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Light-Duty Vehicles in Tripped-Rollover Situations

by Kenneth L. d'Entremont [1]

INTRODUCTION

The National Highway Traffic Safety Administration (NHTSA) recently demonstrated its interest in preventing light-duty vehicle rollover accidents and protecting vehicle occupants involved in such accidents by proposing a rollover-prevention safety standard.[2] The danger of rollover accidents to those driving or riding in light-duty vehicles is supported by recent accident statistics[3] which show that, during one year, rollover impacts accounted for 9 percent of multiple-vehicle accident fatalities while rollovers accounted for 51 percent of single-vehicle accident fatalities. Light-duty vehicles include passenger cars, pickup trucks, vans, and sport-utility vehicles.

Although much attention has been given to the study of vehicle rollover stability and to rollover-accident avoidance, research has yet to conclusively uncover an individual vehicle characteristic or rollover-stability measure which can account for the rollover accidents experienced by light-duty vehicles. The scope of the research abstracted herein[4] includes the full-scale experimental tests of eight light-duty vehicles as well as the validation of complex computer models for these vehicles and the computer simulation of these vehicles in soil- and curb-tripped rollover situations. The results of both experimental testing and computer modelling are analyzed against various vehicle characteristics, measures of rollover propensity, and the environmental tripping scenarios.[5]

CONCLUSIONS

The analyses support the conclusion that tripping from soil is qualitatively different than tripping over curbing since different types of vehicle characteristics are correlated to rollover velocities in soil-tripped situations than in curb-tripped situations. Vehicle-geometry parameters, including the static stability factor, are the most significant factors for soil-tripped rollover situations, while suspension-stiffness characteristics are most significant under curb-tripped situations. In addition, the levels of correlation are generally higher in soil-tripped analyses than in curb-tripped analyses.

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[2] See other side of this Safety Bulletin.

[3] "Facts, 1994 Edition." Insurance Institute for Highway Safety, July 1994.

[4] d'Entremont, K.L. "The Effects of Light-Vehicle Design Parameters in Tripped-Rollover Maneuvers — A Statistical Analysis Using an Experimentally Validated Computer Model." SAE Paper No. 950315, 1995.

[5] d'Entremont, K.L. "Validation of an Advanced Vehicle-Dynamics Model for Soil- and Curb-Tripped Rollover of Light Vehicles." Ph.D. diss., Dept. of Mechanical and Aerospace Engineering, University of Missouri-Columbia, 1993.

A reprint of this paper is available at no charge from Triodyne Inc. To order, call (708) 677-4730, ext. 162. Portions of the abstracted research were supported by the National Highway Traffic Safety Administration (NHTSA), U.S. Department of Transportation, under Contract No. DTNH22-89-C-07005. The opinions, findings and recommendations contained herein are those of the author and do not necessarily represent those of the NHTSA.

NHTSA's Proposed Rollover-Prevention Rulemaking

The NHTSA's Advanced Notice of Proposed Rulemaking (ANPRM)[1] announced the consideration of a Federal Motor Vehicle Safety Standard (FMVSS) to reduce casualties of light-duty vehicle rollover accidents. This could be accomplished through increased vehicle rollover stability, improved vehicle crashworthiness, or consumer information — either individually or jointly. With the exception of evaluating a lone petition requesting reconsideration of the proposal,[2] the NHTSA has concluded its rulemaking process[3] by deciding not to propose a vehicle-stability standard at this time.

This decision was based on the NHTSA's requirement that any proposed vehicle-stability measure satisfy three criteria. The first criterion was that the measure, or metric, must be causally linked to rollover likelihood; the second, that the metric must be statistically related to rollover-accident frequency; and the third, that significant safety benefits would be realized at reasonable cost. Since nearly 60 percent of rollover fatalities involve passenger cars, the NHTSA concluded that any rollover-prevention measure adopted must affect the safety of passenger-car occupants and that doing so would necessitate the "redesign of nearly all sport utility vehicles, vans, and pickup trucks." [4] Due to efforts involved in vehicle redesign and losses of customer-desired vehicle characteristics, the cost of implementing a rollover-stability standard was determined to be too high. Additionally, the NHTSA determined that there was no rationale for proposing one stability criterion for one type of light-duty vehicle and another criterion for other types of those vehicles. In closing, the agency stated, "NHTSA has decided not to propose a vehicle-stability rule, and is deferring any further action on this subject until such time as information becomes available demonstrating the cost effectiveness of such a rule." [5]

While completing its rollover-standard rulemaking, the NHTSA at the same time proposed making rollover stability a consumer-information issue by requiring vehicle manufacturers to label light-duty vehicles with information pertaining to rollover stability. Vehicles made after September 1, 1996 would be required to have labels informing buyers of three items. First, any vehicle can roll over; second, always wear seat belts; and third, a rollover measure for that vehicle with respect to similar vehicles. The two rollover measures proposed by the NHTSA are the tilt-table angle *(TTA)* and the critical sliding velocity *(CSV).* The NHTSA has yet to determine if this proposed rulemaking will apply to specialty vehicles such as campers, motorhomes and walk-in vans.

The *TTA* is measured from an experimental test in which the vehicle is placed upon a hinged platform which is tilted sideways until the uphill side of the vehicle lifts off of the platform. The *CSV* is a calculation which estimates the minimum velocity required to roll the vehicle over as it slides sideways into a curb. The figures suggested for use by the NHTSA in informing consumers about vehicle *TTA* and *CSV* values are similar to those appearing as Figures 1 and 2, respectively. The value of "X" in Fig.1 is the tilt-table angle rounded to the nearest whole degree. The critical sliding velocity, "Y" in Fig. 2, is calculated to the nearest kilometer per hour.

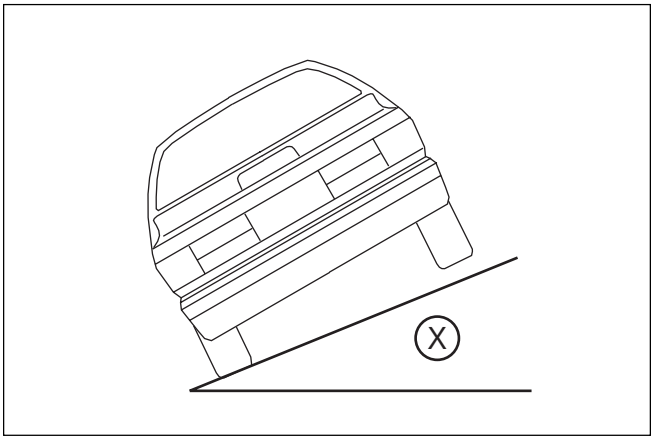

Figure 1. Tilt-Table Angle.

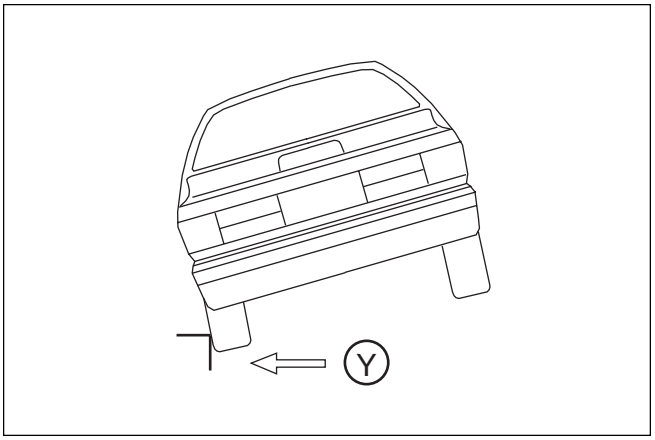

Figure 2. Critical Sliding Velocity.

[1] Federal Register. USDOT/NHTSA Advanced Notice of Proposed Rulemaking, "Rollover Prevention." Washington, D.C.: U.S. Government Printing Office, January 3, 1992, pp. 242–252.
[2] Petition for Consideration: Termination of Rulemaking on Light Passenger Vehicle Rollover Prevention. Advocates for Highway and Auto Safety, et al. July 28, 1994.
[3] Federal Register. USDOT/NHTSA Notice of Proposed Rulemaking, "Consumer Information Regulations; Federal Motor Vehicle Safety Standards; Rollover Prevention." Washington, D.C.: U.S. Government Printing Office, June 28, 1994, pp. 33254–33272.
[4] Ibid.
[5] Ibid.