COMPRESSIVE STRENGTH OF CONCRETE WITH COCONUT ASH AS CEMENT REPLACEMENT

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Diploma in Civil Engineering

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ABSTRAK

Harga bahan binaan terpaksa meningkat dari hari ke hari berikutan keadaan ekonomi negara yang semakin meruncing. Justeru, kajian ini disiasat dan dijalankan untuk menghasilkan konkrit dengan menggunakan abu kelapa yang diambil daripada sabut kelapa sebagai pengganti simen bagi mengurangkan penggunaan simen. Dalam kajian ini, konkrit akan dihasilkan dengan menggunakan abu kelapa, simen, agregat kasar, agregat halus, dan air yang bertujuan untuk mencapai objektif iaitu menentukan kebolehkerjaan konkrit dan menentukan kekuatan mampatan konkrit. Peratusan abu kelapa yang akan digunakan sebagai pengganti simen adalah 0%, 6%, dan 8%. Isipadu konkrit yang akan dihasilkan dengan menggunakan acuan ialah panjang 100 mm, lebar 100 mm, dan tinggi 100 mm. Konkrit yang dihasilkan akan diuji dalam masa 7 hari, 14 hari, dan 28 hari.

ABSTRACT

The price of construction materials ha to increase day by day due to the deteriorating economic situation of the country. Hence, this study was investigated and conducted to produce concrete by using coconut ash which took from coconut fiber as cement replacement to reduce the use of cement. In this study, concrete will be produced by using coconut ash, cement, coarse aggregate, fine aggregate, and water where it aims to achieve the objectives which are to determine the workability of concrete and to determine compressive strength of concrete. The percentage of coconut ash that will be used as cement replacement is 0%, 6%, and 8%. The volume of the concrete that will be produced by using a mold is a length of 100 mm, a width of 100 mm, and a height of 100 mm. The concrete produced will be tested in 7 days, 14 days, and 28 days.

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LIST OF SYMBOLS

%	Percent
µm	Micrometer

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MPa	Megapascal

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Researchers have long been interested in the use of recycled materials in new-build constructions. This is due to the fact that the cost of construction materials rises over time because construction materials are in high demand and difficult to obtain. As a result, green materials are recommended as one of the construction materials because they are made of renewable materials. The emergence of green materials has the potential to reduce environmental harm.

Concrete is widely regarded as one of the most important building materials. Concrete is a composite material composed of coarse and fine aggregates that bond with cement paste and harden over time. Ordinary Portland Cement is used in the construction industry to create high-quality building materials. Carbon dioxide, which may contribute to the greenhouse effect, is released during the cement manufacturing process. Thus, it is recommended that agricultural waste be used in construction.

1.2 Background of Study

Coconut fibre ash is used as a cement substitute in construction. Coconut fibre is one of the agricultural waste materials that can be easily obtained because coconut is Malaysia's fourth largest industrial. Coconut ash is created when coconut fibre is dried and burned at high temperatures (Mahawar, 2019). Coconut ash will be added to a concrete cube in various percentages of 0 %, 6 %, and 8 %. Each percentage of coconut ash has 9 concrete cubes. This study will produce a total sample of 27 specimens.

1.3 Problem Statement

Nowadays, cement is widely used, and the demand for cement is growing by the day. This is because cement is a basic building material that also serves as a binder in concrete. Cement is made by baking limestone, clay, and marl in a kiln. Carbon dioxide is released during the process, which may contribute to the greenhouse effect.

Previously, most researchers worked hard to reduce the use of concrete and replace it with suitable materials that have similar properties to concrete. The utilisation of industrial and agricultural wastes is being emphasised because they are the environmental burden (Batayneh et al. 2007; Senthamarai and Manoharan 2005). Agricultural waste is difficult to dispose of because it still has an environmental impact.

However, it is advantageous when used in concrete. It will not only save money, but it will also reduce the use of cement in the concrete structure, reducing the carbon dioxide emissions associated with cement production, and the building's stability must be considered (Hanle et al. 2004; Ma et al, 2007; Aitcin 2011).

1.4 Objectives of Study

This study is carried out to achieve the objectives as shown in below:

i. To determine the workability of fresh concrete with coconut fibre ash as cement replacement

ii. To determine the compressive strength of hardened concrete with coconut fibre ash as cement replacement

1.5 Scope of Study

The main purpose of this study is to investigate the compressive strength of concrete with coconut ash as cement replacement. Coconut ash is obtained from the 'Make Stuffs' nursery shop and the other materials such as cement, coarse aggregates and fine aggregates is obtained from the Concrete and Structure Laboratory, Faculty of Civil Engineering Technology, Universiti Malaysia Pahang. The targeted strength of the concrete is 30MPa. The quantity of coconut ash, cement, coarse aggregates, fine aggregates and water had calculated by using Concrete Mix Design Form. The percentage of coconut ash that being used is 0%, 6% and 8%. The amount of concrete is 27 blocks and 9 blocks for each percentage of coconut ash. The test date of concrete is 7, 14 and 27 days according to Eurocode 2: EN1992-1-1.

1.6 Significant of Study

According to this study, the use of coconut ash provides numerous benefits to our country. The first benefit that can be obtained from this research is a reduction in the cost of construction materials. The cost of construction materials has risen in tandem with the growth of the national economy, particularly after the implementation of the Movement Control Order (MCO). Thus, the usage of green materials like coconut ash is being researched and suggested to the community. This is because coconut ash is less expensive than other raw materials like cement and aggregates.

The proper treatment of coconut fibre is the second advantage of employing coconut ash as a cement alternative. This is due to the community's view of coconut fibre as a waste material. This study will provide the community with additional information about green building materials. Furthermore, coconut ash increases the strength and workability of concrete, lowering the cost of construction materials.

The third advantage of employing coconut ash as a cement alternative is that air pollution can be decreased. This is due to the fact that surplus and unused coconut fibre will be disposed of by burning it in the open. As a result, poisonous gases will be emitted during the burning of the coconut fibre. Coconut fibre ash has been employed in construction throughout this investigation. Therefore, it may aid in avoiding open burning of coconut fibre and air pollution.

The sustainable cities and communities that will occur when coconut ash as cement replacement reduces the environmental impact of cities. This is because cities were built up by using construction materials such as cement which will release carbon dioxide into the environment. Thus, coconut ash as a cement replacement is investigated. The use of coconut ash as cement replacement can reduce air pollution as the quantity of cement used in construction is reduced.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides an overview of the studies done on the use of ash derived from coconut fibre in concrete as a replacement for cement. This study served as a guideline since it was based on the development of preceding research that had been done by previous researchers.

2.2 Concrete

As a construction material, concrete is widely used across the globe and is the most widely used building material on Earth. The construction sector has advanced significantly since reinforced concrete was first used as a structural material. The most often-used substance is concrete, which is utilized by every individual on the earth in three tonnes annually (Gagg, 2014). Concrete is one of the most often utilized building materials in modern civil engineering projects. Because concrete has unbeatable advantages over other building materials, only last name is also somewhat determined by the level of concrete construction technology (Yuzhen Guo, 2021). Cement, water, and coarse and fine aggregates make up traditional concrete. They combine to form a construction material that eventually becomes harder. Because of its excellent structural qualities and formability, which enables it to take on any shape regardless of geometric complexity, concrete is a common building material in the construction industry and has been used extensively in the construction of residential and commercial buildings and infrastructures (Li et al., 2022).

Figure 2.1: Concrete cube

2.3 Ordinary Portland Cement

Ordinary Portland Cement is one of the most employed materials in the world because of its abundance in the world market (Huntzinger and Eatmont, 2009). According to Kuder et al. (2012), Ordinary Portland Cement has gained a key role in the construction industry because of its versatility, availability, and affordable price. It is considered the central pillar of the construction industry and in general civil engineering and it is the main element that offers multiple properties of flexibility and a competitive price-quality ratio (Torres and Burkhart, 2016). The cement allows an infinite variety of applications, including the realization of safe, economic, and resistant constructions. Cement is the most suitable material for constructive solutions required by the evolution of a society that induces a demographic increase in the various nations and cities of the world and uncontrolled urbanization on a large scale (Regd et al., 2015; Kang et al., 2015). Cement offers optimal performance as it is able to absorb variations in ambient temperature over the entire life cycle of civil engineering, reducing energy consumption in buildings (Wan et al., 2016). Traditional cement mortar is a common paste material in construction; it is a composite material containing Portland cement (OPC), fine aggregate (sand), and water, and is widely used in numerous applications (Bernat-Masó et al., 2016). However, cement mortars are inherently fragile and have problems such as weak cracking resistance, low deformability, and low bending resistance compared to compression strength (Al-Ghaban et al., 2018). Of all the components of concrete, OPC is the binding material and therefore the main ingredient (Basha and Reddy, 2016; Kang et al., 2015).

Figure 2.2: Ordinary Portland Cement

2.3.1 Chemical Composition of Ordinary Portland Cement

Table 2.1: Chemical Composition of Ordinary Portland Cement

Compound	% of Mass
SiO_2	17-25%
Al_2O_3	4-8%
Fe_2O_3	0.5-0.6%
CaO	61-63%
MgO	0.1-4%
SO_3	1.3-3%
Na_2	0.4-3%

2.4 Coconut Ash

Coconut Fibre Ash (CFA), produced by the Center of Environmental Health Engineering, contains 67.55 percent chemical Silica (SiO2). This combination demonstrates how CFA and fly ash (FA) can be used together as cement substitutes

(Bayuaji et al., 2016). Depending on its calcium oxide level, coconut ash can be categorised as having a high or low calcium content. Less than 5% of coconut fiber's carbon content is present. Due to its durability, affordability, and capacity to conserve energy, it is advised for use (Ramesh Kumar & Kesavan, 2020). Harvesting the coconut filaments is the first step in making coconut ash. Next, the fibre must be properly dried before being consumed and burned outside in the sun. These developments may enable coconut ash to replace cement, which would lessen the effect of carbon dioxide emissions during the production of cement (Bayuaji et al., 2016). As a result, by utilising coconut ash in more environmentally friendly methods, the positive effects of concrete technology could be increased.

The Center of Environmental Health Engineering produced Coconut Fibre Ash (CFA) using a chemical composition of 67.55 percent Silica (SiO_2). This mixture shows how CFA and fly ash (FA) can function as cement replacement materials when combined (Bayuaji et al, 2016). Coconut ash can be categorised as high or low calcium depending on the calcium oxide content. Coconut fibre still has a carbon concentration of less than 5%. It is suggested for use due to its durability, affordability, and energy-saving attributes (Ramesh Kumar & Kesavan, 2020). The coconut filaments must first be picked, the fibre must then be properly dried, and last, it must be consumed outside in the sun where it will burn and become ash. If coconut ash succeeds in replacing cement as a result of these developments, the effect of carbon dioxide emissions in the manufacturing process of cement could be reduced (Bayuaji et al, 2016). Therefore, using coconut ash in more environmentally responsible methods could maintain the beneficial effects of concrete technology.

Figure 2.3: Coconut Ash

2.5 Coarse Aggregates

Coarse aggregate is considered the most important materials in construction, which provides volume and strength to concrete. Coarse aggregate is mainly obtaines from natural resources by mining rocks or dredging river beds (Mohanta & Murmu, 2022). Coarse aggregate refers to the aggregate whose particle size is greater than 4.75mm or retained on 4.75mm sieve. Aggregate makes up about one-third of concrete's volume, and coarse aggregate makes up 50-60% of the mix, depending to the mix ratio. Coarse aggregate is some particles larger than 0.19 inches in diameter, but mostly between 1.5 inches. Gravel makes up most of the coarse aggregate in concrete and crushed stone makes up most of the rest. The aggregate shape and grade have a great influence on the workability of concrete. Poorly shaped and graded aggregates adhere less than well shaped and graded aggregates, so more cement needs to be used to cover the spaces between the aggregates (Thomas et al., 2021).

Figure 2.4: Coarse Aggregates

2.5.1 Type of Coarse Aggregate

Table 2.2: Type of Coarse Aggregate

Coarse Aggregate	Size
Fine Gravel	4-8mm
Medium Gravel	8-16mm
Coarse Gravel	16-64mm
Cobbles	64-256mm
Boulders	>256mm

2.6 Fine Aggregate

When the aggregate passes through a 4.75mm sieve, the aggregate that passes through it is called fine aggregate. Natural sand is generally used as fine aggregate, silt and clay also fall into this category. Soft sediment consisting of sand, silt, and clay are called loam. The purpose of the fine aggregate is to fill voids in the coarse aggregate and act as a softener.

Figure 2.5: Fine Aggregate

2.6.1 Type of Fine Aggregate

Table 2.3: Type of Fine Aggregate

Fine Aggregate	Size Variation
Coarse Sand	2-0.5mm
Medium Sand	0.5-0.25mm
Fine Sand	0.25-0.06mm
Silt	0.06-0.002mm
Clay	<0.002mm

2.7 Water

Water is an important component of concrete not only participates in the hydration of cement, but also contributes to the workability of fresh concrete. Therefore, the quality of the mixing water is critical to the performance of fresh and hardened concrete, including strength and durability. Most standards in the world state that concrete water should be moderately clean and free from oil, acid, alkali, organic matter or other harmful substances (Su et al., 2002).

Figure 2.6: Water

2.8 Cement Replacement

When cement is mixed with water, chemical reactions begin between various chemicals and water. Many compounds are formed as a result of the reaction. Tricalcium aluminate causes initial hardening but contributes little to ultimate strength. Tricalcium silicate has a pronounced effect on the strength of concrete when young. Dicalcium silicate contributes to the strength of concrete. At least to ultimate strength (Chon et al., 2014).

2.9 Environmental Issue Caused by Normal Concrete

The most important environmental issue in cement and concrete production is energy consumption. Cement production is one of the most energy-intensive industrial production processes. Cement production requires approximately 1,758 kWh per tonne of cement. This includes direct fuel consumption for quarrying and transportation of raw materials. Industry's reliance on coal results in particularly high emissions of CO2, nitrogen oxides, sulphur, and other pollutants. Coal is also used to generate large amounts of electricity (Dan Babor, Diana Plian, Loredana Judele, 2009) et al. Water pollution is another environmental problem associated with cement and concrete production. Wash water from plant washing is often discharged to the settling tank of the batch plant where the solids settle. A portion of the recycled concrete is placed in tailings ponds and washed away to recover aggregates (Dan Babor, Diana Plian & Loredana Judele, 2009).

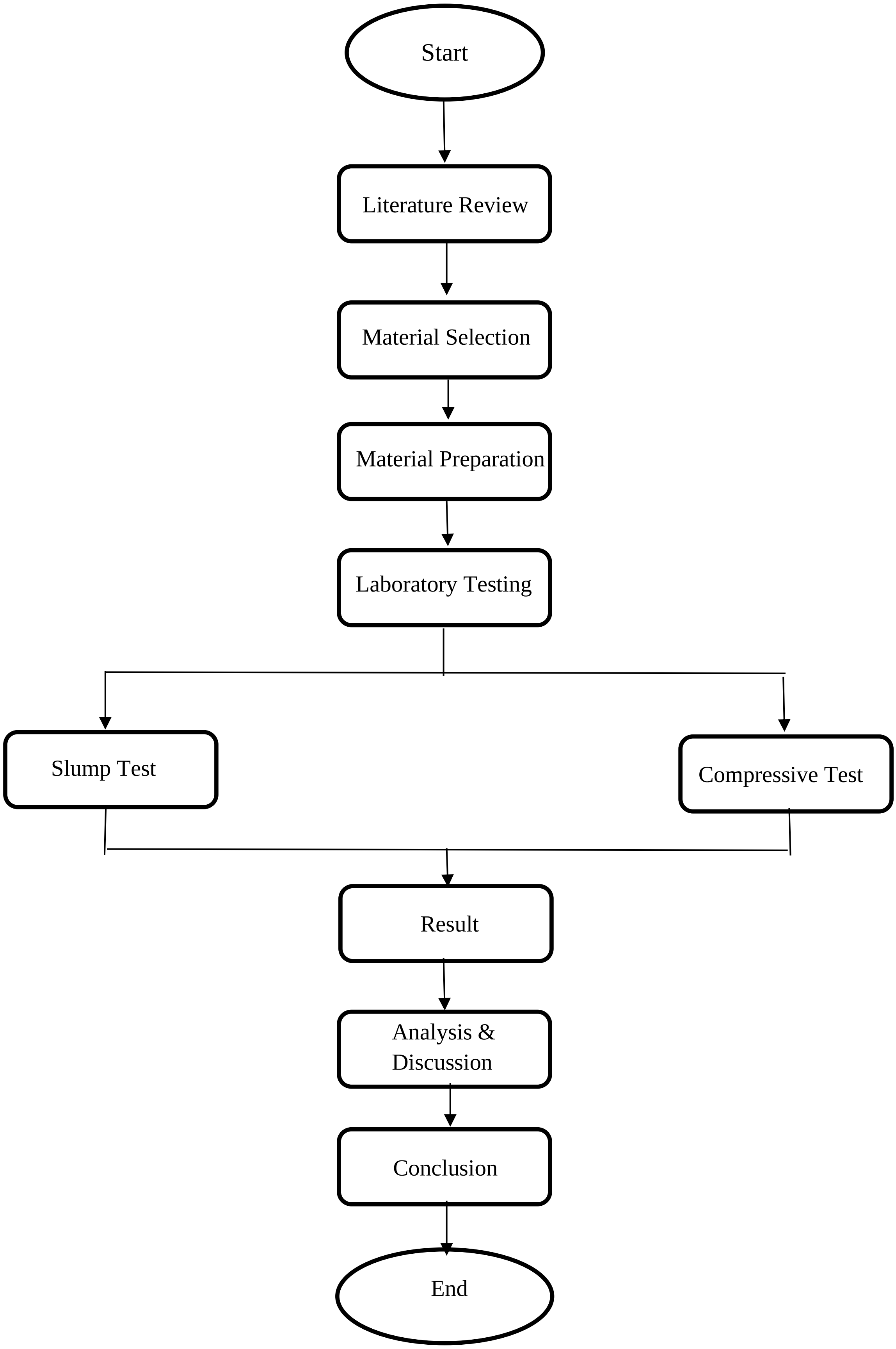
CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, M30 grade concrete will be made using coconut ash as a cement substitute. The produced concrete is tested to determine its difference from standard concrete. The percentages of coconut ash used as cement replacement are 0 %, 6 %, and 8 %, respectively. The total number of concrete blocks is 27. In this study, concrete blocks will be tested, with the slump test referring to standard BS EN12350-2:2019 and the compressive strength test referring to standard BS1881: Part116: 1983 and standard ASTM C 39-03.

3.2 Methodology Flow Chart



3.3 Gantt Chart

Task/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Identification of the study title	■	■												
Literature review	■	■	■	■	■	■	■	■	■	■	■			
Material and sample preparation			■	■	■	■	■							
Laboratory testing						■	■	■	■					
Data collection							■	■	■	■	■			
Data analysis								■	■	■	■	■		
Thesis preparation										■	■	■	■	■
Thesis submission														■

Table 3.1: Gantt Chart

3.4 Material Use

The materials that will used to achieve targeted compressive strength of concrete during the laboratory testing.

3.4.1 Coconut ash

Coconut ash is made from coconut fiber that had been burnt in high temperature. Coconut ash can be used as cement replacement to cut down the amount of cement used during construction. Coconut fibers are considered good materials because it is harmless to the environment and helps to solve environmental problems. Coconut fiber is a biodegradability and environmental friendliness materials.

3.4.2 Ordinary Portland Cement

Ordinary Portland Cement is used in this project because this cement is widely used in Malaysia. Ordinary Portland Cement have strong binding capabilities, thus higher strength provided to the construction. Ordinary Portland Cement should be stored in a dry, clean and ventilated place.

3.4.3 Aggregates

Aggregate can be categorized into two types which is fine aggregate and coarse aggregate. In this project, fine aggregates and coarse aggregate is used to produce a concrete. Aggregate materials help to compact the concrete mixes. Aggregates able to interlock within the mixture, providing strength based on its and the cement internal properties.

3.4.4 Water

Water is the most important material in produce a concrete. Paste will be produced when water is mixed with cement and hold all the aggregates together. In order to produce a high strength concrete, quality of water cannot be ignored (Farid et al., 2019). Water used must clear from impurities such as dissolved salts, floating particles, all of which might have negative consequences.

3.5 Laboratory Testing

3.5.1 Concrete Mix Design Procedure

Concrete Mix Design can be divides into 5 stages. The first stage is selection of cement ratio. The first step in stage 1 is determine the margin, M. Secondly, calculate the target mean strength, f_m. From table 3.2, a value is obtained for the strength of a mix made with a cement ratio of 0.5 according to the specified age, the type of cement and the aggregate to be used. The last step in first stage is the strength value from above is plotted on the starting line on Figure 3.1 and an envelope curve is drawn from this point and parallel to the printed envelope curves until it intercepts a horizontal line passing through the ordinate representing the target mean strength. In stage 2, free-water content is determined from table 3.3 depending upon the type and maximum size of the aggregate to give a concrete mix with specified slump or Vebe time. In stage 3, the cement content is determined. The next step is the resulting value must be compared to the specified maximum or minimum value. If the cement content calculated is below the specified minimum value, this specified minimum value will be accepted. Based on this specified minimum cement content, a corrected cement ratio is calculated and the calculation process is repeated from step 1 until all requirements are met. The last step in stage 3 is if the design method indicates a cement content higher than the specified maximum, it may not be possible to meet the specifications for strength and machinability requirements at the same time as the material selected. Next, you should consider changing the cement type, aggregate type and maximum size, concrete workability, or the use of water-reducing admixtures. In stage 4, density of the fully compacted concrete is estimated from Figure 3.2 depending upon the free-water content and the relative density of the combined aggregate in the saturated surface-dry condition. The second step is if no information is available regarding the relative density of the aggregate, an approximation can be made by assuming a value of 2.6 for uncrushed aggregate and 2.7 for crushed aggregate. From the estimated density of the concrete, calculate the total aggregate content. In stage 5, determine the quantity of materials smaller than 10mm form the total aggregate content. Figure 3.3 recommend value for the proportion of fine aggregate depending on the maximum size of aggregate, the workability level, the grading of the fine aggregate and the free-water/cement ratio. The last step for concrete mix design is calculate fine aggregate content and coarse aggregate content.

Table 3.2: Approximate Compressive Strength (N/mm^2) of Concrete Mixes Made with a Free-Water/Cement Ratio 0.5

Cement Strength Class	Type of Coarse aggregate	Compressive strengths (N/mm^2) (age in days) 3	7	28	91
42.5	Uncrushed	22	30	42	49
	Crushed	27	36	49	56
52.5	Uncrushed	29	37	48	54
	Crushed	34	43	55	61

1 N/mm^2 = 1 MN/mm^2 = 1 MPa

Table 3.3: Approximate Free-Water Content (kg/m3) Required To Give Various Levels of Workability

Slump (mm) V-B (s)		0-10 >12	10-30 6-12	30-60 3-6	60-180 0-3
Maximum size of aggregate(mm)	Type of aggregate				
10	Uncrushed	150	180	205	225
	Crushed	180	205	230	250
20	Uncrushed	135	160	180	195
	Crushed	170	190	210	225
40	Uncrushed	115	140	160	175
	Crushed	155	175	190	205

Note: When coarse and fine aggregates of different types are used, the free-water content is estimated by the expression

$$\frac{2}{3}W_f + \frac{1}{3}W_c$$

where W_f = free-water content appropriate to type of fine aggregate

and W_c = free-water content appropriate to type of coarse aggregate.

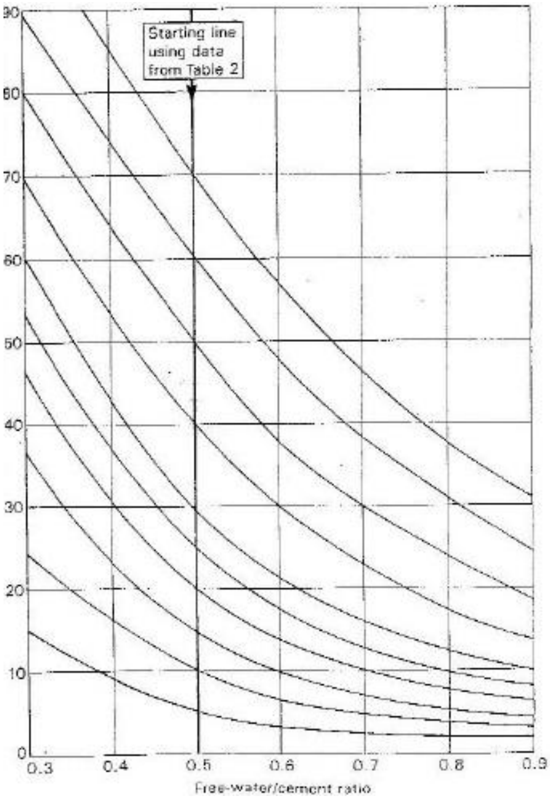


Figure 3.1: Relation between compressive strength and free-water/cement ratio

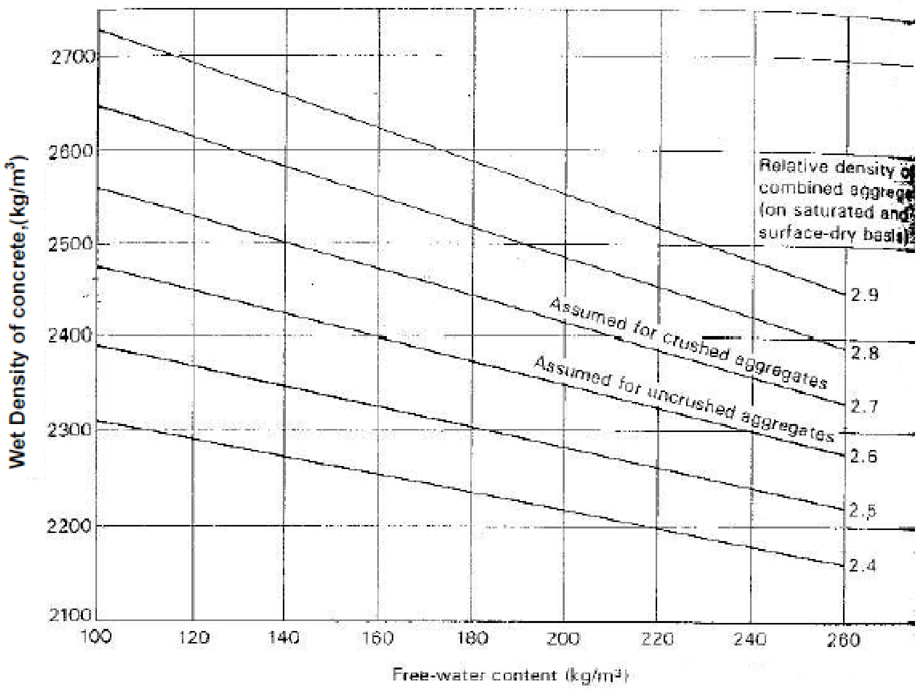


Figure 3.2: Estimated wet density of fully compacted concrete

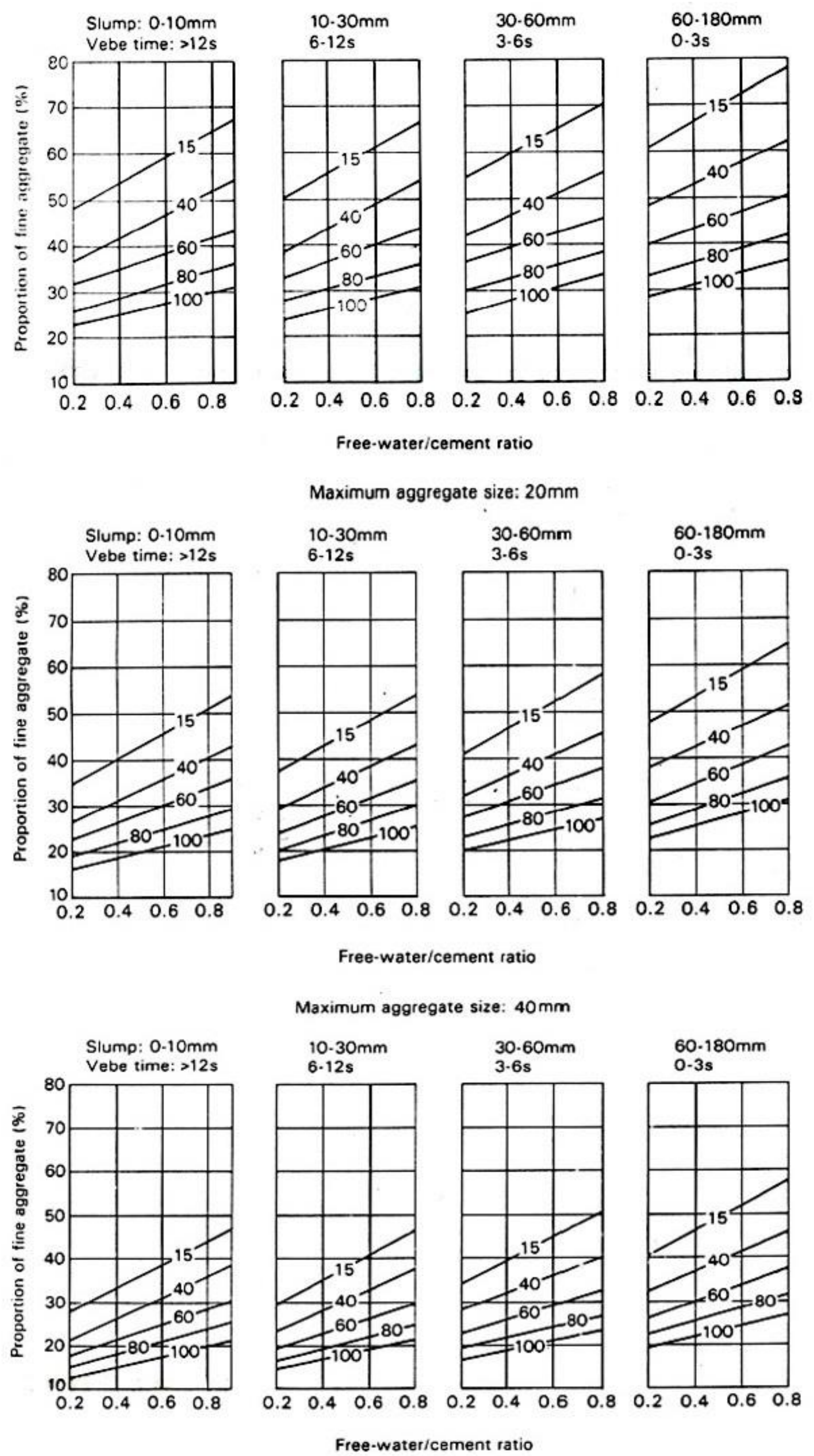


Figure 3.3: Recommended proportions of fine aggregate according to percentage passing 600µm sieve

3.5.2 Slump test

Slump test is carried out before the construction because slump test is used to compare the consistency of various concretes. The advantages of completing a slump test are that it reveals the workability and flowability of the concrete and serves as a warning sign for a batch that was poorly mixed.

3.5.2.1 Slump Test Procedure

First of all, apply oil after cleaning the mold's inside surface. Secondly, place the mould on a flat, smooth surface that is free of pores. Thirdly, add four roughly equal layers of the prepared concrete mixture into the mould. Fourth, tamp each layer with 25 regular strokes of the rounded end of the tamping rod. The tamping should pierce the base layer for the next layers. Fifth, remove any extra concrete and level the surface with a trowel. Next, remove any mortar that may have caused water to leak between the base plate and the mould. Then, raise the mould from the concrete in a vertical direction slowly. Lastly, measure the difference between the height of the mould and the height of the test specimen.

3.5.2.2 Slump Test Result

There are 4 type of slump test result that is true slump, zero slump, collapsed slump and shear slump.

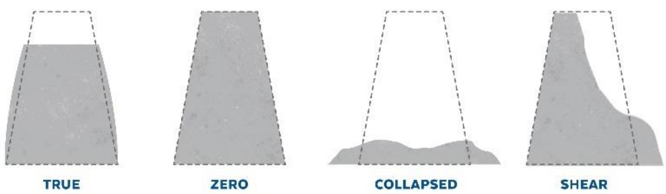


Figure 3.4: Standard of Slump Test Result

3.5.3 Compressive Test

Compressive test is one of the most important properties of concrete. Therefore, the performance characteristics of the combination and the overall quality of the completed product are greatly influenced by the strength of the cement.

3.5.3.1 Compressive Test Procedure

Firstly, remove the sample from the water and wipe excess water off the surface after the specified curing time. Secondly, clean the bearing surface of the testing machine. Thirdly, place the sample in the machine so that the load is applied to the opposite side of the cube case. Fourth, place the sample in the centre of the machine's base plate. Fifth, rotate the moving part by hand gently to bring it into contact with surface of the sample. Next, apply the load continuously and without shock until the specimen fail. Then, record the compressive strength, type of failure and the apperance of the specimen. Lastly, repeat the same step for other specimens.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, two type of laboratory testing have been carried out to determine the workability and the compressive strength of the concrete when coconut ash as cement replacement which is slump test and compressive strength test.

4.2 Laboratory Testing

4.2.1 Slump Test

Initially, Slump test is a crucial technique for determining whether freshly mixed concrete was workable. In order to assess the fluidity and flexibility of the conditioned soil, many researched have developed this method and used the slump value (Wang et al., 2021).

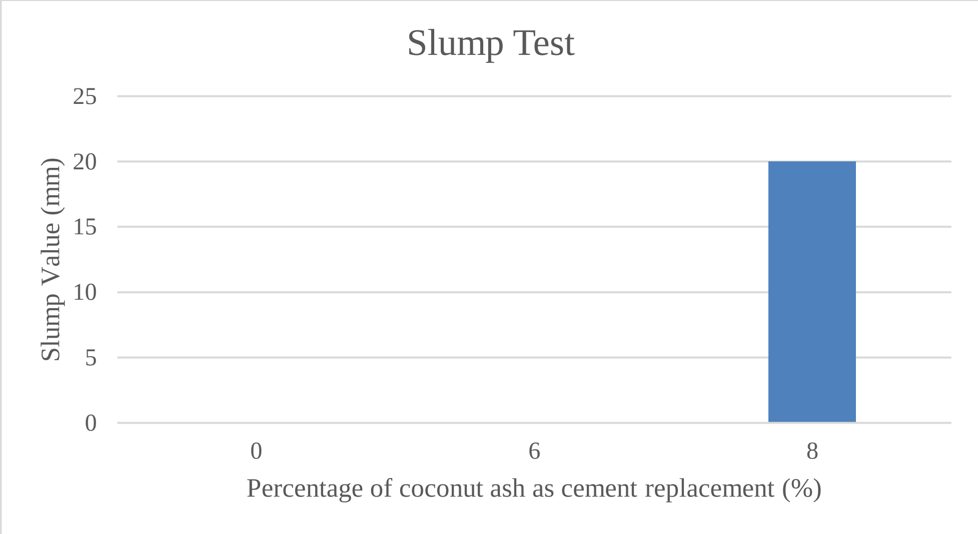


Figure 4.1: Result of Slump Test

The workability of 8% coconut ash as cement replacement is highest because the slump value of 8% coconut ash as cement replacement is the highest which is 20mm. The workability of 0% and 6% of coconut ash as cement replacement is lower than 8% of coconut ash because the slump value of 0% and 6% coconut ash as cement replacement is 0mm.

4.2.2 Compressive Strength Test

Compressive strength can be defined as the capacity of concrete to withstand loads before failure. The compressive strength test is the most crucial of the numerous tests conducted on the concrete since it provides information about the properties of the materials (Jaya, 2020).

Table 4.1: Result of Compressive Strength Test

Days	Percentage of coconut ash (%)		
	0	6	8
7	1: 18.72 MPa	1: 18.20	1: 24.88

	2: 14.98 MPa 3: 14.05 MPa	2: 18.45 3: 18.56	2: 21.45 3: 22.31
	Average:14.52 MPa	Average: 18.40 MPa	Average: 21.88 MPa
14	1: 20.57 MPa 2: 20.78 MPa 3: 23.03 MPa	1: 20.93 MPa 2: 22.28 MPa 3: 20.41 MPa	1: 25.50 MPa 2: 24.30 MPa 3: 23.77 MPa
	Average: 20.68 MPa	Average: 20.67 MPa	Average: 24.52 MPa
28	1: 24.67 MPa 2: 30.01 MPa 3: 24.52 MPa	1: 20.40 MPa 2: 20.84 MPa 3.: 22.82 MPa	1: 27.29 MPa 2: 27.32 MPa 3: 29.78 MPa
	Average: 24.60 MPa	Average: 21.35 MPa	Average: 27.31 MPa

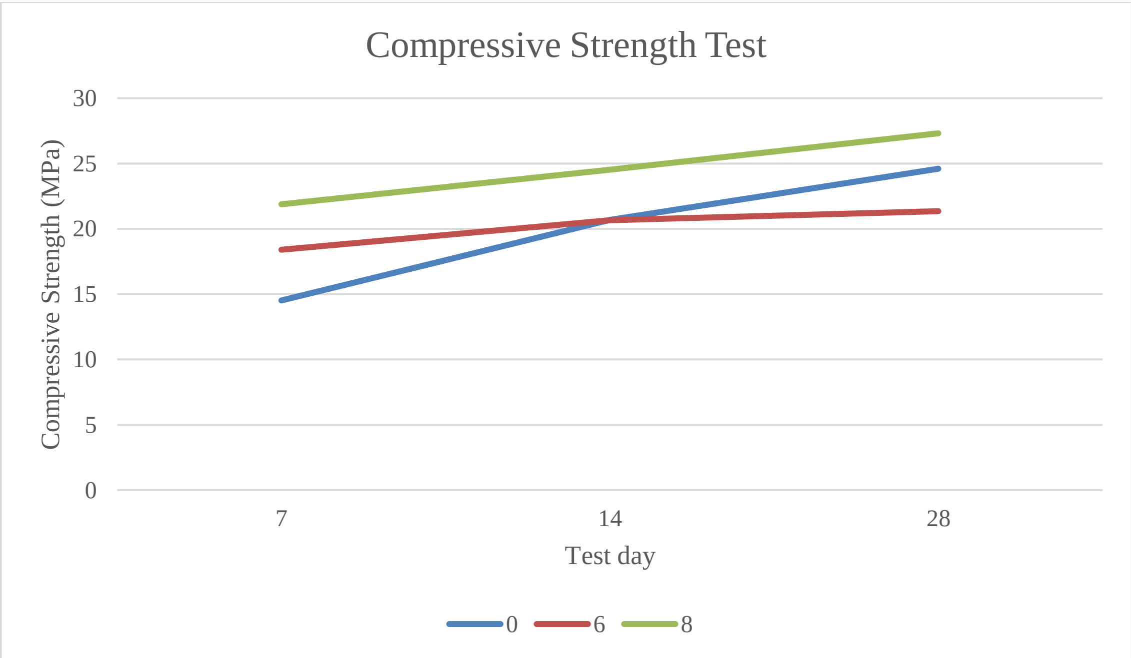


Figure 4.2: Result of Compressive Strength

Figure 4.3: Compressive Strength Test Failure

4.3 Discussion

The result of 6% coconut ash as cement replacement is increasing a little bit only because during the specimen preparation, the water is poured out accidentally thus the specimen is dry compare to other percentage and the compressive strength of 6% coconut ash is lower than normal concrete. For 0% and 8% coconut ash as cement replacement, the targeted strength does not achieve because in concrete mix design, the water cement ratio is too low, so the specimen produce is dry. The slump test of 0%, 6% and 8% coconut ash as cement replacement is also not achieve the targeted slump that stated in concrete mix design.

CHAPTER 5

CONCLUSION

5.1 Introduction

In this chapter, conclusion and recommendation will be discuss for this study which titled "Compressive Strength of Concrete When Coconut Ash as Cement Replacement" as a conclusion of this report.

5.2 Conclusion

5.2.1 Workability

From this study, the conclusion that can be conclude is coconut ash is not suitable as construction material This is because, during the laboratory testing, the slump value of 0% and 6% coconut ash are zero slump whereas for 8% of coconut ash as cement replacement, the slump that has been obtained is 20mm. Slump value of 0%, 6% and 8% of coconut ash as cement replacement does not achieve the targeted slump which is between 60mm and 180mm.

5.2.2 Compressive Strength

From the compressive strength test result, the compressive strength of 8% coconut ash as cement replacement is the highest compare with 0% and 6% of coconut ash. However, coconut ash is not suitable to be a construction material to reduce the quantity of cement use. This is because, result of 0%, 6% and 8% of coconut ash were tested in 28 days, and the result is not achieved the targeted strength which is 30MPa.

5.3 Recommendation

In order to reduce the use of cement as construction materials, other waste materials beside coconut fibre ash can be investigate to be use as cement replacement such as pulverised fuel ash and ground granulated blast-furnace slag. This is because, the price of waste materials in used is more economical than cement as construction materials. The use of waste materials also helps to reduce air pollution. Waste materials as non-biodegradable material and will be incinerated in the open air.

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APPENDICES

Appendix A: Concrete Mix Design Form

Stage	Item	Reference or Calculation	Values
1	1.1 Characteristic strength	Specified	___30___ N/mm2 at ___28___ days Proportion Defective ___10___ %
	1.2 Standard Deviation	Table 1.1	___7___ N/mm^2 or no data ___ N/mm^2
	1.3 Margin	C1 or Specified	(k = ___1.28___) ___1.28___ x ___7___ = ___8.96___ N/mm^2
	1.4 Target mean Strength	C2	___30___ + ___8.96___ = ___38.96___ N/mm^2
	1.5 Cement type	Specified	**OPC**/SRPC/RHPC
	1.6 Aggregate type : coarse Aggregate type : fine		**Crushed**/uncrushed **Crushed**/uncrushed
	1.7 Free – water/cement ratio	Table 1.3, Figure 2	___0.6___
	1.8 Maximum free-water/cement ratio	Specified	___0.55___ Use the lower value **0.55**
2	2.1 Slump or Vebe Time	Specified	Slump ___60-180___ mm or Vebe time ___0-3___ s
	2.2 Maximum aggregate size	Specified	___20___ mm
	2.3 Free water content	Table 2.1	___225___ kg/m^3 **225** kg/m^3
3	3.1 Cement Content	C3	___225___ / ___0.55___ = ___409.09___ kg/m^3
	3.2 Maximum cement content	Specified	___-___ kg/m^3
	3.3 Minimum cement content	Specified	___325___ kg/m^3
	3.4 Modified free-water/cement ratio		use 3.1 if < 3.2 use 3.3 if > 3.1 **409.09** kg/m^3
4	4.1 Relative density of aggregate (SSD)		___2.7___ known/**assumed**
	4.2 Concrete density	Figure 3	___2300___ kg/m^3
	4.3 Total Aggregate content	C4	___2300___ - ___225___ - ___409.09___ = 1665.91 kg/m^3 **1665.91kg/m**
5	5.1 Grading of fine aggregate	Percentage passing 600 µm sieve	___30___ %
	5.2 Proportion of fine aggregate	Figure 4	___51___ %
	5.3 Fine aggregate content	} C5	**1665.91 x 0.51 =** **849.61** kg/m^3
	5.4 Coarse aggregate content	} C5	**1665.91 - 849.61 =** **816.3** kg/m^3

Quantities	Cement (kg)	Water (kg or L)	Fine Aggregate (kg)	Coarse Aggregate (kg) 10 mm	20 mm	40mm
Per m^3 (to nearest 5 kg)	**409.09**	**225**	**849.61**	-	**816.31**	-
Per trial mix of **0.045** m^3	**18.41**	**10.13**	**38.23**	-	**36.74**	-

1 N/mm^2 = 1 MN/m^2 = 1 MPa
OPC = ordinary Portland cement; SRPC = sulphate-resisting Portland cement; RHPC = rapid-hardening Portland cement.
Relative density = specific gravity
SSD = based on a saturated surface-dry basis.