C1 Pickup Rear Bumper Damage Patterns and Force-Deflection Characteristics

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The goal of this presentation is to present a method for full scale force-deflection bumper testing for accident reconstruction. The specific results will be set forth and their utility will be demonstrated through a case study.

This presentation will impact the forensic science community by providing specific information that is useful in accident reconstruction and in replicating the characteristic damage sustained by pickup rear bumpers.

The results of force-deflection testing of the rear bumper installed on a pickup are presented. The usefulness of the characteristic bumper behavior is demonstrated using a specific example of a rear-end impact, in which it was suspected that the damage was deliberately enhanced. By replicating the damage it was demonstrated how the characteristic pattern of damage could appear suspicious in post-accident photographs, and the associated impact magnitude was derived.

A small pickup was rear-ended by a small SUV. The driver of the SUV described accelerating to about 10 mph and then skidding into the pickup after it abruptly stopped ahead. The SUV driver insisted that the post-accident photographs depicted a pickup from an older year range with greater downward bumper deflection than was observed at the accident scene.

Figure 1, Post Collision Photograph of the Pickup.

Post-repair inspection of the pickup revealed the absence of the side braces between the bumper ends and the brackets. In post-collision photographs, before repair, the side braces were not visible, as seen in figure 1 above.

Given the apparent absence of side braces, it was theorized that the loosening or removal of the bolts that connect the bumper to the bumper brackets could result in the enhanced downward appearance of the pickup rear bumper, thereby exaggerating the appearance of the damage as was alleged by the SUV driver. Indeed, as shown in Figure 2, the photographs of the SUV fail to reveal the type of under-ride damage that would ordinarily be associated with the pickup's rear bumper deflection.

Figure 2, Post Collision Photograph of the SUV. However, inspection of the SUV revealed that there was damage above the front bumper to the left head light and grille areas. In addition, a horizontal rectangular imprint was found on the central front bumper. Thus, the SUV's damage was consistent with a direct contact between its central front bumper and the pickup's rear bumper step. As the

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pickup's bumper rolled under, the SUV's head light and grille areas sustained damage as they directly contacted the top of the pickup's rear bumper.

The SUV's bumper presumably pocketed the pickup's rear bumper step. This pocketing may have been enhanced by the SUV's license mounting hardware. As a result, the SUV did not fully under-ride as would normally be expected for the amount of downward deflection of the pickup's rear bumper. As such, a unique combination of vehicle damage patterns was produced.

By capturing the pickup's rear bumper step, contact forces continued to be applied to the lower portion of the rear bumper, even after the bumper began to roll under. This loading pattern lends itself to analysis by generating force vs. deflection curves to determine the amount of work required to cause the damage pattern exhibited on the pickup.

For the demonstration, an exemplar pickup and four sets of rear bumper assemblies were acquired. The vehicle was mounted on jack stands to make room for equipment and enhance visualization of the bumper during the testing. Bumper defection was produced using a 12,000 pound capacity winch attached to the under-side of the pickup. The tests were instrumented with a 10,000 pound Interface load cell, and an Ametek 50 inch high tension linear motion transducer. The data was collected at 10,000 Hz using a Diversified Technical System's TDAS Pro.

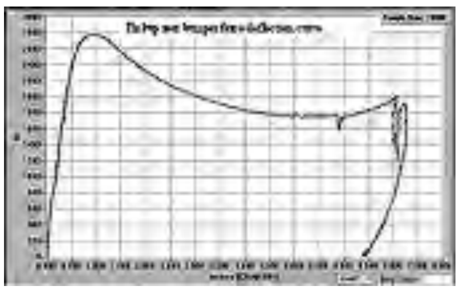

Figure 3, Force-deflection of the Pickup's Rear Bumper. Shown above is the force deflection collected on the fourth test.

The first three tests were halted due to winch mounting, chain slipping, or instrumentation interference issues. Test numbers two and three resulted in similar initial curves before the tests were halted. Between tests the damaged brackets, etc. were replaced. Integrating the above force-deflection curve for the work required to cause this damage resulted in a velocity change of nearly 3½ mph.

Post-test examination of the bumper brackets revealed that the presence of the side braces forced the bumper brackets to bend just ahead of the brace attachment in a characteristic manner. As viewed from above and behind the bumper, only the narrow bent portion of the bumper bracket was visible between the bumper and the cargo bed, as depicted in figure 1 above. Therefore, the post-collision bumper damage was replicated with an intact bumper assembly.

As such, it can only be concluded that the post-collision appearance of the pickup did not depict a bumper position that was exaggerated by removal or loosening of bumper to bracket mounting bolts and side braces. Indeed, the SUV's head light and grille area damage confirms that it forced the pickup's rear bumper to roll under to the extent depicted in post-collision photographs. However, the pocketing of the pickup's rear bumper step prevented the under-ride type damage that would ordinarily result.

Pickup, Bumper, Testing