STUDY OF THE INFLUENCE OF RATIO OF YOUNG`S MODULI ON CRITICAL STRESSES APPLIED TO BIMATERIAL NOTCHES

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Key Words: *bimaterial notch, stability criteria, generalized stress intensity factor.*

ABSTRACT

Failures in constructions usually start in the vicinity of a geometrical or material discontinuity. The existence of such places leads to high stress concentrations and consequently to a crack initiation. Especially if material properties change in step or the geometry contains sharp notches, the stress field around such concentrators exhibits singular distribution. Generally, by using the model of a bi-material wedge it is possible to analyse many construction points such as sharp notches in both homogeneous and non-homogeneous materials, the edges of protective coatings, sharp notches with their vertex at a bi-material interface, free edge stress singularity or sharp material inclusions. The basic assumptions of the paper are the validity of linear elastic fracture mechanics, notch radius R $\rightarrow$ 0, and the interface of a welded type.

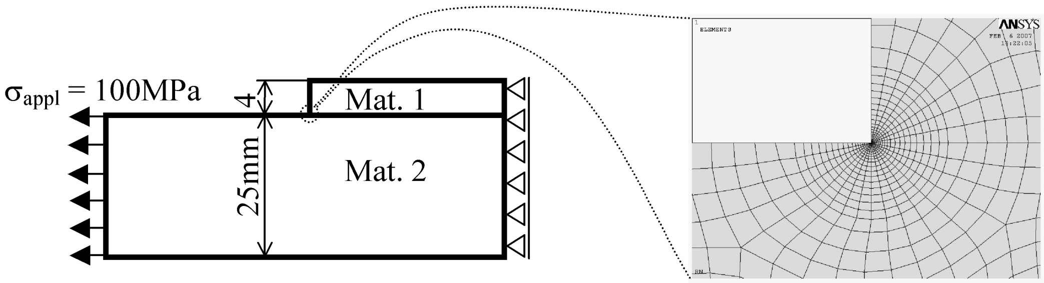

Fig.1: Rectangular bi-material wedge used in the numerical example, a detail of a FEM mesh.

The paper presents process leading to the evaluation of conditions for crack initiation in singular stress concentrators. Two stability criteria of a bi-material notch are presented. Namely the criteria are based on a mean value of generalized strain energy density [1] and on a mean value of tangential stress [2]. Both criteria are tested for a wide range of ratios of Young`s elastic moduli of both material components. The numerical study is performed on the rectangular bi-material notch loaded as shown in figure 1. The results of both criteria are compared. Figure 2 shows the dependence of a crack initiation direction q_0 and the critical applied stress $s_{\mathrm{appl,C}}$ on the ratio of moduli $E_1/E_2 \in \langle 0.0125; 10\rangle$. Note that for the ratios E_1/E_2 greater than 12 there is no singularity for the studied geometry, i.e. only non-singular terms occur in the stress distribution relations. The crack initiation direction for the studied configuration is calculated and discussed. The diversity between the two criteria is caused by the different physical substance of the criteria. As to the critical applied stress (see Fig. 2), the both criteria return similar results. The stress $s_{\mathrm{appl,C}}$ is the applied stress necessary to initiate the crack in the notch vertex in the direction q_0. The critical stresses are calculated based on the mean value of generalized strain energy density factor (SEDF) and the mean value of the tangential stress (STT). The values of $s_{\mathrm{appl,C}}$ follow from the ratio of calculated generalized stress intensity factors and their critical values, for details see [1], [2].

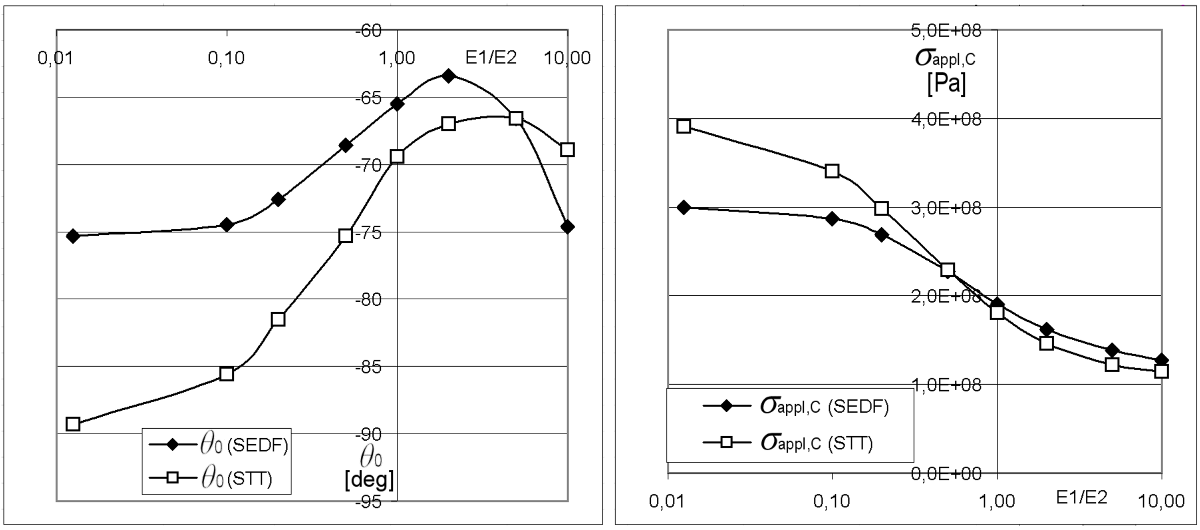

Fig.2 The crack initiation direction and the critical applied stress for the range of E_1/E_2.

Acknowledgements

The authors are grateful for financial support through the Research project of Academy of Sciences of the Czech Republic (AVOZ20410507) and the project of Czech Science Foundation (101/08/0994).

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