UNIVERSITI TEKNIKAL MALAYSIA MELAKA

VALIDATION OF STRESS CONCENTRATION FACTOR IN PERFORATED PLATES USING FINITE ELEMENT SOFTWARE

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A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Maintenance) with Honours

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2023

DECLARATION

I declare that this Choose an item. entitled "Validation Of Stress Concentration Factor In Perforated Plates Using Finite Element Software" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : Mugilarasan A/L Subramaniam

Date : 11/01/2023

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Maintenance) with Honours.

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Date : 11/02/2023

DEDICATION

I'd want to thank my close friends and family for their support during this journey. I would want to extend my deepest gratitude to both of my parents and to all of my siblings.
In addition, I would like to dedicate my dissertation to the many people who have supported me during this process, as well as to my adviser, Mr. Setyamatana Parman. I will always be grateful for what they have done.

ABSTRACT

This thesis presents the validation of stress concentration factor in perforated plates using finite element software. The plate that changes its width will have a high stress at the location of the shape changing. The ratio of the highest stress that occurs to the nominal stress that occurs is termed the stress concentration factor. In this project, the finite element software will be tested for its ability to provide results in accordance with engineering charts that are already to provide results in accordance with engineering charts that are already available and are widely used by current reference. The simulation was run in two finite element software this is solidwork and inventor. To prove the accuracy there have some calculation from existing chart like pick nine point from existing chart and find the radius of fillet area to get stress concentration. They have two different modal used to simulate that is I and T plates. I have studied the FEA in two different software. The simulation run for get FEA data and make comparison between finite element software and prove the accuracy of data between existing chart and finite element software.

ABSTRAK

Tesis ini membentangkan pengesahan faktor kepekatan tegasan dalam plat berlubang menggunakan perisian unsur terhingga. Plat yang menukar lebarnya akan mempunyai tekanan yang tinggi di lokasi perubahan bentuk. Nisbah tegasan tertinggi yang berlaku kepada tegasan nominal yang berlaku dinamakan faktor kepekatan tegasan. Dalam projek ini, perisian elemen terhingga akan diuji keupayaannya untuk memberikan hasil mengikut carta kejuruteraan yang telah pun memberikan hasil mengikut carta kejuruteraan yang sedia ada dan digunakan secara meluas oleh rujukan semasa. Simulasi dijalankan dalam dua perisian elemen terhingga iaitu solidwork dan inventor. Untuk membuktikan ketepatan terdapat beberapa pengiraan daripada carta sedia ada seperti pilih sembilan mata daripada carta sedia ada dan cari jejari kawasan isi untuk mendapatkan kepekatan tegasan. Mereka mempunyai dua modal berbeza yang digunakan untuk mensimulasikan iaitu plat I dan T. Saya telah mempelajari FEA dalam dua perisian yang berbeza. Simulasi dijalankan untuk mendapatkan data FEA dan membuat perbandingan antara perisian elemen terhingga dan membuktikan ketepatan data antara carta sedia ada dan perisian elemen terhingga.

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Dr. SETYAMARTANA PARMAN, from the Faculty of Mechanical and Manufacturing Engineering Technology at Universiti Teknologi Malaysia Melaka, has my deepest gratitude for his assistance, counsel, and motivation. His steadfast patience in mentoring and imparting invaluable insights will be remembered forever.

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P	-	Pressure
psi	-	Pounds per square inch
F	-	force
P	-	Density
K	-	Stress intensity factor
m	-	mass
r	-	radius
d	-	diameter

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CHAPTER 1

INTRODUCTION

1.1 Background

The biggest problem facing engineers in developing nations is being able to obtain expensive computer packages. A majority of the time, engineering software packages such as CAD/CAM/CAE systems are too expensive for smaller private companies or universities. Moreover, computers can be effectively used to solve characteristics engineering problems, but most of the time engineers must purchase costly software packages to solve them. Solving them involves the purchasing of a costly software programmer.

Stress concentration is one of these issues, which is generated by unexpected changes in the shape of machine parts. Software such as ANSYS, CATIA V5, and Solid Works may be used to analysis stress concentration during the design phase of machine parts. This programmer is based on a number of numerical methods (Finite element method FEM). The software mentioned above is quite expensive, and purchasing it just for the purpose of stress concentration study is not cost effective. Because the engineer must manually determine value from diagrams, the analysis utilizing experimentally obtained diagrams is relatively inaccurate.

Based on the findings of my research study on the stress concentration factor utilizing the Solid Works program, which makes it possible to simply calculate or confirm the theory using the current graph, my conclusions are as follows: An abrupt alteration in the geometry of a body causes it to accrue tension, which in turn causes stress concentration. In addition, cracks, sharp corners, holes, and a reduction in the cross-sectional area of the body may all produce an abrupt change in the geometry of the body, which can lead to an increase in the localised stress around these fractures, sharp corners, holes, and reduced cross-sectional areas. When there is a greater amount of stress, the body has a greater propensity to break down as a consequence. Therefore, in order to prevent a body from failing, it is essential to either completely avoid or significantly lower the concentration of stress.

1.2 Problem Statement

In today's world, it is difficult to find software developed exclusively for stress concentration analysis. The majority of engineers use a module that's developed in Microsoft Office Excel. An independent software package that is simple and precise for the analysis of stress concentrations is being developed. By using Solid Works software, engineers should be able to quickly find the stress concentration factor for machine elements that change in shape.

Additionally, a stress concentration is known as a stress riser or raiser when the degree of stress is much greater than in the nearby area. The irregularities in the geometry or material of a component structure that obstruct the stress flow are what lead to the stress concentrations. In addition, these interruptions are often brought on by discontinuities like holes, grooves, notches, and fillets. Stress levels may also rise as a result of accidental harm, such as nicks and scratches.

1.3 Research Objective

a) To model and simulate the stresses in flat plates using finite element software's

- This study aims to prove that solid work software can identify data between chart and simulation easily and accurately.

b) To calculate stress concentration factors based on the results of finite element software.

- The objective is to solve a specific engineering problem by using solid work software for the stress concentration factor.

c) Comparing results of solidwork, inventor and exist chart.

- The objective is to compare data between solidwork, inventor and exist chart for know which software are better for FEA.

1.4 Scope of Research

The scope of this research are as follows:

- To design the perforated plate using finite element software.
- To show that data between charts and simulations (solid work) must be precise.
- To show that solid work software may be used to determine stress concentration factors.
- To show that stress concentration factor based on the use of Solid Works software that can quickly establish or verify the theory based on the current graph.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The goal of this literature review is to learn anything that will help me with my thesis. To complete this study, some research on this title was conducted in order to acquire some insight. This chapter looks at past initiatives or research into themes connected to this project that can help you lead it in the right direction. This section also includes many perspectives and strategies related to the project. This chapter is often known as the contextual analysis part, because it contains new ideas and plans from earlier projects. Looking through websites, papers, conferences, reference books, and any other publications linked to this subject finished the literature review. It will also go over extra information gathered in order to figure out the best strategy for this project.

2.2 Stress Concentration Factor

Due to an oversimplification of the real weld geometry, the existing parametric equations for calculating the notch stress concentration factor of fillet welds frequently result in reduced accuracy. The current study suggests a parametric method for evaluating the notch SCF based on the spline weld model, which provides a better approximation of the fillet weld's true shape. Under varied loading situations, the spline model was used in FE analyses on T-shape joints and rectangular bar models to suggest a parametric method for the determination of the SCF via regression analysis. Furthermore, the accuracy of parametric equations based on the line model was investigated. The probability distribution was used to examine the magnitude of the stress concentration. When the weld profile is factored into the equation, the results show that the line model is insufficient to compute the SCF of a fillet weld. According to the testing data system, the inaccuracy of the SCF using the provided parametric equations is less than 5%. If the confidence interval of 95 percent survival probability is used, the stress concentration of cruciform joints under tensile stress indicates the worst case scenario.(Yixun Wang 17 2020). It is considered the stress concentration factor around a circular hole in an infinite plate subjected to uniform biaxial tension and pure shear. The plate is built of a functionally graded material with radial variations in Young's modulus and Poisson's ratio. The governing differential equation for the stress function is generated and solved for plane stress situations. In the case of biaxial tension, a general form for the stress concentration factor is described. The stress concentration factor for pure shear is derived using a modulo series solution. By adding these two modes, the stress concentration factor for uniaxial tension is derived. Marine and aerospace structures frequently use thin plates. Different types of holes or openings are typically drilled into the plates for practical purposes such as reducing the system's weight and allowing access to system equipment. Due to the presence of holes or slots, large stresses are produced around holes or openings when a plate is exposed to tension or shear loading. Many scholars are concerned about the stress concentration problem of a plate with a hole, which must be considered in structure design. (zuxing pan , 2013) . Local stress concentration, which occurs around holes, cracks, undercuts, angular depression in the material, and flanges, is one of the causes of fatigue fracture creation and development. The subject of stress state analysis in plates or discs with holes and slots has been addressed using a variety of analytical, experimental, and numerical methods. Near variations in the section of a loaded structural component or machine element produce stress distributions in which the peak stress achieves substantially bigger magnitudes than the average stress over the section, according to mathematical analysis, experimental measurement, and numerical analysis. Stress concentration is the increase in peak stress near holes, grooves, notches, sharp corners, faults, and other changes in section. The section variation that causes the stress concentration is referred to as a stress raiser. Under longitudinal compression, an isotropic plate with a centrally positioned hole (circular hole, elliptical slot, flat slot) has found broad uses in aircraft, marine, car, and mechanical engineering. Accurate understanding of deflection, tensions, and stress concentration is necessary for the design of plates with holes. Any rapid change in the geometry of the plate under load causes stress concentration. As a result, stress distribution over the cross section is not uniform. Fatigue cracking and plastic deformation are common failures that occur at stress concentration locations.

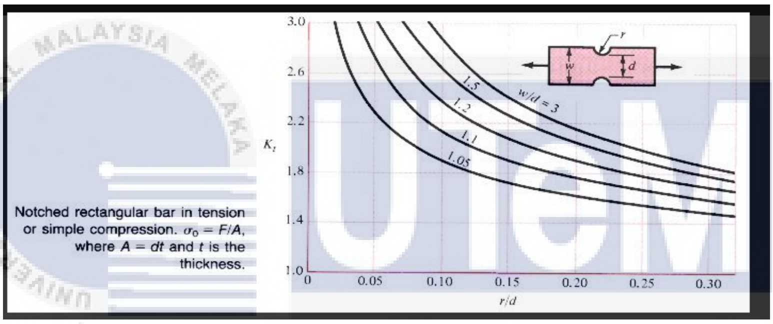

Figure 2-1 stress concentration chart of flat plate (I)

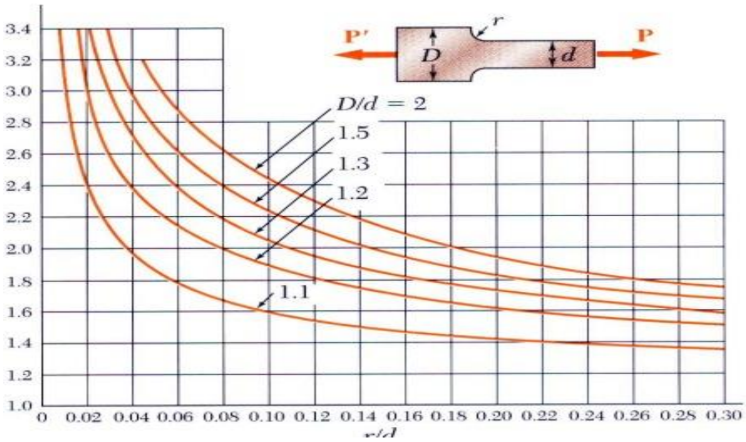

Figure 2-2 stress concentration chart of flat plate (T)

2.3 Stress Concentration Factor for Flat Plates

The maximum stress will occur at this position in a structure or machine part with a notch or any sudden change in cross section, and it will be larger than the stress calculated using simple methods based on basic assumptions about the stress distribution. The stress-concentration factor Kt is the ratio of this maximal stress to the nominal stress (calculated using fundamental formulas). This is a geometrical constant that is unaffected by the material, as long as it is isotopic. The stress-concentration factor can be calculated experimentally or theoretically using the mathematical theory of elasticity in specific instances. (Rou Li, 20 April 2020).

2.3.1 Flat plate with semi circular fillets and grooves or with holes. I, II and III are in tension or compression; IV and V are in bending.

The factors depicted in the figure above were determined using both photo elastic tests and elasticity theory. Brittle materials will fail due to stress concentration if the concentrated stress is greater than the ultimate strength of the material. In ductile materials, concentrated stresses higher than the yield strength will generally cause local plastic deformation and redistribution of stresses (rendering them more uniform) (rendering them more uniform). Areas of stress concentration, on the other hand, can be sites of fatigue even in ductile materials if the component is cyclically loaded.

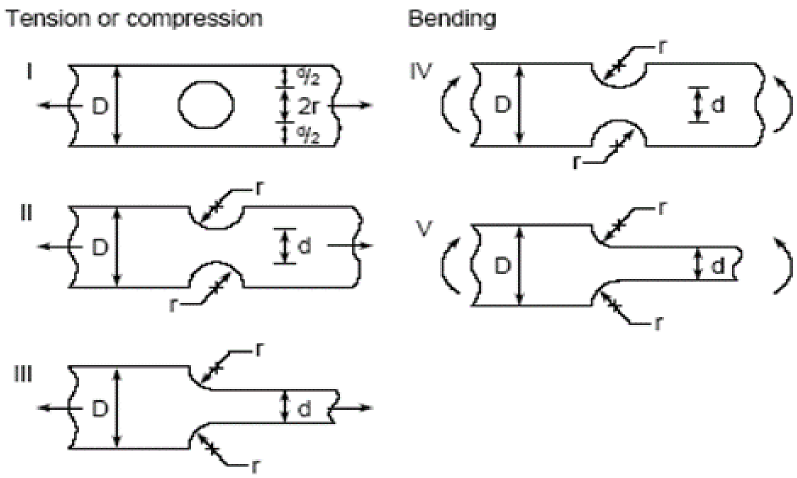

Figure 2-3 Flat plate with semi circular fillets

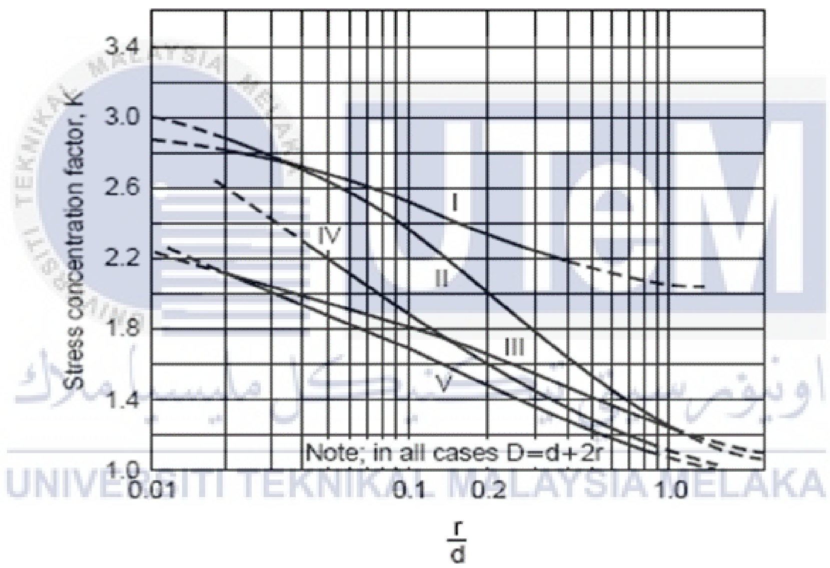

Figure 2-4 stress concentration chart for all perforated plates

2.3.2 Flat plate stress concentration factors with grooves, in tension.

The stress concentration factor, Kc, is a relationship between the maximum stress that actually happens and the expected average stress. It is determined experimentally or analytically and then presented as graphs for easy interpretation. The stress concentrators are