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A REVIEW ON ANALYSIS OF STRESS CONCENTRATION FACTOR FOR PLATE

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ABSTRACT

The stress concentration factors are widely used to predict the maximum stress value above which the mechanical structure can be destroyed, thus the two most common occurrence of stress concentrations are due to discontinuities in continuum and contact forces. Many chart data of those factors are available in literature but they are conditioned by the structure shape and the principal geometric dimensions, for thin plate with eccentric hole, the stress Concentration factors values calculated by classical formulas given in ulterior studies and a numerical simulation using commercial software. The effects of the relative hole position in the plate and the various geometric properties are examined and reviewed in this article. Also various theories and experimental results and its effect are also noticed in terms of stress concentration factor.

Keywords*: Square Plate, Relative hole position, Stress Concentration Factor (SCF).*

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1. INTRODUCTION

A stress concentration (often called stress raisers or stress risers) is a location in an object where stress is concentrated. The plates with discontinuities like circular or elliptic holes exist in all metal structures. Those areas represent dangerous zones because of the multiplication of the stresses values under the effect of the stress concentration phenomenon. These stress concentration zones are often areas of crack initiation. They can be dangerous if the loading conditions allow the brutal propagation of the cracks and than promote the rupture. The values of this factor are calculated using analytical approaches based on the stress and deformation distributions evaluation around the discontinuity or by numerical models or also by experimental studies using the photo-elasticity method. The results of these investigations are resumed in curves according to the structure geometry dimensions.

2. LITERATURE REVIEW

The immense literature review has been done on analysis of stress concentration on a plate by considering hole position, materials for plate and applied load.

Analytical solutions for the three-dimensional stress distribution around typical stress concentrators in an isotropic plate of arbitrary thickness has been studied which based on generalized plane-strain theory, assuming that thickness extensional strain is uniform in the thickness direction. Emphasis has been carried out and important results are presented on the effects of the plate thickness. By extending the theoretical method to a plate with a non-circular notch, an approximate solution has been obtained for the through-the-thickness constraint factor in a plate with a V-shaped notch having a circular tip and another finite element analysis had been done and the same results was validated by comparing the FEM an analytical solution [1].

Another research on the three- dimensional stress distribution in terms of notch fatigue assessment had been carried out experimentally and obtained results shows that for certain types of 3D stress concentration, fatigue prediction methods give highly conservative results in comparison with all other traditional methods and

also applied to methods using elastic–plastic analysis as well as linear-elastic approaches and obtained result shows the main reason for stress distribution which is the physical geometry of the stress concentration feature rather than any special properties of welded joints and their heat affected zones [2].

Further Detailed numerical investigations of the three-dimensional effects of maximum stress concentration at elliptic holes in finite thickness piezoelectric plates in comparison with metallic materials in the three-dimensional (3D) stress concentration factors (SCFs) and the planar SCFs had been carried out. Study include an elliptic hole in finite thickness piezoelectric plates Were subjected to uniaxial far-field tensile stress and applied electric field were conducted using 3D finite element method and very Large range of elliptical shape factor t (from0.01 to 1) and ratio of plate thickness to root radius of the hole B/r (from1 to 100,000) were considered and proved that three-dimensional effects can be much stronger in piezoelectric ceramics than in conventional methods [3].

Crack developed in various shapes and the reason behind crack development had been hypothesized in the current article in comparison with 2D and 3D, a method has been developed for assessing crack shape effect, leading to a correction factor which reduces the errors in the fatigue limit predictions. Development of new approach of fatigue limit in notched specimen was successfully predicted. Also using fatigue assessment method, it was concluded that crack shape can have an effect on the fatigue life of sharp, crack-like stress concentrations, for which the fatigue limit is characterized by the growth of non-propagating cracks [4].

Stress concentration factor (SCF) and deflection in isotropic, orthotropic and laminated Composite plates under different transverse static loading condition was studied using finite element analysis method considering D/A ratio (where D is hole diameter and A is plate width). Graphical form of the variations of SCF and deflection with respect to D/A ratio had been presented using ANSYS package considering three different boundary conditions with central circular hole under transverse static loading. Obtained results shows that the stress concentration for all stresses occurred more in plate with loading at boundary of hole than uniformly distributed loading for respective boundary condition and type of plate [5].

3D finite element method was adopted in order to examine elastic stress and strain fields of finite thickness large plate containing a hole subjected to uniaxial tension. Simultaneously the sensitivity of the stress and strain concentration factor to plate thickness as well as the Poisson's ratio was examined by comparing 2D field in terms of the stress concentration factor and the strain concentration factor. Lastly it was also pointed that magnitude of stress concentration factors larger than the one of strain concentration factor in the same plate [6].

The elastic deformation and quasi-brittle fracture of plate components was reviewed in this article in terms of recent analytical efforts, numerical and experimental studies including V-shaped notched plates and plates with through-the thickness cracks. Also paper was briefly outline the first-order plate theory by Kane and Mindlin and some analytical solutions obtained within this theory. In addition to this location of fracture initiation of notched components was found to be close to the mid-plane for the symmetric loading and moves closer to the free planes for the anti-symmetric loading was concluded from this analytical solution [7].

Using three dimensional finite element method(3D FEM) the through-thickness variations of stress and strain concentration factors for plate with small central notch, circular notch or double U-notch, subjected to uni-axial and biaxial loading have been systematically analyzed. Obtained results proved that the stress and strain concentration factors increase with decreasing the biaxial ratio at the plate interior, while, the opposite trend was found at the plate surface [8].

Dynamic photo-elastic system was the new approach in addition to the Finite Element Method (FEM) which was used for static loading in order to analyse Dynamic Stress Concentrations. Researcher considered two-dimensional finite element model for the falling disk and the strut. Obtained results in this article are much closed to that of experimental methodology giving the superior solution in terms of analytical method [9].

In addition of metal plates a current research also includes stress concentration at weld toes or weld roots as severe variation of the shapes near the weld. To study this phenomenon new A stress intensity factor (SIF) equation was developed in this research by combining the Yamada and Hirt iterative procedure which was verified by comparing with experimental data of a semi-elliptical surface crack within a finite width and thickness in a flat plate which gives right direction to the fatigue limit of welded joint [10].

Analysis of the stress concentration factors around a circular hole in an infinite plate subjected to uniform biaxial tension and pure shear which was influenced by the effect of non-homogeneous stiffness and varying Poisson's ratio was studied in the current study for uni-axial tension. An exponential function has been used to model the spatial variation of the elastic properties. Finally obtained results permits to increased the stiffness very satisfactory [11].

Paper proposed new software based on simple language module in order to study stress concentration factor. Proposed software is made less expensive which reduces the expensive software's used to analyze the concentration factor. Software developed named AlfaK software. This will go in direction of enabling automatic optimization of stress concentration factor by adding additional shoulders, fillet, holes etc in future giving near about 100% accuracy in solution of stress concentration factor [12].

Deforming the bus structure using DIC equipment measure and characterization of the strain concentration factor (SCF) of welded junctions was carried out. From the results it is found that SCF was characterized as function of load type and level. Article methodology is valid for any type of junction of the structure of the LPTV in terms of structural design point of view [13].

An elliptic hole in unidirectional functionally graded material (UDFGM) plates was studied under uniaxial and biaxial loads using ANSYS Parametric Design Language (APDL) in order to modeled Stress concentration factors (SCFs) in this article. Models were very efficient and well verified to estimate the hole effect on plate structures made of functionally graded materials. Research models in futures become tool for the designers to analyze the stress concentration problem under uniaxial or biaxial loading conditions [14].

Recently in addition to the metals, semiconductor materials are also analyzed using the finite element theory for the concentration factor. Same study was carried out in this research article in terms of failure of silicon chips during thinning and machining process caused by stress concentration factor. The methodology was simply providing nano-notch at the chip. Results were very predictable showing that using this nano notch stress concentration factor was reduced up to 40%. Thus this nano-notched is very useful for improving material properties in terms of stress concentration factor [15].

3. CONCLUSION

The calculation of stress concentration factor is largely treated in the literature, but the obtained results remain valid for the treated cases and cannot be always generalized. This study shows that the conventional literature formulas do not give the same values obtained by finite element analysis. Knowing the high stress concentration and it's location around hole is a practical importance in designing engineering structure. In designing the perforated plate, effective parameter can be selected in order to achieve minimum stress concentration factor.

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