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Non-Linear Damage Analysis in Accident Reconstruction

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ABSTRACT

Frontal, side, rear, pole and offset car to car data sets are examined using familiar damage analysis models: constant stiffness, bilinear stiffness, and force saturation. In addition to these, a non-linear power-law formulation is introduced and compared to the others. The power-law provides a nonlinear stiffness coefficient that transitions between a constant force model and constant stiffness model as the power goes from 0 to 1. It also provides a continuous, single valued function that is easily integrated and used in the analysis. Power-law non-linearity can be used to smoothly fit low through high crush data.

Geometric integral parameters are developed which represent irregular crush profiles. These permit graphical comparison of tests with non-uniform crush data (such as offset, side, and narrow object) with uniform crush test data. They also provide a means for comparison of accident damage with the test data set.

Force- deflection data supplements energy-residual crush data to define non-linear crush stiffness coefficients for accident reconstruction damage analysis. Improved modeling results for both low crush levels and for extrapolation to damage profiles well beyond the test data level. Load cell barrier data is provided in some NCAP frontal barrier tests in the NHTSA database.