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Development of an Implicit Coupled Partitioned Model for the Prediction of the Behavior of a Flexible Slender Shaped Membrane in Interaction with Free Surface Flow under the Influence of a Moving Flotsam

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Abstract : This research is part of an interdisciplinary project, promoting the design of a light temporary installable textile defence system against flood. In case river water levels increase abruptly especially in winter time, one can expect massive extra load on a textile protective structure in term of impact as a result of floating debris and even tree trunks. Estimation of this impulsive force on such structures is of a great importance, as it can ensure the reliability of the design in critical cases. This fact provides the motivation for the numerical analysis of a fluid structure interaction application, comprising flexible slender shaped and free-surface water flow, where an accelerated heavy flotsam tends to approach the membrane. In this context, the analysis on both the behavior of the flexible membrane and its interaction with moving flotsam is conducted by finite elements based solvers of the explicit solver and implicit Abacus solver available as products of SIMULIA software. On the other hand, a study on how free surface water flow behaves in response to moving structures, has been investigated using the finite volume solver of Star CCM+ from Siemens PLM Software. An automatic communication tool (CSE, SIMULIA Co-Simulation Engine) and the implementation of an effective partitioned strategy in form of an implicit coupling algorithm makes it possible for partitioned domains to be interconnected powerfully. The applied procedure ensures stability and convergence in the solution of these complicated issues, albeit with high computational cost; however, the other complexity of this study stems from mesh criterion in the fluid domain, where the two structures approach each other. This contribution presents the approaches for the establishment of a convergent numerical solution and compares the results with experimental findings.

Keywords : co-simulation, flexible thin structure, fluid-structure interaction, implicit coupling algorithm, moving flotsam
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