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Auto Rickshaw Impacts with Pedestrians: A Computational Analysis of Post-Collision Kinematics and Injury Mechanics

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Abstract : Motor vehicle related pedestrian road traffic collisions are a major road safety challenge, since they are a leading cause of death and serious injury worldwide, contributing to a third of the global disease burden. The auto rickshaw, which is a common form of urban transport in many developing countries, plays a major transport role, both as a vehicle for hire and for private use. The most common auto rickshaws are quite unlike ‘typical’ four-wheel motor vehicle, being typically characterised by three wheels, a non-tilting sheet-metal body or open frame construction, a canvas roof and side curtains, a small drivers’ cabin, handlebar controls and a passenger space at the rear. Given the propensity, in developing countries, for auto rickshaws to be used in mixed cityscapes, where pedestrians and vehicles share the roadway, the potential for auto rickshaw impacts with pedestrians is relatively high. Whilst auto rickshaws are used in some Western countries, their limited number and spatial separation from pedestrian walkways, as a result of city planning, has not resulted in significant accident statistics. Thus, auto rickshaws have not been subject to the vehicle impact related pedestrian crash kinematic analyses and/or injury mechanics assessment, typically associated with motor vehicle development in Western Europe, North America and Japan. This study presents a parametric analysis of auto rickshaw related pedestrian impacts by computational simulation, using a Finite Element model of an auto rickshaw and an LS-DYNA 50th percentile male Hybrid III Anthropometric Test Device (dummy). Parametric variables include auto rickshaw impact velocity, auto rickshaw impact region (front, centre or offset) and relative pedestrian impact position (front, side and rear). The output data of each impact simulation was correlated against reported injury metrics, Head Injury Criterion (front, side and rear), Neck injury Criterion (front, side and rear), Abbreviated Injury Scale and reported risk level and adds greater understanding to the issue of auto rickshaw related pedestrian injury risk. The parametric analyses suggest that pedestrians are subject to a relatively high risk of injury during impacts with an auto rickshaw at velocities of 20 km/h or greater, which during some of the impact simulations may even risk fatalities. The present study provides valuable evidence for informing a series of recommendations and guidelines for making the auto rickshaw safer during collisions with pedestrians. Whilst it is acknowledged that the present research findings are based in the field of safety engineering and may over represent injury risk, compared to “Real World” accidents, many of the simulated interactions produced injury response values significantly greater than current threshold curves and thus, justify their inclusion in the study. To reduce the injury risk level and increase the safety of the auto rickshaw, there should be a reduction in the velocity of the auto rickshaw and, or, consideration of engineering solutions, such as retro fitting injury mitigation technologies to those auto rickshaw contact regions which are the subject of the greatest risk of producing pedestrian injury.

Keywords : auto rickshaw, finite element analysis, injury risk level, LS-DYNA, pedestrian impact
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