FINITE ELEMENT MODELLING OF BENDED LAMINATE CHANNEL BEAMS

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1. INTRODUCTION

Engineer running the computing system is focused on the development of computational model, often without being aware of how the software is imperfect in modelling of some phenomena, especially the stability and behaviour of the structure after the stability loss. It is easy to overestimate the considered structure that is built based on a wrong calculation model. Among the engineers carrying out FEM calculations it is well known that the result often depends on the adopted boundary conditions (the way of support and load) and way of solving issues. Analysis of nonlinear stability of thin-walled composite structures (e.g. multilayer laminates) is very important issue. In literature there are still not enough publications on stability and load capacity of thin-walled composite girders loaded with bending moment [1, 2].

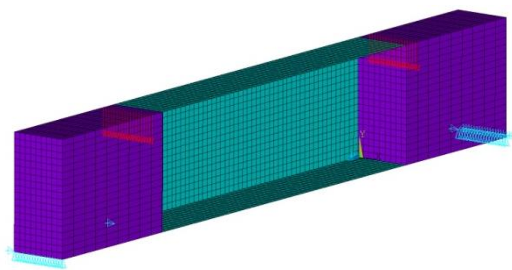

Fig. 1. Model 2 - loading corresponds to four-point bending test

2. NUMERICAL MODELS

For the calculations Ansys v15 finite element method software was used. Two numerical models were prepared. Model 1 includes a fragment of the actual beam located between the handles. The considered part of the channel beams were loaded by stress distribution corresponding to pure bending. Model 2 (Fig. 1) includes the beam with the handles, and the load is the same as at the test stand (four-point bending). For discretization of the composite beam in both cases the multi-layer shell element, defined by eight nodes with six degrees of freedom at each node was applied. In Model 2 to model both handles the cuboid solid element was used, defined by twenty nodes with three degrees of freedom at each node.

3. RESULTS

On the basis of numerical calculations critical moment (M_{cr}) for local buckling was defined which for Model 1 is equal to M_{cr} = 229 Nm, while for Model 2 M_{cr} = 282 Nm. The difference of about 20% is due to obtained different mode of deformation. In the case of the Model 1 on compressed flange two sine half-waves appear and for Model 2 these are three sine half-waves.

The difference between the models in the critical load is due to difference of applying of the load and how the supports are modelled. Similar differences were observed in the results of nonlinear stability compared between the models and the experiment. For the case of a failure mode received from both numerical models and experimental result they are the same (Fig. 2).

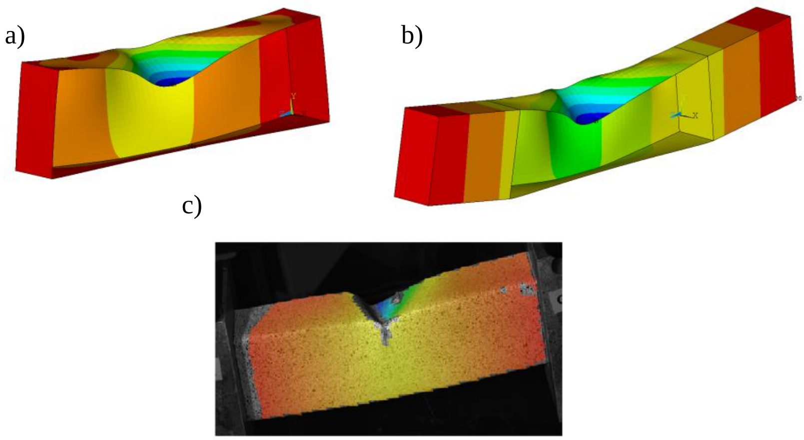

Fig. 2. Failure modes: a) Model 1; b) Model 2; c) Test

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