



**Faculty of Manufacturing Engineering**

**STUDY ON IMPACT STRENGTH OF COMPOSITE BETWEEN  
CEMENT PASTE AND CORN HUSK ASH**

**Sarah Nadiyah Binti Mohd Ghazali**

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(Manufacturing System Engineering)**

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**STUDY ON IMPACT STRENGTH OF COMPOSITE BETWEEN CEMENT  
PASTE AND CORN HUSK ASH**

**SARAH NADIAH BINTI MOHD GHAZALI**

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Disahkan oleh:

Alamat Tetap: 

No 7, Jalan Kelapa Gading,

Taman Soga, 83000,

Batu Pahat, Johor

Tarikh: 30/3/2017

Cop Rasmi:   
**DR. ROSE FARAHYAN BINTI MUNAWAR**

Senior Lecturer  
Faculty of Manufacturing Engineering  
Universiti Teknikal Malaysia Melaka

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## APPROVAL

I hereby declare that I have read this dissertation/report and in my opinion this dissertation/report is sufficient in terms of scope and quality as a partial fulfillment of Master of Manufacturing Engineering (Manufacturing System Engineering).

Signature	:..... <i>Rose</i> .....
Supervisor Name	:..... <b>DR. ROSE FARAHIYAN BINTI MUNAWAR</b> <i>Senior Lecturer</i> Faculty of Manufacturing Engineering Universiti Teknikal Malaysia Melaka.....
Date	:..... <i>30/3/2017</i> .....

## **DEDICATION**

To my beloved family, mother and father.

## ABSTRACT

This study is about impact test behaviour of composite between cement paste and corn husk ash. In order to help the environment for future, the idea of mixing natural waste material in original composition is something that could be an idea for designing sustainable product and to make use of corn husk into something useful by mixing it with cement paste. The objectives of this study are to identify the effect of curing days and amount of corn husk in composite mixture and examine the impact strength of impact force on the composite mixture. A combination of mixing cement with varied percentage of corn husk (0%, 25%, 50% and 75% by weight) and sand (1:2 ratio) and fix amount of water (0.6 ratio) were carried out in order to determine the impact strength in this mixture. This study uses 7, 14, 28 and 56 curing days in order to determine the most optimum parameter since curing day gives effect to mechanical properties. In addition, experiment also analyse the mixture composition microstructure by using SEM and Rockwell Hardness test. The observation of SEM showed that the particle size between the aggregate, cement and corn husk ash led to lack of impact strength. As for Rockwell hardness result presented the same pattern as impact strength. The outcome gain from the 56 curing days with 25% corn husk ash has resulted to better impact strength. This can be concluded that corn husk ash as cementitious material able to replace small amount of cement paste and can help on creating useful natural waste material.

## ABSTRAK

*Untuk membantu masa depan alam sekitar, adalah dengan mewujudkan adunan menggunakan bahan buangan semula jadi kepada campuran bahan baru. Disebabkan itu, dengan mencampurkan kulit jagung dengan simen bersama pasir dan air dapat menghasilkan adunan konkrit dan mewujudkan bahan mampan. Objektif kajian ini adalah untuk mengkaji kesan pengeringan hari and jumlah kandung abu kulit jagung kepada konkrit dan kesan adunan tersebut terhadap kekuatan daya tahan hentaman. Kombinasi campuran simen dan peratusan abu kulit jagung (0%, 25%, 50% dan 75% terhadap jisim) dan pasir (kadaran 1:2) dan jumlah air yang kekal (kadaran 0.6) telah dihasilkan untuk mengkaji kesan terhadap kekuatan daya tahan hentaman. Kajian ini juga menggunakan iaitu pengeringan hari 7, 14, 28, dan 56 hari. Dalam kajian ini juga ada menggunakan SEM dan kajian kekerasan permukaan untuk menganalisis campuran adunan tersebut. Kombinasi adunan antara abu kulit jagung dan simen yang memberi kesan paling besar terhadap daya kekautan hentaman berbanding pengeringan hari. Dengan menambah jumlah abu kulit jagung sehingga 25% dapat menghasilkan konkrit dimana daya hentaman adalah sama dengan 100% kandungan simen sahaja. Dari keputusan kajian menunjukan pengeringan hari 56 dan kandungan 25% menghasilkan kekuatan daya hentaman yang lebih bagus. Ini boleh disimpulkan bahawa campuran abu kulit jagung dapat menghasilkan adunan bersimen, tetapi menambah kulit jagung lebih dari 25% menyebabkan pengurangan daya tahan hentaman. Ini menunjukkan bahawa, abu kulit jagung boleh digunakan sebagai bahan bersimen dengan menggantikan sedikit jumlah simen asal dapat membantu dalam menghasilkan bahan buangan semulajadi kepada bahan serbaguna.*



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## TABLE OF CONTENTS

	PAGE
<b>DECLARATION</b>	
<b>APPROVAL</b>	
<b>DEDICATION</b>	
<b>ABSTRACT</b>	<b>i</b>
<b>ABSTRAK</b>	<b>ii</b>
<b>ACKNOWLEDGMENTS</b>	<b>iii</b>
<b>TABLE OF CONTENTS</b>	<b>iv</b>
<b>LIST OF TABLES</b>	<b>vi</b>
<b>LIST OF FIGURES</b>	<b>vii</b>
<b>CHAPTER</b>	
<b>1. INTRODUCTION</b>	<b>1</b>
1.1 Background of study	1
1.2 Problem Statement	2
1.3 Aims and Objectives	3
1.4 Scope of the study	3
1.5 Importance of Study	4
1.6 Research Activity	5
<b>2. LITERATURE REVIEW</b>	<b>6</b>
2.1 Clay as basic material	6
2.2 Cement	7
2.3 Concrete properties	9
2.4 Corn husk	11
2.5 Mixing composition	14
2.6 Curing days	16
2.7 Impact test in Concrete	19
2.8 Hardness test	21
2.9 Scanning Electron Microscope (SEM)	24
2.9 Taguchi method	27
<b>3. METHODOLOGY</b>	<b>31</b>
3.1 Corn husk ash	31
3.2 Design of Experiment (DOE)	34
3.3 Impact test	34
3.4 Rockwell Hardness test	35
3.5 Scanning Electron Microscope (SEM)	36
3.6 Flow Chart of Project	37
<b>4. RESULT AND DISCUSSION</b>	<b>38</b>
4.1 Data on impact test result	38
4.2 Data Analysis	
4.2.1 Discussion on Impact test result	39
4.2.2 Analysis Design of Experiment	39

<b>5. CONCLUSION AND RECOMMENDATION</b>	<b>53</b>
5.1 Conclusion	53
5.2 Recommendation for future work	55
<b>REFERENCES</b>	<b>56</b>

## LIST OF TABLES

<b>TABLES</b>	<b>TITLE</b>	<b>PAGE</b>
1.1	Project Gantt Chart	5
2.1	Quantity of Sawdust Introduced into the Concrete	16
2.2	Array selector	28
2.3	Standard L16 orthogonal array	29
3.1	Parameters and the variation of level	32
3.2	Composition of corn husk ash with cement	32
3.3	L'16 orthogonal array	33
3.4	Number of specimen will be tested	34
4.1	Data and result on impact test and hardness	38
4.2	Result on impact test	39
4.3	SN ratio of the impact strength result	51
4.4	ANOVA for Impact strength result	52

## LIST OF FIGURES

FIGURE	TITLE	PAGE
3.1	Corn Husk preparation	31
3.2	Preparation of specimen	33
3.3	Impact Test Apparatus	35
3.4	Rockwell Hardness Testing Machine in analysing specimen	36
3.5	Scanning Electron Microscopy (SEM) Carl Zeiss EVO 50	36
4.1	Graph on energy absorption (impact strength) versus curing days	40
4.2	Graph on hardness and impact test for mixture 1.	41
4.3	Graph on hardness and impact test for mixture 2.	42
4.4	SEM image of the specimen with highest impact strength (mixture 2)	43
4.5	Graph on hardness and impact test for mixture 3.	44
4.6	Graph on hardness and impact test for mixture 4.	46
4.7	SEM image of the specimen with medium impact strength (mixture 3)	47
4.8	SEM image of the specimen with low impact strength (mixture 4)	48
4.9	Graph of the Main Effect Plot for SN ratio	50
4.10	Main Effect for mean	51

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background of study

Cement is material that consist of calcined lime or limestone and clay that are powdery compositioned. By mixing with water it will form to be mortar or in other words cement paste. Cement is widely use in all over the world where today each country are strive to become a develop country and the development causing to create building or housing. This development will mostly use cement as its main material. The excessive use of cement and sand to create concrete would cause to detrimental environmental effect in future life. In order to make the natural waste to become more useful product, the idea of mixing natural waste material in original composition is something that could be an idea for designing sustainable product.

Corn is one of the largest crop in Malaysia in which by year 2010, the need for corn supply has reached to 47000 tan and it kept on increasing to 55000 tan in 2013 (Unit Perangkaan, 2013). The increasing of corn crop in Malaysia simultaneously raised to the production of corn husk waste. As this waste need attention, it is better to make use of the corn husk into something useful by mixing the corn husk with cement paste rather than utilizing full use of only cement with water and sand to create concrete. However, the properties of this composite need to be studied and examined so that comparison on its strength behaviour of the cement and water mixture and corn husk could be tested to achieved its maximum efficiency. The mechanical properties can be determined by

conducting destructive test on the composite with different rate of composition in order to find the best mixture of cement paste and corn husk mixture.

## 1.2 Problem Statement

In an ideal setting, cement is an important material in construction that is used as binder for strength and durability in concrete. Most of concrete is formed from a mixture of sand, cement and water. In today situation, most concrete used by developer are composed from a mixture of sand and cement paste so that a building can be made. The current method used to form concrete development leads to high demand in cement. In order to create cement, industry uses raw material which is limestone added with clay or shale and other materials to achieve the correct chemical proportions. However the use of raw material are not the main cause to the environment but the process of making it cause to release releasing hazardous gasses such as  $\text{CO}_2$ ,  $\text{NH}_4$  and  $\text{NO}_x$  that contribute to global warming.

Based on a previous research, corn husk ash is Pozzolanic materials that function as a cementitious material and is suitable to replace cement. The process to make the corn husk ash that is natural waste into a useful item is by turning it into composite to be mixed into the cement. The purpose of this research is to reduce the use of cement in concrete by mixing it with corn husk a natural waste that usually left unused.

To determine the composite effectiveness, a study on impact behaviour of this composite will be done. Knowing the value of impact would help in finding the amount of the blow that would cause fracture to the concrete and also energy that require causing the concrete to fail. The impact test result is significantly important in knowing the strength of the concrete that able to withstand when being blast. The ability of the concrete to

withstand from impact is the main interest in military and civil application and as the main respond in the study.

### **1.3 Aims and Objectives**

For future research development in the idea of combining material with natural waste is finding the best mixing parameter and suitable composition in order to create better composite. This research is derived by the following objectives:

- i) To develop new composite between cement paste and corn husk ash
- ii) To study the effect of its curing days on the impact strength properties of the composite cement paste and corn husk ash by different composition.
- iii) To observe the microstructure and hardness of produced composite.

### **1.4 Scope of the study**

With the idea in creating new product that goes for sustainable development and environmental friendly material, mixing material of natural waste (corn husk) with cement gives effect to environment. The material would be specific type of cement that is sold in nearest place which is YTL cement (Castle: Portland Composite Cement, certified to MS 522-1: 2007 CEM II / B-L 32.5N) and corn husk. This research is experimental type of research by controlling the variable in order to find the impact force behaviour result. The mixture of cement paste is between water, sand and cement and the standard ratio for mixing cement and sand is 1:2 respectively with the 0.6 ratio of water from the mixture total weight. In this experiment, the cement will be mixed up with corn husk ash with fix ratio of total weight 1:2 that is 1 portion (cement + corn husk): 2 portion (sand). The study on the impact strength of each mixture is by using digital pendulum impact testing



machine. Also the hardness test would be evaluated to the specimen in order to analyse the surface strength due to correlation in between surface hardness test and impact test. After that, this specimen will be analysed using the scanning electron microscope (SEM) to determine the microstructure composition of cement paste mixture with corn husk ash.

### **1.5 Importance of Study**

The important of this study is it would contribute to the environment and building construction by using natural waste into something useful. Also it could contribute to the future research development in the idea of combining material with natural waste. Corn husk is a natural waste that are currently will disposed by farmers or buyers without realizing that corn husk can be used in other situation for example mixing in other material to create better composite. The significant of this study is to reduce the use of cement in concrete and to support nowadays situation to have green environment and make use of natural waste (corn husk) that might be a new finding or solution to reduce the use of cement in construction. Study the impact test on cement would leads on finding the best mixture of material that is able to withstand unexpected extreme load or blast load and this will be useful in the civil application.

## 1.6 Research Activity

Research activity or planning cited in Gantt chart

Table 1.1: Project Gantt Chart

TASK	WEEK														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Execute Experiment Plan	█	█	█	█	█	█	█	█	█	█					
Collecting Data For Impact & Hardness Test					█	█	█	█	█	█	█				
Data Analysis With SEM												█			
Discussion And Conclusion													█		
Report Writing	█	█	█	█	█	█	█	█	█	█	█	█	█		
Submit Draft Project 2													█	█	
Project Report Submission, Presentation															█

## CHAPTER 2

### LITERATURE REVIEW

This thesis is about impact behaviour on mixing of cement paste and corn husk. The suitable mixing was reviewed as main item in cement that is clay.

#### 2.1 Clay as basic material

Clay as the main material in creating cements which act as a binder in construction of building. Clay a raw material that are vital in today industry and mostly use in the traditional ceramic (Aramide, 2012). However in order to create cement, clay and limestone or calcined lime are process together in using chemical. Cement Industry Federation (2015) a website that are about manufacture cement stated that the main raw material in producing cement are clay, limestone, shale, sand and iron ore which also highlight the use of clay in creating cement. It claimed that clay as raw material not just used to make ceramic but also an important part in creating cement. From the raw material, it will undergoes a process whereby combination of raw material is essential to ensure the target chemistry for clinker is achieved (Cement Industry Federation, 2015). The site also explains that these clinkers are the target so that cement clinker with a mineralogical structure that is highly reactive with water can be created which will act as binder in concrete. A research carried out by Temimi (1998) cited in Aramide (2012) found that clay are widely used in construction area that are generally blended together in order to achieve standard composition and optimum properties for any application that includes cement.

## 2.2 Cement

Cement is widely used in construction material. This increasing demand for housing has been a major problem facing governments in most developing countries around the globe (Asiedu, 2013). The rapid growth in infrastructure development has caused to high demand of cement that is currently happened in most developing countries. The exponential development of infrastructures, especially in rising regions further increases the demand for concrete materials such that the worldwide construction and usage of concrete will soon exceed the 10 billion tons per year mark (Mobasher, 2011). Cement that mostly used is known as Portland cement in which act as binder for the sand and other aggregate in creating solid form of mass. The function of the Portland cement is to react with water to form a firm product known as cement paste, which abide by to the particles of sand and stone together to form a hard solid mass of the fitting shape (Carolyn, 2013). Having cement paste to bind the aggregate together also determine it strength that can withstand in the environment condition. In order to have better mixture of concrete it depends on the suitable amount of cement uses in which it helps in creating stronger bind between course. The amount of cement paste needed is only that which is sufficient to coat all the aggregate particles (typically 10%–20% of the concrete by weight), it is the component that is most susceptible to environmental degradation of the concrete and, therefore, can undermine the durability of the structure.

As from before, cement one of the clay composition in which the characteristic are more to ceramic that is a brittle and a solid material. Cement is made from raw material that contains mixture of calcium, silica, aluminium and iron (Cement Industry Federation, 2015). Cement that uses in construction are mix with sand which called as concrete. The mixing of cement, sand and water are very important where a study by Olubajo (2014)

stated that the water-cement ratio is one of the most important parameters that affect the performance (mechanical properties) of mortar.

The cement is a material that came from limestone and clay and this material had been processed and heated at a  $1450^{\circ}\text{C}$  which end up creating  $\text{C}=\text{CaO}$ ,  $\text{S}=\text{SiO}_2$ ,  $\text{A}=\text{Al}_2\text{O}_3$ , and  $\text{F}=\text{Fe}_2\text{O}_3$  (Carolyn, 2013). This process that causing to create this type of chemical composition leads to create cementitious properties. The surplus water is considered to be a separate phase in the hardened cement paste and plays a main role in both the structure and properties of the paste in which the interlayer water in the C-S-H is thought to be held together and to hold the layers of the C-S-H together by hydrogen bonds (Carolyn, 2013). By mixing with water it would cause the cement to harden and bind the concrete together. Cement mixed with water cement elements reacts to form their hydrates which  $\text{C}_3\text{S}$  is responsible for the hardening of the concrete and, together with the  $\text{C}_2\text{S}$ , produces calcium-silicate hydrate (C-S-H) and that responsible for the binding and strengthening of the cement paste considered as a colloidal solid with its particles bound together with water and increasing in polymerization over time (Carolyn, 2013). This hardening process gives effect on the strength of the concrete since it depends on strength of cement bonding with the sand and other types of supplementary cementitious material.

In current situation, the idea of creating a sustainable material are still progressing to improve the future living and most are trying to develop product that are recyclable and environment friendly. With that, the situation for cement material also needs to consider the sustainable concept in to meet the current trend in developing and innovating product for better future. As current situation is to build taller structures with improved seismic resistance and an indefinite service life that require materials with better performance than the conventional materials causing for manufacturer to consider the society's need to sustain it, the need for new and innovative materials for the repair and rehabilitation of

civil infrastructures (Mobasher, 2011). The idea to create sustainable cement or concrete for construction are still in experiment in which several properties to be apply to the invention that produce better result. The current trends and speculations of research and development efforts as they apply to the sustainable design philosophy of construction materials leads to consider in the durability, quality, economical alternatives, cross-disciplinary efforts, appropriate analysis, design, and technology transfer tools (Mobasher, 2011). This statement support the idea that creating sustainable concrete is should be developed in which it is important for the future life and the current trend producing better material.

### **2.3 Concrete properties**

After cement is created mixing it with sand and granite would make a concrete and this can be used in construction. Concrete is a composite material bound together by hardened cement paste containing of aggregates stones and sand (Mobasher, 2011). The idea of using natural waste to be mixed with material to create new composite had been proposed in some studies that uses variety of component. Researchers have investigated into the used of by-industrial wastes and other wastes as components that could be blended with cement clinker without compromising the quality of the cement produced, or partially replaced the cement during batching in concrete production (Akaninyene, 2013). It can be seen that the current trend in research is aiming to support the sustainable development and environmental product. It is possible to replace 50% to 70% cement with one or several supplementary cementing materials, such as coal fly ash, granulated blast furnace slag, silica fume and rice husk ash to produce blended cement concrete, with dramatic improvements in the properties of the concrete (Akaninyene, 2013).

To create concrete using composition other than cement and common composition, the amount of water should be controlled to reach perfect consistency of the mixture. This means the water-cement ratio affects the durability, permeability and shrinkage cracking of a material (Olubajo, 2014). This show that water does gives effect on concrete. It is known that concrete strength is affected by changing the water–cement ratio and cement dosage stated by Yasar *et al.*, 2004 cited in Olubajo, 2014. Therefore, to have a better concretes the amount of water in to be considered. Having the suitable mixture of concrete are depends on the situation and its application. Not all concrete have the same ratio of mixture and some situation adding another type of supplementary cementitious material would determine to have different type of ratio. Concrete from suppliers can be personalizing order to meet the needs of the customer by accomplished through modifications in the concrete mix design that depends on the type and amount of cement used, the replacement level of cement with supplementary cementitious materials, the type, size, and proportion of coarse and fine aggregates (Carolyn, 2013). This shows that the ratio of water, sand, cement and other type of supplementary can be adjusted depending on the type, size and proportion that use. The varied composition needs to be studied in order to have the most suitable mixture the leads to create composite with better mechanical strength.

In recent study, adding fibre into the mixture is found helpful to increase the strength and durability of the concrete. However, the new addition of fibre are still under development due to certain situation where test in lab showed different result compared to actual concrete environment condition. The fact that the adding of fibres significantly decreases the crack width and it will directly affect the diffusivity of several ionic species and also the role of fiber reinforced materials in covering the durability service life is still one of the unrequited queries in the civil area (Mobasher, 2011).

On the contrary, mixing ratio in cement also plays a crucial part on mechanical properties where a study by Olugbenga (2014) on the mixing ratio of cement and the different percentage of sawdust fraction stated that the compressive strength value are not to confirm on the increase of curing age. The result on his study indicated that different value of strength may not vary to increase of curing age if each specimen has different mixing ratio. Therefore in order to have the perfect composition of cement not only to consider on the ratio of water but also taking into point on the curing age and mixing ratio.

#### **2.4 Corn husk as supplementary cementitious material**

To increase the durability of concrete in its environment has become the main interest by the civil industries due to the ability of the concrete to withstand in any condition for example crack and pores. It had been stated that the recent development is to discourse the request for durability based design through suitable engineering intricacy, design efficiency, and an improved service life through more durable construction (Mobasher, 2011).

The use of corn waste as in its cob turn into ashes and use as cement in concrete had been studied before. Result from few studies showed that the strength of the mixture decreases as the amount of the corn ash increase. Compressive strength generally increases with curing period and varies with increasing pozzolanic content for which the highest compressive strength was obtained at 10% replacement as 27.01N/mm<sup>2</sup> (Corn Cob Ashes) for 28 days curing period, and strength decrease as the 20% replacement gives compressive strength of 23.65N/mm<sup>2</sup> (Corn Cob Ashes) and the lowest compressive strength occurs at 30% replacement as 14.06N/mm<sup>2</sup> (Corn Cob Ashes) at 28 days (Tsado, 2014). This shows the decreases of strength as the corn cob ashes increase in the cement mixture even though it is a pozzolanic material.