A PARTITIONED FSI METHODOLOGY FOR ANALYSIS OF SLOSHING-INDUCED LOADS ON A FUEL TANK STRUCTURE

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Liquid sloshing is a source of major concern in the structural design of containers and has been analysed in various industrial applications [1, 2]. In fuel tanks of heavy duty trucks, with capacities of as high as 900 litres, this phenomenon is capable of causing fuel to impact the container tank with high forces, and exposing the vulnerable parts of the tank to heavy dynamic loads. This highly non-linear and transient phenomenon is simulated using the commercial Computational Fluid Dynamics (CFD) code STAR-CCM+. The two phase (air-fuel) problem is solved using the VOF interface capturing approach.

Owing to the thin walled structures of the fuel tank, it becomes indispensable to cater to the effects of FSI. To this end, a partitioned FSI methodology is employed by coupling the CFD and Finite Element Analysis (FEA) solvers for this multi-physics problem. The numerical methodologies are validated with results from benchmark studies in the literature [3, 4], and are subsequently extended for further analyses on the fuel tanks of trucks. A comparison is carried out between the one-way, two-way coupled FSI methodologies and experimental results. One-way coupled simulations yield good agreement of wall deformations with the experiments for low filling levels. While the two-way coupled FSI analysis corroborates well with the experiments for all filling levels, its high computational costs render the one-way coupled methodology a promising tool to analyse sloshing for industrial applications. This coupling strategy could inform a fuel tank design suited to prevent structural damage due to sloshing, thus contributing towards its safety and longevity.

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