UNIVERSITI TEKNIKAL MALAYSIA MELAKA

STUDY OF COMBINED LOAD ON THE BUCKLING BEHAVIOUR OF CONE-CYLINDER TRANSITION

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive) with Honours.

By

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive) with Honours. The member of the supervisory is as follow:

Signature: ……………………………………………….

Supervisor: DR OLAWALE IFAYEFUNMI

ABSTRAK

Penyelidikan ini bertujuan untuk mengkaji beban gabungan pada tingkah laku tenggelam peralihan kon silinder yang dikenakan kepada mampatan paksi dan mampatan haba. Kerja-kerja penyelidikan ini melibatkan dua belas sampel peralihan kon silinder dengan kes-kes yang berbeza yang dibuat menggunakan lembaran keluli ringan 1mm. Perisian SolidWorks digunakan untuk menarik model kon dan silinder dalam lukisan 2D. Lukisan itu diimport ke perisian FlowPath manakala mesin jet air digunakan untuk memotong lembaran keluli ringan ke dalam dua belas sampel kon dan silinder. Dua belas sampel telah menjalani proses rolling dan kimpalan untuk membentuk peralihan silinder. Ujian mampatan paksi dan pemampatan haba pada dua belas peralihan kon silinder dilakukan menggunakan mesin ujian sejagat. Kajian yang dilakukan adalah untuk membandingkan hasil percubaan dan berangka. Dua spesimen dengan setiap kes telah direka untuk memastikan kebolehulangan data yang diperoleh. Data hasil pada beban gabungan pada tingkah laku peralihan kon silinder dibentangkan dalam laporan ini. Keputusan eksperimen menunjukkan bahawa peningkatan suhu akan mengurangkan kekuatan silinder kon dari gesper.

ABSTRACT

This research aims to study the combined load on the buckling behaviour of cone-cylinder transition subjected to axial compression and thermal compression. This research work involves twelve samples of cone-cylinder transition with different cases that were fabricated using 1mm mild steel sheet. SolidWorks software was used to draw the model of cone and cylinder in 2D drawing. The drawing was imported to the FlowPath software while water-jet machine was used to cut the mild steel sheet into twelve samples of cone and cylinder. The twelve samples were undergone rolling and welding processes to form cone-cylinder transition. Axial compression test and thermal compression on twelve cone-cylinder transition were done using universal testing machine. The research conducted was to compare experimental and numerical results. Two specimens with each case were fabricated to ensure the repeatability of data obtained. The results data on the combined load on the buckling behaviour of cone-cylinder transition were presented in this report. The experiment results indicated that the increasing of temperature will reduce the strength of the cone-cylinder from buckle.

DEDICATION

This report is dedicated to my beloved parents, my siblings and my friends, who always support me during this final year project work. Last but not least, my final year report group mates who were always with me to complete my final year project research.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF SYMBOLS

d	-	Diameter
F_{cyl}	-	Elastic Critical Buckling Load of Cylinder
E	-	Young Modulus
v	-	Poisson's Ratio
t	-	Wall Thickness
r	-	Radius
N	-	Rotational velocity
P	-	Pressure
Q	-	Volumetric flow-rate
r	-	Radius

LIST OF ABBREVIATIONS

UTeM	Universiti Teknikal Malaysia Melaka
MAG	Metal Active Gas
MIG	Metal Inert Gas
CNC	Computerized Numerical Control

CHAPTER 1

INTRODUCTION

1.1 Background

Cone-cylinder shells are used widely as pressure vessels for ocean engineering and chemical engineering. The local stresses of the intersection between the cone and the cylinder for this sort of shell subjected to hydrostatic pressure will be much higher than those in other parts of the shell and can lead to damage (Anwen, 1998).

One of the major failure phenomenon of conical shells is buckling. When in use, it may be influenced by the type of applied load, material properties of the shell and imperfections in construction. Rolling and construction-induced imperfections give the direct effect to the conical structures proved through the investigation of buckling behavior towards conical shells (Golzan & Showkati, 2008).

Thermal buckling is other problem when involving aerospace. When the hypersonic vehicles accelerate at high speeds in the atmosphere, shocks sweep across the vehicle interacting with local shocks and boundary layers and expose structural surfaces to severe local pressures and heat fluxes (Thornton, 1993).

1.2 Statement of the Purpose

The purpose of the research is to investigate the influence of combined load on the buckling behaviour of cone-cylinder transition with different height of cylinder and thermal buckling.

1.3 Problem Statement

Generally, thin shell can withstand very high buckling loads and this property has proved that it is an efficient structure. The buckling heights were found to be proportional to thickness raised to the power of approximately 1.5, compared to 1.0 as in the classical theory. Moreover, the Figure 1.1 shows the distribution of buckling test data for cylinders with closed ends subjected to axial compression, from Brush and Almroth (1975). Thus, an investigation involving different height of cylinder must be carried out to identify the buckling strength.

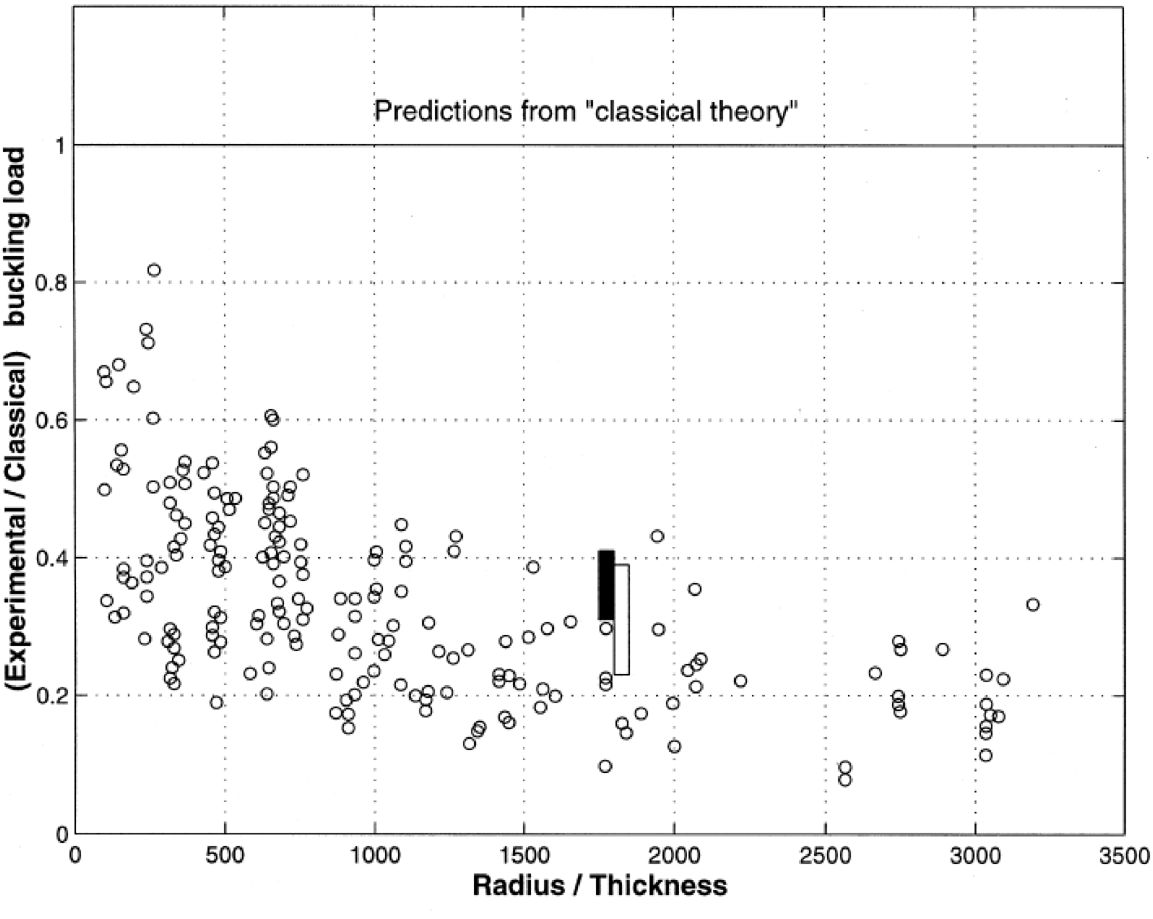

Figure 1.1 Distribution of buckling test data (Brush and Almroth, 1975)

In one case, the temperature varies along the generator and the conical shell is restricted completely at both ends. In the other case, the temperature changes in two principal directions and the cone is constrained along the perimeter, but free of resultant longitudinal force at boundaries (Chang and Lu, 1967). However, the aircraft nacelle should provide some crucial function as it used to protect internal compartment from lightning, engine noise reduction, good aerodynamics, landing or taking off. The engine nacelle must not only protect the engine, but also isolate the plane of the engine (Bennouna & Langlois, 2012). In addition, a reduction in noise level occurs if the mixing rate is accelerated or if the velocity of the exhaust jet relative to the atmosphere is reduced by changing the pattern of the exhaust jet (Soares, 2015).

1.4 Objectives

The objectives for this study are:

1. To design and fabricate the mild steel cylindrical shells with different height and conical shells.
2. To investigate the influence of different height on the buckling behavior for the axially compressed mild steel cone-cylinder.
3. To investigate the effect of thermal buckling behavior for the axially compressed mild steel cone-cylinder.
4. To validate the experimental results after the compression by using numerical analysis.

1.5 Scope

This research is conducted to examine the influence of different height cylinder with same dimension of cone. The material that used to be designed and fabricated are 1mm mild steel plate.

Each of the sample will be made with extra one piece to get high accuracy of experimental data. For the buckling of different height of the cylinder, there are six cones with same dimension and six cylinders with three different height. The thermal buckling also has six sample but with same dimension of cone and cylinder.

The dimensions of the specimens will be sketched using SolidWork software to avoid material wastage before fabrication. After finishing with the drawing, waterjet machine is used to cut all the specimen. The drawings were ensured to meet the format that is used in the water jet machine to make sure there are no wrong cutting of shell. After that, the fabrication continued with rolling and welding.

Last step of this experiment is by testing all sample. The results were recorded and analyzed. ABAQUS analysis was used to analyze the buckling strength of specimens. A comparison between experimental results and theoretical calculations was conducted at the end of the process.