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Added mass and critical mass in vortex induced vibration EFSTATHIOS KONSTANTINIDIS, Department of Mechanical Engineering, University of Western Macedonia, Kozani 50100 — The critical mass phenomenon is the observation that a circular cylinder suspended freely in a fluid stream without a mechanical restoring force exhibits significant vortex induced vibration if its mass is below some value whereas insignificant vibration occurs if the mass is above this value. While the phenomenon is known, its origin remains largely unknown. Furthermore, there are several outstanding questions regarding this phenomenon which cannot be explained on the basis of the existing theoretical framework. In this work, a new formulation of the added mass in the context of potential flow is presented. This leads to a new expression for the potential force, which is more complex than the classical one, that is subsequently employed in simplified form in order to analytically model the flow-structure interaction by decomposing the fluid force into potential and vortex components via the equation of cylinder motion. It is found that the model predicts a significant increase in the amplitude response of a freely suspended cylinder in sharp contrast to predictions using the classical formulation of the added mass. Finally, the model equations are employed to exemplify the phenomenology of the critical mass in real flows.

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