

On Nonlinear Buckling and Collapse Analysis using Riks Method

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Abstract: *Nonlinear analysis using Riks method is suitable for predicting buckling, post-buckling, or collapse of certain types of structures, materials, or loading conditions, where linear or eigenvalue method will become inadequate or incapable, especially when nonlinear material, such as plasticity, is present, or post-buckling behavior is of interest. These structures usually undergo finite deformations due to complicated loadings or material plasticity before buckling actually occurs, which changes system matrices, and thus, makes the eigenvalue analysis inaccurate, difficult, or even impossible to perform. This study intends to demonstrate the use of Riks method in the nonlinear analysis of buckling and post-buckling behaviors of a flexible structure under bending and compressive loads. The null-point on load-displacement curve is used as criteria for the onsite of instability. The predicted results from finite element analysis compare well with testing data.*

Keywords: *nonlinear, structure, buckle, post-buckle, collapse, Riks, critical load, bifurcation, instability, load-displacement curve, null point*

1. Introduction

Buckling is when a flexible structure loses its stability, which may lead to a sudden and catastrophic failure, such as the complete collapse or breakage of the structure [Ugural, 1987]. When compressive loading is present, buckling may become a concern. Sometimes, it is the limiting factor for structural designs. Some of the examples are found in petrochemical, refining, or nuclear industries, where reactors could be subjected to net external pressures or other types of compressive loads. Understanding the buckling, post-buckling, or collapse behaviors in some cases, is critical for maintaining safe operating conditions.

In linear elastic stress analysis, equilibrium is based on the original undeformed configuration; while for linear elastic instability problem, deformed shape is considered, although the deformation before instability is usually very small compared to structure's original geometry. Typical applications are the long and slender beams under compressive axial loads. The onsite of buckling will lead to an instantaneous increase in lateral deflections. For this type of problems, theory of linear elastic buckling analysis serves well in predicting the onsite of the buckling or critical loads. In other situations, when a structure undergoes finite deformation due to complex