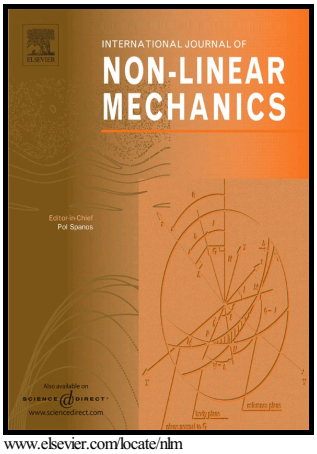

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Mode Interaction in Triple-Bay Prestressed Stayed Columns

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Abstract

Prestressed stayed columns are an innovative type of structural system where the compressive load-carrying capacity can be enhanced through prestressed external cable stays. A nonlinear analytical model for prestressed stayed columns with multiple crossarm systems along the column length, based on the Rayleigh–Ritz method, is presented that captures modal interactions for perfect geometries explicitly for the first time. It is demonstrated that the theoretical compressive strength enhancements under certain configurations can only be obtained at the expense of triggering a sequence of destabilizing bifurcations. This can give rise to dangerously unstable interactive post-buckling behaviour including so-called 'mode jumping' and 'snaking' phenomena. Parametric spaces where the system is most susceptible to the modal interactions are identified and it is for those configurations that the system is likely to be highly sensitive to initial imperfections. The model is validated using a nonlinear finite element model formulated within the commercial code ABAQUS and excellent comparisons are obtained.

Keywords: Interactive and cellular buckling; Mode jumping; Analytical and finite element modelling; Prestressing

1. Introduction

Prestressed stayed columns, comprising a slender main column element, a system of crossarm members and pre-tensioned cable stays, as shown in Figure 1, offer an innovative, aesthetic and practical solution to the problem of low critical buckling loads in columns with highly slender geometries [1, 2, 3, 4, 5, 6, 7]. This type of element has been employed in practice where a column needs to span a long distance but has to be of relatively light-weight construction. For example, during the construction of the Rock in Rio III stadium in Brazil [8, 9], such columns were used to prop the incomplete stadium roof while the construction was completed. The columns were constructed and prestressed on site such that they eliminated the need for using expensive shoring systems that would have increased the time and cost of the construction significantly. Figure 2 shows some other

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