Controlling Aero-/Hydro-elastic Instability of a Flexible Plate in a Uniform Flow through Localised Structural Inhomogeneity

Background
A classical fluid-structure interaction problem: A simple flexible plate first loses its stability to divergence that is replaced by modal-coalescence flutter at higher speed.

Theoretical and Computational models

3D Wall dynamic equation
\[ \rho_m \frac{\partial^2 \eta}{\partial t^2} + d \frac{\partial \eta}{\partial t} + B \nabla^2 \nabla^2 \eta = -\Delta p(x,y,0,t) \]

3D perturbation potential \( \phi \)
\[ \phi(r_Q, t) = \int_S \frac{\sigma(r)}{|r_Q - r|} dS \]

Finite Difference Method
Boundary Element Method

Combine to form state-space model

The main merit of this method
Analyse the FSI of panels having arbitrary structural inhomogeneity

Applications
Curtain Wall
Aircraft Skin Structure
High Speed Ferry

Figure 1: Schematics of (a) 2D and (b) 3D problems studied wherein a uniform flow interacts with a flexible panel having localised structural inhomogeneity.
1. Extend a 2D hybrid theoretical-computational method to 3D system.
2. A single spring support to the plate can stabilise 2D system while it is replaced by stiffening strip for 3D system.
3. The addition of stiffening at panel midpoint/midline is an effective way to postpone divergence onset to higher flow speeds.

References


Further publications can be found at: