MITIGATION OF BLAST AND IMPACT LOADS USING THIN WALLED TUBES

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In many cases, a protective device (such as a wall or a multi-layered cassette) has to be supported on some existing structure. It is assumed that the protective device is designed to withstand the oncoming threat, but that the existing structure cannot provide the necessary support to the forces created by the attack and transferred to it by the protective device. In such cases a buffering mechanism, having the function of reducing the transferred forces to an acceptable level by the existing structure, is required. The buffering of forces could be achieved by providing an elasto-plastic element that limits the force due to its special geometry, and at the same time allows a large displacement to compensate for the force reduction. One popular example of such an elasto-plastic element is a thin walled tube, which can be deformed extensively until it forms the shape of an infinity sign. In this particular case it is necessary to tailor the tube parameters to the incoming threat, the protective device and the support structure. The present work deals with such an application.

We present an example of a 25 mm steel plate serving as a protective device against a 40 kg TNT charge placed one meter above the plate (Figure 1). The plate rests on 0.5-inch thick tubes, 200 mm in diameter. (The support structure below the tubes is not shown). We carried out two simulations of the problem using the MSC.Software Pisces code. This code is capable of simulating the blast wave of the explosion and its interaction with the plate employing a robust fluid structure interaction algorithm. Similarly, the plate and tubes are interacting via a contact (solid-solid) algorithm. In the first simulation (Figure 2) the tubes are assumed to be rigid, and the plate is deformed significantly. In the second simulation (Figure 3), the tubes are deformable, (having a realistic yield strength), and the plate deformation is minimal while the tubes are deformed significantly. It is clear from these two extreme cases of tube rigidity that it is necessary to tailor the tube plastic response parameters to the threat level in order to obtain an optimal buffering.