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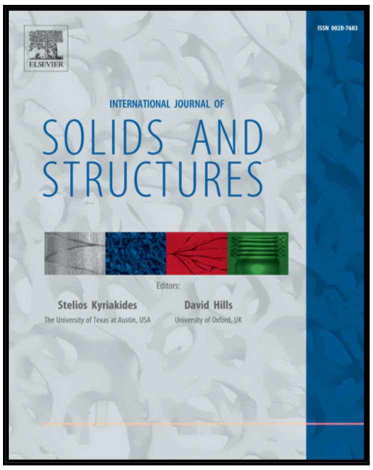

Thermal-Induced Buckling and Postbuckling Analysis of Continuous Railway Tracks

Guotao Yang , Mark A. Bradford

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Guotao Yang and Mark A. Bradford

Centre for Infrastructure Engineering and Safety, School of Civil and Environmental Engineering, UNSW Australia, UNSW Sydney, NSW 2052, Australia.
Emails: guotao.yang@unsw.edu.au and m.bradford@unsw.edu.au

Abstract

Railway tracks are vulnerable to buckling when subjected to temperature increases, as occurs frequently during heatwaves. This paper presents an investigation of the lateral buckling and postbuckling response of railway tracks under thermal loading that includes the restraining effect of the ballast in the longitudinal and lateral directions. The principle of stationary total potential is used to develop the differential equations of equilibrium, as well as the bifurcation buckling from this equilibrium, and these equations are shown to be highly non-linear. The buckling analysis shows that first-order symmetric and antisymmetric modes may govern the buckling, and that for very long members the two buckling loads are the same. The highly non-linear equations for the postbuckling response are solved by making recourse to a shooting technique, and it is shown that following the bifurcation buckling under displacement control the response is initially unstable, followed by a stable branch of the postbuckling equilibrium response. Under thermal loading, which occurs in practice, the response is one of snap-through buckling to the remote stable path, and the solution is shown to capture the localisation of the buckling modes that is observed in practice. The effects of the lateral and longitudinal ballast resistance are quantified, and it is shown that the lateral resistance is predominant when compared with the longitudinal resistance. The influence of lateral track imperfections is also studied, which is shown to have considerable effect on the critical temperature.

Key Words: Thermal buckling; postbuckling localisation; railway tracks; buckling.