RELEVANCE OF FLUID-STRUCTURE INTERACTION FOR BLAST LOADED STRUCTURES: A NUMERICAL AND EXPERIMENTAL STUDY

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Design and validation of reinforced concrete structure against blast load are important for modern society to protect citizens and facilities. The first step to achieve this goal is to estimate the load applied to the structure. As a first idea, engineers gathered knowledge in facility criteria [UFC] for organizing analytical methods. However, these approaches cannot satisfy all the needs regarding complex structures and material considerations. To do so, engineers can use commercial software (Radioss, LS-Dyna, Europlexus…) but an issue can't be overcome : the computational time is not affordable for most companies. To deal with this problem, a first approach consists in replacing the detonation processus by an analytical model to express the pressure profile [Taylor, Sakurai, Bach and Lee]. Another solution can be the consideration of the burst of a pressurized spherical volume of air [Brode, 1959]. The study focuses on the discrepancies between both approaches and experiments taken from the literature [UFC-3-340-2, Kinney-Graham, …] First the above-mentioned models are studied and compared, then a finite-element software [Radioss] is used to compute the pressure.
A parametric study is performed on element types, global size of the model (with respect to Hopkinson-Cranz scaling laws) and the approach considered to model the source. Results from pure finite-element to semi analytical methods are discussed and compared with experimental databases from literature in order to underline the most relevant methods for dealing with a blast-structure interaction problem.
The first value of interest is the decay of the maximum overpressure with respect to the radial distance that can be obtained according to the point source calculation from Brode, Taylor and Sakurai and experimental data from UFC-3-340.
In a second time, it is of interest to focus on the modelling of the interaction between the blast wave and the structure. A full modelling taking into account Eulerian and Lagrangian coupling has been identified as expensive in CPU time. It is then necessary to identify Overpressure and Impulse domains for which resorting to this numerical procedure becomes necessary. In order to evidence this it, an experimental approach has been carried out with the shock tube of ENSTA Bretagne turned into blast wave generator. Membranes of various stiffnesss have been clamped at the shock tube extremity. Time resolved pressure and membrane deflection have been recorded. Experimental results are then compared with analytical approaches and numerical simulations.