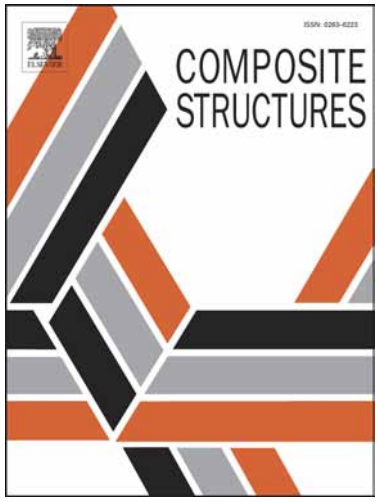

Micro-buckling of periodically layered composites in regions of stress concentration

Konstantinos Poulios, Christian F. Niordson

PII: S0263-8223(16)31677-4
DOI: http://dx.doi.org/10.1016/j.compstruct.2016.08.030
Reference: COST 7711

To appear in: *Composite Structures*

Received Date: 8 April 2016
Accepted Date: 27 August 2016

Please cite this article as: Poulios, K., Niordson, C.F., Micro-buckling of periodically layered composites in regions of stress concentration, *Composite Structures* (2016), doi: http://dx.doi.org/10.1016/j.compstruct.2016.08.030

Micro-buckling of periodically layered composites in regions of stress concentration

Konstantinos Poulios* and Christian F. Niordson†

Department of Mechanical Engineering, Technical University of Denmark
Nils Koppels Allé, Building 404, 2800 Kgs. Lyngby, Denmark.

August 30, 2016

Abstract

Under longitudinal compressive loading, periodically layered composites are prone to micro-buckling, which is often the decisive mechanism determining their strength. This paper is concerned with the load carrying capacity of structures made of layered composites with respect to micro-buckling related failure in regions of stress concentrations. A series of parametric studies show the effect of non-uniform stress distributions due to bending loads and the presence of geometrical features such as notches and holes on the initiation of micro-buckling. The contribution of the bending stiffness of the reinforcing layers on the resistance against micro-buckling introduces a dependence on the layer thickness, resulting in size-scale dependent strength limits. Therefore, both the shape and dimensions of the considered geometrical features and the layering thickness of the micro-structure are varied as part of the parametric studies. Moreover, the impact of imperfections in the composite micro-structure on the strength of the considered specimens is investigated.

Keywords: composite materials, micro-buckling, stress concentration, size effects

1 Introduction

Composite materials represent a very attractive option in mechanical design, due to their –in many cases– excellent strength and stiffness to weight performance. Nevertheless, it is well understood how the compressive strength in the direction parallel to the reinforcement of unidirectionally reinforced composites as well as the in-plane compressive strength of periodically layered composites are limited due to micro-buckling and subsequent formation of kink-bands (Fleck, 1997). For this reason, compressive loads parallel to the reinforcement of unidirectionally reinforced composites are undesirable, but unfortunately they are not always possible to avoid. Even if at global level only tensile and bending loads are applied, unfavorable compressive loads occurring locally are often the decisive factor determining the load capacity of a structure, which can be limited further due to stress concentration in critical regions.

A large number of papers have addressed the initiation of compressive load instabilities in unidirectionally reinforced and layered composite materials. In the classical work of Rosen (1965),

*E-mail: kopo@mek.dtu.dk
†E-mail: cn@mek.dtu.dk