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LIFE CYCLE ENGINEERING AND MANAGEMENT

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June 25-26, 2026, Prijevor, Serbia

Conference Topics:

Plenary Lectures
Quality Engineering
Reliability Engineering
Industrial Engineering
Systems Engineering
Military Engineering
Energy Efficiency
Lean Production

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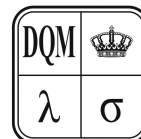
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About the Proceedings Editor

LJUBISA PAPIC

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APPLICATION OF THE ANSYS COMPUTER PROGRAM FOR DETERMINING THE TRAJECTORY OF THE MAIN STRESSES

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Summary: Constructing can be at a certain level of scientific and technical progress only if we have the development and application of computer techniques as an auxiliary tool. Due to its importance, the use of computers is growing into a new discipline, and in constructing, computer techniques is increasingly applied and becomes a useful auxiliary tool. The application of computer techniques allows the constructing process to be accelerated, facilitated and improved. Therefore, the goal of this study is to show that by applying computer techniques and computer programs, it is possible to achieve certain results in the constructing process very quickly and easily. In this paper, the computer program ANSYS was used to obtain results on the trajectories of the main stresses. Tests were performed on plate-type elements. They are uniaxially tensioned and weakened by a rectangular opening in the middle of the plate. The material of the plate is steel.

Key words: Plate, rectangular opening, ANSYS computer program, main stress trajectories.

1. INTRODUCTION

Sustainable development is based on a model that qualitatively satisfies the socioeconomic needs and interests of citizens, while at the same time eliminating or significantly reducing impacts that threaten or damage the environment and natural resources [1]. One of the goals of sustainable development is the need for a fundamental change in behavior from industrial processes to individual decisions.

Making individual decisions is inevitable in the process of constructing machine parts. Machine parts are most often of irregular geometric shape and contain some singularities, such as openings. In their study, Nikolic et al. [2], consider the influence of an elliptical opening on the state of stress in an anisotropic (orthotropic) uniaxially tensioned plate exposed to the effect of static loading. The application of numerical methods in solving the theory of thin plates was dealt with by Radojković et al. [3]. The aim of the research by Sarkocecic et al. [4] is the creation of a document that specifies the best methods for assessing defects in pipelines, i.e. a brief description of the Pipeline Defect Assessment Manual (PDAM). In their studies, Radojkovic et al. [5, 6] analyze the influence of rectangular and square openings in isotropic plates on the distribution and concentration of stress, during uniaxial and biaxial tensioning of those plates. In their study, Joksić et al. [7] deal with stress state analysis and gearbox fork optimization. Using finite element method and computer program ANSYS, Radojkovic et al. [8] arrive at results on the stress distribution in uniaxially tensioned rectangular steel plates weakened by an elliptical opening. In their studies, Iqbal et al. [9] provide a systematic overview of the stress concentration factor (SCF) in composite reinforced Circular Hollow Section (CHS) joints, and Hart and Terokhin [10] propose methods for reducing stress concentration around holes in thin plates and cylindrical shells with annular radially inhomogeneous inclusions.

2. DISPLAY OF THE RESULTS OBTAINED USING THE ANSYS COMPUTER PROGRAM

In this study, the finite element method and the computer program ANSYS [11] were used to obtain results on the trajectories of the main stresses. Since the finite element method uses finite elements to approximate the domain, 2D triangular solid finite elements with six nodes are used here.

The obtained results on the trajectories of the main stresses, which were reached in this study, refer to plate-type elements, the dimensions of which in all examples are $5 \text{ m} \times 2 \text{ m} \times 0.1 \text{ m}$. The plates are weakened by a rectangular opening in the middle. The lengths of the sides of the rectangular opening are $a = 100 \text{ mm}$ and

$b = 20 \text{ mm}$, and the coordinate axes x and y are parallel to the sides of the plate. The tested plates are exposed to uniaxial tension, where the intensity of the tension surface forces is $p = 1 \text{ N/m}^2$, and the angle between the lines of attack of the tension forces and the x axis is denoted by α . The material of the plates is steel, for which the modulus of elasticity of the material is $E = 2.1 \times 10^5 \text{ MPa}$, and Poisson's coefficient $\mu = 0.33$.

Figure 1 shows the trajectories of the main stresses in a uniaxially tensioned plate, weakened by a rectangular opening in the middle of the plate, the length of the sides of the opening $a = 100 \text{ mm}$ and $b = 20 \text{ mm}$, the radius of rounding of the

corners of the opening $r = 6$ mm and when the angle between the attack lines of the tensile forces and the x axis is $\alpha = 60^\circ$.

Figure 2 shows the trajectories of the main stresses in the same plate, but for the case when the angle between the attack lines of the tensile forces and the x axis is $\alpha = 30^\circ$.

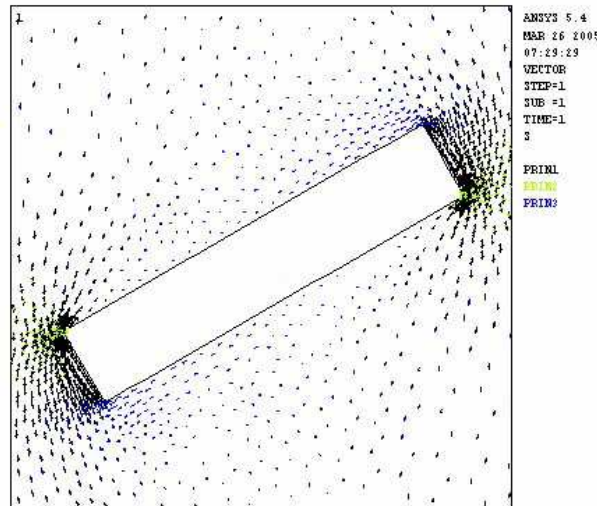


Figure 1. The trajectories of the main stresses, uniaxially tensioned plates weakened by a rectangular opening, sides $a = 100$ mm and $b = 20$ mm, the radius of rounding the corners of the opening $r = 6$ mm and the angle $\alpha = 60^\circ$

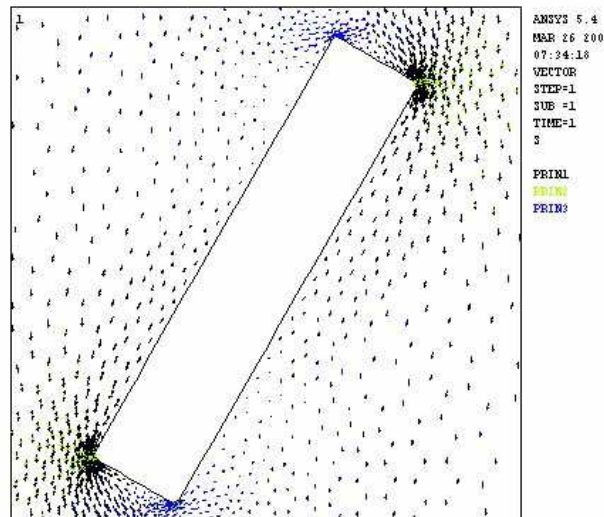


Figure 2. The trajectories of the main stresses, uniaxially tensioned plates weakened by a rectangular opening, sides $a = 100$ mm and $b = 20$ mm, the radius of rounding the corners of the opening $r = 6$ mm and the angle $\alpha = 30^\circ$

Figure 3 shows the trajectories of the main stresses in the plate as in the previous two cases, where the angle between the attack lines of the tensile forces and the x axis is $\alpha = 0^\circ$.

Figure 4 shows the trajectories of the main stresses in the plate as in the previous three cases, where the angle between the attack lines of the tensile forces and the x axis is $\alpha = 90^\circ$.

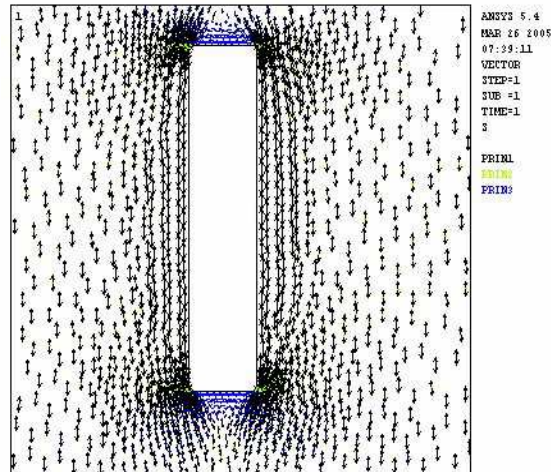


Figure 3. The trajectories of the main stresses, uniaxially tensioned plates weakened by a rectangular opening, sides $a = 100$ mm and $b = 20$ mm, the radius of rounding the corners of the opening $r = 6$ mm and the angle $\alpha = 0^\circ$

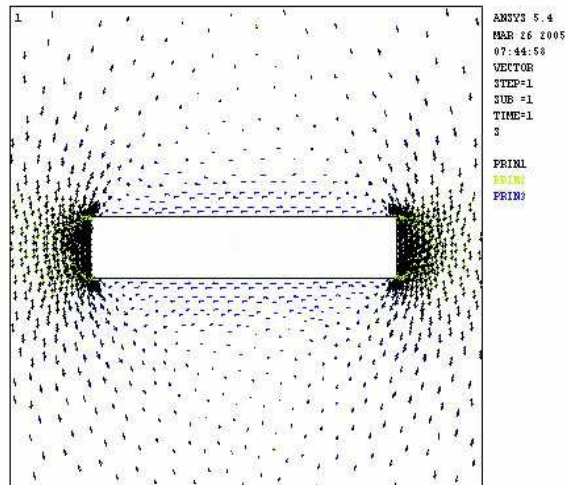


Figure 4. The trajectories of the main stresses, uniaxially tensioned plates weakened by a rectangular opening, sides $a = 100$ mm and $b = 20$ mm, the radius of rounding the corners of the opening $r = 6$ mm and the angle $\alpha = 90^\circ$

3. CONCLUSION

The results on the trajectories of the main stresses, in this paper, were obtained using the finite element method and the ANSYS computer program.

In the study, tests were performed on steel plates of rectangular shape, weakened by a rectangular opening in the middle of the plate, whereby the tested plates were subjected to uniaxial tension.

The aim of these studies was to demonstrate the influence of the position of the rectangular opening on the image of the main stress trajectories in plate-type elements, and also the justification of the application of the finite element method and the ANSYS computer program.

These studies have shown that in terms of the trajectories of the main stresses, i.e. in terms of their curvature, the most unfavorable case is when the position of the rectangular opening is such that the angle between the attack lines of the tensile forces and the x axis is $\alpha = 90^\circ$ (Figure 4). The case where the position of the rectangular opening is such that the angle between the lines of attack of the tensioning forces and the x axis is $\alpha = 60^\circ$, in terms of the curvature of the trajectories of the main stresses is somewhat more favorable, and the most favorable could be characterized as the cases when the positions of the rectangular openings are such that the angles between the lines of attack of the tensioning forces and the x axis are $\alpha = 0^\circ$ and $\alpha = 30^\circ$.

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