WATER ABSORPTION OF CONCRETE CONTAINS 5% OF COCONUT SHELL AS FINE AGGREGATE

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Diploma in Civil Engineering

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ABSTRAK

Muktahir kini, permintaan terhadap pembinaan pembangunan semakin meningkat dengan jumlah penggunaan konkrit betambah pada kadar tertinggi. Hal ini demikian, konkrit mempunyai kekuatan bagi menampung beban yang bertindak ke atasnya. Namun, bekalan atau sumber terhadap agregat halus semakin lama, semakin berkurangan pada masa akan datang. Selain itu, beberapa kajian yang dilakukan, tercetus idea untuk mengatasi masalah ini bagi menggantikan bahan lain untuk digantikan dalam konkrit seperti sisa bahan buangan semula jadi seperti kelapa. Dalam kes ini, tempurung kelapa boleh dijadikan sebagai bahan menggantikan agregat halus. Oleh hal demikian, menggunakan kajian ini adalah untuk mengurangkan penggunaan agregat halus dan tempurung kelapa sebagai pengganti. Kajian ini menunjukkan hasil penyerapan air dan kekuatan mampatan yang dijalankan ke atas spesimen konkrit yang bergred 20 N/mm^2 yang mengandungi 5% tempurung kelapa dalam campuran konkrit. Tempoh dalam pengawetan konkrit diuji pada 7 dan 28 hari menghasilkan kadar penyerapan yang bagus apabila tempurung kelapa tersebut direndamkan terlebih dahulu berbanding dibiarkan kering.

ABSTRACT

Concrete usage is at its highest level right now due to rising demand for construction and development. This is true; concrete has the strength to withstand the pressure being applied to it. The supply or resource of fine aggregate is, however, increasing longer and will eventually run out. Furthermore, after numerous investigations were conducted, the concept to solve this issue by substituting natural waste products like coconut for other resources to be used in concrete emerged. Coconut shell can be used for fine aggregate in this situation. As a result, this study aims to decrease the usage of fine aggregate and increase the use of coconut shell as a replacement. This study shows the results of water absorption and compressive strength conducted on concrete specimens graded 20 N/mm^2 containing 5% coconut shell in the concrete mix. The duration of concrete curing was tested at 7 and 28 days resulting in a good absorption rate when the coconut shell was immersed first rather than left to dry.

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LIST OF SYMBOLS

m	meter
m^2	meter per square
kg	kilograms
%	percentage
mm	millimeter
℃	temperature
N/mm^2	unit grid concrete
W/mK	Watt per meter-Kelvin

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
BS	British Standard
CSA	Coconut Shell Aggregates
LWC	Light Weight Concrete
OPC	Ordinary Portland Cement
W/A	Water Absorption
W/C	Water Cement

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CHAPTER 1

INTRODUCTION

1.1 Background Study

The most often used building material worldwide is concrete. Due to the global development of infrastructure and construction activities, concrete is being used more frequently. However, there are certain drawbacks to increased concrete manufacturing, such as the imbalanced ecological system and extinction caused by ongoing aggregate extraction from natural resources. The extraction of aggregates from rivers and mountains harms the ecosystem, thus finding a replacement for the aggregates used today is a job worth researching. If there are naturally occurring alternatives to aggregate and the resource is abundant and renewable, getting aggregate will deplete the resource.

For some people in this nation, the use of coconut goods has long been a source of revenue. In the creation of composite materials that can be utilized in the construction of houses, such as concrete cubes, beams, and cylinders, the usage of coconut shells can be a useful substitution. The coconut plant is renowned for its ability to serve a variety of purposes with all its parts. To decrease costs or enhance the mechanical qualities of composite materials, farm waste can also be used to replace existing components in commercial products. Many coconut-producing nation's industrialists extol the advantages of utilizing trash from coconut plantations from an economic, environmental, and technological standpoint. By producing these items from agricultural waste, we can develop alternative building materials with lower production costs, which will lessen social and environmental issues.

1.2 Problem Statement

In many countries, especially those that want to develop their economy, the building business is growing quite quickly. In the study produced, which is lightweight concrete, it is used in the construction of partition walls and panel walls in frame structures. It is also used to obtain a given surface for exterior walls of small houses, and even used for reinforced concrete. However, due to the economic situation and the high demand for concrete, there may be a shortage of raw materials and an increase in the purchase price. As a result, the use of raw resources decreases due to high demand, and finally, it becomes difficult to obtain raw materials such as sand, gravel, etc. According to research, agricultural waste, such as coconut shells, can be used as a substitute for sand in concrete. As a result, by substituting coconut shells for sand, the problem of raw materials can be solved.

The issue with coconut shells, however, is probably compatible with using sand and coconut shell to make concrete. The purpose of this experimental investigation is to assess the effects of water absorption on concrete over a 7 and 28 day timeframe. The initial moisture content of the specimen, the aggregate, the volume % of paste, and the ratio of water to cement were the main areas of focus in the studies that examined the factors that affect concrete's capacity to absorb water.

1.3 Objective of Study

The objective of this research is:

i. To investigate the effect of water absorption in concrete by replacing 5% coconut shell.

ii. To determine the percent difference of water absorption due to the curing period.

1.4 Scope of Study

The aim of this research is to determine the effect of water absorption and strength of the coconut shell concrete. The coconut shell used as fine aggregate in this study.

1. The concrete mix design according to department of environment (POE method).
2. Two different percentage, 0% and 5% replacement by weight of fine aggregate used in this study.

1.5 Significance of Study

This study is based on more experimental is to identify the effects of coconut shell concrete in building. Meanwhile, to develop a new building material, it is hoped that the study will contribute to the process of developing more sustainable and affordable material that will have an easier impact on better housing and the fast delivery of housing expenditure on the affordability of housing in socio-economic groups, with the hope that it will contribute to the knowledge and appreciation of real housing condition to improved housing strategies.

Environmental pollution is also brought on by waste products that landfills are unable to keep up with. As a result, to lessen this issue, it must come up with fresh concepts that can guarantee the preservation and proper care of the land. Therefore, it enables it to manage this waste material properly and get significant environmental, economic, and social benefits by employing plant waste material, such as coconut shell or other waste material, in manufacturing new value.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The increase in global infrastructure and industry has led to a high growth rate in the use of concrete in this age of progress. The cost of purchasing materials in construction is also increasing every day. On the other hand, the production of concrete using agricultural waste as a substitute material has been the subject of many investigations and tests. This is the case; in this initiative, coconut shells are used to pick and discuss agricultural waste.

Throughout, material like cement, water, and aggregate are the three basic components used in the production of concrete. Aggregate comes in two varieties: coarse and fine. In this project, it was considered using coconut shell in place of fine aggregate, one of the elements in making concrete. Similarly, several studies include waste materials in their quest, including eggshells, rice husk shells, and many others.

2.2 Concrete

Concrete is a composite material made by combining binders (like cement or lime) with aggregate (such sand, stone, or brick fragments), water, and other ingredients. Concrete's quality and strength are influenced by the material's mixing rate. But a structure made of concrete can also be long-lasting and designed with concrete's dimensions.

Concrete becomes stronger over time and continues to get stronger for some time. Typically, concrete strength tests last 7, 14, and 28 days. On the other hand, the concrete's strength is unstable or lacking on the seventh and fourteenth days. It has high strength for 28 days. As a function, throughout the hardening, the temperature and humidity also affect the rise in concrete's compressive strength. This is due to the fact that cement water also has an impact on concrete control.

Furthermore, the results of the study replaced coconut shell for fine aggregate in the concrete used for this project by using it. According to research findings (Leman, 2016), some people are replacing concrete with coarse aggregate made from coconut shells. Therefore, it turns the coconut shell into a fine aggregate in this project.

It was discovered that coconut shell concrete's flexural behaviour is equivalent to that of other lightweight concretes. The findings of concrete compression strain and steel tension strain shown that under flexural loadings, coconut shell concrete is able to reach its maximum strain capacity. Deflection and fracture characteristics of coconut shell concrete are comparable to control concrete under serviceability conditions.

2.2.1 Fresh Concrete

The test was all conducted under the standard procedure of ASTM that include bulk density.

2.2.1.1 Bulk Density

According to (Mahajan,2021) the density of fine aggregate used for used to make concrete has a bulk density is between 1540 and 1680 kg/m^3. Besides that, the standard test method to the determine the bulk density of sand is given in ASTM.

However, density of Concrete is normal in 2400 kg/m^3. So, the normal concrete is about 2400 kg/m^3 for unreinforced concrete. That is dependent on the density of concrete material used.

Furthermore, the bulk density of the additional coconut shell in this study is less than 2400 kg/m^3 (Mahajan, 2021). Considering its density, the concrete is likely to be classified as lightweight concrete. Lightweight concrete is advantageous for building since it has extra advantages and is simpler to handle.

2.2.2 Hardened Concrete

Hardened concrete is concrete that must be durable enough to endure the environmental dangers for which it is built and strong enough to support the loads placed on the structure and its services. It is the sturdiest and longest-lasting material for construction.

2.2.2.1 Water retention

In this study, specimens were prepared, and the initial weight of all concrete cubes was taken. After completing each curing stage again, the weight of all the cubes is taken and recorded as the final weight. The amount of water retained in air-dried cubes and self-healing cubes was calculated and compared (Raju,2020).

2.2.2.2 Water Absorption

Specimens were prepared, and the initial weight of all the cubes was taken. After completion of 7, and 28 days of curing period concrete cubes are soaked in water for 24 hours. The amount of water absorbed by the concrete cube is calculated by its initial weight. The amount of water absorption in air-dried cubes and self-healing cubes was calculated and compared. Table 2.1 below shows the mix proportion from (S.P. Raju. V, 2020).

Table 2.1 Mix Proportions

Concrete design strength (MPa)	Cement	Fine aggrgate (30% of quary dust)	Coarse aggregate (10 mm + 20 mm)	W/C ratio
25(without flyash)	425.73	(191+445)	563+563	0.45
25(with flyash)	298+ 128	(187+436)	551+551	0.45

(*Source: S.P. Raju. V, 2020)*

2.3 Characteristic of Coconut Shell in Concrete

So the surface of the coconut shell concrete is smooth, it is easier to work with. When compared to regular concrete, coconut shell concrete has a great impact resistance. Moreover, compared to typical aggregate, coconut shell has a greater potential to retain moisture and absorb water.

2.3.1 Fire Resistance

The properties of coconut shell include excellent insulation against temperature and sound, unaffected by moisture and dampness toughness and durability (Anthony, 2015).

2.3.2 Heat Insulator

Ismail, (2020) found that the thermal conductivity of coconut shell composite to be in the range of 0.062 – 0.078 W/m K which is less than 0.1 W/m K. Therefore, coconut shell using epoxy resin adhesive is a good thermal insulator.

2.3.3 Durability

Durability of concrete can be defined as its capacity to withstand weathering, chemical attack and abrasion while maintaining appropriate engineering qualities. Depending on the exposure environment and intended qualities, different concretes require varying levels of durability (Kryton, 2014).

Concrete's resilience also allows it to defend against environmental factors like cooling and weather. The proper sort of quality and material mixing rate must be used in the concrete to meet this condition.

Due to its strength and high modulus characteristics, coconut shell has great potential as a replacement material in concrete.

2.3.4 Water Absorption

Concrete's waterproofness could be assessed using a water absorption test such as the BS 1881-122:2011 test. In this test, the amount of water that seeps into the concrete sample when submerged is measured (Yuan,2020). Furthermore, the effects of the treatment's water absorption are consistent with the presence of pores in the treated coconut shell aggregate.

Likewise, coconut shell is extremely resilient to abrasion and is not readily harmed. The percentage of beginning and ultimate weight values fluctuate greatly.

2.4 Factors Influence the Strength of Concrete

Certain factors, including the quality of the raw materials, the proportion of water to cement, the amount of coarse and fine aggregate, the duration of the concrete, the temperature, the relative humidity, and the curing of the concrete, affect the strength of the material.

2.5 Water-Cement Ratio

Concrete is produced using water to create easy-to-work-with, non-plastic concrete. The strength and density of concrete will diminish if water is used above the recommended limitations, and it will be difficult to work with and the hydration process will not be completely effective.

The link between the water and cement ratios in concrete mixtures is known as the cement-water ratio. The amount of water to cement used in the mix is known as the "cement water ratio." The strength of concrete generally increases as the cement-water ratio decreases, but the workability of the concrete decreases, making it more challenging to compact and cast it.

2.6 Cement

Cement is a material produced by burning a mixture of limestone and clay. The cement has cohesive properties that allow it to bind its component materials like fine and coarse aggregates into solid concrete. Cement has many ties and is used according to the needs and the suitability of the situation somewhere.

Portland Cement (OPC) was employed in this investigation. This cement is frequently used in buildings. It serves as the building block for plaster, mortar, and concrete.

Ordinary Portland cement is commonly used in the construction industry. This is because it is suitable for use in the building for general concrete and places where there is no sulfate or groundwater. The main chemical compounds are measured to have a moderate strength of growth and teat evolution that is appropriate for the purpose. The Portland cement properties change gradually according to its chemical composition.

2.7 Aggregates

Aggregates are terms used to describe a material such as sand and gravel used the in concrete mix. Aggregates are obtained either from a river or a probe. The forming of rocks from the rivers is round while the quary are sharp. There are two types of coarse aggregates such as 10 mm and 20 mm. The most widely used size is 20 mm size for reinforced concrete grade 20 or 1:2:4 mixed ratios 10 mm and 40 mm sizes hard to fill a small space. Coarse aggregates of 10 mm and 20 mm can be mixed to rm a better concrete. The type of aggregates commonly used in Malaysia granite, limestone, sandstone and, conglomerate.

2.7.1 Characteristic of Aggregates

Aggregate containing natural shale or shale-like particles, soft and porous particles, and certain types of cherts should be avoided because they have poor resistance to weathering. The properties of quality aggregates are described as follows:

i. The strength of the stone and it is bond.
ii. Physical properties such as relative density, bulk density, porosity, absorption of moisture content, bulk strength and, resistance to acid and alkali attack.
iii. Particle size and distribution.
iv. Its hardness must exceed the hardness of cement.
v. Does not contain ingredients that prevent hydration and damage iron.
vi. The shape must be almost round and the surface must be rough to produce strong force.

2.8 Previous Research on Coconut Shell

It can be used as one of the alternatives to make concrete, based on the study's findings (Kumar,2019) that were obtained using natural resources. Concrete is created utilising natural elements like coconut shells. In the study, coarse aggregate of 5%, 10%, and 20% was used in place of coconut shell. Coconut shell concrete's compressive strength was assessed after 7 and 28 days. As the replacement % rises, coconut shell concrete's durability declines. Therefore, coconut shell is particles are used as reinforcing material for investigation. Coconut Shell has high strength and modulus properties.

While the study has data related to water absorption when concrete has been modified by using coconut shells. In this test, the effect of water absorption is important in case the material that has been developed when used for application comes in contact with water. The effect was observed after 24 hours and the results are given in table 2.2

Table 2.2 Water absorption of coconut shell reinforced composite.

Sample	Coconut Shell (5%)	Coconut Shell (10%)	Coconut Shell (20%)
1	0.431	0.483	0.518
2	0.432	0.482	0.520
3	0.430	0.481	0516

(*Source: Kumar,2019)*

Based on the results, 20% of coconut shell particles have the highest capacity to absorb water, and the rate of increase of that capacity is almost 20% less. Therefore, coconut-related particles will show a stronger affinity with each other. Since it won't grow, space will be limited. This is the case, the percentage of 20% is the appropriate in water absorption.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Research methodology is the specific procedures or strategies used to find, select, process, and analyze information about a topic. In a research paper, the methodology section allows the reader to objectively examine a study's overall validity and dependability.

3.2 Research Methodology

The flow chart of the research has summarized the research of study show in Figure 3.1

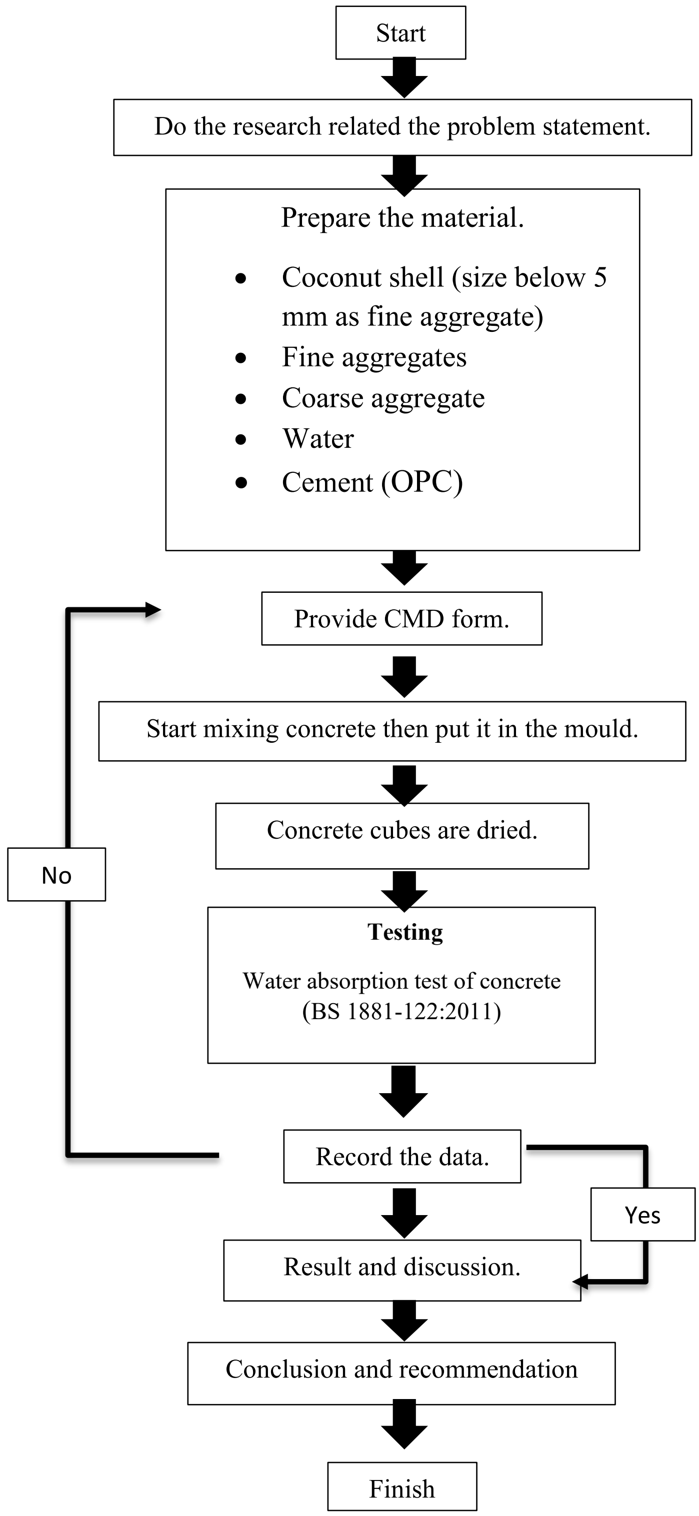

Figure 3.1 Flow chart for project workflow

3.3 Preparation of Material

Preparation to produce concrete as follows this study.

3.3.1 Cement

Cement is a material produced by burning a mixture of limestone and clay. The cement has cohesive properties that allow it to bind its component materials like fine and coarse aggregates into solid concrete. Cement has many ties and is used according to the needs and the suitability of the situation somewhere. Usually, Portland cement is the most cement used in construction and for precaution the, cement must place to be arranged and kept at dry place to avoid become hardened. The main chemical compounds are measured to have a moderate strength of growth the heat evolution that is appropriate for construction. The Portland cement properties change gradually according to its chemical composition

.

Figure 3.2 Ordinary Portland Cement

3.3.2 Coarse Aggregates

The formation of stones used for the preparation of concrete materials is round and sharp. For the study, we used two sizes of coarse aggregate which are 10 mm and 20 mm. to mix in the concrete.

Figure 3.3 Coarse Aggregate

3.3.3 Fine Aggregates

In this project, 2 types of fine aggregate are used, namely natural fine aggregate (sand) and coconut shell. For normal concrete using completely natural fine aggregate (sand). To produce modified concrete by using crushed coconut shells in place of the remaining 5% of natural fine aggregate. Filling voids in coarse aggregate and serving as a workability enhancer are the two main functions of fine aggregate.

Figure 3.4 Fine aggregates

3.3.4 Coconut Shell

In this project have replace 5% of the fine aggregate with coconut shell. As a result, coconut shells were bought from supplier of coconut in Selangor which is located next to a residential area. There are several techniques to break the coconut shell into fine aggregates to reach a size below 5mm. Coconut shell used were prepared in towards different batches. First batch, dry coconut shell will be mixed in concrete and for second batch, the coconut shell will be soaked in water for 24 hours and will be tossed and remove excess water before mixing in concrete. Figure 3.2 shows the size of the coconut shell that has been crushed to a size of 5mm.

Figure 3.5 The Crushed Coconut Shell

3.3.5 Water

Water is needed in concrete for hydration and concrete workability. Water is often used to mix the concrete should be free of impurities such as silt, soil, organic acids, and other organic matter such as salt and alkali. Usually, the water used to mix concrete is water that clean and clear form impurities or taken from an approved source.

3.4 Concrete Mix Design

The concrete mix design using DOE method is a method to specify the proportions of concrete mix ingredients to achieve the strengths that have been specified. The ingredients in the concrete are cement, water, coarse aggregate, natural fine aggregate, and coconut shell as a particle of fine aggregate. For this research, the strength target is 20 N/mm^2 concrete at 7 and 28 days.

There is percentage replacement of fine aggregate was determined by the weight method. The percentage used in this research are 5% of coconut shell shown in table 3.1. Besides that, the mix design also including of 20% wastage.

Table 3.1 Mix proportion table

Percentage (%)	Cement (kg)	Water (kg)	W/c ratio	Fine aggregate (kg)	Coarse aggregate (kg)	Coconut shell (kg)
0%	10.85	7.70	0.71	33.57	50.34	-
5%	10.85	7.70	0.71	31.89	50.34	1.68

3.5 Preparation of Equipment

In this research using a cube mold of size 150 mm × 150 mm × 150 mm was used to prepare 20 samples of lightweight concrete. The cube mold is placed with oil for easy removal from the mold when the cube concrete dries. The equipment used in this research is a scope, a spatula, an iron tray, a scale and a wheelbarrow.

Procedure to make cube specimen

The surface of the cube molds has to apply with oil. Then, the mold is placat above the base of the flat condition. the concrete was poured in two layers, and it would have the same thickness. Every layer must be compacted at least twenty-five (25) times using iron rod. All the cube concrete has marked with the numbers.

All the materials of the concrete were prepared according to the mix design. Then, poured into concrete mixer for mixing process to ensure the material mix very well. After completed mixing process, the fresh concrete was poured into the mold and the concrete surface was finished with trowel to provide a smooth surface. Next, the specimen left for 24 hours after completing of casting such as in Figure 3.6. After 24 hours, the specimen was removed from the mold and the specimen were cure with different method.

Figure 3.6 The concrete cube in the mold after casting

3.6 Curing

Curing is to control the moisture content and temperature after the placement process is complete. This stage is important when minimizing drying which can cause cracking after the concrete has fully hardened. In addition, it will build and achieve the necessary strength. Concrete curing can be done in several ways. Contains water or moisture close to the concrete surface such as water spray, splash water and dishes. This can prevent the loss of moisture from concrete such as placing plastic sheets, spraying preservative membranes and others.

For this study, concrete samples with two different curing methods were used. First, the cube specimen soaked in water as shown in Figure 3.7 and second Figure 3.8 shows the air curing method after the concrete sample is left to dry for 24 hours after being removed from the mold. The curing period for cube specimens is 7 and 28 days.

Figure 3.7 Water curing tank

Figure 3.8 Air curing

3.7 Concrete Test

Concrete testing is important for determining the strength of the concrete also workability the concrete. The factors that influence the strength of the concrete depends on water content, mixture ratio, size of aggregates, the shape of aggregates, additive and others.

3.7.1 Water Absorption Test

The process that involves the preparation of the concrete, first that concrete contain ordinary mixture and second the concrete that contains coconut shell. Next, all the test will be conducted on the sample cube concrete on the 7 days and 28 days.

The oven drying method is used to carry out this test in accordance with the guidelines specified in ASTM C 642-06. For this test 150 mm $\times$ 150 mm cube size was used. The specimen is kept in a curing tank for 24 hours. Specimens are removed from the curing tank after 7 and 28 days and dried in the open air to remove any remaining surface moisture. The specimen is next dried in the oven for 24 hours at 100 $\pm$12 ℃ as shown in Figure 3.9. At the end of the 24 -hour, the weight of the specimen was measured using a standard weighing balance sheet.

Figure 3.9 Cube placed in oven

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter show the results obtained from the experimental testing and discussion of test preceding chapter which examine overall performance of coconut shell waste in concrete composition. The outcomes of the test covered the water absorption and concrete density of the specimen. The results and discussion targeted on the material properties, and concrete strength. All the results f the test was mentioned in this chapter and all the records were illustrated in table and graph for more detail description.

4.2 Water Absorption

The water absorption test is to determine the amount of water absorbed by the aggregates between their immersion and the first reading on the scale. All the mixed were subjected to water absorption test at the end of water curing period of 7 and 28 days.

Table 4.1 show the results percentage of water absorption at 7 days in control concrete and modified concrete.

Table 4.1 Percentage of water absorption at 7 days

Sample	Control (%)	Modified Dry Coconut Shell (%)	Modified Wet Coconut Shell (%)
1	17	17	86
2	1	1	32
3	7	7	28
4	1	1	95
5	10	10	62

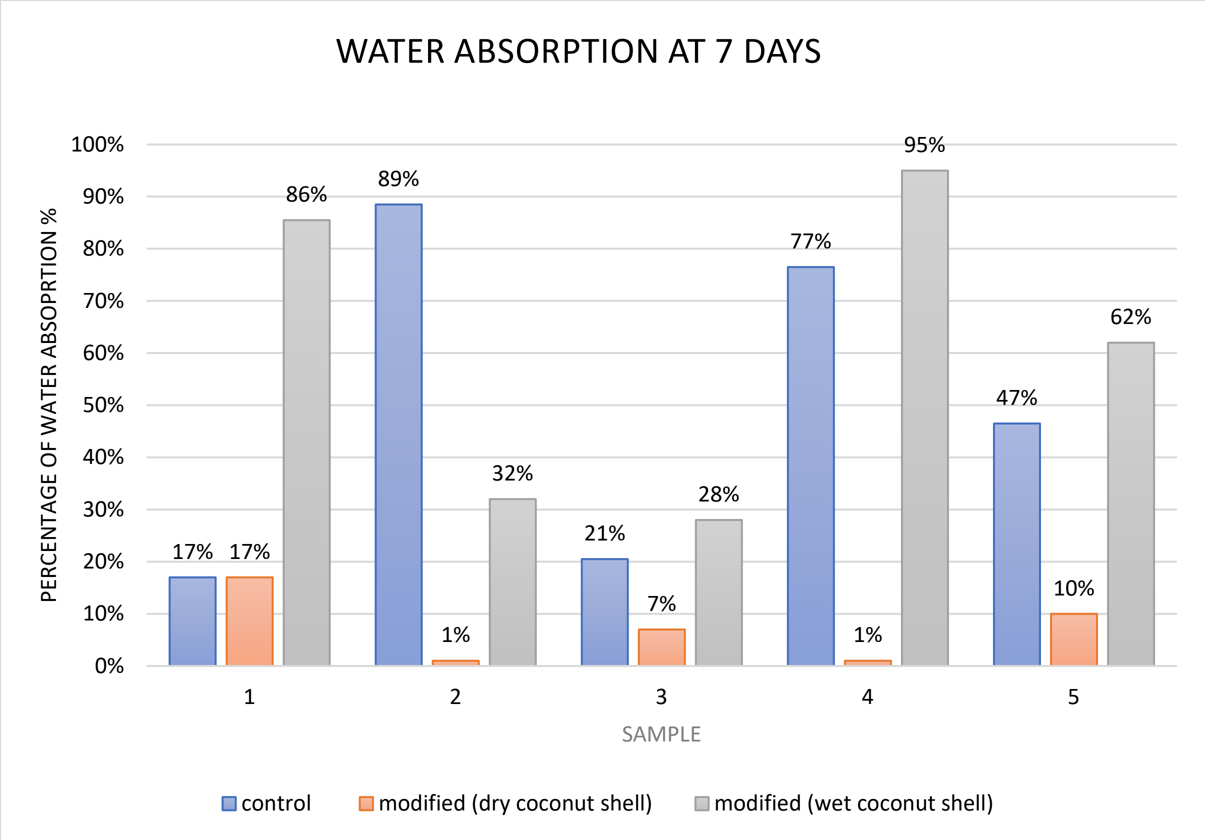

Figure 4.1 Graph of water absorption at 7 days

The results for control concrete (conventional concrete) and modified concrete after 7 days are shown in Table 4.1 and Figure 4.1. The modified concrete (wet coconut shell) in sample 4 has the maximum water absorption value, with a water absorption rate of 95%, based on the observation made above. The lowest is modified concrete (dry coconut shell), which is found in samples 2 and 4 with a value of 1%. The highest figure for control concrete, sample 2, had an 89% water absorption rate. Given this, the material with the highest water absorption rate can be used to make concrete. Therefore, compared to control and modified concrete (dry coconut shell), the rate of water absorption in modified concrete for wet coconut shell is good.

Table 4.2 show the results percentage of water absorption at 28 days in control concrete and modified concrete.

Table 4.2 Percentage of water absorption at 28 days (testing 2)

Sample	Control (%)	Modified Dry Coconut Shell (%)	Modified Wet Coconut Shell (%)
1	13	42	7
2	16	8	9
3	13	8	42
4	36	48	55
5	1	8	39

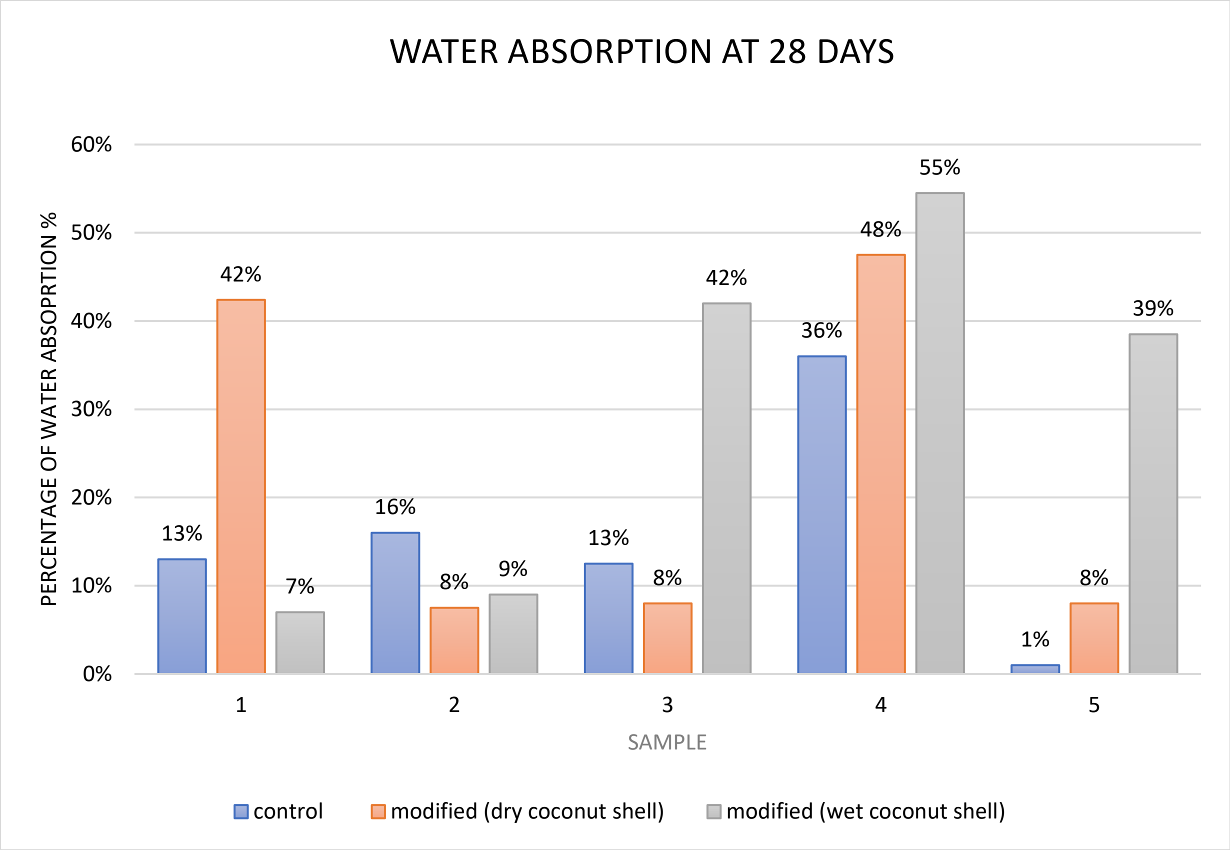

Figure 4.2 Graph of water absorption at 2 days

The results for control concrete (conventional concrete) and modified concrete after 28 days are shown in Table 4.2 and Figure 4.2. The modified concrete (wet coconut shell) in sample 4 has the maximum water absorption value, with a water absorption rate of 55%, based on the observation made above. The control concrete in sample 5 has a value of 1%, which is the lowest. Sample 4 has the highest modified concrete (dry coconut shell) results, with a value of 48%. Given this, the material with the highest water absorption rate can be used to make concrete. As a result, when compared to control and modified concrete, the rate of water absorption in concrete for wet coconut shells is the best (dry coconut shell).

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter discusses the study's findings in light of the goals outlined in the study. Besides that, to evaluate the impact of water absorption in concrete by replacing 5% coconut shell, this study aims to estimate the percentage difference in water absorption due to the curing duration. The purpose of the experimental test was to determine whether coconut shells could be used to produce concrete with a 15% water absorption rate that is more sustainable than ordinary concrete.

5.2 Conclusion

Based on the results and discussions obtained in the previous chapter, many conclusions were obtained for this study. There is one thing that needs to be fulfilled to carry out this study which is the water absorption test in concrete for two tests, and 10 control concrete samples for 7 days and 28 days. Next, 10 samples are concrete (coconut shell) for 7 days and 28 days.

Therefore, have two tests were performed with two concrete conditions, namely modified concrete and conventional concrete. These tests are performed at 7 days and 28 days, respectively, used to determine water absorption. In this produced project, 5% coconut shell is used as fine aggregate in concrete. At 7 days of curing period, it was found that concrete modified with coconut shell soaked in water had the highest absorption value compared to concrete modified with dry coconut shell and control concrete. Likewise with 28 days of curing period, the highest value is concrete modified by way of wet coconut shell. Therefore, both curing periods have the highest water absorption rate of modified concrete (wet coconut shell).

Besides that, two curing techniques were used in this study: air curing and water curing. In this study, air curing outperforms water curing in terms of results. This occurs when too much water in the pores of the concrete reduces its strength of the concrete. Concrete gets stronger after drying out on the surface.

Finally, the water absorption test showed that the concrete made from coconut shells was successful. Due to this, it is appropriate to produce concrete. When the percentage of absorbed water is greater than 15%, there has been good water absorption.

5.3 Recommendation

From the result analysis and discussion some recommendations may improve the additional study on this topic:

1. The coconut shell is suitable for replacing fine aggregate.
2. Half immersed in the curing tank of the specimen are better than fully in the curing tank.
3. Increase the percentage of coconut shells to find the rate of water absorption in concrete.

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APPENDICES

APPENDIX A

Data of Water Curing Test

Initial (before\curing tank)

CUBE	TESTING 1			
	CONTROL		MODIFIED	
	7	28	7	28
1	7.93	7.775	6.52	6.34
2	7.485	7.585	6.64	6.665
3	7.93	7.81	6.54	6.41
4	7.595	7.6	6.57	6.675
5	7.955	7.53	6.475	6.523

CUBE	TESTING 2			
	CONTROL		MODIFIED	
	7	28	7	28
1	7.82	7.945	7.855	7.435
2	7.8	7.575	7.86	7.48
3	7.905	8.095	7.93	7.495
4	7.995	7.655	8.015	7.855
5	7.035	7.465	8.06	7.68

Final (after curing tank)

CUBE	TESTING 1			
	CONTROL		MODIFIED	
	7	28	7	28
1	7.64	7.74	6.35	5.916
2	7.36	7.415	6.631	6.59
3	7.805	7.75	6.47	6.33
4	7.42	7.31	6.565	6.2
5	7.645	7.505	6.38	6.515

CUBE	TESTING 2			
	CONTROL		MODIFIED	
	7	28	7	28
1	7.65	7.815	7	7.365
2	6.915	7.415	7.54	7.39
3	7.7	7.97	7.65	7.075
4	7.23	7.295	7.065	7.31
5	6.57	7.455	7.44	7.295

APPENDIX B: Data CMD

Stage	Item	Reference or Calculation	Values
1	1.1 Characteristic strength	Specified	20 N/mm2 at 28 days Proportion Defective %
	1.2 Standard Deviation	Table 1.1 C1 or Specified	5 N/mm^2 or no data N/mm
	1.3 Margin	C2	(k = 1.64) 1.64 x 5 = N/mm^2 8.2 +
	1.4 Target mean Strength	Specified	20 + 8.2 = 28 N/mm^2 2
	1.5 Cement type		OPC/SRPC/RHPC
	1.6 Aggregate type : coarse Aggregate type : fine	Table 1.3, Figure 2	Crushed/uncrushed Crushed/uncrushed
	1.7 Free – water/cement ratio	Specified	0.71
	1.8 Maximum free-water/cement ratio		Use the lower value 0.71
2	2.1 Slump or Vebe Time	Specified	Slump 30-60 mm or Vebe time 3-6 s
	2.2 Maximum aggregate size	Specified	20 mm
	2.3 Free water content	Table 2.1	190 kg/m^3 190 kg/m^3
3	3.1 Cement Content	C3	190 / 0.71 = 268 kg/ m
	3.2 Maximum cement content	Specified	kg/m^3
	3.3 Minimum cement content	Specified	kg/m^3 268 kg/m^3
	3.4 Modified free-water/cement ratio		use 3.1 if < 3.2 use 3.3 if > 3.1
4	4.1 Relative density of aggregate (SSD)		2.65 known/assumed
	4.2 Concrete density	Figure 3	2530 kg/m^3
	4.3 Total Aggregate content	C4	2530 - 190 - 268 = 2072 kg/m^3 268 kg/m^3
5	5.1 Grading of fine aggregate	Percentage passing 600 µm sieve	50 %
	5.2 Proportion of fine aggregate	Figure 4	40 %
	5.3 Fine aggregate content	} C5	0.40 x 2072 = 829 kg/m^3
	5.4 Coarse aggregate content	} C5	0.60 x 2072 = 1243 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)	268	190	829	414	829	
Per trial mix of 0.040 m^3	10.854	7.695	33.576	16.767	33.57	

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.