Sensors and Materials, Vol. 6, No. 5 (1994) 293-309
MYU Tokyo

S & M 0173

Characteristics of Quasi Buckling

Jan Söderkvist[1,2] and Ulf Lindberg[2]

[1] Colibri Pro Development AB, Torgnyvägen 48, S-183 72 Täby, Sweden
[2] Department of Technology, Uppsala University, Box 534, S-751 21 Uppsala, Sweden

(Received December 17, 1993; accepted April 8, 1994)

Key words: buckling, quasi buckling, compressive stress, energy method, frequency shift

The classical theory of Euler buckling (EB) does not fully describe compressed structures with transverse loads, imperfections, or asymmetries. For instance, strongly undesirable transverse deflections may occur far below the buckling load, an occurrence which is not predicted by EB. A simple and accurate nonlinear method for characterizing quasi buckling (QB), i.e., bucklinglike deflection of compressively and transversely loaded structures, is derived from the principle of least work. The general method, which does not use series expansions, results in a cubic equation which agrees well with nonlinear finite-element analysis (FEA). Several important effects of QB are discussed, and exemplified with a double-clamped beam. Some characteristics are that (1) smooth transition into a stable transverse postbuckling state starts at zero compressive stress, (2) the bifurcation load, above which snap-through between several states is possible, increases with the transverse load, (3) the transverse force needed to neutralize a transverse deflection is independent of compressive stress, and (4) the dependence of the flexural resonance frequency on the compressive stress changes its sign for large transverse loads. The results are general and apply as well to two- as to three-dimensional structures.

1. Introduction

Beams that become unstable under compressive loads were studied as early as in the 18th century by Euler.(1) Yet, it was not until a century later that the validity of his results became generally accepted. The Euler buckling loads for variously supported beams are now well established, and serve as a simple guideline for the onset of buckling.(2,3) However, Euler's classical buckling theory gives little information on structure behavior in the presence of transverse loads. Neither does it describe postbuckling well, i.e., the finite