6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

A variational formulation for motion design of adaptive structures

Renate Sachse[1] and Manfred Bischoff[1]

[1]Institute for Structural Mechanics, University of Stuttgart
Pfaffenwaldring 7, 70569 Stuttgart, Germany
{sachse, bischoff}@ibb.uni-stuttgart.de

Key Words: *Adaptive Structures, Motion Design, Variational Formulation*

In building construction there is fast growing importance in energy efficiency and sustainability. Therefore, extremely efficient structures need to be designed by architects and engineers. Adaptive structures are one option to satisfy this requirement by a continuous adjustment to current loading conditions. This may also help to avoid overdesigning when dealing with rare events like extreme wind, earthquakes or terror. Beyond classical structural optimization, providing one specific configuration for a dominating load case, structural adaptation implies geometry changes between multiple configurations that cope with changing requirements. Also for deployable and retractable structures, an efficient motion between the different configurations is needed. This contribution deals with such shape transitions as a motion between two (or more) geometrical configurations and their design, based on a variational formulation.

Like the individual geometrical configurations, the motion itself also needs to fulfil efficiency requirements, for instance by minimizing strain energy during the whole deformation process. Referring to the Brachistochrone curve as one of the first problems in calculus of variations, a variational principle is used to find the minimum of a particularly quantity related to the motion. A discretization of the motion path leads to a linear system of equations, comparable to a geometry discretization in the finite element method.

The proposed method is verified by means of applications with known exact solutions, for instance the motion of a kinematic system with zero strain energy throughout the entire process. With this method, various movements with different properties can be designed.