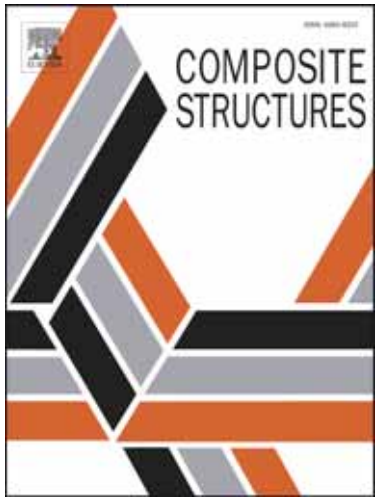

Remarks on experimental and theoretical investigations of buckling loads for laminated plated and shell structures

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Remarks on experimental and theoretical investigations of buckling loads for laminated plated and shell structures

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Abstract: The present paper deals with the description of the stability loss and postbuckling for multilayered composite structures. Both, the experimental results and theoretical predictions are presented and discussed. The wide literature review is also pointed out considering the issue of both experimental and theoretical buckling analyses for composite rectangular plates and shells. A special attention is focused on the buckling and postbuckling behaviour od structures with cutouts and reinforcement.

Keywords: buckling, failure analysis, numerical modeling, experimental study, multilayered plated and shell structures with holes

1. Introduction

The composite materials are advantageous to be used in comparison to conventional materials due to its excellent mechanical properties such as its durability, low density and corrosion-resistant characteristics. Therefore, fiber-reinforced composite materials are applied everywhere in the industrial products. The heterogeneous behaviour of these materials makes their damage analysis very important. Buckling is one of the critical failures for these materials. To allow structural designs with lower mass, it is necessary to have access to accurate failure prediction theories for composite structures subjected to arbitrary loading conditions. For design purposes, however, the most accurate theories require a considerable amount of computational resources which is often not available. Additionally, current theories allowing less computational resources are unfortunately only valid for a specific load, material or specimen size and their reliability is still questioned – see Soden et al. [1].

Buckling loads of composite multilayered structures are very sensitive to various factors not significant for isotropic structures. Therefore, laminate configurations and the bending-extension coupling effects are studied extensively to examine their influence on the buckling resistance. The complexity of those problems increases due to: the special building of the wall thickness (the stepped construction, e.g. blended/tapered structures – see He et al. [2]), the local reinforcement of the structural wall by the piezoelectric layers – see Muc and Kędziora [3-4] the delamination fracture, which can occur because of machining errors, or low velocity impact during the service life [5-6]. In addition, the presence of cutouts complicates the pre-buckling stress distribution in the composite panels and the estimations of the stiffness and the buckling loads – see Nemeth et al. [7].

The aim of the present paper is two-fold:

- to present problems encountered in the buckling theoretical analysis of plated and shell composite structures,
- to discuss experimental tests for various composite structures, i.e. rectangular and square plates, cylindrical shells, cylindrical sandwich panels and different types of domed heads (spherical, ellipsoidal and torispherical) having different geometrical ratios. In general, the analysed experiments deal with structures which have a complex (in the sense of stacking sequences) wall constructions and/or material constructions