ANALYSIS OF VEHICLE KINEMATICS AND OCCUPANT INJURY RESPONSES DURING A VEHICLE ROLLOVER

By

MOHAMMAD U FAROOQ ANSARI

Spring 2002

ABSTRACT

The increasingly stringent safety standards, which require tests to simulate complex injuries, make virtual simulation imperative. Simulated crash testing allows hundreds of potential designs to be tested to determine how the occupant would fair in a range of different scenarios such as Frontal, Side, Rear impacts and Rollovers. With increased developments in safety countermeasures, serious/fatal injuries in frontal and side impacts have decreased and as a result, rollover accidents are getting increased interest.

Rollovers result from the vehicle leaving the roadway and tripping. Vehicle rollover motion is very violent and complex to understand and analyze. The resulting injury to the occupant because of this violent and complex motion of the vehicle could be severe. In order to understand the potential for injury during rollover, the effects of occupant motion need to be studied. To perform this type of test using the conventional approach of crash testing is costly and time consuming. Simulation software products have reduced this time dramatically.

In this thesis crash analysis of a vehicle rollover and the resulting occupant injury have been performed in two stages using simulation software Mathematical Dynamic Modeling (MADYMO). A Dolly initiated test setup was modeled to study the kinematics of the vehicle and the resulting injury criteria have been evaluated for a restrained and unrestrained occupant.

The vehicle was modeled with the actual specifications of Ford Explorer 2002 (Sports Utility Vehicle) in MADYMO. The reason for modeling a sports utility vehicle was because the fatality rates for rollover crashes are highest in utility vehicles and pickup trucks. This is because utility vehicles have a higher center of gravity and lower track width and the tendency to rollover is more. A 50th percentile Hybrid III dummy was used to study the occupant responses. The simulation analysis was conducted for a restrained and unrestrained occupant and different injury criteria's have been evaluated.

The vehicle's peak center of gravity and chassis accelerations were calculated. The Dolly Initiated analysis showed how safety restraint systems such as, lap and shoulder belts were effective in containing the passenger in the seat and reduce injury to a great extent. The peak accelerations of Upper Torso, Lower Torso and Head Injury Criteria for restrained and unrestrained occupant were calculated. The accelerations for the restrained occupant were with in the critical values. Where as, the chances for the unrestrained occupant to survive

the crash is minimal as the occupant ejected out of the vehicle. The Head Injury Criteria for the unrestrained occupant was above the critical value.