WEB SITE: www.simulate-events.com

Technical Note No.38

Subject: **Bursting of steel tubes using internal explosive charges**

A set of tests had been carried out, in which short cylindrical charges of high explosives were placed in open-ended tube segments and detonated. (The arrangement is shown in Fig.1). The effects of such explosions were dependent on charge masses involved.

This work recreates one series of these tests. The computational model is shown in Fig.2. Apart from the charge and the tube the model also involves a control air volume (blue mesh), which facilitates observation of pressure changes and allows interaction between the explosive and the tube.

The preliminary calculation has shown that the tubes with a large charge will split in longitudinal pieces, between 8 and 10 of them. We have therefore introduced longitudinal seams in the shell model, at 45 deg. apart. (One-half of the shell is in Fig.3.) The seams are allowed to split open when the elongation of material exceeds the allowable value. We have then simulated detonation of three charges, 90g, 130g and 200g of explosive, in turn. (Those are later referred to as small, medium and large.)

Figure 4 shows the deformation of the tube after the small charge went off. The bulging around the transverse plane of symmetry is visible, but there is no breakage. The medium charge gives a visible splitting of the tube, as in Fig.5. Finally, with the large charge splitting is quite pronounced, as per Fig.6.

DETAILS
Many tubes were exploded, but for this simulation we used only one, having the internal radius of 103.5 mm and thickness of 3.5 mm. The material was mild steel. The explosive was TNT/RDX, 35/65.

COMPARISON WITH PHYSICAL TESTING.
This work was based on the field experiments under the direction of Professor Manfred Held. In his paper on the subject matter he shows three photos, corresponding to three charge sizes. (For each different tube the masses of explosive used were different, of course.) Compared with those photos our bulging due to a small charge spreads somewhat too far along the axis. Also, the fractures due to medium charge seem too long, while ballooning due to the big charge is too small.

This is a fair comparison as long as the pictures presented in the source article are representative of all tests. If not, the differences mentioned above need not be as marked as stated above.

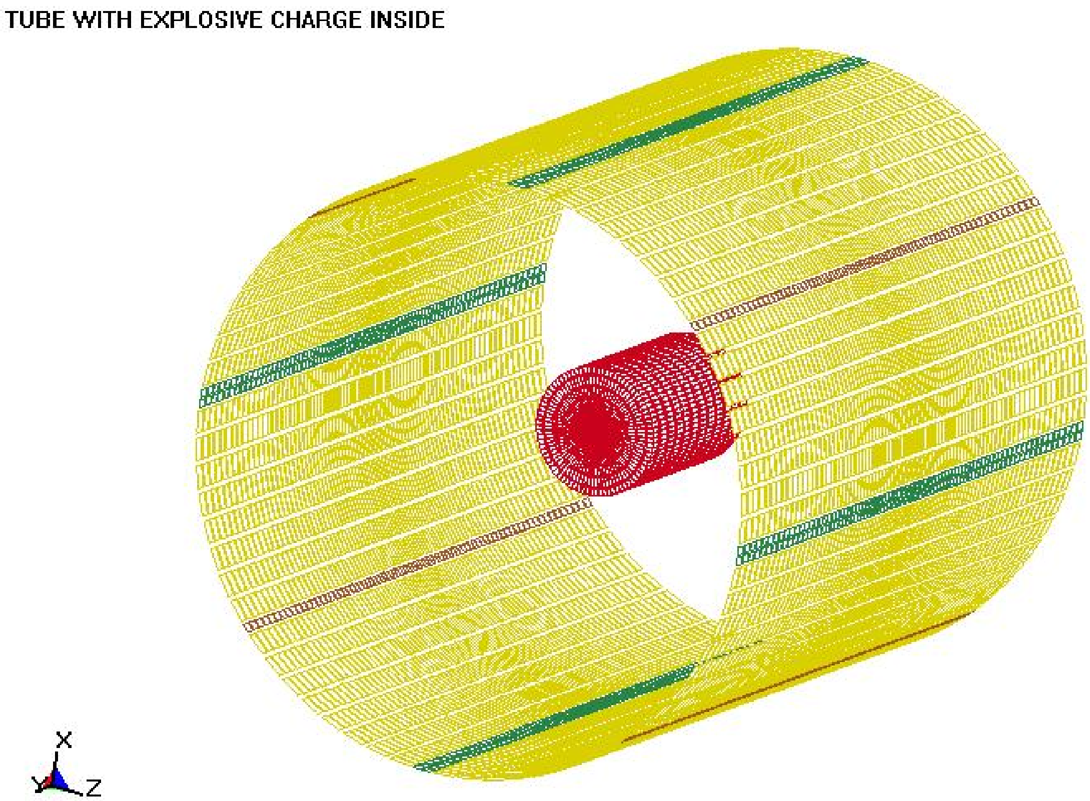

Fig.1 Cylindrical charge in a tube.

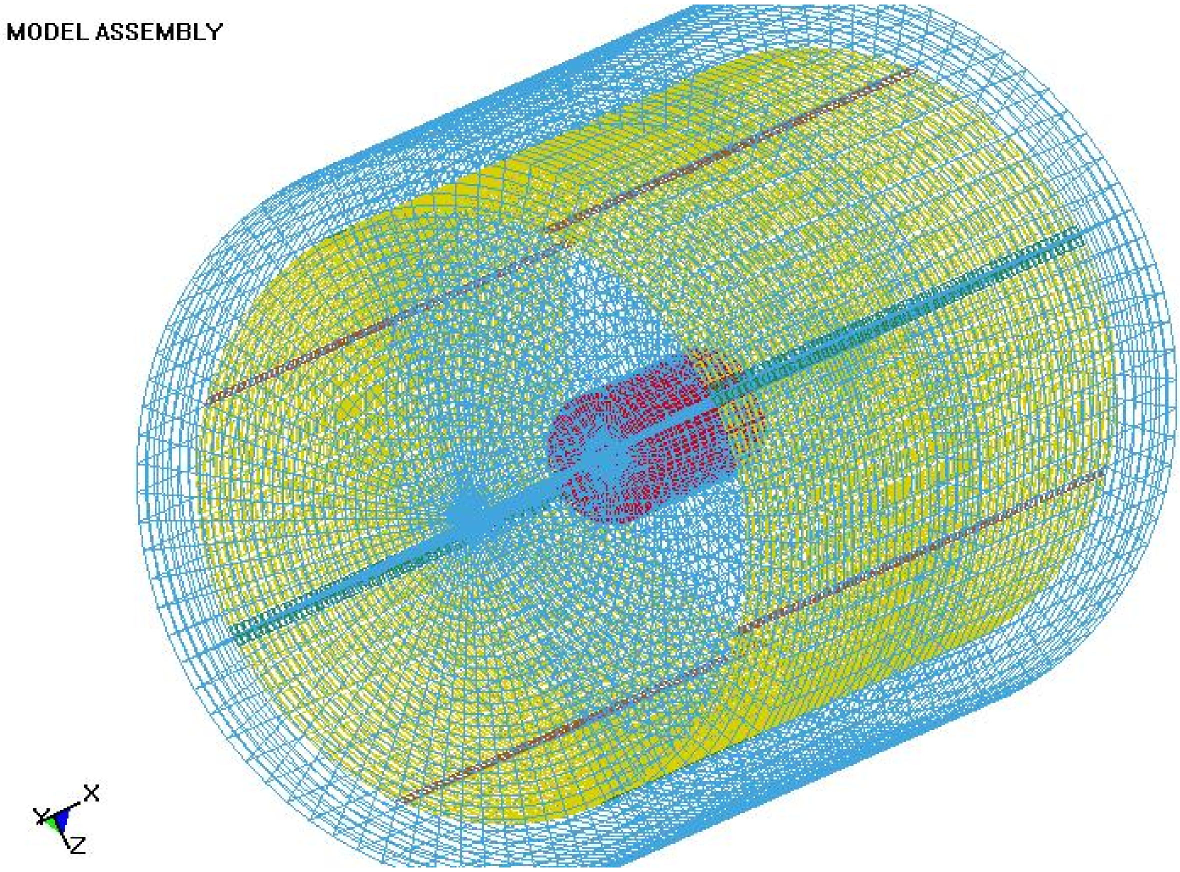

Fig.2 Computational model: charge, shell and air volume.

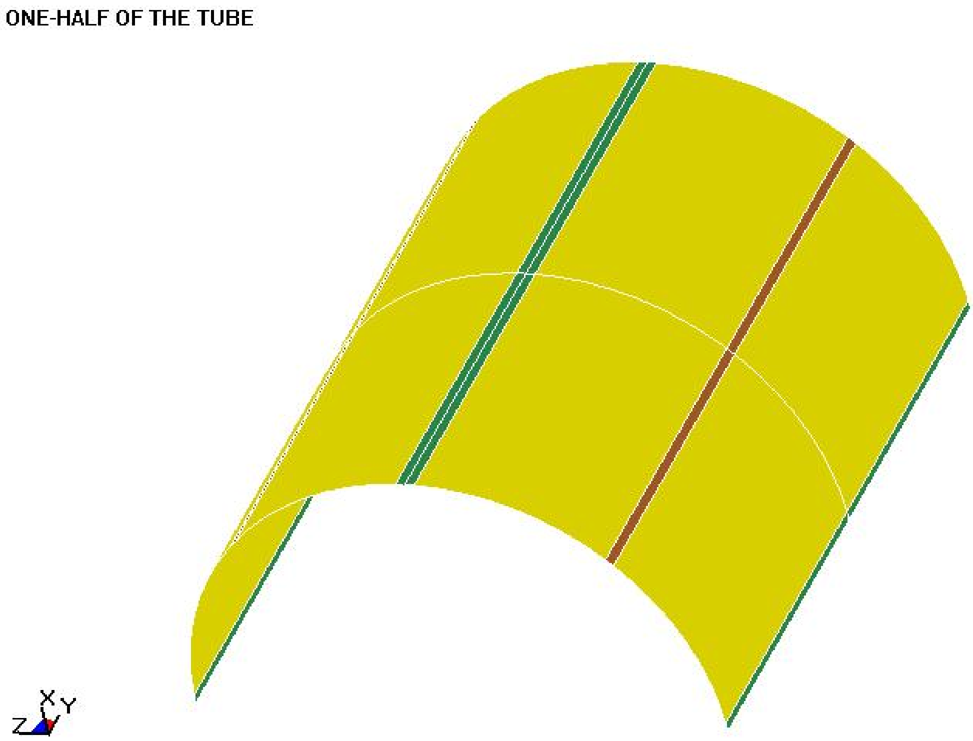

Fig.3 Upper part of the tube, with breakable seams.

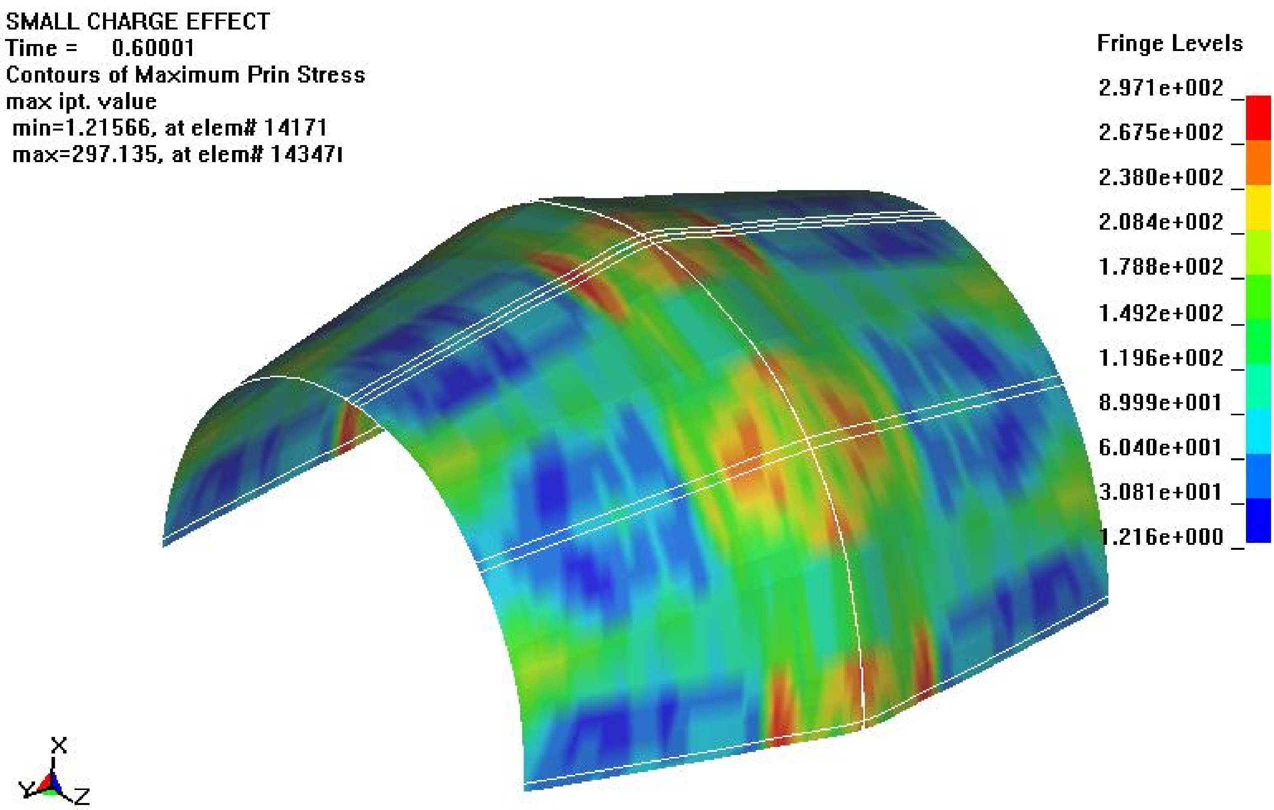

Fig.4 Deformation after a small charge was exploded.

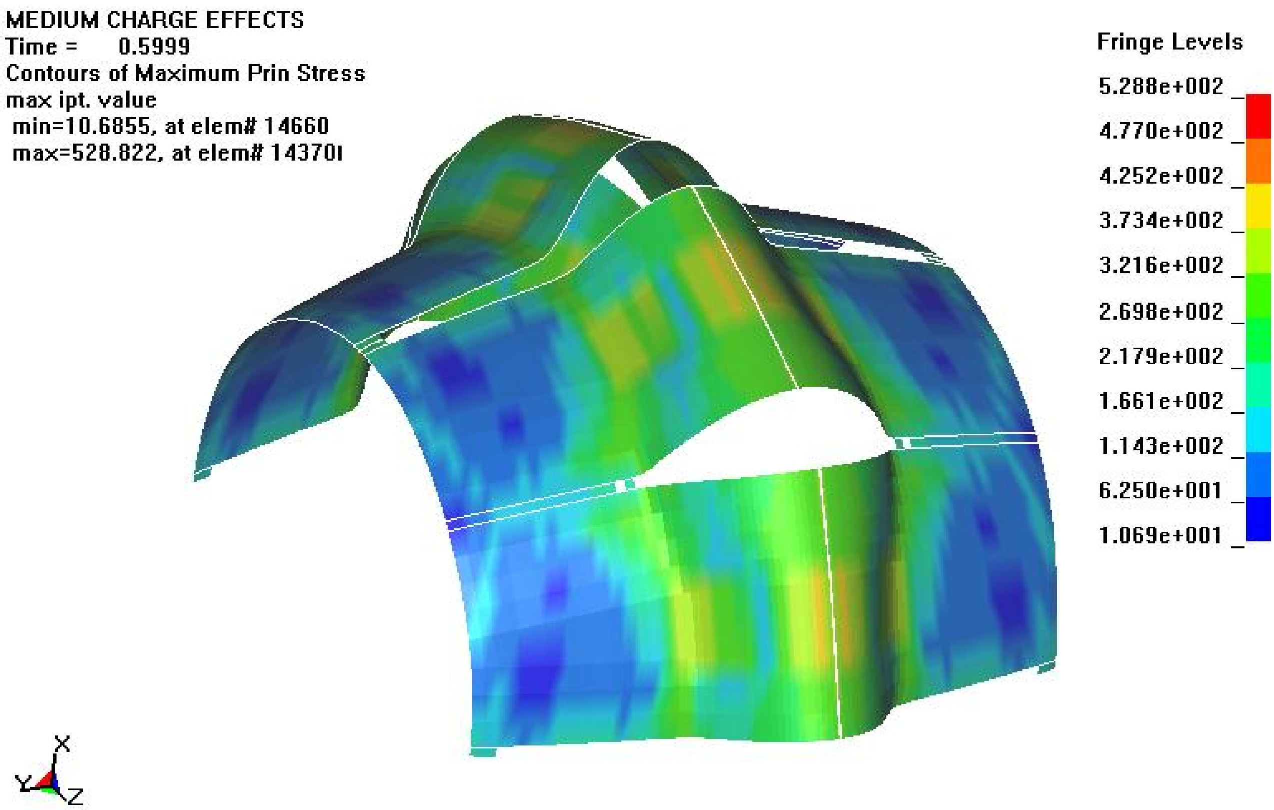

Fig.5 Deformation and splitting after a medium charge was exploded.

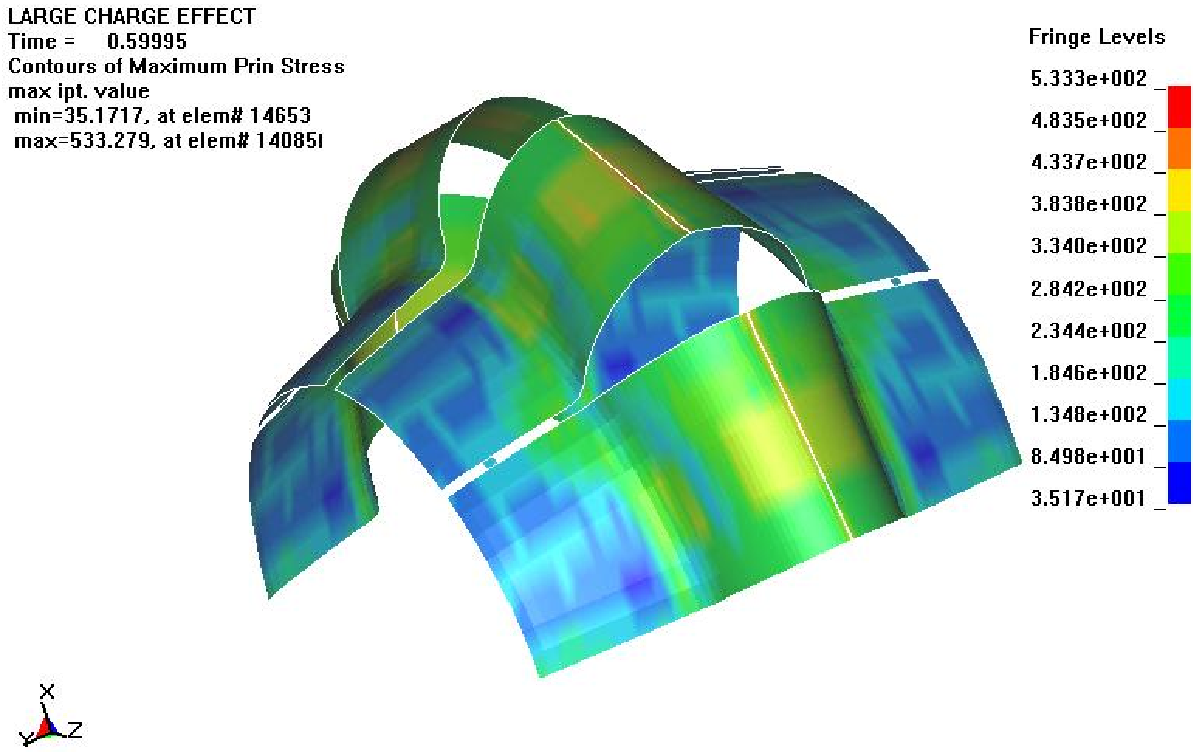

Fig.6 Complete splitting after the large charge was detonated.