RELIABILITY OF INDIRECT TENSILE STRENGTH TEST ON HOMOGENOUS MATERIAL USING FINITE ELEMENT METHOD

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Dedicated to my beloved grandfather, grandmother, parents, cousins and friends, for their endless support and prayers

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ABSTRACT

The difficulties associated with performing a direct tensile test on a rock specimen have led to a number of indirect methods for assessing the tensile strength. This study focuses on the influence of the contact area between loading plates and the sample on the stress distribution, deformations and cracks initiation within homogenous material (Acrylic) disc samples subjected to indirect tensile loading by Brazilian testing with flattened plates. Finite element software of RS2 from Rocscience was utilized to simulate the condition and compared with the laboratory testing to generate gain in depth understanding of the Brazilian test. The analysis showed that the indirect tensile strength dramatically decreased as the contact area increased. Furthermore, from the simulation work, it is observed that cracks initiates as points near to the loading plates rather than centre, this condition occurred due to the induced shear stresses initiate near the flattened loading plates.

ABSTRAK

Masalah yang berkaitan dengan ujikaji tegangan langsung ke atas spesimen batu telah membawa kepada beberapa kaedah tidak langsung untuk menilai kekuatan tegangan. Kajian ini memberi tumpuan kepada pengaruh kawasan sentuhan antara beban plat dan sampel pada agihan tegasan, anjakan dan permulaan retakan dalam bahan homogenus sampel iaitu akrilik. Sampel yang berbentuk cakera ini tertakluk kepada beban tegangan tidak langsung dengan menggunakan ujian Brazilian dengan plat rata. Perisian kaedah unsur terhingga, RS^2 dari Rocscience telah digunakan dalam simulasi dan kemudiannya dibandingkan dengan ujian makmal untuk menjana pemahaman yang mendalam bagi kaedah ujikaji Brazilian. Hasil analisis menunjukkan bahawa kekuatan tegangan tidak langsung menurun secara dramatik apabila kawasan sentuhan meningkat. Hasil simulasi juga membuktikan bahawa retakan bermula berhampiran dengan beban plat dan bukannya dari pusat sampel, keadaan ini berlaku disebabkan oleh tegasan ricih di mana tegasan bermula berhampiran dengan plat beban yang berbentuk rata.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The last two decades have seen a growing trend towards the construction of tunnels in civil infrastructures. However the tensile strength of rocks has a pivotal role in controlling the failure of tunnels roofs because rocks are much weaker in tension than in compression.

A rock's tensile strength is much less than its compressive strength, so rock breakage in rock engineering is mainly caused by the relatively low tensile strength and hence attention has been paid to the methods for measuring the tensile strength of rock. However, the tensile strength is usually measured in an indirect way, rather than directly, because of difficulties in implementing the direct tensile strength test. Furthermore, the tensile strength is a key parameter for determining the load bearing capacity of rocks, their deformation, damage and fracturing, crushing, etc., and is used to analyse the stability and serviceability of rock structures. Therefore, tensile strength is frequently used as key input parameter in many applications in civil engineering, mining and petroleum engineering.

There are many risks that need to be mitigated/minimized in tunnels design due to the complex geological conditions, uncertainties and difficulties in determining in advance the actual geology and the behaviour of geotechnical structures.

1.2 Problem Statement

Brazilian test has been practised in obtaining the tensile strength of the rock indirectly. Stress and deformability undergo during the test reflected by the total contact area between the sample and loading platen. This study is essential in understanding the deformation behaviour of homogenous material under tension. Analytical study shows that the tensile stress generated near the loading plates is influenced by the contact area between the loading plates and the specimen in diametrical compression test (Tsutsumi, 2010), a verification on the physical model and numerical simulation will gain in depth understanding of this simple Brazlian test.

1.3 Research Aim and Objectives

The aim of this study is to assess the reliability of tensile strength obtained from diametrical compression test on homogenous material (Acrylic). The objectives of the study are as follows:

1. To understand the mechanics of tensile stress under Brazilian test.

2. To perform the Brazilian test on Acrylic with different contact areas of 0%, 4% and 8%.
3. To generate numerical modelling of Brazilian test in finite element model of RS^2 in order to study the stress/ strain distribution and cracks evolution inside the Acrylic sample model.

1.4 Scope of Study

The scope of this study will include aspects as below:

1. The laboratory tests that will be conducted are; Density test, UCT and Brazilian Test with different contact areas.
2. Testing will be carried out on artificial homogenous material of acrylic.
3. Results obtained will be used to create a model using FEM software to study the stress/strain distribution and cracks evolution inside the Acrylic sample.

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