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Injury Analysis Validation of A Deformable Vehicle Front End Model

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Abstract. In the event of an impact with an automobile, pedestrians suffer multiple impacts with the bumper, hood and the windscreen. The characteristics of a vehicle's front end and structural stiffness have a significant influence on the kinematics and injury risk of the pedestrian's body regions, in a vehicle-to-pedestrian collision. In this present study, the injury risk of the pedestrian is investigated in an impact with a deformable vehicle front end model for the purpose of validating the developed model. A simplified vehicle front end model consisting of a multi body windscreen and a finite element cowl, hood and bumper is developed. The MADYMO human pedestrian multi body dummy model is impacted by the vehicle front end model at the speed of 40 km/h. The injury to the various body segments namely the head, neck, sternum, lumbar, femur and tibia is obtained. The simulation values are compared to the experimental values for verification of the vehicle front end model.

Introduction

Pedestrian safety has become an essential issue in the field of vehicle safety regulations. More than 0.8 million people killed and 10 million injured annually in road traffic accidents globally are pedestrians[1]. In Malaysia, nearly 600 pedestrians were killed in road accidents annually since 2010, most of them being senior citizens and children. A report by the Malaysian police force shows that these statistics make up for about 10% of traffic fatalities [2]. MIROS, the Malaysian Institute of Road Safety Research which functions as a one-stop centre for the generation and dissemination of road safety information through the print media and concerted training programmes highlights that 40% of pedestrian casualties were children with at least 40% of them killed or severely injured[2]. Whereas the senior citizen pedestrians aged 66 up to 70 years made up the highest number of fatalities according to statistics. While pedestrian deaths only represented less than 10% of the total road accident fatalities each year, the number recorded was a cause for concern, and it also reported that pedestrians ranked third in road fatalities after motorists and motorcyclists [2].

More than 70% of casualties take place due to the negligence of the pedestrians refusing to use the facilities provided or crossing roads at wrong places [2]. Although the total number of pedestrian accidents locally has decreased from 2006 to 2008[3], nevertheless it contributes to health and socio-economic problems in this country. Passive mitigation approaches through isolation techniques such as pedestrian bridges, road infrastructure, public education and traffic regulation have long been introduced in the attempt of reducing pedestrian accidents. This however does not provide a permanent solution as when the crash event occurs, these mitigation techniques does not lessen the injury severity sustained by the pedestrians[4]. Thus to address this issue, a more design inherent approach is required whereby the pedestrian protection provided is built-in to the vehicle design. Therefore this research aims to develop a simplified vehicle front end profile consisting of finite element segments and a multi body windscreen to evaluate the injuries sustained by the various body parts of the pedestrian in a collision. The validity of the vehicle model