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**SUMMER NEWSLETTER**

# PRELIMINARY ANALYSIS REPORT

## UNDER $1,000

Engineer reviews file, analysis, calculations, research at $150/hr
Defers time consuming field inspections

## 2 WEEK TURNAROUND

Report prepared within two weeks
Documentation required: Police Report, Photos, Appraisals, Statements

### ACCIDENT RECONSTRUCTION
Speed, Intersections, Point of Impact, Time and Motion, Driver Reaction

### MECHANICAL FAILURE
Tires, Fires, Brakes, Unintended Acceleration
Causative or Accident Damage ?
Covered Under Warranty ?
Subrogation Management and Assistance

### INJURY
Seat Belts, Soft Tissue, Air Bags, Helmets

### OUR REPORT
Brief 5-10 page Report
Analysis and Opinions
Recommendations

### PURPOSE
Pay or Deny Claim ?
Subrogate or Not ? Difficulty ?
Pursue Litigation or Not ?

**Have all the facts to make a wise decision**

Portions Excerpted From:

# ***The Aggressivity of Light Trucks and Vans in Traffic Crashes***

During the past decade, a profound shift in the composition of the passenger vehicle fleet has been realized in the U.S.. Fueled by the growing popularity of pickup trucks, minivans, and, more recently, by sports utility vehicles, the demographics of the U.S. fleet are characterized by a growing population of light trucks and vans (LTVs). As a group, LTVs are heavier, of more rugged construction, and have higher ground clearance than the passenger cars with which they share the road. The concern is that these design features, introduced to allow specialized functions e.g. off-road driving, may make LTVs fundamentally incompatible with cars in highway crashes, and in some cases dangerous to the occupants of cars struck by LTVs.

A disproportionate number of the fatalities in LTV-car crashes are incurred by the car occupants. Of the 5259 fatalities in LTV-car crashes in 1996, 81 percent of the fatally-injured were occupants of the car. As shown in Figures 2 and 3 and tabulated in Table 2, side impacts in which an LTV was the bullet vehicle led to 56.9 percent of all fatalities in side struck vehicles. As illustrated in Figure 4 and tabulated in Table 3, frontal impacts in which an LTV was involved accounted for 59.7 percent of all fatalities in frontal-frontal impacts. These statistics suggest that LTVs and passenger cars are incompatible in traffic crashes, and that LTVs are the more aggressive of the two vehicle classes. In particular, crashes with an LTV cause a disproportionate number of vehicle-to-vehicle fatalities.

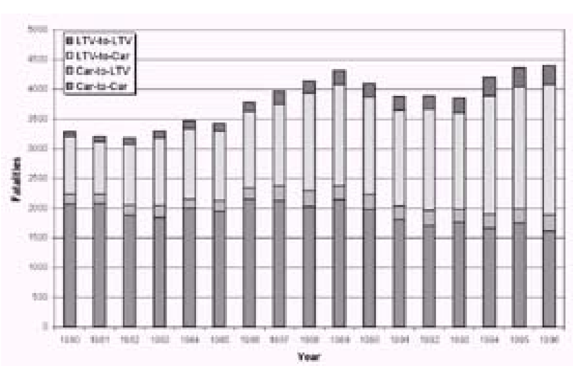


Figure 3. Distribution of Side Impact Fatalities (FARS 1980-96).

*Why are LTVs more aggressive?*

The preceding analysis of crash statistics has clearly demonstrated the incompatibility between cars and LTVs in highway crashes. Still remaining to be determined however are the design characteristics of LTVs which lead to their incompatibility with cars. In general, crash incompatibility arises due to the three factors:

Mass Incompatibility
Stiffness Incompatibility
Geometric Incompatibility

The following section will examine the relationship between LTV-car compatibility and these sources of incompatibility.

*Mass Incompatibility*

LTVs are 900 pounds heavier than cars on average [5]. The conservation of momentum in a collision places smaller vehicles at a fundamental disadvantage when the collision partner is a heavier vehicle. As shown in Figure 10, LTVs, as a group, tend to be heavier than passenger cars [7]. Figure 10 crossplots AM as a function of vehicle weight, and demonstrates the strong relationship between mass and aggressivity. The mass incompatibility between cars and LTVs appears to be growing. As shown in Figure 11, during the time frame of 1985-1993, average mass of both cars and LTVs has steadily increased, and the weight mismatch between the two classes of vehicles has slowly grown as well.

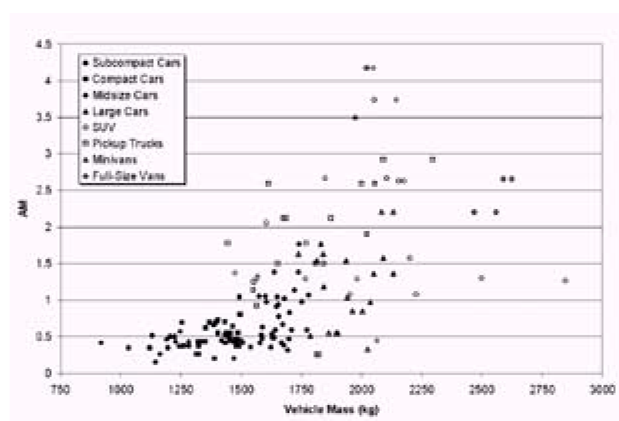


Figure 10. Aggressivity as a function of Vehicle Mass.

*Stiffness Incompatibility*

As a group, LTV frontal structures are more stiff than passenger cars. LTVs frequently use a stiff frame-rail design as opposed to the softer unibody design favored for cars. Drawing on NHTSA New Car Assessment Program crash test results, the linear stiffness of a selection of LTVs and cars was estimated using the following relationship:

$$k = (mv^2) / x^2 \quad \text{(Eqn. 1)}$$

where m is the mass of the vehicle, v is the initial velocity of the vehicle, and x is the maximum dynamic crush of the vehicle.

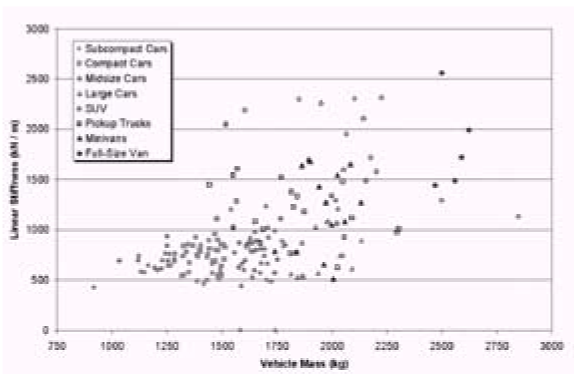

Figure 12. Aggressivity as a Function of Linear Stiffness as computed from NCAP crash test results.

*Geometric Incompatibility*

LTVs, especially four-wheel drive sport utility vehicles, ride higher than cars. This creates a mismatch in the structural load paths in frontal impacts, and may prevent proper interaction of the two vehicle structures in a collision. In a side impact, this imbalance in ride height allows the LTV structure to override the car door sill, and contributes to the intrusion of the side-impacted vehicle.

Ideally, the ride height used in an analysis of this type would be the height of the forward-most load bearing structural member of the vehicle. The location of this forward-most structural element however has no precise definition, and must be estimated from other measurements. Some analyses have used bumper height as the height of this load bearing member. However, because in the U.S., the bumper must only meet a 2-½ mile/hour bumper impact standard, and LTVs have no bumper standard, our belief is that, with respect to occupant protection, bumpers are largely ornamental, and their location provides little evidence of the location of load bearing members. The rocker panel, on the other hand, is a much more substantial structural member, and because the rocker panel is typically lower than the forward-most structure, serves as a superior lower bound on the location of the frame structure.

*Conclusions*

This paper has examined the compatibility of LTVs and cars in vehicle-to-vehicle collisions. Using struck driver fatalities per crash involvement of the subject vehicle as an aggressivity metric, examination of U.S. crash statistics has clearly shown a striking incompatibility between cars and all categories of LTVs. LTVs now account for over one-third of light vehicles on U.S. highways, but collisions between cars and LTVs lead to over 50% of all fatalities in light vehicle-to-vehicle collisions. Furthermore, a disproportionate number of the fatalities in LTV-car crashes are incurred by the car occupants. A comparison of LTVs and cars reveals that the LTVs are more aggressive than cars for a number of reasons including their greater weight, stiffer structure, and higher ride height. This mismatch in design has serious consequences for crash safety as approximately one-half of all passenger vehicles sold in the U.S. are LTVs, and presents a growing source of incompatibility within the fleet.

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