C7 Directional Control of a Vehicle Towing a Small Trailer Related to the Overturn Parameters of Tow Vehicle

Robert L. Anderson, MS, Applied Research and Investigations, PO Box 1208, Scottsdale, AZ 85252*

After attending this presentation, attendees will be aware of test results that show that under some circumstances the ability of a vehicle to successfully tow a small trailer can be reduced if the tow vehicle has a susceptibility to overturning.

This presentation will impact the forensic science community by making attendees aware how the loss of control of a vehicle towing a trailer can be influenced by overturn stability characteristics.

The determination of whether a vehicle can adequately tow a trailer is usually determined by things like engine size, suspension, tire ratings, and weight ratios between the tow vehicle and trailer. Testing that has demonstrated that the Static Stability Factor (SSF) can also play a role in the tow vehicle's ability to control trailer sway, even for a small trailer, is presented.

The accident that prompted this testing involved a Sport Utility Vehicle (SUV) towing a small trailer with an All Terrain Vehicle (ATV). The reconstruction showed the vehicle combination swayed with increasing amplitude until it went into a grassy median and rolled.

The tow vehicle weighed approximately 4,400 lbs. and the loaded trailer weighed approximately 1,100 lbs. for a weight ratio of approximately 4 to 1. Normally that would mean that the tow vehicle could easily withstand a swaying trailer.

The propensity of the SUV tow vehicle to rollover without a trailer was also evaluated for the stock vehicle and again with the tow vehicle modified so that the SSF was higher. The stability testing presented consists of testing that utilizes turns in one direction, like the J turn as well as several reverse steer tests.

It is well known that trailers sway for a variety of reasons, but those reasons are not always readily identified. The directional control tests consisted of a rapid double lane change to consistently and predictably produce significant trailer sway at a predetermined time and location. Combination vehicle testing was performed with the stock tow vehicle as well as with the modified tow vehicle.

The tow vehicle modifications merely consisted of changing the wheels. The modified wheels had a smaller diameter, lower profile and a larger lateral offset. This effectively lowered the axle by approximately 1¾ inches and widened the track width by approximately 6.7 inches, thereby increasing the SSF.

The modified SUV tow vehicle, with a higher SSF, was sufficiently stable to not go up on the outriggers, even when subjected to more severe testing maneuvers than had previously caused rollovers with the stock tow vehicle.

During the directional control testing it was observed that the trailer had a tendency to pull the rear end of the stock tow vehicle out of alignment more easily as compared to the modified vehicle.

Between the modified and unmodified conditions there were two runs that were the most comparable with essentially the same steering inputs for the first two turns. The directional divergence between the vehicles was apparent during the second turn, where the measured heading angle was approximately 25% higher for the stock vehicle. This indicates that the slip angle for the stock vehicle was significantly higher due to the trailer pulling it's rear-end towards the outside of the turn.

Correspondingly, the stock vehicle's lateral acceleration, which was corrected for roll angle, was significantly lower during the second turn, particularly the initial part. This also indicates that the stock vehicle's rear end was being pulled out of alignment. Finally, the stock vehicle's roll angle was twice as great as the modified vehicle's during the second turn. The increased roll angle probably contributed to allowing a higher heading angle and a lower lateral acceleration.

An even greater directional divergence was observed in the third turn of the directional control tests and in one instance the trailer rolled over.

The conclusion is that in spite of a favorable weight ratio, engine size, etc, a tow vehicle with a low SSF can also be inadequate to resist sway for even small trailers. **Trailer Towing, Trailer Controllability, Overturn Stability**

 ** Presenting Author*