



Engineering Sciences Section - 2014

C31 Swaying Trailer Caused a Fatal Crash: How Can That Happen?

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After attending this presentation, attendees will learn the conditions and parameters involved in causing a trailer under tow to become unstable and sway, resulting in loss of driver control leading to a fatal crash. Attendees will also learn how a published basic mathematical model was modified and expanded to account for additional real-world phenomena that are present in the actual case.

This presentation will impact the forensic science community by informing those who are reconstructing crashes involving trailer sway. Certain tow vehicle-trailer system design parameters can lead to unstable operation in response to interactions at tire contact patches on road surfaces.

A suburban family began a journey from their home for a Memorial Day weekend of camping. The man of the house was driving a Sports Utility Vehicle (SUV) with his wife as a front seat passenger, his children and pet dogs as rear seat passengers, and camping gear in the rear storage area. He was towing a travel trailer with modest living quarters, camping gear in the interior, and externally mounted bicycles on the back trailer end. The loaded trailer weight was approximately 75% that of the loaded SUV weight. Since the trailer tongue weight is sufficiently heavy, a distributive hitch was used for the purpose of shifting some of the tongue weight forward from the SUV rear axle onto its front axle. Before starting the trip, a quick check of trailer brakes showed them to be mechanically functioning; however, brake performance was not thoroughly tested and no brake adjustments were made.

A few miles after the entrance ramp onto the interstate highway, they entered a road construction zone wherein temporary jersey barriers separated the opposing travel lanes. The construction zone began a few hundred feet beyond a moderate hill crest with a moderate right curve. Temporary travel lanes were offset and consumed most of the median space. The left lane for the SUV driver was concrete and the right lane was asphalt about 1-2 inches lower in elevation. The ridge between the two lanes followed within a few inches from the lane divider line.

While approaching the hill crest preceding the construction zone, the trailer began to sway in yaw that a following driver described as side-to-side. The swaying stopped and normal operation resumed for a short distance. Beyond the crest, the trailer began swaying unstably with increasing amplitude of oscillation. The SUV driver actions did not stop the swaying which caused him to lose control. The SUV front impacted and climbed the temporary median jersey barriers. The catapulted SUV front right wheel came down onto the hood top of an oncoming vehicle in the opposite travel lane nearest the barrier. The oncoming vehicle driver and rear seat passenger behind him suffered fatal head injuries as the roof was peeled back.

Multiple defendants with varying assets and insurance limits were named in the ensuing legal action. An expert was retained to evaluate parameters and variables involved in causation of trailer sway. This was deemed necessary to assess the SUV driver's contributory negligence for the unstable operation which culminated in trailer sway, loss of vehicle control, and the fatal crash.

The subject of trailer sway and instability is addressed by Hans B. Pacejka in the 2006 SAE publication entitled, *Tire and Vehicle Dynamics* and perhaps in other references. A mathematical model is presented consisting of a set of linear differential equations with constant coefficients including several design parameters. Questions were posed about contributions of several parameters known to exist for the subject case that are not included in the published mathematical model. The modified and expanded published model was to include these additional parameters. The expanded model was programmed for computer computations and stability determinations based on classical control theory criteria. Calculated results are presented demonstrating effects of various system parameters. Questions are posed about causation contributions of the SUV driver, the SUV, trailer, hitch manufacturers, and the dealers.

Accident, Trailer, Sway