IMPACT BIOMECHANICS IN TWO WHEELED AND THREE WHEELED VEHICLES

Anoop Chawla, Sudipto Mukherjee and Dinesh Mohan
Indian Institute of Technology, New Delhi 110016 INDIA
achawla@mech.iitd.ernet.in

INTRODUCTION

In many Asian countries two wheelers (motorcycles and scooters) as well as three wheelers (three wheeled scooter taxis, TSTs) form a very important means of urban transport. We have been studying crashes in which these vehicles are involved over the past decade through simulations of these vehicles under different impact conditions [D Mohan et. al, 1995, A Chawla et al 2001]. In this paper we discuss use of computer simulations to highlight biomechanics issues in these conditions.

TWO WHEELER IMPACT KINEMATICS

We have conducted Finite Element based simulations (using PAMCRASH^{TM}) of the car–motor cycle impact in several orientations. For riders on two wheelers, the body segment upwards of the hip is largely unrestrained and hence cannot be controlled directly during impact. Simulations help us understand how making changes in the leg environment at the design stage can control the impact on the upper body.

To conduct crash tests with the MC, a modified version of the Hybrid III dummy, MATD (Motorcycle Anthropometric Test Device) is used. The MATD has tighter joints and a modified handle grip to ensure stability in the pre–run to the crash [ISO13232]. The simulations verify the experimentally observed result that the grip on the MC handle lasts as much as 100 msec after the impact. As a result the whole dummy pivots about the handle and the height gained by the head increases by about 5 cms. [S Mukherjee etal, 2001a]. We think that this modification is not biofidelic as the real life MC rider can not hold on to the handle bar during a crash. Such changes needed for convenience of testing therefore need to be carefully evaluated for their biofidelity.

Figure 1: A snapshot of car – motor cycle impact simulation.

In addition to gaining a better understanding of vehicle design issues, these computer simulations thus give us a strong tool to understand important bio-mechanics issues in these crashes.

THREE WHEELER IMPACT KINEMATICS

Partially open three wheeled vehicles (TSTs) are a low cost mode of transport in many South Asian countries. Over the last few years we have carried out a number of simulations of these vehicles to evaluate safety issues (eg, Figure 2). These vehicles run at maximum speeds of 50 kmph. and impact speeds are typically of the order of 25-30 kmph. As a result the severity of injuries caused are low. This is in spite of the fact that typically the TSTs are not equipped with seat belts.

A different paradigm is hence needed to augment safety in these vehicles. Computer simulations suggest for injury evaluation, thorax, head, and knees are areas of concern. Additionally, soft tissue injuries in abdominal region could be possible in severe crushing events. With low cost changes, the interiors of the TSTs can be redesigned to minimize these impacts. Enclosing the partially open structure to prevent the occupant being ejected during a crash is also suggested.

TST's are not fitted with a bumper. The first impact with the pedestrian is thus often with the upper thigh or the pelvis region as against the lower leg (Figure 3). This reduces knee injuries and whole body rotation. When we consider that these vehicles have low mass and velocity they may be the most pedestrian friendly vehicles around. There is scope to modify the fronts of TSTs further to reduce injuries to pedestrians.

A special feature of TST's is the high lateral mobility. An area of public concern is the issue of stability of the vehicles during maneuvers and when passing over bumps and potholes. We are currently in the process of investigating this aspect of the 3 wheeled vehicles through multibody simulations.

SUMMARY

We have discussed how computer simulation help understand the important biomechanics issues in two wheeler and three wheeler crashes. There is a need to evaluate these aspects in detail in order to reduce likelihood of injuries / fatalities in case of crashes.

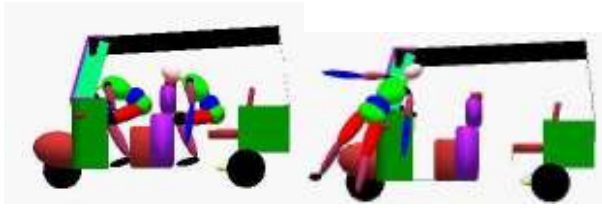

Figure 2 and Figure 3: Snapshot of simulations of a TST - occupant and TST – pedestrian crashes.

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