An Analysis of Pedestrian Dummy Throw Characteristics for Forward Projection Pedestrian Collisions

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Abstract

Pedestrian crash kinematics have been well documented for automobile versus pedestrian collisions. However, there is not significant amount of data concerning impact of pedestrians with a high profile vehicle. A series of pedestrian crash tests using full-sized vans was performed to add to the existing database of forward projection pedestrian collisions and to compare the crash test data to existing forward throw equations.

Introduction

There is a considerable amount of published data correlating pedestrian throw distance to vehicle impact speed for lower profile vehicles (e.g. typical passengers cars). This research project focused on evaluating the interaction between larger profile vehicles (e.g. passenger vans, sport-utilities and trucks) and pedestrians. The aim of this study was to examine the trajectory behavior of the pedestrian and compare the impacts to both existing pedestrian throw models for forward projection style pedestrian impacts.

Test Procedure

In performing the tests, the pedestrian dummy (Alderson Research Labs, Inc., Model CG-95) was suspended from a cantilever beam using an 18.2 kg tensile strength monofilament wire. The impacting vans were instrumented with a triaxial accelerometer (IC Sensors, Milpitas, CA) triggered at impact with the dummy. The trials were videotaped using two high-speed digital camcorders (JVC DVL 9500, JVC DVL 9800) that recorded at 120 Hz and 240 Hz., respectively. Each trial was computer digitized and analyzed using motion analysis software (Peak Motus™ 2000, Peak Performance Technologies, Inc., Englewood, CO). The results of the digitized analysis were compared to the measured throw distance and velocity profile integrated from the from the accelerometer data of the van. Forty-eight tests were performed on dry pavement using two different vans. The impact speeds ranged from 4 km/h to 60 km/h, with most of the data falling under 32 km/h. The impact speed versus throw distance was plotted and compared to existing forward projection throw models.

Results

The graph seen in Figure 1 represents the pedestrian throw distance versus the vehicle impact speed and the correlation to the Northwestern University forward projection throw equation (1). The Northwestern curve
follows the same general trend as the pedestrian throw data. Figure 2 represents a comparison of the pedestrian and vehicle trajectories for similar impact speeds of approximately 9.6 kph for a low profile vehicle and a passenger van. The takeoff angle of the pedestrian in each of these instances is less than zero. The trajectory for the forward projection follows a simple curvilinear trajectory. The pedestrian motion from the lower profile vehicle has an initial dip where the pedestrian’s center of gravity descends to contact the vehicle hood after which the trajectory follows a simple curvilinear path as commonly seen in projectile motion. Figure 3 compares the pedestrian trajectory for a 33.6 kph impact between a forward projection and wrap trajectory. The forward projection trajectory has an initial upward takeoff angle. The pedestrian motion for the wrap trajectory is initially downward followed by a takeoff angle that is substantially steeper than the forward projection trajectory.

**Discussion**

The current pedestrian impact data provided good correlation with the Northwestern University pedestrian throw model for forward projections. The general trend of the Northwestern curve using a 0.8 g deceleration factor for the pedestrian closely correlated with the pedestrian throw data. There was a distinct difference in the post-impact kinematic pattern of the forward projection pedestrian trajectory when compared to impacts with a lower profile vehicle, especially at higher speeds. Limitations of the data were imposed by the delimitations set by the authors and included: use of a single dummy, use of two similar high-profile vehicles and a lateral view from the cameras that permitted only a 2-dimensional kinematic analysis in the longitudinal plane. The pedestrian and vehicle data for this study were used to correlate the Northwestern forward projection model and to add to the existing database of pedestrian crash testing. Further work will examine the model in greater detail and compare the relationship of pedestrian throw distance to vehicle impact velocity over a variety of impact situations.