APCOM & ISCM
11-14th December, 2013, Singapore

Added Mass and Aeroelastic Instability of a Flexible Plate Interacting with Mean Flow in a Confined Channel

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This work presents a theoretical study of added mass and aeroelastic instability exhibited by an elastic plate immersed in a flowing fluid. We first present a combined added-mass result for the model problem with a mean incompressible and compressible flow interacting with an elastic plate, using the Euler-Bernoulli model for the plate and 2D viscous potential flow theory. Then we present a formulation for predicting critical velocity for the onset flapping instability. Our proposed new formulation for aeroelastic coupled instability considers tension effects due to viscous shear stress explicitly along fluid-structure interface. In general, the tension effects are stabilizing in nature and become critical in problems involving low mass-density ratios. We further study the effects of mass-density ratio and channel height on the aeroelastic instability using the linear stability analysis. Finally we conclude this paper with the validation of the theoretical results with experimental data presented in the literature.

Keywords: Linear stability analysis, Mass ratio effects, Tension effects, Critical velocity, Confined channel, viscous potential theory, Added mass.