C18 Crash Testing to Validate Accident Reconstruction

Darren Franck, BSCE, and Harold Franck, MSEE, Advanced Engineering Assoc., 4713 MacCorkle Avenue, SE, Charleston, WV*

The goals of this presentation are to discuss analysis and reconstruction of a two-vehicle accident and to present crash test measurements that validated independent reconstruction methods.

The accident in question occurred during an especially foggy morning on a mountainous four-lane highway. A late model pick-up truck was carrying two passengers northbound on this highway. A large, unarticulated flatbed transport truck was traveling on a road intersecting the highway. According to police and witness statements, the thick fog limited visibility to 150 to 200 feet. Seeing no oncoming vehicles, the flatbed truck driver pulled onto the highway in an attempt to turn left onto the southbound lanes. As the flatbed was pulling out, the pick-up truck approached the intersection. The pick-up skidded for approximately 60 feet and struck the driver's side of the flatbed. As a result of the collision, the two passengers in the pick-up endured fatal injuries.

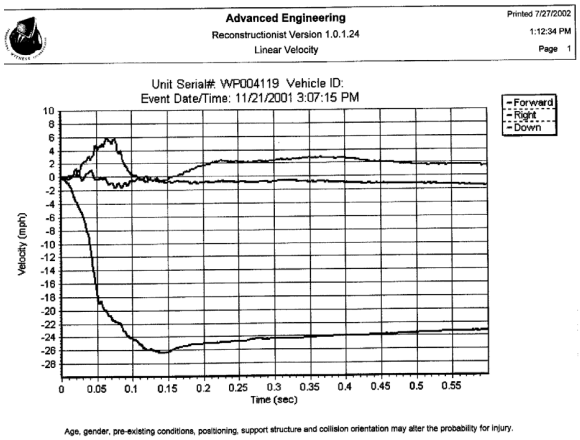
In order to reconstruct the accident, inspections of the vehicles and surveys of the accident site were performed. The analysis involved application of two independent methods. The first method employed the conservation of linear momentum. Due to the accurate scene data and minimal rotation involved, the linear momentum model was deemed to be applicable. This analysis revealed that the pick-up truck was traveling approximately 54 miles per hour at impact. Given the pre-impact skids, the pick-up truck was traveling at 64 miles per hour prior to braking. The collision caused the pick-up to be driven backwards approximately four feet from the impact point. As such, the approximate change in speed, or ΔV, from momentum was 54 miles per hour.

The second method involved use of crush measurements and appropriate stiffness parameters for the vehicles. Application of this data into EDCRASH revealed that the pick-up truck's ΔV was of the order of 56 miles per hour. The crush measurements were based on the vehicle inspections, which indicated that the crush extended to the firewall of the pick-up. Furthermore, the impact shortened the pick-up truck's wheelbase by nearly a foot. The stiffness parameters for the pick-up were culled from NHTSA crash tests of the same model vehicle. These NHTSA crash tests were performed at 35.1 miles per hour. The NHTSA crush deformation measurements were 60-65% of the values measured on the pick-up involved in this collision. The NHTSA crash test speed and crush depths were consistently less than the calculated speeds and measured crush for the pick-up. As such, the NHTSA crash data seemed to qualitatively validate the analysis.

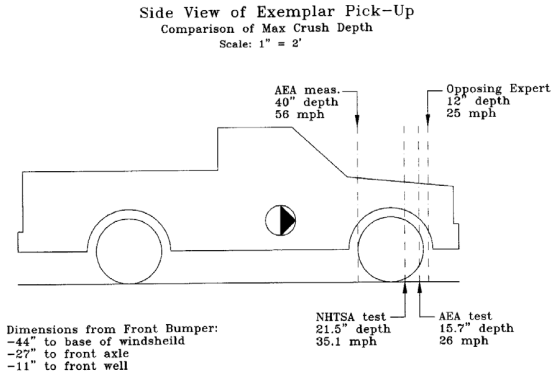
This accident had also been reconstructed by other experts acting on behalf of the opposing side. These experts stated that the collision produced ΔV=s of 18 to 20 miles per hour for the pick-up. They placed a limit on the collision by stating that the pick-up was traveling at no more than 25 miles per hour at impact. This limit resulted in a speed of 45 miles per hour for the pick-up prior to skidding. The opposing experts performed an analysis using crush deformation. These experts stated that the maximum crush on the pick-up extended only 12 inches from the front bumper, and thus the maximum ΔV was 25 miles per hour. This 12-inch depth corresponds to deformations extending only to the front of the front wheel wells. It should be noted that the opposing expert entered the crush deformation code to indicate that the maximum penetration extended to the firewall and front windshield.

In order to determine the validity of the reconstructions, a crash test was performed using the same make pick-up. This pick-up was dragged into the same flatbed truck that was involved in the accident. The actual collision was distinguished by the impact of the pick-up's front end into the rear tandem wheels and a steel storage box of the flatbed. An exemplar steel storage box had since been built and installed at the same location on the flatbed truck. In order to analyze the crash, black box instrumentation was installed to record ΔVs and linear and angular accelerations. The black box was installed on the floor of the cab at the vehicle's centroid. This test was performed by dragging the exemplar pick-up at a speed of 25 miles per hour. The results of the crash were recordings of a 26 mile per hour ΔV and a forward deceleration of approximately 40 g's. A graph of the measured ΔVs recorded by the black box are displayed below.

 ** Presenting Author*



Following the crash test, the exemplar pick-up was measured to determine its crush profile. These measurements revealed that the maximum extent of penetration was 15.7 inches, or just beyond the front of the front wheel well. The crash test produced no shortening of the wheelbase. Below is a diagram of the pick-up.



From a review of the photographs taken during the vehicle's inspection, it is obvious that the impact-induced crush extended beyond the front axle and to the firewall. Conversely, photographs of the crash tested pick-up reveal that crush did not extend to the front axle.

The measured decelerations are critical in determining the speed of the pick-up at impact. Cadaver experiments have shown a direct correlation of occupant injuries to increasing decelerations. This correlation was revealed by a linear relation between pressure and acceleration data in the same cadaver tests. Reports have shown that injuries to the heart occur at 150 g's, while the threshold of serious head or brain injury occurs at 179 g's. The damage to the interior of the pick-up revealed that the passengers died of either head or chest trauma. The 40 g deceleration, which corresponds to a 26 mile per hour ΔV, does not appear to be sufficient to cause serious injury or death. Applying a 56 mile per hour ΔV, the corresponding deceleration is 187 g's, which is above the thresholds for serious head and chest injuries.

All of the evidence indicates that the pick-up was traveling approximately 54 miles per hour at impact. As such, the pick-up's speed prior to skidding was excessive for the foggy conditions. Given the limit of visibility, a time-motion analysis revealed that the pick-up could have completely avoided a collision if it had been traveling between 43 and 51 miles per hour prior to braking. None of the physical evidence is consistent with the opinion that the pick-up struck the flatbed at 25 miles per hour. The crash test and accompanying instrumentation validate the employed reconstruction methods and contradict the opinions of the opposing experts.

Crash Test, Crush Deformation, Delta V (ΔV)

 ** Presenting Author*