UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PRODUCT DEVELOPMENT OF SEMI AUTOMATIC SLUMP TEST

This report submitted in accordance with requirements of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) with Honors.

By

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APRPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) with Honors. The member of the supervisory committee is as follow:

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ABSTRACT

Concrete slump test (or simply the slump test) is an in situ test or a laboratory test used to determine and measure how hard and consistent a given sample of concrete is before curing. The concrete slump test is, in essence, a method of quality control. A higher slump concrete result means the concrete sample is not stable and a lower slump concrete result means the concrete is firm. A manual slump test is the problems that always occur when applying this method test. Inconsistent speed and lateral vibration while lifting up the cone and human error that cause the cone move in slight angular direction are the main problem that need to be counter with. This project presented is to overcome the problems occur in handling the manual concrete slump test. The aims of the project are to design and produce semi automatic slump test prototype and to analyst and test the functionality of the lifter. Several designs of semi automatic slump test were designed and the electrical motor lifter was selected. The design uses electric motor lifter to move the slump cone in proper direction as well as overcoming the problems occur in manually done slump test. This selected design then fabricated and undergo the functionality test. In the end, the collected data from the functionality test between manual operation and semi automatic slump test is analyzed with using Pearson correlation. The result carried out shown that The Semi Automatic Slump Test could replace the manual slump test due to Pearson Correlation result's obtained 0.9807 nearly to 1. Semi automatic Slump equipment is compatible and fits with the slump test value obtained by standard equipment such as that described in British Standard (BS 1881: Part 102: 1983).

ABSTRAK

Ujian penurunan ialah satu ujian makmal yang digunakan bagi menentukan dan mengukur kebolehkerjaan sesebuah konkrit. Ujian penurunan konkrit adalah satu kaedah didalam kawalan mutu didalam industri pembinaan. Keputusan yang dihasilkan sekiranya keputusan penurunan lebih tinggi beerti sampel konkrit tidak kukuh dan untuk keputusan konrit yang rendah beerti sampel konkrit adalah kukuh dan stabil. Semasa ujian penurunan manual ini dilakukan terdapat masalah yang sering berlaku iaitu dari segi kelajuan yang tidak selaras, gegaran semasa mengangkat kon dan juga kesilapan manusia apabila memindahkan kon dari konkrit. Projek ini dihasilkan adalah untuk mengatasi masalah – masalah yang dihadapi ketika mengendalikan ujian tersebut. Matlamat projek ini adalah untuk mereka bentuk dan menghasilkan protoip mesin separa automatik bagi ujian ini dan menguji dan menganalisa fungsi mesin ini .Beberapa rekaan mesin separa automatik telah dihasilkan dan keputusannya adalah mesin yang menggunakan motor elektrik. Mesin yang terpilih akan dihasilkan dan diuji prestasinya. Akhirnya,data yang dihasilkan diantara mesin manual dan separa automatik dianalisis dengan menggunakan kaedah Pearson Correlation. Hasil yang ditunjukkan adalah mesin separa automatic boleh menggantikan mesin manual di sebabkan pearson correlation yang diperolehi 0.9807 menghampiri 1. Keputusan analisis ini menunjukkan bahawa mesin separa automatic adalah sesuai dan serasi bagi menggantikan mesin manual kerana keputusan yang dihasilkan adalah seperti didalam Standard British(BS 1881: Berpihak 102: 1983).

DEDICATION

For a warmth of love to Abah and Emak, Siblings, friends and my love one.

Thank you for the undivided loves and supports.

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LIST OF ABBREVIATIONS

CAD	Computer Aided Drawing
CAM	Computer Aided Machine
USA	United State America
BS	British Standart
AC	Alternating Current
DC	Direct Current
3D	Three Dimension
ASTM	American Society for Testing and Materials
Mm	millimeter
Avg	average

CHAPTER 1
INTRODUCTION

1.1 Background

"Working with my dad for a few years and associating myself with people who are passionate about concrete and making concrete better, I find that it is quite amazing," says Chris Yong, one of the most successful concrete entrepreneur in Brunei. In this world of technology, buildings and houses grow rapidly to overcome wants and needs of human being. Humans are eager to grip the profit here and there to compete with others. Malaysian populations that increase drastically from time to time in certain advance city requires place of living and other essentials which comes in construction and architectures such as buildings, highways, streets, parking lots, parking garages, bridges, high-rise buildings, dams, homes, floors, sidewalks, driveways, roads and numerous other applications.

Concrete's versatility, durability, and economy have made it the world's most used construction material. It is a constructional material composed of cement, water, coarse and fine aggregates materials, and admixtures (if required). A properly proportioned concrete mix possesses acceptable workability of the freshly mixed concrete and durability, strength, and uniform appearance of the hardened concrete while being economical. Basically, concrete is a mixture of two components: aggregates and paste. The paste, comprised of cement and water, binds the aggregates (usually sand and gravel or crushed stone) into a rocklike mass as the paste hardens because of the chemical reaction of the cement and water. Supplementary cementations materials and chemical admixtures may also be included in the paste.

Concrete slump test (or simply the slump test) is an in situ test or a laboratory test used to determine and measure how hard and consistent a given sample of concrete is before curing. The concrete slump test is, in essence, a method of quality control. *"Slump"* is simply a term coined to describe how consistent a concrete sample is, rather than using obscure descriptions such as "wet" or "runny". The height of the concrete mix after being placed in the slump cone differs from one sample to another. Samples with lower heights are predominantly used in construction, with samples having high slumps commonly used to construct roadway pavements. For a particular mix, the slump should be consistent.

A change in slump height would demonstrate an undesired change in the ratio of the concrete ingredients; the proportions of the ingredients are then adjusted to keep a concrete batch consistent. This homogeneity improves the quality and structural integrity of the cured concrete. Those concrete conditions were taken into account when satisfying requirements of concrete strength, and to make sure that a consistent mixture of cement is being used during the process of construction.

The manual slump test has several problems in processing the method. Using the manual slump test, operator will be using the man power to lift up the slump cone. This condition will lead to inconsistency in speed and a slight angular upwards direction resulting unreliable measurement result data. Thus, this study main objective is to design and produce semi automatic slump test that can provide consistent speed when lifting the slump cone and further it can overcome the problems occurs when manually operate concrete slump test. According to the topic, project development is explaining on the semi-auto slump test. Hence, automatic are behalf of running testing with mechanism either motto, spring or pneumatic while semi is means power to insert cement in the cone using roding that conducted by man’s power.

1.2 Problems Statements

Concrete is quite literally the foundation of many of today's construction projects. It is also widely used for exterior surfaces driveways, sidewalks, patios, stoops, steps, and another else. No wonder the Concrete is strong, durable, and relatively inexpensive and can be formed into many shapes and sizes. But concrete also has its drawbacks. It's prone to crumbling, cracking, settling and heaving when exposed to the elements. It also stains rather easily. Commonly, the slump test is operated manually by operator.

In manually done slump test, there are several problems that occur when operating this measurement method. These situations affect the results of the slump test unreliable because:

a. The resulting concrete was collapses or shear to one side.
b. Data from the slump test result need to be measure several times.

These entire problems have been researched to understand the reason of these problems. Thus basically these entire problems happen due to:

a. Inconsistent speed when lifting the slump cone.
b. Human error that cause the lifting process move in slight angular direction.
c. Lateral and torsion vibration of the slump cone during lifting process.

1.3 Objectives Of Projects

a. To design and produce semi automatic slump test prototype.
b. To Analyze and test the functionality of the lifter.

1.4 Scope and Limitation

a. To study the existing product performance.
b. To compare result between manual slump test and semi automatic slump test

c. To verify and analyzed the data using Pearson correlation method.
d. The design of semi automatic slump test with using the CAD software and illustrate it in technical drawing.

1.5 Essential of the Project

The essential of this project is:

a. To apply the product design and development concept that related to the subject.
b. Propose a design concept of slump cone lifter that has a consistent speed when lifting the cone upwards, reduce the slight angular upward direction and reduce the lateral and torsion vibration during the lifting process.
c. As a reference for academic studies that related to an automatic slump cone lifter.

1.6 Project Outline

This PSM report will contain six chapter which is chapter 1 that contains the introduction of the PSM project, Product Development Semi Automatic Slump Test where include objectives, problem statement and also some of the important information about the background of the project. Chapter 2 contains the literature review of the existing slump cone and others topic that related in this PSM project. Chapter 3 will represent the methodology of the PSM project from research until the development of the project. Chapter 4 will represent the result and discussion from the analysis taken using the functionality test. Chapter 5 contents the conclusion and recommendation of this entire report.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The slump test is the simplest and most commonly used test for workability. This chapter will describe about all element that are considered assisting and method used by authors in understanding and completing the project of design and development of semi automatic slump test. Literature reviews is a research or study that taken from primary and secondary data collection. Primary data is an investigation or direct search taken from discussion, site visit and interview with an expert of this field. The secondary data is a data from printed document such as books, journal, and recent design and also internet.

In process to do the research, investigation and design of a new product, literature review is an important guidance to support the acts and process of a research. The title of study, research, and applied method will be explain in sequence of authors comprehension from the concrete slump test application, working procedure, and function of the test until the design consideration and evaluation of semi automatic slump test using the Pugh concept selection matrix. The apparatus set for slump test as shown in figure 2.1

Figure 2.1: Apparatus set for slump test

(Source: http://www.atm-bishay.com/data/sections/SLUMP%20TEST.pdf)

The slump cone is placed on the base plate of the lifter and filled in the normal method. Semi automatic slump test is a need for constructions field to get a reliable measurement test result and to improve the old design to have an ease of handling personality. This paper is based on the problems that occur from unreliable measurement test result of a manual concrete slump test. Another problem that can occur is that operators lift the cone sideways, as well as upwards during the test, causing the concrete to slump sideways. It can only prevent such as misdiagnosis of the situation by recognizing that slump changes with time. Perhaps one of the most effective, high-tech accessories for improving the precision of slump testing is a wristwatch.

2.2 Concrete

Concrete is the most commonly used man made construction material. It has become very popular not only among civil engineers but among common people also. The basic ingredients to produce or make concrete are cement, water, coarse and fine aggregates, and admixtures (if required) (Concrete Basics: A Guide to Concrete Practice, 1996). This ingredients or material is mixed in measured amounts to make concrete easy to transport, place, compact, and finish a concrete mix. Only fresh water is used in larger amounts, and this is very often because it is wasted. Although the two words concrete and cement are used interchangeably, cement is actually one of the ingredients in concrete. It's the fine gray powder that, in combination with

water, binds sand and gravel or crushed stone into the rocklike mass known as concrete. Therefore, even though cement constitutes only 10-15% by weight of concrete's total mass, cement is the essential binding agent in concrete. (Environmental Council of Concrete Organizations, 1996). Figure 2.2 shows percentage of ingredients in a mix concrete.

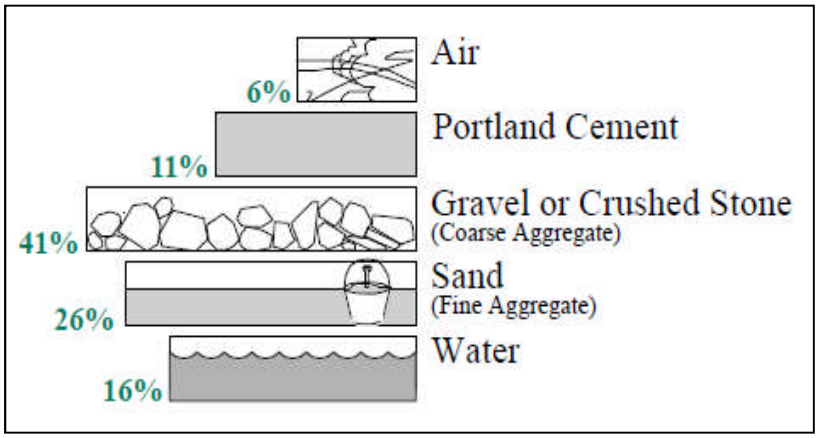

Figure 2.2: Pie chart of ingredient in concrete

(Source: Environmental Council of Concrete Organizations, 1996)

2.2.1 Theory of Concrete

Concrete is at once the fruit of a simple technology and a complex science that is beginning to be mastered, but not in all its details. In fact, the hardening of modern concrete results from reactions between amorphous or mineral products, water, more or less complex organic molecules, and in some cases with some mineral salts (Kenneth C. Hover, 2008). Concrete after mixing with water and placement will solidify and hardened due chemical process known as hydration. This incident happen when the water from the mixing reacts with the cement further bonds with the other component together, in the end producing a stone-like material that act like glue to holds any aggregate together. The reactions are highly exothermic and care must be taken that the build-up in heat does not affect the integrity of the structure. Concrete is used to make pavements, architectural structures, foundations, motorways and roads, bridges and overpasses, parking structures, brick/block walls and footings for gates, fences and poles.

Three different states to mixed concrete:

a. Plastic state: is when the concrete first mixed, when it is still soft and still can be worked or molded into any shapes. During this state, the concrete is best to placing and compaction to any desired place and shape.
b. Setting state: this state takes place after compaction and during finishing. After that the setting state concrete begins to gain strength and harden.
c. Hardening state: this cannot be place or molded to other place or shape.

There are four main properties of mixed concrete which is:

a. Workability
b. Cohesiveness
c. Strength
d. durability

Workability of a concrete affected b the amount of cement paste and the aggregate grading inside the concrete mixed. A well made concrete is naturally strong and durable material. It is necessary to be sure that this concrete will keep its mechanical strength during the whole life of the structure. It is dense, reasonably watertight, able to resist changes in temperature, and as well as wear and tear from weathering. If the concrete is not constructed properly, it will not be as strong or durable when finally hardened.

A measurement method to check concrete workability will be discussed in the next sub topic. Cohesiveness properties are how well the concrete holds together in plastic state. This property was affected by the aggregate grading and the water content of the mixed concrete. The strength and durability properties of concrete were affected by the compaction of the concrete. Although concrete compressive strength is not its essential characteristic because it is its durability that it is more important, it must be admitted that these two characteristics are intimately linked to one another. Compaction is removing the air within concrete. A proper compaction results the concrete with increasing the density which is stronger and more durable.

2.2.2 Concrete and Cement's History

Concrete is a manmade building material that looks like stone. Combining cement with aggregate and sufficient water makes concrete. Water allows it to set and bind the materials together. Different mixtures are added to meet specific requirements. Concrete is normally reinforced with the use of rods or steel mesh before it is poured into moulds. Interestingly, the history of concrete finds evidence in Rome some 2000 years back. Concrete was essentially used in aqueducts and roadway construction in Rome. Cement and concrete will remain, at least during the first half of the 21st century the most widely used construction materials in the world, although this future concrete could be quite different from that used today. (Pierre-Claude, 2000)

It is said that the Romans used a primal mix for their concrete. It consisted of small gravel and coarse sand mixed with hot lime and water, and sometimes even animal blood. To trim down shrinkage, they are known to have used horsehair. Historical evidence states that the Assyrians and Babylonians used clay as the bonding material. Even ancient Egyptians are believed to have used lime and gypsum cement for concrete. Lime mortars and gypsums were also used in building the world-acclaimed pyramids.

However, Romans are known to have made wide usage of concrete for building roads. It is interesting to learn that they built some 5,300 miles of roads using concrete. Concrete is a very strong building material. Historical evidence also points that Romans used Pozzalana, animal fat, milk and blood as admixtures for building concrete (http://nabataea.net/cement.html)

Table 2.1: Concrete and cement timeline
(Source: http://nabataea.net/cement.html)

1	**1200 - 1500 The Middle Ages**	The quality of cementing materials deteriorated. The use of burning lime and pozzolana (admixture) was lost, but reintroduced in the 1300's.
2	**1779**	Bry Higgins was issued a patent for hydraulic cement