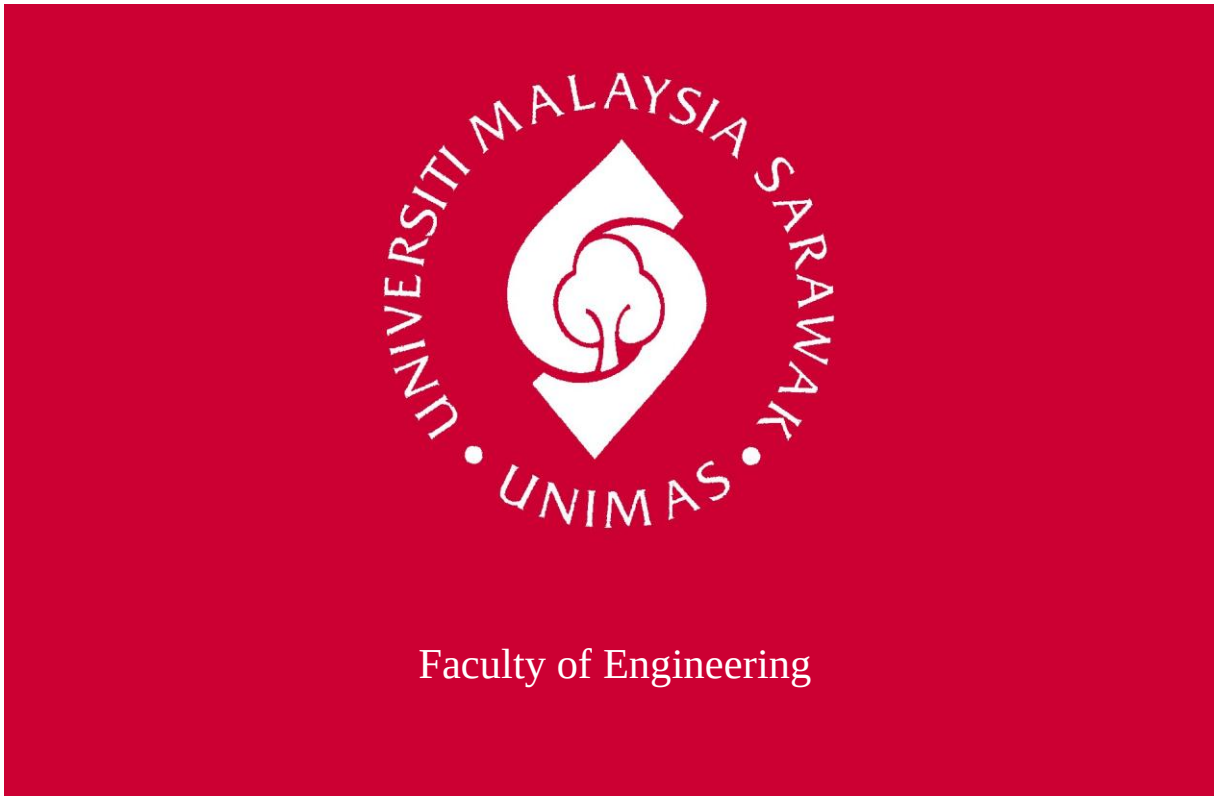

Faculty of Engineering

COMPRESSION BENDING TEST FOR PVC PIPE

Wan Abdul Aziz Bin Wan Ahmad

Bachelor of Engineering with Honours
(Mechanical and Manufacturing Engineering)
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APPROVAL SHEET

This project report, which entitled "**Compression Bending Test for PVC pipes**", was prepared by Wan Abdul Aziz Bin Wan Ahmad as a partial fulfillment for the Bachelor's Degree of Engineering with Honours (Mechanical and Manufacturing Engineering) is hereby read and approved by:

_____ _____

Associate Professor Dr. Sinin Hamdan Date

Project Supervisor

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COMPRESSION BENDING TEST FOR PVC PIPE

WAN ABDUL AZIZ BIN WAN AHMAD

Thesis is submitted to
Faculty of Engineering, Universiti Malaysia Sarawak
In Partial Fulfillment of the Requirements
For the Degree of Bachelor of Engineering
With Honours (Mechanical and Manufacturing Engineering) 2008

For my beloved family, my sweetheart and my family and my friend in Islam

May Allah bless us, gives us strength and health to fight against and destroy our enemies.

Let's prepare a higher priority of our faith with Allah toward the international campaign against Islam

Allah (SWT) blesses Mohammad (SAW), Your servant and messenger, and his family, and companions, and gives them peace. All gratitude to Allah the Lord of the Worlds

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In the name of Allah, Most Gracious and Most Merciful

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ABSTRAK

Dalam projek ini, keberkesanan bagi kaedah ujian lenduran mampatan akan di tunjukkan dan di bandingkan dengan kaedah ujian lenduran konvensional seperti ujian lenduran 3 titik. Ujian lenduran mampatan adalah kaedah ujian lenduran yang baru. Paip PVC digunakan sebagai bahan ujian dalan projek ini. PVC mempunyai kecemerlangan penentangan kepada bahan kimia melintasi kadar suhu operasi dengan tekanan operasi yang luas disebabkan oleh ciri-ciri kekuatan yang tinggi dalam jangka masa yang lama, kekenyalan yang tinggi dan kos yang effektif. Fokus utama dalam ujian lenduran mampatan adalah menilai modulus lenduran dan kekuatan lenduran. Berdasarkan keputusan yang diperolehi, keberkesanan bagi ujian lenduran mampatan dapat dibandingkan dengan ujian lenduran tiga titik. Disamping membandingkan dua kaedah ujian lenduran, projek ini juga membandingkan kekuatan lenduran dan modulus lenduran bagi paip PVC yang dihasilkan oleh dua negara yang berbeza.

ABSTRACT

In this project the superiority of the compression bending testing method will be demonstrated and compare with other conventional bending test method such as three point bending. Compression bending is a new bending test method. PVC pipe were used as the test specimen for these evaluation. PVC has excellent chemical resistance across its operating temperature range with a broad band of operating pressures due to its long term strength characteristics, high stiffness and cost effectiveness. The main focus in the compression bending test are measured the bending strength and bending modulus. Based on the result, the superiority of the compression bending test can be compared with the three point bending test. Instead of comparing this two bending test method, this project also compare the bending strength and the bending modulus of the PVC pipe that manufactured by two different countries.

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b	–	Width of test beam (mm)
d	–	Depth of tested beam (mm)
D	–	Maximum deflection of the center of the beam (mm)
E_{bc}	–	Young's modulus for compression bending (MPa)
ε_f	–	Strain in the outer surface
σ_A	–	Bending strength (MPa)
σ_f	–	Stress in outer fibers at mid-point (MPa)
L	–	Support span (mm)
δ_A	–	Deflection at the mid-span
λ	–	Crosshead movement
M_A	–	Bending moment at the mid-span A
F	–	Axial load
I	–	Moment of inertia of the section
ρ	–	Radius of curvature.
ε_t	–	Tensile strains at the outer planes
ε_c	–	Compressive strains at the outer planes
$K(p)$	–	The perfect elliptical integral of the first kind
$E(p)$	–	The perfect elliptical of the second kind

α	–	Angle of deflection at the loading point
E_b	–	Modulus of elasticity in three point bending
m	–	Slope of the tangent to the initial straight-line portion of the load deflection curve

CHAPTER 1

INTRODUCTION

1.1 History

Since the very start of mankind, men have been trying to develop materials with better characteristics than the natural products. Plastics were first developed in the 19th century. Plastics are meet practically everywhere and everyday. Alexander Parkes discovered the first plastic (cellulose nitrate) in mid 19th century. It was first introduced to the public at the Great London Exhibition in 1862 [1]. According to Burgess R.H polyvinyl chloride (PVC) has been produced commercially for 50 years but most of the expansion has taken place since the end of the 1939-45 War [2].

From it early beginning in Germany the market has grown to the present 12 millions tones per year worth £5 billion a year in turnover. It is manufactured by over 70 major companies in more than 30 countries. The growth of this large market and the involvement of many major companies have stimulated much development work over the years on the manufacturing process, on the product produced and on its subsequent fabrication. Such a large effort has led to importance advance in the

technologies employed in the processes used to produce PVC and in the ways in which it is subsequently converted to the final articles [2].

This early commercial success stimulated the development of cheap processes for the production of the monomer, vinyl chloride (VCL), initially based on the reaction of hydrochloric acid with acetylene, both material cheap to produce and readily available[2]. More recently cheaper process involving the reaction of chlorine with ethylene has been developed. It was soon realized that PVC mixtures could be used for a wide range of applications such as cable covering, raincoats, fabric coating, etc [2].

Today, plastics replace traditional materials, such as wood, metals, glass, leather, paper, rubber, because they are lighter, corrosion resistant, sturdy, and easy to process and have better insulating characteristics [1]. Therefore, the use of plastics is more economical compared to traditional materials. Plastics are found in the industry, homes, shops, schools, hospitals, cars etc. They influence the fashion and our lives [1, 3]. There are various types of plastics such as polyethylene, polypropylene and polystyrene. One of the major plastics is polyvinyl chloride known as PVC, it represents about 23% of all plastics produced and sold globally [1].

1.2 What is PVC?

Polyvinyl chloride commonly abbreviated PVC, is a widely used thermoplastic polymer [3]. PVC is a thermoplastic made of 57% chlorine (derived from salt) and 43% carbon (derived from oil / gas via ethylene) [1]. H. V. Regnault first synthetically prepared it in 1835. Its mass production was initiated in Germany 90 years later by Farbenindustrie (I.G.Farben) [1]. PVC has a special position due to its physical-chemical characteristics. There are no other plastics, which can be modified by additives to such an extent as PVC. PVC is a white powder. The powder is compounded with various additives to achieve all the unique properties of PVC. PVC can be rigid, semi-rigid or flexible. It can be clear, translucent or coloured [1]. The desired characteristics depend upon the required properties that are needed for the final applications.

The properties of PVC make it suitable in tough long-life applications. For example, PVC products used in some construction applications should have an expected “service-life” of minimum 50 years [1]. Studies show, that PVC pipes may reach a ”service-life” of 100 years in 75% of all cases, provided there is no mechanical damage. PVC products are long-life products consuming relatively low amount of energy in the course of the production and comparing favourably with most alternative products or solutions when analyzed in a Life Cycle Assessment (LCA) [1]. PVC products are furthermore non-toxic and can be recycled several times. Nonflamability, weatherability, chemical resistance, low gas permeability, rather wide processability range and low cost are the other outstanding of PVC [4].

In terms of world consumption, PVC account for approximately 24% of all plastics, with an annual volume of about 25 million tones [1].

1.3 Background study

This project addresses a compression bending test for the PVC pipes. Three and four bending tests are commonly used to evaluate the bending strength of advanced composite [5]. Although these tests are simple and easy to operate, they have some disadvantages. The primary disadvantages being the stress concentration due to the loading devices. It has been reported that the stress distribution with three and four-point bending is greatly different from the classical beam theory especially near the loading nose [5]. In order to reduce this desirable effect, a new bending method was developed by Fukuda and his colleagues for advanced composites [6].

In their method, a compression load was applied along the long axis of the specimen with a rectangular cross section. Young's modulus and bending strength were measured by means of the elastics phenomenon [6]. However the above review is applicable only for flat coupons. In the case of pipes, undesirable effects by the loading device will be more serious. In most cases the pipe will be crushed by the loading nose rather than the bending failure [7]. Therefore in current project, compression bending test method is applied to PVC pipes.

1.4 Objective of Experiment

The primary objective in this project is to measure and determine the bending modulus and bending strength of the PVC pipes by the compression bending test using the Universal Testing Machine. Another objective is to examine the applicability of the testing method by comparing it with conventional bending test methods. This study also compares the effect and strength of the pipes according to it diameter size when applied to the axial load.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this experiment the major components that need to be considered are compression bending of the PVC pipes. Compression bending test provide information about the mechanical properties of rigid PVC pipes. This experiment also compares result of 3 point bending test with the result obtained from the compression bending test.

2.2 Type of pipe system

Plastic Pressure Pipe Systems produced for the conveyance of drinking water, waste water, chemicals, heating and cooling fluids, foodstuffs, ultra-pure liquids, slurries, gases, compressed air and vacuum system applications. Plastic Pressure Pipe Systems have many advantages to offer to the designer, installer and end user of pipe systems, they are light weight, easier to install than metal piping systems, faster to install as well as being more cost effective than metal piping systems. They are used for both above and below ground applications. A well installed and well maintained

Plastic Pressure Pipe System could have a life cycle of up to 50 years. This is dependent upon the medium, temperature, chemical consistency, pressure and type of plastic pressure pipe system selected. Plastic Pressure Pipe Systems have been in use since the 1950s [8]. There are several types of plastic pressure pipes available in the market.

2.2.1 ABS (Acrylonitrile Butadiene Styrene)

ABS is suitable for the conveyance of potable water, slurries and chemicals. It's used for chilled water applications due to its low temperature properties. ABS is also suitable for use in compressed airline systems. ABS is good chemical and abrasion resistance. It's also good material strength and high pressure resistance. ABS operating temperature range is between -40°C to +80°C [8].