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Mr. Gustav A. Nystrom
Amador Newtonian Engineering
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Dear Mr. Nystrom:

We are in receipt of a pre-publication copy of your paper “Stiffness Parameters for Vehicle Collision Analysis, an Update” to be published as paper 2001-01-0502 at SAE 2001. We are disappointed to find that your publication contains erroneous and misleading statements related to our prior SAE papers. Since you had contacted us previously (3/97, 4/97, 8/00), we wonder why you did not attempt to get any feedback or clarification on the subject material to insure that the paper was on a solid technical foundation prior to publication.

We had volunteered to serve as reviewers for the 2001 SAE “peer review” process and, therefore, we were surprised to find that your paper, which was intimately related to our work and area of expertise, was proposed, reviewed and published without our being contacted for clarification or input. It demonstrates a serious shortcoming with the SAE “peer review” process.

The following are some comments related to the paper:

The original CRASH A and B model can be used to determine the impact speed change up to the point of common velocity. It does not include restitution.

The SMAC collision model includes restitution.

CRASH A & B implicitly contain restitution in that the observed residual crush contains the effect of the restitution (restitution acts to reduce the damage while increasing the speed change) yet the fundamental theory behind CRASH A & B coefficients uses the Speed Change only to the point of common velocity for the fitting procedure. Any inference that the CRASH A and B model includes restitution is erroneous. Our (the “McHenry”) restitution model analytical approach contains two additional constants, Rho and Gamma, to address the magnitude and form of restitution (structural recovery and energy feedback). Your test for “Numerical Consistency of A and B Parameters”, outlined on page 11 of your paper, contains the misunderstanding that A and B alone can be used to include and reconstruct restitution. You make no mention of any consideration of Rho and Gamma for the “McHenry Model”. A stiff vehicle with low restitution can share the same A and B coefficients as a soft vehicle with high restitution. This fact has been presented and discussed extensively in our paper (Reference 1), on our website (www.mchenrysoftware.com) and in our recent SAE TOPTEC presentation of December 1999 (see http://www.mchenrysoftware.com/TOPTEC.htm), yet your paper ignores this fundamental flaw of the EDSMAC4 approach to restitution modeling.

A and B alone do not include any information on the restitution properties of the vehicle. Structural restitution includes both energy feedback and partial dimensional recovery of the deformed

structure. The CRASH B coefficient does not provide any information related to these two properties of restitution.

It should have been made completely clear in your paper that any reference to results obtained with the McHenry restitution analytical approach ("McHenry model") was solely based on your interpretation and implementation of the analytical approach. Had you contacted us during your research related to the paper then we might have either provided you with a beta copy of our actual implementation of the restitution model or provided comments and corrections to your implementation. Unfortunately you did not contact us and therefore your implementation of the "relatively complicated" (your assessment from your paper, page 17) relationships is erroneous.

We agree that negative values of residual crush are "nonsensical". However, such values are the result of your erroneous implementation of our relationships outlined in Reference 1.

Obviously there is a range of maximum crush for which there is no residual crush. This is true of actual vehicle structural behavior, as well as our proposed analytical approach. In the analytical relationships of Reference 1, that range exists where

$$\delta_m \le \sqrt{\frac{A}{BK_1}} .$$

The zero residual crush range is such a fundamental aspect of the overall research approach as to seemingly make it obvious that any negative values should be set to zero:

SAE 970960, Appendix 1, Equation (9):

$$\delta_f = \delta_m \sqrt{\frac{K_1}{B}} - \frac{A}{B} \quad \text{INCHES}$$

If $\delta_f \le 0$, $\delta_f = 0$

OR

IF $\delta_m \le \sqrt{\frac{A}{BK_1}}$, $\delta_f = 0$

ELSE $\delta_f = \delta_m \sqrt{\frac{K_1}{B}} - \frac{A}{B}$ INCHES

With regard to your equation 5 ("The McHenry restitution equation"), you indicate that "the program" automatically limits EPS to a value of 0.6. "The program" that you refer to is your interpretation and implementation of the McHenry restitution model.

You indicate without critical comment, that the SMAC 40 program calculates a residual crush of 0.60 inches in a 3.0 MPH barrier crash even though that result deviates from the general assumption of zero residual crush at 5.0 MPH.

Your figure 3b differs markedly from our Figure 10 of Reference 1, without explanation. This would appear to further indicate that you have errors in your interpretation and implementation of the McHenry restitution analytical approach. Our own implementation of the analytical approach has not yet been released.

The fact that your analysis of the McHenry restitution approach, because of its "complexity", has been based entirely on the "simplified" conversions defined by Neptune should be given a more prominent disclosure in the paper. Our implementation of the approach includes a preprocessor routine to automatically generate the required restitution inputs. Reference 1 was aimed at presenting and explaining the research approach rather than defining a detailed implementation procedure.

Your statement in the Closing Remarks section of your paper that "Users of the Barrier Equivalent Time methodology need to beware of using a method that seems to treat very nonlinear structures as if they were linear" in relation to the SAE paper by Long (Reference 2) appears ill informed. In the energy analysis approach of CRASH3 the effect of the intercept, A, is eliminated by the constant of integration, G, in the energy calculation, and thereby the vehicle structures in CRASH3 are treated as though they are linear. This fundamental assumption forms the basis for the CRASH3 and related damage analysis procedures.

Had you contacted us with your questions or problems then you possibly could have avoided the many errors and misstatements contained in your paper. As it stands, your paper is another demonstration that the SAE "peer review process" contains serious flaws and inconsistencies.

Very truly yours,
McHENRY CONSULTANTS, INC.

References:

1. McHenry, R.R., McHenry, B.G. Effects of Restitution in the application of Crush Coefficients", SAE paper 970960
2. Long, T.J., "Introduction to the Barrier Equivalent Time (BET) Methodology in the Analysis of Delta-V", SAE paper 2000-01-0462

Cc: SAE Session Chairmen, Brach, Varat, Husher, Thebert