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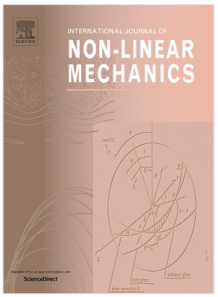

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A general condition for the existence of unconnected equilibria for symmetric arches

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Abstract

This paper presents a semi-analytical study of unconnected equilibrium states for symmetric curved beams. Using the Fourier series approximation, a general condition for the existence of unconnected equilibria for symmetric shallow arches is derived for the first time. With this derived condition, we can directly determine whether or not a shallow arch with specific initial configuration and external load has remote unconnected equilibria. These unconnected equilibria can not be obtained in experiments or nonlinear finite element simulations without performing a proper perturbation first. The derived general condition is then applied to curved beams with different initial shapes and external loads. It is found that initially symmetric parabolic arches under a uniformly distributed vertical force can have multiple groups of unconnected equilibria, depending on the initial rise of the structure. However, small symmetric geometric deviations are required for parabolic arches under a central point load, and half-sine arches under a central point load or a uniformly distributed load to have unconnected equilibria. The validity of the analytical derivations of the nonlinear equilibrium solutions and the general condition for the existence of unconnected equilibria are verified by nonlinear finite element methods.

Keywords: Unconnected equilibrium states, A general condition, Symmetric curved beams, Post-buckling responses

1. Introduction

Curved beams have been studied extensively due to their rich nonlinear structural behavior and broad applications in aerospace, civil and mechanical engineering. When these

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