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BLAST BUCKLING OF THIN-WALLED METAL TANKS

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This paper investigates the response of steel storage tanks under blast loads. It is based on semi-analytical simplified approaches and finite element simulations which are compared with experimental results.

In a first part, the blast loading, resulting from the diffraction of the blast wave by the structure, is studied. The problem of the reflection of a shock wave by a non straight surface such as a convex cylinder is known to be a very hard analytical problem [1]. As a consequence, the overpressure distribution on the cylindrical shell during the blast is determined from small scaled experiments [2]. A simplified semi-empirical blast loading function, giving the reflected overpressure as a function of the incident overpressure idealized with a Friedlander pressure-time history pulse description, is developed. This model neglects non regular phenomena such as Mach reflection.

One of the most currently observed response of thin-walled tanks to blast loads is buckling. The occurrence of dynamic buckling is analyzed with simplified semi-analytical models based on shallow-shells Donnell's equations and critical imperfection amplification thresholds. This simplified approach is used to construct buckling curves in pressure-impulse diagrams which adequately predict the experimental results [3].

In a last part, explicit dynamic finite element simulations are carried out . In these uncoupled simulations, the tank is modeled using thin shell elements in a full non-linear framework. The loading is calculated using the proposed simplified model instead of the usual empirical air-blast loading function [4]. The loading is prescribed, on the initial configuration, as a time and coordinates dependent pressure function for each element of the structure. This means that potential fluid-structure interaction effects which could reduce the impulse transmitted from the blast to the structure are not taken into account. In particular, we focus our attention to the mesh characteristics that permit to obtain the correct structural response. Indeed, a very fine mesh is needed on the front face of the tank to ensure a good description of the spatial variations of the load and to catch the high buckling modes.

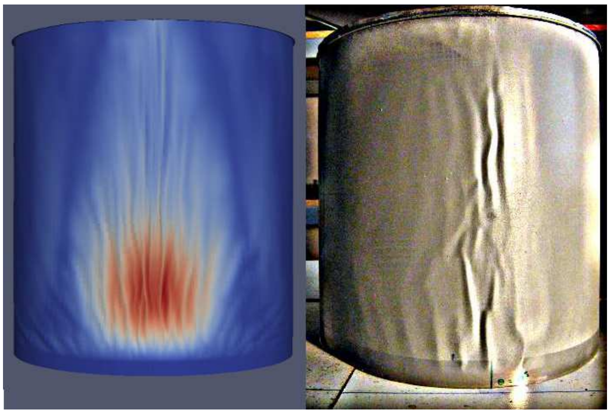

Figure 1: Empty tank buckled : numerical simulation versus experimental results

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