C9 Comparison of Barrier Impact Crush and Vehicle to Vehicle Crush in Head-On Collisions

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After attending this presentation, attendees will understand how to compare vehicle to vehicle and vehicle to barrier crashes in terms of comparable damage.

This presentation will impact the forensic community and/or humanity by making the NHTSA crash test data base more useful.

During an accident reconstruction, one is sometimes presented with the need to assess collision impact speed in a head-on collision, based solely on an examination of the damage to the vehicles involved. This examination may involve a direct inspection of the vehicles or a review of photographs of the vehicles.

In order to determine an appropriate vehicle to vehicle (VTV) impact speed, it is often helpful to consult the National Highway Traffic Safety Administration (NHTSA) crash test data base to find vehicle to barrier (VTB) crash tests involving the subject vehicles (or their sisters). This is done in order to compare vehicle crush and overall damage in the staged NHTSA crash test to the damage to the vehicles that are under investigation. The NHTSA database contains thousands of VTB and impactor to vehicle crash tests, but only a small number of VTV staged crashes. It has been observed that a higher impact speed is often required in a VTV crash to produce the same level of damage as in a VTB crash. The question addressed in this paper is, how does one convert from a VTB impact speed to the VTV impact speed required to achieve equivalent damage?

In this paper NHTSA staged crash tests involving eight different domestic and foreign vehicle models[1] were examined. Head-on (zero degree) crash tests were chosen from the NHTSA database for cases where both VTV and VTB crash results were available for the same vehicle or sister vehicles. Vehicle crush values were compared to the impact speed producing the crush. A barrier impact speed multiplier factor was derived for each VTV impact to achieve damage comparable to that observed in a VTB crash involving like vehicles.

The results are depicted in Figure 1. Each data point represents two crashes; a VTV crash and a VTB crash using like vehicles. The crush in the VTV crash is expressed as a percentage of the VTB crush. The VTV impact speed is calculated as a percentage of the VTB impact speed. The VTB speed multiplier required yielding comparable VTV crush is derived by dividing the crush percentage by the impact speed ratio. The uncertainty associated with each data point in Figure 1 is very small in the vertical direction, but ranges from 15% to 30% horizontally. This is because there can be 10% to 20% differences in staged crash crush values involving like vehicles at the same impact speeds.

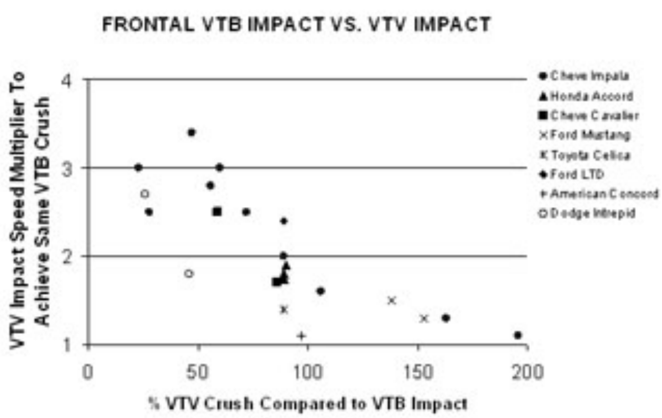

Figure 1

The trend of the data points in Figure 1 is as one might expect. A typical VTB impact speed is 35 m.p.h. VTV impact speeds in excess of 70 M.P.H. produce crush ratio values of 150% to 200% of the VTB crush. At these higher speeds the VTB speed multiplier approaches one. In other words at higher speeds (crush values) the VTB impact speed is the same as the VTV impact speed required to produce comparable crush. This is because the higher collision energy values involved overwhelm other factors that become important at lower crush values, as discussed below. It may be that different vehicles with different stiffness factors have

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multiplier factors that fall along families of best fit data curves.

At VTV impact speeds in the 20 to 25 M.P.H. range (crush ratio values of 25% to 50%), the VTB speed multiplier increases to a value of 2.5 to 3.5. This makes sense since it is known that some 5 m.p.h. IIHS[2] VTB crash tests produce damage, while the same vehicle does not experience damage in a VTV collision until the impact speed reaches 10 to 15 m.p.h. This is because the barrier does not carry off significant kinetic energy nor does it absorb significant energy through deformation. Thus the collision energy in a VTB collision is directed primarily into damaging the vehicle involved. In a VTV crash both vehicles can carry away kinetic energy in the form of post impact velocity and both vehicles can absorb energy in the form of crush. These effects are more pronounced at lower collision energy values than at higher values and can result in less vehicle damage in the VTV collision than in the VTB collision.

References:

1 Chevrolet Impala 1978-1981, Chevrolet Cavalier 1982-1994, Honda Accord 1982-1985, Ford Mustang 1979-1993, Toyota Celica 1986-1989, American Concord 1980, Ford LTD 1979-1991, Dodge Intrepid 1993-1997.

2 Insurance Institute for Highway Safety.

Barrier, Speed, Crush

