**From:** "Smith, Jeffrey" <jasmith@sandia.gov>
**To:** "'Mahendra Shah'" <MJS3@nrc.gov>, "Smith, Jeffrey" <jasmith@sandia.gov>
**Date:** 12/19/02 12:18PM
**Subject:** RE: Porous Aluminum model

Mahendra:

Yesterday you requested some information on the porous aluminum model used in CTH for the aircraft fuselage. I am inserting text from Steve Attaway on the basis of this model. I believe Greg Bessette had already sent this. There is some discussion in the draft report on this. Also, you will find information in the report that Bernie has brought back for you (the report we sent to Boeing, "Technology Overview for Analysis of Aircraft Impact"). See page 27 of that report for a description of the C-141 test that is referenced and page 43 for the description of the "Aircraft Fuselage Model using CTH." Let me know if those page numbers do not make sense (I could be referencing the wrong draft of that report...mine is dated 11-26-02).

Also contained in that report there is a description of the PRONTO/SPH methodology that was discussed in some of the conversations yesterday.

Let me know if you have any other questions,
Jeff

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FYI

-----Original Message-----
From: Stephen W. Attaway [mailto:swattaw@sandia.gov]
Sent: Tuesday, August 06, 2002 2:00 PM
To: Bessette, Gregory Carl
Subject: Re: FW: CTH and ZAPOTEC material inputs and models

Greg,

The justification for the "porous" aluminum model was based on an AMR 2D CTH run where a ribbed cross section of an aircraft was meshed with sub millimeter accuracy. This cross section was used as a base line to compare with the porous aluminum model. The baseline model was impacted into a hard target and a soil target. The material properties for the p-alpha model were adjusted (within reasonable bounds) to match momentum (=force) time curve for the ribbed cross section.

The underlying assumptions of this method is based on the fact that 95% of the impact force is generated form the change in momentum of material flowing into the active crush zone. In the report "Axial Impact Testing of a C-141B Aircraft Fuselage Section with Shipping Containers," SAND94-2739, the velocity of a C-141B fuselage section was plotted as a function of time for an impact with a rigid target at 47 m/sec. The estimated force transmitted from the crush zone to the fuselage was on the order of 1M lbs. This order of magnitude

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was consistent with a static crush test done at LANL. The crush force of a ( )would be expected to be less than the C-141 due to the fact that the C-141 is designed to hall cargo. Reira estimated fuselage crush force to be about 500,000 lbs. Ex 2

Given that the impact force computed from the porous aluminum CTH model for the ( ) Ex 2

is an order of magnitude greater than the fuselage crush force, the errors associated with the material properties for the p-alpha model will be small compared to the errors in the location of the mass of the aircraft.

At slower speeds, any error in the crush strength of the fuselage will have a greater effect. There is not doubt that the existing p-alpha model could be improved. However, before we spent effort to improve this model, a better model of the aircraft is needed. Currently the wings are modeled as a simple cross-section. I was able to find enough data on a ( )model to create a wing cross section that has stiffening ribs. However without the weight of the wing as a function of it's length, I have no way to estimate the mass errors. We should get better data from Boeing soon. Ex 2

Remember that the current models are stressing the computing resource. Any refinement in airplane model will require a more materials. As you know, more material will greatly increase the memory and cpu requirements of CTH. Dave Crawford and Bob Schmit have been modifying the Diatom material insert to allow different material properties to be input for a common material model.

Steve

**CC:** "Bernard White" <BHW@nrc.gov>, "Daniel Huang" <DTH.owf1_po.OWFN_DO@nrc.gov>, "Robert Shewmaker" <RES.twf4_po.TWFN_DO@nrc.gov>, "Ron Parkhill" <RWP.owf1_po.OWFN_DO@nrc.gov>, "Sprung, Jeremy L" <jlsprun@sandia.gov>, "Sorenson, Ken B" <kbsoren@sandia.gov>

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