UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION OF BUCKLING BEHAVIOUR OF AXIALLY COMPRESSED CYLINDER WITH UNEVEN LENGTH HAVING TRIANGULAR WAVES

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

Kajian ini bertujuan untuk menyiasat kesan panjang yang tidak sempurna pada kelakuan gelang silinder shell yang mempunyai bentuk ombak segi tiga. Tujuh belas keluli ringan silinder dihasilkan dengan panjang gelombang tidak sempurna yang berterusan, 2A = 0.56. Semua sampel dibuat dengan plat keluli ringan 1mm dan dipotong dengan menggunakan mesin laser jet. Semua sampel silinder telah diuji di bawah mampatan paksi. Beban runtuh telah disahkan dengan membandingkan hasil percubaan dan hasil berangka. Dalam projek ini, semua hasil menunjukkan peratusan perbezaan kecil yang hampir sama, yang kurang daripada 10 peratus antara keputusan percubaan dan berangka. Keputusan ini dapat disahkan dengan membandingkan graf dan bentuk cacat. Dari hasilnya, dapat disimpulkan bahwa beban runtuh menurun seiring dengan peningkatan jumlah gelombang.

ABSTRACT

This research aims to investigate the effect of imperfect length on the buckling behaviour of cylindrical shell having triangular waves. Seventeen mild steel cylinders were manufactured with a constant imperfect wavelength, 2A = 0.56. All of the samples were manufactured with 1mm mild steel plate and were cut using laser jet machine. Next, the cylindrical samples were all tested under axial compression. The collapse loads of all samples were validated by comparing the experimental results and the numerical results. In this project, all of the results show a small difference percentage of similarity, which is less than 10 percent between the experimental and numerical results. These results can be validated comparing the load versus displacement plot and the deformed shapes. From the results, it can be concluded that the collapsed load decreases as the number of waves increases.

DEDICATION

This report I dedicate to my beloved parents, Fatimah Binti Mohd Affandi, Zulkefli bin Abd Rahman and Shahril Anuar. Also dedicate to my little brother, cats and friends who always support me during this final year project process. In addition, my final year group mates, who always help, guide and assists me to complete my final year project investigation.

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LIST OF SYMBOLS

Fcyl	-	Elastic Critical Buckling Load of Cylinder
E	-	Young Modulus
v	-	Poisson's Ratio
t	-	Wall Thickness
Fref	-	References Buckling Load to Cause Yield
D	-	Diameter of Cylinder
σ_{yp}	-	Yield Stress
2A	-	Amplitude of Waves

LIST OF ABBREVIATIONS

SPLA	Single Perturbation Load Approach
DESICOS	New Robust Design Guideline for Imperfection Sensitive Composite Launcher Structures
SGI	Seeded Geometric Imperfection
DXF	Drawing Exchange Format
MIG	Metal Inert Gas

LIST OF PUBLICATION

1. Ifayefunmi, O., Zulkefli N.A., 2019. Buckling of Cylinder with Uneven Length Subjected to Axial Compression, Proceeding of the International Offshore and Polar Engineering Conference, ISOPE-2019, Honululu, Hawaii, June 16-21 (Abstract Accepted).

CHAPTER 1

INTRODUCTION

1.1 Background

Thin walled cylindrical shell are widely used in the industries such as aerospace and nuclear power. In many situations, the thin walled cylindrical shells structures are subject to high speed wind and hydrostatic or hydrodynamic loads which might fluctuate with time and trigger instabilities in these structures (Kumar et. al, 2015). Thin walled cylindrical shells always use rings or stringer to increase the stiffness effectively (Zhou, 2012). The properties of shell structures included the efficiency of load carrying behaviors, high stiffness and aesthetic value (Guo & Zheng, 2018).

The applications of cylindrical shells in various industries is because the circular cylindrical shell combine light weight with high strength. This pros of the cylindrical shell also make they widely used in the most branches of engineering technologies (Aghajari et. al, 2006). Customarily, people usually use a cylindrical shell in real life. The cylindrical segments are interfaced to make a prime load bearing structure in many situations. For example, when the type of load is axial compression, the relation between two neighboring cylindrical segments becomes a key point (Blachut, 2015).

Thus, cylindrical shell nature of elastic stability under fundamentals loads of uniform axial compression, external pressure and torsion is strongly controlled by its length (Fajuyitan et. al, 2018). However, the buckling load of circular cylindrical shells subjected to axial compression is extremely sensitive to even very small geometric imperfections (Brush and Almroth, 1975).

The geometric imperfections would affect the buckling and post buckling behavior of cylindrical shell structure. Experimental studies show that the buckling strength of ideal shells without geometric imperfections is much more than that of imperfect shells. Therefore, the highly imperfections sensitivity behavior of these structures must be counted carefully and properly (Aghajari et. al, 2006). Cylindrical shells have been relatively less used since they require more rigorous modelling and, more importantly, because of their high sensitivity to imperfections. The post buckling response of cylindrical shells is difficult to predict due to the random nature of the imperfection profile (Hu and Burgueno, 2015)

Buckling is a phenomenon that has been known for centuries. Fully mature field in mechanics from the point of view of determining such critical event for avoidance in design is known as buckling. However, recognition of the positive features of buckling and post buckling response for use in smart and adaptive materials and structures began approximately 10 years ago. Such increasing interest has rekindled the popularity of studying buckling and elastic instability in general (Hu & Burgueño, 2015).

In order to investigate the effect of geometry imperfection on the buckling behavior of the cylindrical shell, numbers of experiments had been conducted. For example, a transverse device equipped with two diametrically restricted low pressure and linear contracting transducers are utilized to mount the cylindrical shell. Then, the result will be recorded and set into program. The effect of geometry imperfection could be then computed by analyzing the imperfection amplitudes and the line of power spectral density (Eglitis et. al, 2009).

From the literature study, geometric imperfections are the one that plays a main role in buckling behavior of cylindrical structures. However, there are still other factors