WEB SITE: www.simulate-events.com

Technical Note No.43

Subject: **Blast wave action against elongated bodies.**

In Figure 1 three elongated bodies, resembling human figures are shown. The other object, in front, is an explosive, in the approximate shape of an octasphere or 1/8th of a sphere. As Fig.2 further illustrates, the explosive charge is placed at the corner of a room with the floor and the two adjacent walls treated as rigid planes. The two remaining walls and the ceiling do not exists, so in this sense the room is open to the atmosphere.

The room floor size is 3.04m by 2.4m and the height is 2.0m. In our computer model the volume of the room is filled with air. The mass of the explosive placed at the corner is 5kg. (This is the TNT equivalent.) The human-like figures, which we call Bods have the height of 1.7m and mass of 66.4 kg each. Their volume is filled with soft elements, comparable to a biological tissue. The stiffening component in a Bod is a spine, seen as a dark line, running from top to bottom.

The blast wave resulting from an explosion is visualized in Fig.3 and it serves as a background to the outlines of the three Bods. At a little later time Fig.4 shows the Bods being engulfed by the wave. Finally, at a much later time (close to 15 ms) the Bods are shown moving, distorted by the wave action. The dark, straight lines show the distances that they have traveled so far in time.

Please note that the leg part of each Bod travels the fastest, as it has the smallest mass per the impacted surface area. In the last picture it is only a short time after the passage of the blast wave, but the nearly full velocity has been attained.

We have watched the motion at 3 control points of each Bod: head center, at CG just above the mid-height and at ankles. In the second one, the most representative of the motion, the velocities reached were about 40 m/s (144 km/h). The accelerations peaked at over 500g. (While the last figure seems monstrous, the very short duration has to be kept in mind.)

How representative is this example of what would happen to a real person in such a situation? A human figure of the same mass and height would experience a similar acceleration and gain about the same speed. Predicting internal injuries is a different matter. The Bods are homogeneous, while a human body has different layers of tissue with different mechanical properties. A blast wave applied from outside causes an incredibly complex pattern of internal waves. The tendency to crush or tear can be deduced only from a detailed study of such a complex model.

One may note that acceleration is a measure of direct injuries while the speed attained relates to secondary ones, when a flying body impacts a fixed object.

DETAILS

The application of the force of gravity causes a Bod used in this Note to shrink vertically by less than 3 mm.

The 5kg-equivalent charge nested in the corner is equivalent to 40kg in the open air burst. The explosive material used is diluted, volume-wise. (The mass and energy density are less than TNT.)

The two walls away from the charge and the ceiling were left open in order to avoid wave reflection, as this phenomenon blurs the picture to some extent.

One of the most useful parameters that can be obtained from such a study is an impulse coefficient C, for a Bod, defined as follows:

$C = S/S_0$

where S is the actual impulse applied by a blast wave to a Bod and S_0 is the nominal reflected impulse. (The latter being the specific reflected impulse, as appropriate for the distance from a source, multiplied by the frontal area of the object projected on the plane normal to the direction of flow.)

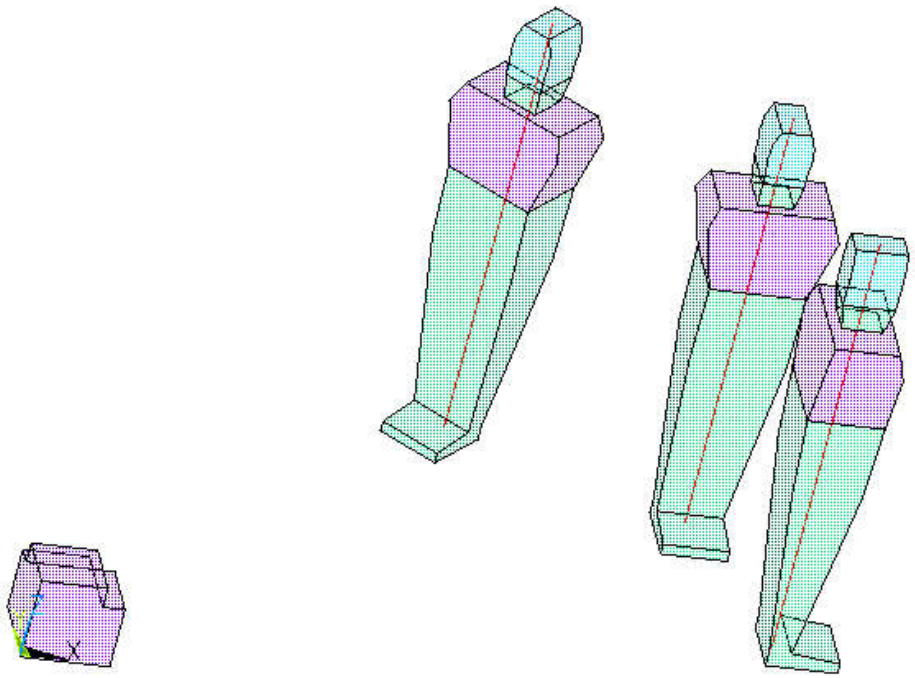

Fig.1 An explosive charge in a corner of a room and three Bods standing some distance away.

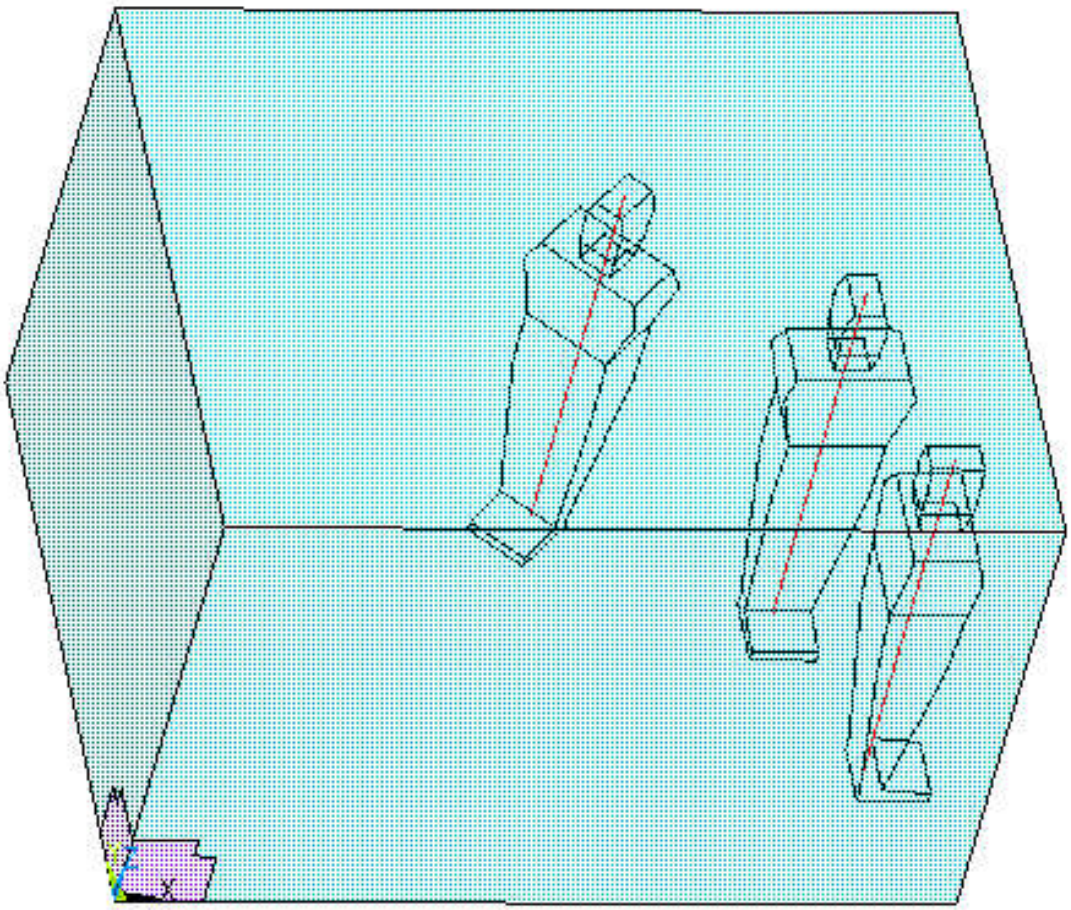

Fig.2 As above, but the outline of the room is also shown.

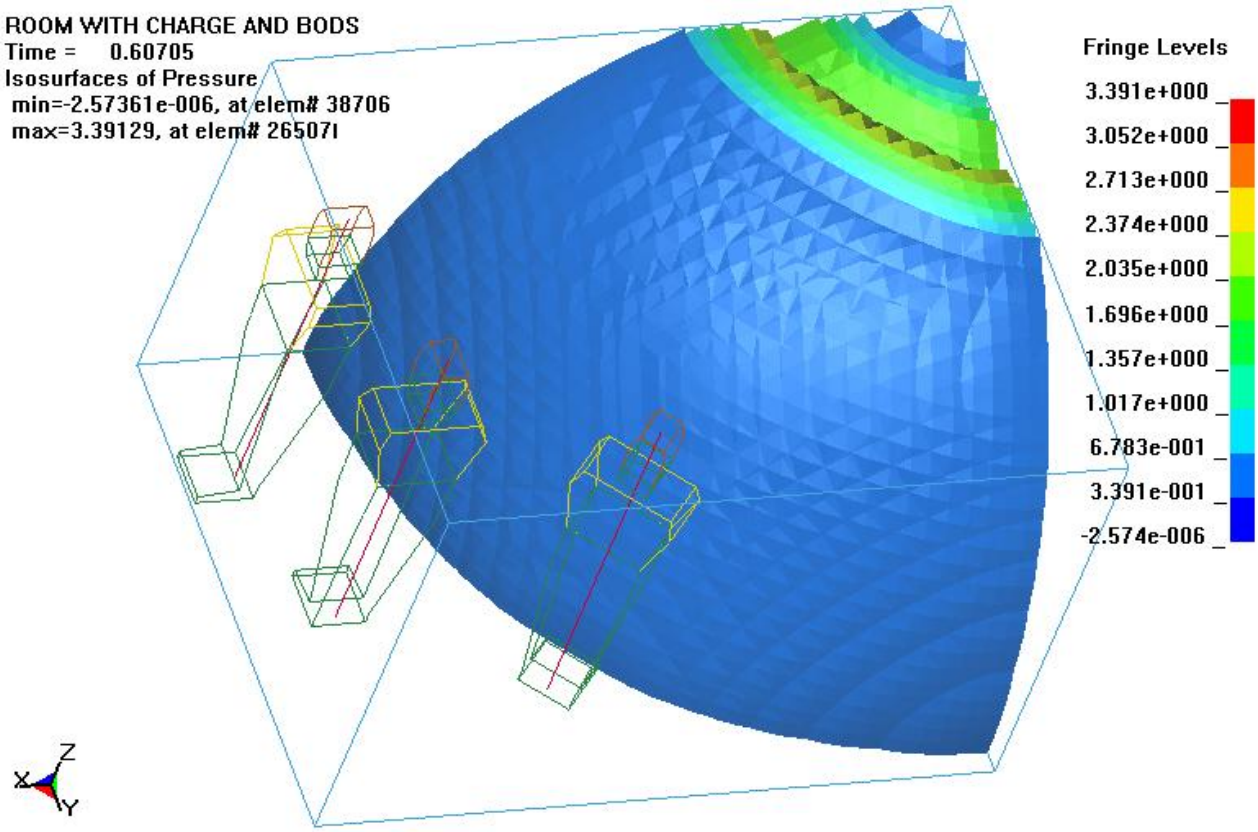

Fig.3 The blast wave approaching the Bods, shown in an outline.

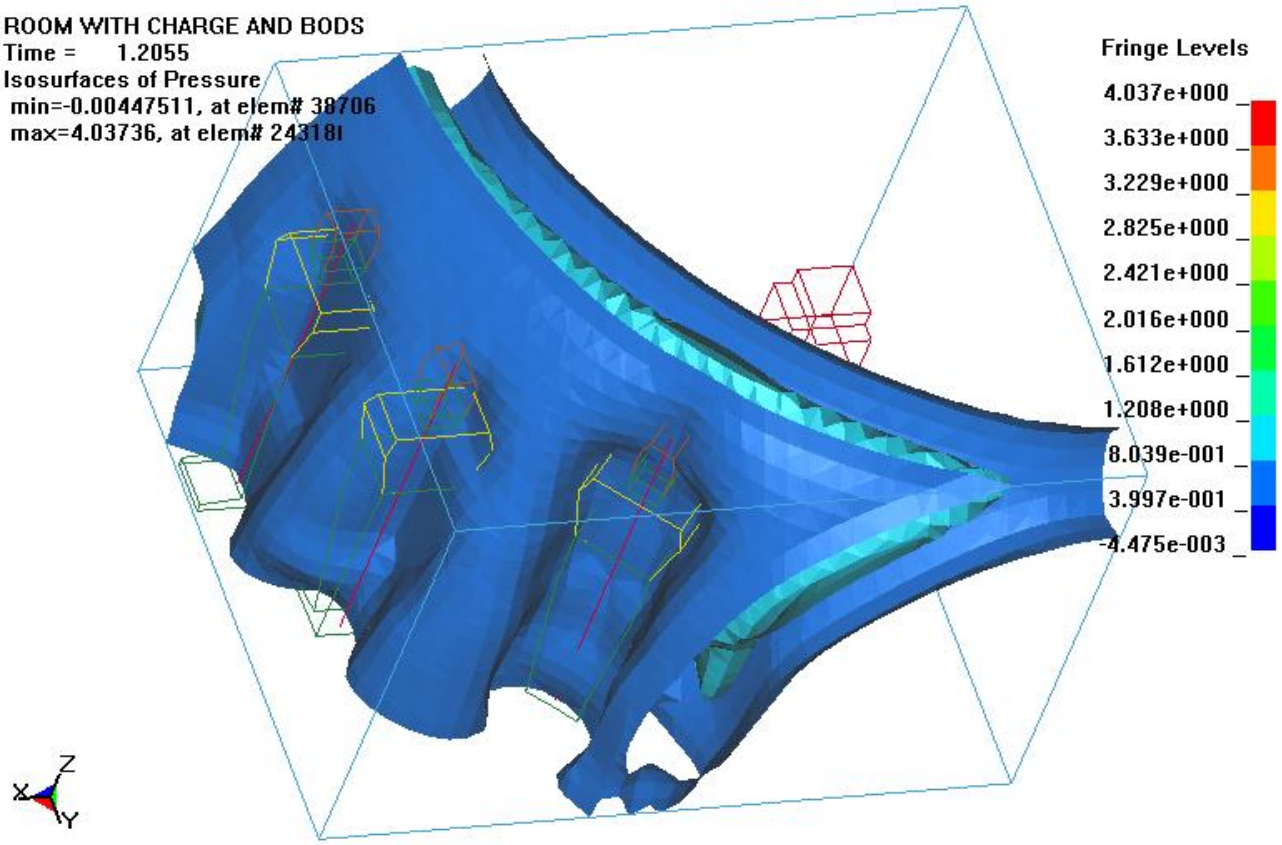

Fig.4 The Bods being engulfed by the wave.

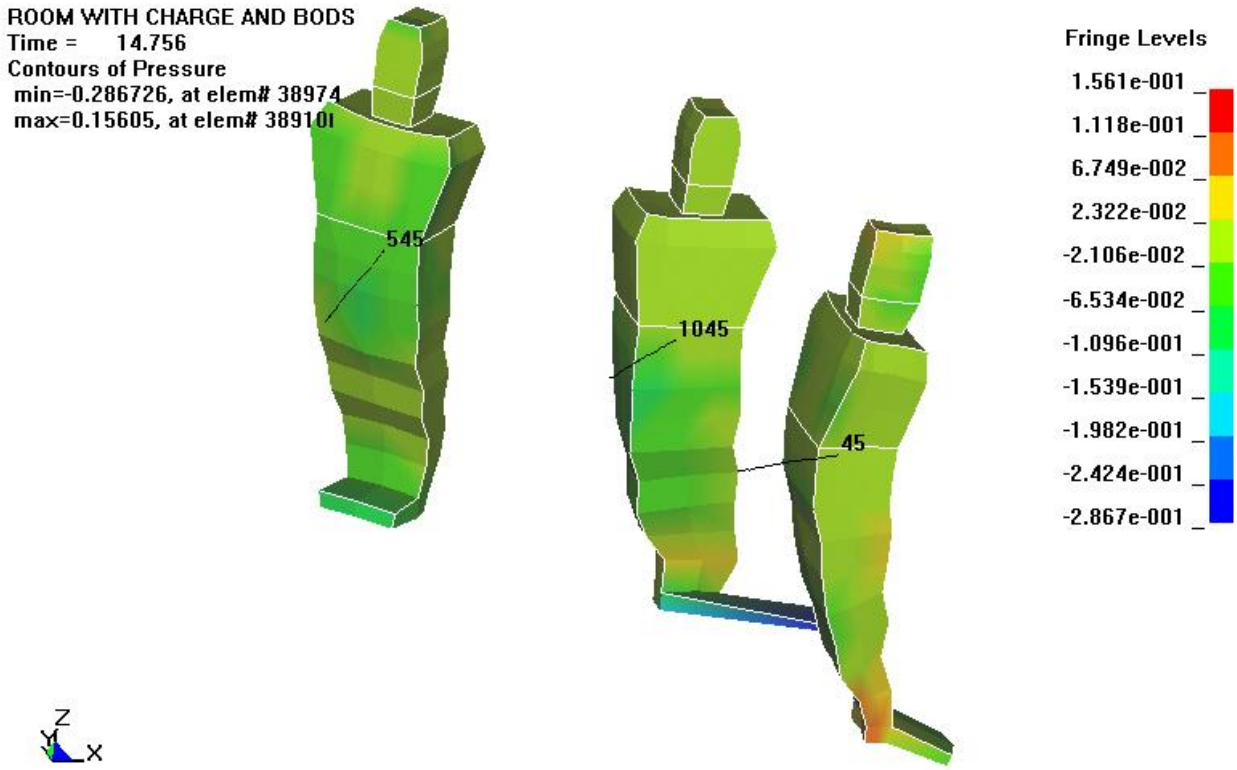

Fig.5 Deformed shapes just after the wave has passed. (The straight lines show the distance traveled so far.) (The viewpoint of the observer is about the same as in Figs 1 and 2)