THREE-DIMENSIONAL ELASTIC-PLASTIC FINITE ELEMENT ANALYSIS OF V-NOTCHED BARS AND BIAXIAL LOADED THROUGH-CRACKED PANELS

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ABSTRACT

The paper is concerned first with numerical experiments on center-cracked panels under various biaxial loading conditions up to general yield. The stress/strain-state on the ligament in the vicinity of the crack-front will be discussed.

The second numerical investigation discussed in the paper is related to experimental studies on three point bend bars with sharp V-notches. The stress-intensification and the effective plastic strain below the notch will be compared with experimental results.

KEYWORDS

Numerical methods in fracture mechanics; finite-element-analysis; biaxial loading conditions; elastic-plastic material; center crack; notches.

INTRODUCTION

In fracture mechanics the problem arises wether some specific information got on test specimens are characteristic to predeterminate the behaviour of complex components. I. e. cracks in pressure vessels are subjected to biaxial nominal stress states but conventional test specimens take into account the largest nominal stress in crack opening direction only.

To study the effect of biaxial nominal stress on large scale yielding and to get information for preparing experimental investigations we used the ADINA-Finite-Element program package to carry out some numerical experiments.

Our first numerical "test specimen" was a panel with a central through-crack subjected to various biaxial loading conditions (in crack opening direction as well as in ligament direction and parallel to the crack front).

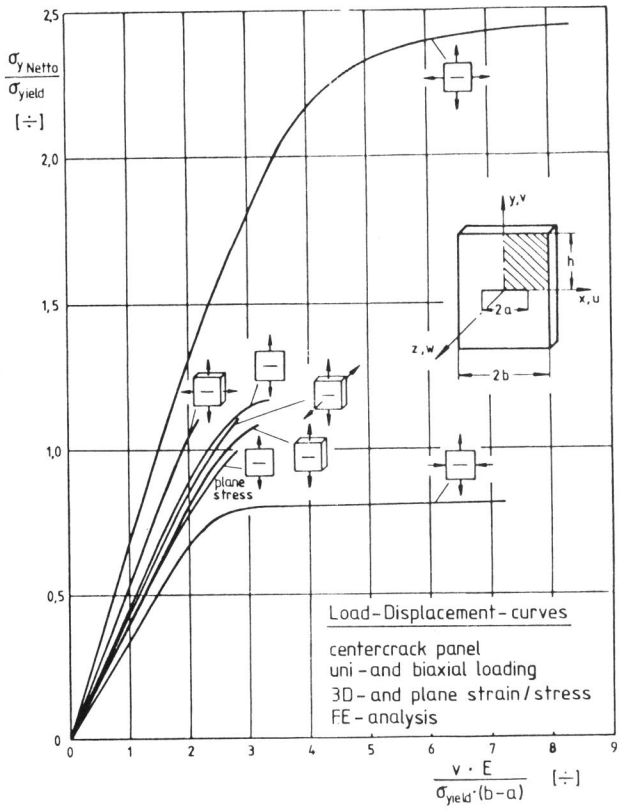

Fig. 1.

In addition to the sharp through-crack we investigated the panel with a central sharp notch.

The elastic-plastic analysis is based on the v. Mises yield condition and linear isotropic strain hardening with the tangential modulus $E_\tau = E/100$ was assumed.

We studied the effect of various biaxial load conditions on stress intensification, effective plastic strain, plastic zone size, COS etc.

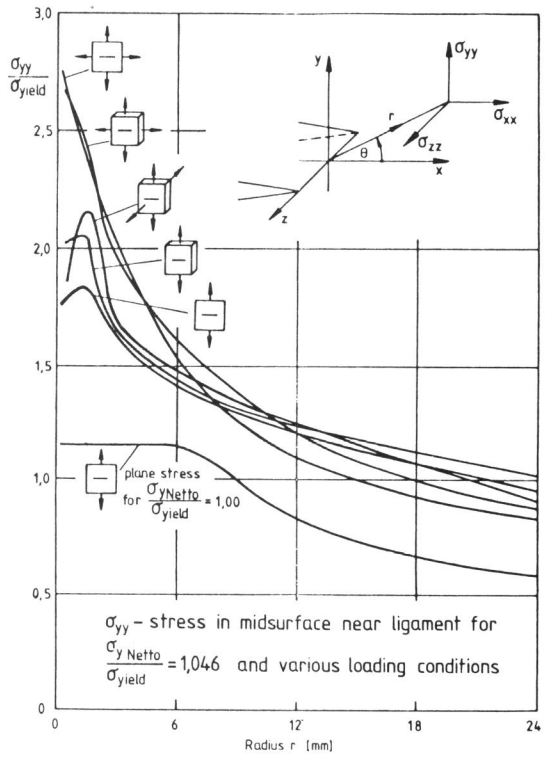

Fig. 2.

Our reference was the two-dimensional plane strain analysis on the same finite element configuration loaded unaxial.

The second numerical "test specimen" is a surface cracked plate subject to biaxial bending as well as biaxial tension.

Our investigations were carried out with applied loads up to general yield. Therefore we took into account large plastic strains at least in the vicinity of crack-front and studied the effect on the global behaviour.

On the other hand an experimental research program on three point bend bars with sharp V-notch has been carried out at our institute.

The paper is concerned with numerical investigations to accompany the experimental studies.

At first we compared the global behaviour of the notched bar and found a very good agreement up to general yield of the experimental load-displacement-curves with the calculated ones.

In the experimental and the numerical study we varied the notch angle (105°, 45°, 0°) and the width of the bar.

The special aim of our three-dimensional numerical investigation was to calculate the stress and strain state in the vicinity of the notch root.

We studied the stress intensification and the effective plastic strain below the notch for various applied loads up to general yield or until fracture occurs.

For carrying out these calculations we had large plastic deformation to take into account.

The experimental as well as the numerical investigations show the significant influence of the notch angle on stress intensification. Eventually we modified the sharp 0°-notch in a crack. The crack-front was modeled with singularity-elements.

Some three-dimensional results will be compared with two-dimensional plane strain calculations using the same finite-element geometry.

(The full length paper will be available at the conference.)