Chapter 6
Vehicle Design Standards for Pedestrian and Cyclist Safety

Introduction

By 1950, 60% of American households owned a car, yet vehicle design for occupant protection was poorly developed, and remained unregulated in the US until 1968\(^1\) [1]. Regulation resulted in dramatic improvements in occupant safety [2]. Similarly, although researchers have had a basic understanding of the relationship between vehicle design and pedestrian injuries since the 1960s [3], the safety of vulnerable road users such as pedestrians and cyclists was not a serious consideration in vehicle design until the 1980s. This has been fuelled by the belief that little could be done to protect pedestrians in the event of a vehicle impact [4, 5] but also by vehicle manufacturers’ reluctance to develop an area not governed by legislation and not considered to provide sufficient added value to the vehicle. Safety research for pedestrians and cyclists was therefore slow and poorly funded in comparison to vehicle occupants and scientific consensus on the requirements of vehicle design for pedestrian protection has still not been achieved. In consequence, existing standards are subject to updates and legal implementation is evolving and remains limited. However, there is now substantial public appetite in many countries for the regulation of vehicle design for pedestrian safety, as evidenced by the introduction of pedestrian safety testing by consumer driven safety organisations such as the New Car Assessment Programs [6] operational in Europe, Japan and Australia.\(^2\)

This chapter provides a summary of the development of crash safety standards aimed at improving passenger vehicle front-end design for pedestrian and cyclist impacts. The principal focus has specifically been on improving pedestrian safety when struck by passenger vehicles but, following early research into cyclist impact mechanics [7], it has been generally assumed that standards governing vehicle design for pedestrian safety will also improve safety for cyclists [8–10]. However,

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\(^1\) FMVSS 208 introduced in 1968 by NHTSA (frontal impact legislation).
\(^2\) For example, the EuroNCAP founded in 1997 publishes safety reports on new cars, and awards ‘star ratings’ based on vehicle performance in a variety of crash tests including impacts with pedestrians (http://www.euroncap.com).
it has been shown that the impact velocity and impact angle for cyclist’s heads on the bonnet are lower than for pedestrians when struck by the fronts of passenger vehicles and test conditions should reflect these differences [11]. Similarly, accident data show that test methods for the fronts of buses, coaches and goods vehicles would be beneficial [12], especially in less motorised countries.

A significant difference in head injury risk between pedestrians and cyclists may exist if the cyclist is wearing a helmet, and a number of safety standards for cycling helmets are aimed at maintaining head linear acceleration at sublethal levels in droptests (e.g. [13–15]). However, these have primarily evolved to protect cyclist’s heads in the event of a fall to the ground: for example, the Snell Foundation test involves a dropheight of 2.2 m, which is roughly 25% greater than an adult head height above the ground. The impact velocity for this test is 6.6 m/s (24 km/h), which is significantly lower than the mean reported vehicle/cyclist impact speed of ca. 35 km/h, see Chapter 2. The effectiveness of cycling helmets in protecting against head injuries resulting from vehicle impacts is the subject of significant debate (e.g. [16–19]). Nonetheless, bicycle helmets which pass the Snell test [15] have a significant potential to reduce the severity of cyclist head injuries in the event of a collision with a vehicle.

Bodies Developing Pedestrian Safety Standards

The main bodies which have developed pedestrian safety standards are Working Groups of the European Enhanced Vehicle Safety Committee (EEVC), the International Organization for Standardisation (ISO) and the International Harmonised Research Activities/United Nations Economic Commission for Europe (UNECE). The EEVC and ISO Pedestrian Safety Working Groups were created in 1987 to determine test methods and acceptance levels for assessing protection afforded to pedestrians by the fronts of cars in an accident. Recognising that the ISO and EEVC tests were formulated based on accident data collected in the 1970s and 1980s, the IHRA program was developed to analyze more recent pedestrian accidents and develop harmonised test procedures to reflect the current accident environment in the member countries. The IHRA accident data from Australia, Europe, Japan and the USA showed that the head and leg each account for almost one third of pedestrian injuries, with the bonnet top and windscreen glass being the leading causes of head injury for children and adults respectively, see Chapter 2. Therefore test procedures for child and adult head impact and the adult leg in the vicinity of the knee were developed by the IHRA [20]. The IHRA has now largely superseded the work of the ISO and, given the global nature of the production vehicle market, the IHRA has been working on a draft Global Technical Regulation (GTR) for pedestrian protec-

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3 The United States National Highway Traffic Safety Administration (NHTSA) was independently active in this field until the 1990s, and now channels its input through the IHRA.