Hybrid analytical-numerical methodology for computationally efficient pre-design analysis of fluid-interacting shell systems

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ABSTRACT

In recent years, an efficient semi-analytical methodology has been developed for modelling the interaction between shell structures and shock waves [1-3]. The methodology was based on the use of the so-called "response functions", the functions that only depend on the geometry of the system and not on the properties of the fluid(s) and structure(s). The methodology was extensively validated and has proven to be an attractive choice for the use by the practitioner due to its high computational efficiency; it is particularly attractive when an extensive parametric analysis of the system is intended, as often is the case at the pre-design stage.

Along with its significant advantages, the methodology also has some rather serious limitations. In particular, in its present form it is only applicable to very specific geometries of the structure such as cylindrical and spherical. This feature significantly limits the applicability of the methodology due to the fact that most industrial systems possess higher geometrical and/or material complexity. In an attempt to overcome this limitation, we propose a hybrid model where the structural part is handled using FEM, while the fluid domain is modelled using the response-functions-based methodology.

We show that such an approach results in a model that is capable of accurately simulating the shock response of many commonly encountered in engineering practice structures that have a degree of geometrical and/or material complexity, while being more computationally efficient than "pure-FEM" approaches. Thus, the proposed methodology is demonstrated to combine the versatility of FEM with the computational efficiency of the response-functions-based methodology.

REFERENCES

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