UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND ANALYSIS OF 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

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ABSTRACT

Concrete slump test is a measurement test that usually applied before applying to a structure. It is a method of quality control to determine the consistency of concrete by measuring the concrete mold height from the slump test. A lower slump concrete result means the concrete sample is firm and a higher slump concrete result means the concrete is not stable. A manual slump test usually has a several problems that always occur in applying this method. 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 study presented in this paper aims to overcome the problems occur in handling the manual concrete slump test. Several designs of an automatic slump test were stated with several CAD drawing of the designs. These design uses spring lifter, electric motor lifter and pneumatic lifter to move the slump cone in proper direction as well as overcoming the problems occur in manually done slump test. Analyses on these designs were using FEA and concept scoring method to determine which design should be selected. As result, Motor Slump Test Lifter was selected based on factors of force reaction, highest allowable stress, design improvement, ease and cost of manufacturing. In the end a prototype of Motor Slump Cone Lifter prototype was made using the rapid prototyping method.

ABSTRAK

Ujian runtuh konkrit ialah ujian sukatan yang selalu dilakukan sebelum mengaplikasikan konkrit ke atas binaan. Ia adalah kaedah kawalan kualiti untuk menentukan kelikatan konkrit dengan mengukur ketinggian acuan pada ujian runtuh konkrit tersebut. Keputusan ujian yang rendah menandakan konkrit tersebut stabil manakala keputusan ujian yang tinggi menandakan konkrit tersebut tidak stabil. Ujian runtuh yang manual kerap kali berlaku masalah ketika melaksanakan ujian tersebut. Halaju yang tidak sekata dan gegaran ketika mengangkat kon dan kesilapan pekerja yg menyebabkan kon tidak terangkat secara tegak merupakan masalah utama yang perlu diatasi. Kajian projek ini yang disampaikan di dalam kertas kerja ini bertujuan untuk mengatasi masalah yang selalu terjadi. Beberapa rekabentuk ujian runtuh automatik disediakan bersama dengan lakaran menggunakan perisian CAD. Rekabentuk ini menggunakan penggerak spring, penggerak motor elektrik dan penggerak pneumatik bagi menggerakkan kon ujian ke arah yang diingini disamping mengatasi masalah yand dihadapi semasa menjalankan ujian runtuh secara manual. Bagi menentukan rekabentuk yang terbaik, beberapa analisa ke atas rekabentuk-rekabentuk tersebut dilakukan dengan menggunakan konsep pemilihan dan analisa FEA. Hasilnya, Motor Slump Cone Lifter telah dipilih berdasarkan factor-faktor seperti tindak balas daya, had terima tekanan, penambah baikan rekabentuk, kesenangan dan kos pembikinan. Pada akhirnya, prototaip Motor Slump Cone Lifter dihasilkan dengan menggunakan konsep rapid prototyping.

DEDICATION

To my beloved parents, Hj Mahyuddin Omar and Hjh Zainab Wazir, my project supervisors, Mr Abdul Halim Hakim bin Abdul Aziz, all my family who gives continuous support and to whomever will benefit from this paper as their guidance.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

PSM	-	Projek Sarjana Muda
FKP	-	Faculty of Manufacturing Engineering
CAD	-	Computer Aided Design
CCAA	-	Cement and Concrete Association of Australia
USA	-	United States of America
CO.	-	Cooperation
OH	-	Ohio
CN	-	Canadian National
MM	-	Millimeters
IN	-	Inches
AC	-	Alternating Current
DC	-	Direct Current
OECD	-	Organization for Economic Co-operation and Development
CD	-	Compact Disk
STD.	-	Standard
RP	-	Rapid Prototyping
FDM	-	Fused Deposition Modeling
ABS	-	Acrylonitrile Butadiene Styrene

CHAPTER 1
INTRODUCTION

1.1 Background

In this era of technology, buildings and houses grow rapidly to overcome standard of living. Malaysian populations that increase from time to time in certain advance city requires place of living and other essentials which comes in construction and architectures of buildings, homes and roads. Concrete is one of the important material uses in architecture engineering. It is a constructional material composed of cement, water, coarse and fine aggregates materials, and admixtures (if required).

When these powders are mixed with water it will form a paste which bonds the aggregates together like glue in three different states: plastic, setting and hardening. Concrete that is stiff or dry may be difficult to handle, place, compact and finish and if not constructed properly, will not be strong or durable when finally hardened. To overcome this problem, a slump test can be used to measure the workability of concrete.

A slump test basically is a method of quality control that measure concrete stiffness and fluidity. It is done in essence to determine the concrete workability. Slump is a test for the liquid concrete state. This method determines the concrete workability by measuring the concrete height in applying the slump test which lower slump concrete is very stiff, and higher slump concrete is more fluid. 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 use man power to lift up the slump cone. This condition will lead to inconsistent speed and a slight angular upwards direction resulting unreliable measurement result data. Thus, this study main objective is to design an 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.

1.2 Problem Statements

In construction area of architecture, concrete are one of the important material to build road and buildings. These concrete must be measure it's stiffness and liquidity using before applying the concrete to the construction site. This measurement method is a simple and reliable method worldly used name as slump test. 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 torsional vibration of the slump cone during lifting process.

1.3 Objectives of Projects

a. To design and produce an automatic slump test prototype.
b. Analyzing several design of the automatic slump test to decide the best design to overcome the problems occurs.
c. Selecting the best method of designing an automatic slump test.

1.4 Scope and Limitation

a. Study the manual slump test design and the measurement procedure of the slump test.
b. The design of an automatic slump test will be using the CAD software to illustrate it in technical drawing.
c. Analyze the automatic slump test using the Finite Element Analysis.
d. Analyzing several design of an automatic slump test using Pugh Concept Selection Matrix.

1.5 Importance of the Project

The purpose of this project is:

a. Expose the product design and development concept that having in the related 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 torsional vibration during the lifting process.
c. Analyze the design concept to make sure that the design can withstand with the pressure applied.
d. 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 content the introduction of the PSM project, Design and Analysis of an Automatic Slump Test where include objectives, problem statement and also some of the important information about the background of the project. Chapter 2 contain the literature review of the existing automatic slump cone lifter and others topic that related in this PSM project. Chapter 3 will be the methodology of the PSM project from research until the development of the project. Chapter 4 will be the result from the analysis taken using the Finite Element Analysis. Chapter 5 will be the discussion of the result taken. Chapter 6 contents the conclusion and recommendation of this entire report.

Time management of all activities during the PSM stage one project is shown in table 1.1 and planning activities of PSM stage two is shown in table 1.2.

Table 1.1: PSM stage 1 gantt chart

PROJECT ACTIVITIES		WEEK													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Project title selection	P														
	A														
Identify problem, objectives and scopes	P														
	A														
Finding literature that relate to the study	P														
	A														
Methodology planning	P														
	A														
Develop possible solution	P														
	A														
Sketch and drawing	P														
	A														
Verification	P														
	A														
Report writing	P														
	A														
Report submission	P														
	A														

Legend:	
Plan	
Actual	

Table 1.2: PSM stage 2 gantt chart

PROJECT ACTIVITES		WEEK													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Finding literature that relate to the study	P														
	A														
Design Selection	P														
	A														
Design and develop product	P														
	A														
Data Analysis	P														
	A														
Result, discussion and conclusion	P														
	A														
Report writing	P														
	A														
Report submission	P														
	A														

Legend:	
Plan	
Actual	

2.2 Concrete

According to CCAA, concrete is not the same as cement; cement is one of the ingredients to produce concrete. Concrete is produce by mixing few ingredients with specific quantities to get the required stiffness and liquidity. The basic ingredients to produce or make concrete are cement, water, coarse and fine aggregates, and admixtures (if required) [1]. This ingredients or material is mixed in measured amounts to make concrete easy to transport, place, compact, and finish a concrete mix. Figure 2.1 shows percentage of ingredients in a mix concrete.

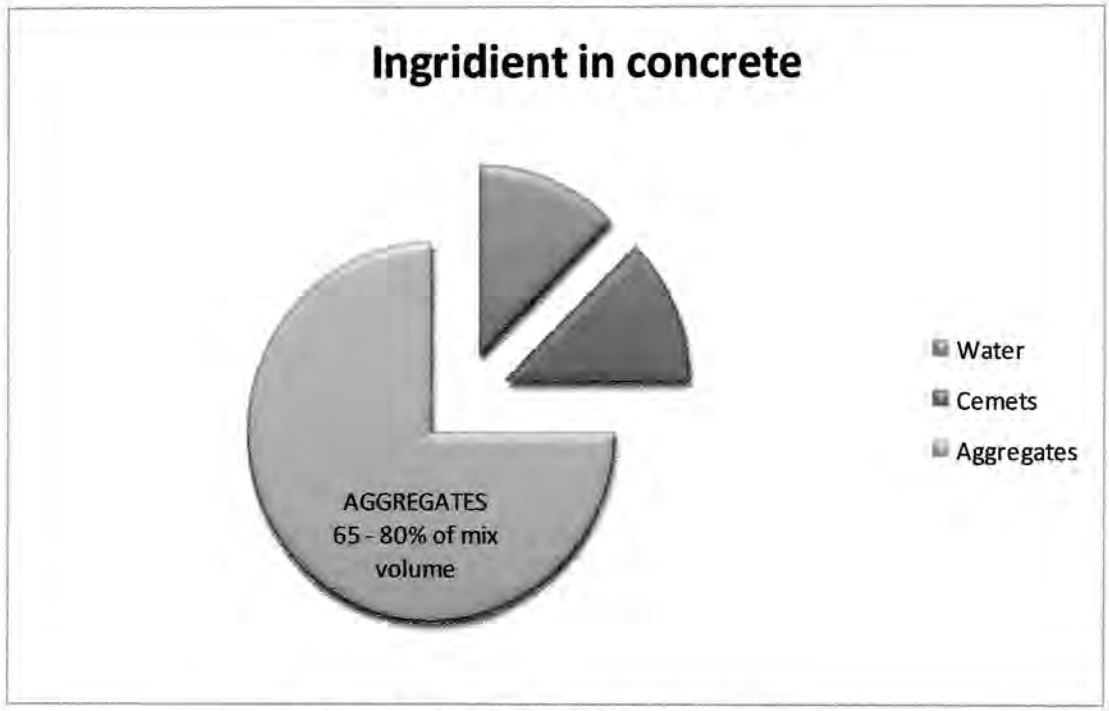

Figure 2.1: Pie chart of ingredient in concrete

2.2.1 Concrete in Theory

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 [1]. 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.

The mixed concrete takes to three different states:

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 [2]:

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

A well made concrete is naturally strong and durable material. It is dense, reasonably watertight, able to resist changes in temperature, and as well as wear and tear from weathering. Workability of a concrete affected b the amount of cement paste and the aggregate grading inside the concrete mixed. 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. Compaction is removing the air within concrete. A proper compaction results the concrete with increasing the density which is stronger and more durable.