield Mounting, relates to windscreen retention in a collision, with the purpose of “*preventing the ejection of occupants from the vehicle*” (NHTSA, 2007). It involves a crash test into a fixed barrier at 48km/h, and requires that for vehicles fitted with passive restraints the windshield mounting of the vehicle shall retain not less than 50 percent of the portion of the windshield periphery on each side of the vehicle longitudinal centreline.

The US FMVSS 212 crash test, while providing one of the relevant performance criteria for the windscreen adhesive, does not of itself validate that all of the OEM’s key structural performance requirements are fully met. This standard only requires that 51% of the windscreen/body bond remain intact after the test.

US FMVSS 216A Roof Crush Resistance is also relevant to windscreen bonding and performance, as this requires the vehicle’s roof to withstand a platen load of 3 times the vehicle mass and, a correctly bonded windscreen can in today’s vehicles improve structural rigidity by up to 40%.

Whilst the roof crush resistance is influenced primarily by the glass used, the use of after-market adhesives that do not meet the OEM specifications obviously compromise crush resistance performance. No after-market adhesive manufacturer markets its compliance with this test.

Most after-market adhesive manufacturers promote the fact that their product is US FMVSS208 frontal impact crash test compliant but as with Euro-NCAP, this test is not relevant and sets no criteria for windscreen retention.

In summary, while it is relevant to cite the adequacy of the windscreen adhesives performance under testing involved in the US FMVSS 212 and 216, these should not be considered as alternative acceptance criteria to that of meeting the OEM’s adhesive specifications.

OEM Adhesive Manufacturers/Suppliers

Adhesive manufacturers/suppliers in Australia make varying claims about being an ‘OEM’ provider which is perhaps designed to provide windscreen repairers with some comfort that using their product will ensure that the customer’s vehicle will be returned with a windscreen replacement that meets OEM specifications for that particular vehicle; and importantly, returned with its designed safety systems uncompromised.

Some of these ‘OEM’ claims are not relevant to passenger vehicles and relate to perhaps trucks or buses, and others relate to the adhesive used by the OEM and not the adhesive manufactured for the

after-market. The OEM and after-market products have distinctly different performance characteristics.

The adhesive used by an OEM has evolved over time to become a multifunctional direct glazing adhesive with the following key requirements which need to be replicated in adhesives used in the after-market:

1. Low Conductivity, to provide protection against electrical and contact corrosion and correct functionality of the rear window defroster;
2. High frequency performance, to ensure no influence on the reception quality of radios, TV, mobile phone and navigation systems with screens fitted with integrated antennas;
3. High shear modulus and tensile strength, to enhance the overall torsional stiffness of vehicle bodies.

Adhesives with a high shear modulus are designed to reinforce the structure of the car body. Due to lightweight construction requirements of modern vehicles the windscreen becomes essential and integral for the overall vehicle torsional stiffness - ensuring passenger safety. The load-bearing components of a car body are special supporting pillars with high strength and stiffness and when coupled with a polyurethane bonded windscreen as a constructive element can improve structural rigidity by up to 40%

Table 1 shows the current after-market products in the Australian market and how they compare to the specifications of major European OEM’s. Many fall short of the OEM specifications.

Direct Glazing products in Australia Vs European OEM specifications.				
	Adhesive Technology Type	Shear Modulus (DIN EN 14869-2)	Tensile Strength (DIN 53504)	Specific Forward Resistance (DIN IEC 60093)
Product 1	MS	1.8 MPa	2.8 MPa	$\geq 10^8 \Omega\text{cm}$
Product 2	MS	1.6 MPa	2.8 MPa	$\geq 10^8 \Omega\text{cm}$
Product 3	PUR	2.4 MPa	10.3 MPa	$\geq 10^8 \Omega\text{cm}$
Product 4	PUR	2.0 MPa	9.6 MPa	$\geq 10^8 \Omega\text{cm}$
Product 5a	PUR	2.9 MPa	9.5 MPa	$\geq 10^8 \Omega\text{cm}$
Product 5b	PUR	2.7 MPa	8.5 MPa	$\geq 10^8 \Omega\text{cm}$
Product 5c	PUR	2.5 MPa	9.0 MPa	$\geq 10^8 \Omega\text{cm}$

Meets Major European OEM specification

Does Not Meet Major European OEM specification

Table 1- A summary table illustrating current adhesives in the Australian market compares to the key requirements of 5 major European OEM’s. (data from Henkel Teroson).

The Australian Standard AS4739-2002 ‘Direct Glazed Automotive Glass Replacement – Light Vehicles’ (Standards Australia, 2002) is currently being reviewed by a Standards Australia industry working group which should result in the clear specification of adhesive properties used in the replacement of windscreens in Australia.

Of note is the incompatibility between Modified Silane (MS) polymer and polyurethane (PUR) based adhesives. When PUR is applied directly over MS adhesive, adhesive failure of the direct glazing adhesive becomes a significant risk as the alcohol byproduct in the MS technology directly affects the adhesion of the PUR technology.

Windscreen Adhesive Specifications currently available

Currently, a windscreen fitter has to take on face value the claims made by adhesive suppliers about being US FMVSS212 or OEM compliance.

Product Data Sheets (PDS) for a number of aftermarket adhesives available in Australia are difficult to reconcile with one another and quote properties like tensile strength, tensile lap shear strength, sheer stress, shear strength, stress, tensile stress, etc. Specifications for these properties are quoted in varying units such as Pa/mm², PSI, Pa, kPa, etc.

It is confusing for the industry and after-market adhesive manufacturers need to adopt an agreed set of properties and units that can be easily reconciled with OEM specifications.

Conclusions

The quality of replacement windscreen installations and compliance with AS4739 is dependent on both the correct adhesive being used and that the correct practice is being used by installers.

Neither of these things are assured in the industry currently which is contributing to a growing incidence of placing vehicle occupants at risk in regards to vehicle crashworthiness.

It is recommended that:

1. AS 4739-2002 needs to include the specifications of glass and adhesives used in Australian windscreen replacements;
2. All Vehicles sold in Australia must include a specification sheet in standardised form made available to the windscreen replacement industry, which readily enables identification of adhesives which meet the OEM specifications;
3. Insurance companies and fleet operators need to require the use of glass and adhesives that meet the updated AS4739 specifications;
4. A regulatory regime to be considered by government (or alternatively industry and insurers) requiring all windscreen installer's to be qualified and certified;
5. That windscreen failures (e.g. lack of bonding) be identified in the police collision reports.

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