POLITEKNIK MALAYSIA

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DEPARTMENT OF CIVIL ENGINEERING

COCONUT COIR FIBRE ROOF TILES

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CHAPTER 1

INTRODUCTION

1.0 Introduction

A roof is the top covering of a building, including all materials and constructions necessary to support it on the walls of the building or on uprights; it provides protection against rain, snow, sunlight, extremes of temperature, and wind. A roof is part of the building envelope.

The characteristics of a roof are dependent upon the purpose of the building that it covers, the available roofing materials and the local traditions of construction and wider concepts of architectural design and practice and may also be governed by local or national legislation. In most countries a roof protects primarily against rain. A veranda may be roofed with material that protects against sunlight but admits the other elements. The roof of a g garden conservatory protects plants from cold, wind, and rain, but admits light (RW Brunskill, (1970:58-61)).

Roofing material is the outermost layer on the roof of a building, sometimes self-supporting, but generally supported by an underlying structure. A building's roofing material provides shelter from the natural elements. The outer layer of a roof shows great variation dependent upon availability of material, and the nature of the supporting structure. Those types of roofing material which are commercially available range from natural products such as thatch and slate to commercially produced products such as tiles and polycarbonate sheeting. Roofing materials may be placed on top of a secondary water-resistant material called underlayment.

In order to optimize the cost of construction, engineers have always been on the lookout for efficient and light roofing which requires minimum maintenance and labour to install. Coir is a green building material and has potential as a raw material for the production of roofing materials like corrugated sheets and tiles. The main objective of the paper is to produce cost effective roofing tiles without compromising their quality by replacing cement up to 15% using coir fibre. On the basis of the results, a composite with a fibre volume of 10% was considered to be the optimum composite. A comparison of material costs indicated that this composite tile was substantially cheaper than the ordinary cement concrete tile. (Emmitt & Gorse, 5 February 2013)

1.1 PROBLEM STATEMENT

Nowadays, there are a big number of pitched roofing products available in the global market. These consist of concrete tiles, clay tiles, slate and shingles. Concrete tiles are a great and ideal option of material for roofing. They are popular for their versatility, as they can be found in lots of different shapes, colours and designs.

They can likewise last a long time. The problem statement of our project is concrete roof tiles are heavy, therefore the roof structure needed to be strong and must be able to handle the weight of a roof tile. Structural reinforcement is needed if it is founded that the weak structure are unable to withstand the load capacity of the concrete roof tiles.

Concrete roof tiles are easily breakable and prone to weathering. Although hard and challenging to damage, heavy hail or branches falling on them can break them. In fact the standard roof tile absorbs more water than Coconut Coir Fibre roof tile

In Malaysia, there are plenty of agricultural waste products such as coconut fibre, which can lead to social and environmental problem if the waste doesn't dispose properly.

1.2 OBJECTIVES

The objectives of this project research are to test the strength of Coconut Coir Fibre Roof Tiles (CCR Tiles) with standard requirements. Next is to produce a lightweight Coconut Coir Fibre Roof Tiles (CCR Tiles). And another objective of this research is to test Coconut Coir Fibre Roof Tiles using water absorption test.

1.3 SCOPE OF STUDY

The scope of study focus on producing our product Coconut Coir Fibre Roof Tiles (CCR Tiles) is produce the in Politeknik Sultan Salahuddin Abdul Shah's Concrete Lab and the study replace sand with coconut fibre for 5%, 10 and 15% in terms of weight. In terms of compressive strength test, 15% of Coconut Coir is selected to be substituted with sand in terms of weight because it obtains higher compressive strength compared to other percentage. The use of coconut fibre in cement has increased the flexural strength and consequence improves the crack resistance. Coconut fibre alters the behaviour of concrete when cracks occur across the structure and thus can provide a residual strength of the concrete.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

A literature review is a scholarly paper, which includes the current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic.

The aim of this literature review is to understand a research topic and to establish the importance of a topic. It also helps to develop our own ideas to be created in our project. More than that, literature review also make sure we are not simply replicating research that others have already successfully completed.

Hence, systematic and detailed planning must be arranged to produce a complete project. The study about the type of materials, mixture of materials, level of product safety, structural strength, project size, and the cost of project should be considered. This is to ensure that no any problems will arise during the completion or presentation of the project.

Roof tiles are designed mainly to keep out rain, and are traditionally made from locally available materials such as terracotta or slate. Modern materials such as concrete and plastic are also used and some clay tiles have a waterproof glaze. Roof tile's purpose is to protect interior from wind, rain, and extreme weather. Many prospects need to be considered when it comes to choosing the suitable roofing products. (RLF Felllow at Trinity & All Dr David Kennedy, Saints College, Leeds, and then a Senior Lecturer at the University of Hull.)

2.1. MATERIALS OF ROOF TILES

No	Author	Year	Material	Reference
1.	Blezard Robert.G Sir Fredrick Lea	2003 1995	**Cement** A substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Cement is the most widely used material in existence and is only behind water as the planet's most-consumed resource. (Blezard, Robert G.)	https://www.researchgate.net/publication/286187486_The_History_of_Calcareous_Cements
2.	K.Padmalal Asian Journal of Convergence in Technology	1976 2018	**Sand** Sand is a granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass. (Padmalal, 1976)	https://link.springer.com/article/10.1007%2Fs002540050475
3.	How coconut coir is made	2006	**Coconut Coir Fibre** Coir, or coconut fibre, is a natural fibre extracted from the husk of coconut and used in products such as floor mats, doormats, brushes and mattresses. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. It has the advantage of not sinking, so can be used in long lengths on deep water without the added weight dragging down boats and buoys. They are made up of small threads, each less than 1.3 mm long and 10 to 20 micrometres in diameter. (How coir is made, 2006-07-14)	https://www.researchgate.net/publication/228067617_Journal_of_Natural_Fibers_Coir_Fiber-Process_and_Opportunities

2.2. TYPES OF ROOF TILES

No	Type of Roof Tiles	Reference
1.	**Slate Roof Tile** Slate roof became very popular in the mid-1800 as slate roof shingles began being replacing wooden shingles. Slate roof tiles are durable, eco-friendly, and fireproof. In fact, some of our nation's oldest structures still carry their original slate roofs. Slate tiles are a popular type of roofing shingles because they create a stone roof that is 100% natural and includes beautiful colour variations in the stone's surface. Each slate deposit holds a different colour of slate, and combinations of colour can be used to create different slate roof designs. As with other popular roof shingle styles, synthetic slate roof tiles are now made from wide variety of manufacturing materials.	https://www.oldhouseonline.com/gardens-and-exteriors/slate-roof-stand-ins https://www.hindawi.com/journals/ace/2018/7361798/
2.	**Bituminous tile** Bituminous tile is a fiberglass or canvas made out of cellulose impregnated with bitumen. In order to provide ductility and strength to the shingles, polymeric additives are supplemented into the bitumen composition. The tile surface is covered with granite or basalt chippings on the outside. Chippings primarily create the so-called protective layer that provides additional strength and helps it obtain a special appearance. Such tiles are used on roofs with a slope of not more than 12 degrees. The lower surface is covered with tile adhesive, which greatly facilitates installation.	http://www.mida.lt/en/products/bitumen-tiles/
3.	**Concrete tile** Concrete tile is made of cement mortar (cement, sand, water). The manufacturing stages of this roofing material are simple: mixing of the components, formation of tile, coloration. Tiles are dried in a special chamber during a day, then the process is repeated, and then the completed tiles are kept to mature for about a month. The chemicals are not added during the process, iron oxide is used as a colouring pigment. The components do not harm human health, making it an eco-friendly material. In appearance, it is most similar to classic natural tile made out of baked clay. Concrete tile has good strength properties, durability, frost resistance, as well as excellent sound and heat insulation properties. The disadvantage is large weight of the roofing material, which requires enhanced building constructions.	https://www.roofcostestimator.com/concrete-vs-clay-roof-tile-cost/

CHAPTER 3
METHODOLOGY

3.0 Introduction

Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. A methodology does not set out to provide solutions it is therefore, not the same as a method. Instead, a methodology offers the theoretical underpinning for understanding which method, set of methods, or best practices can be applied to a specific case, for example, to calculate a specific result.

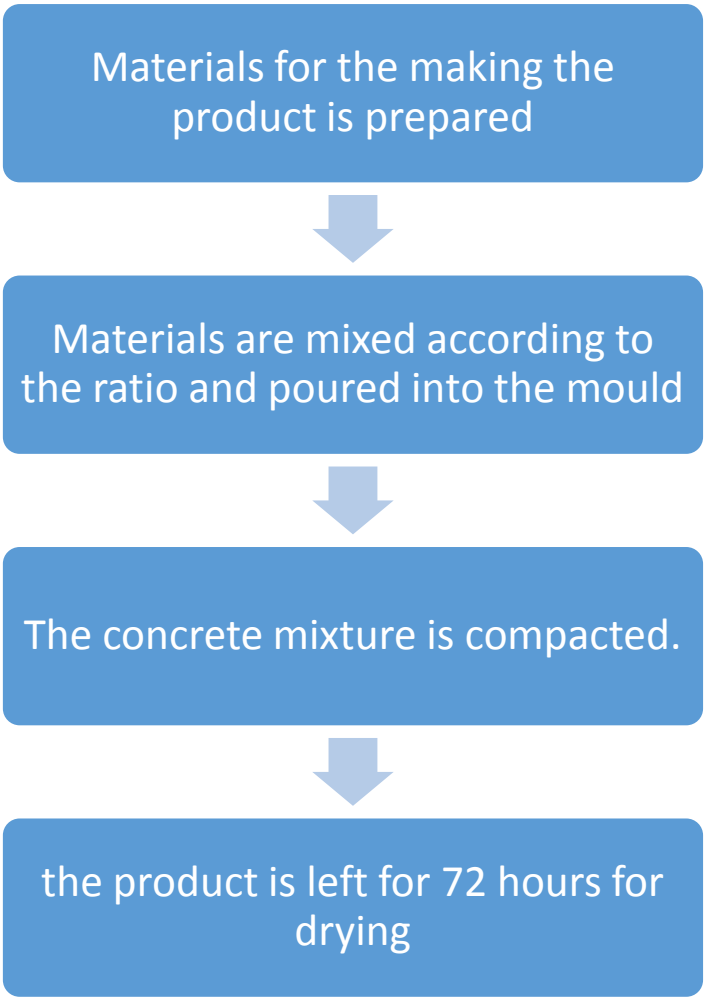
Each step of project is a process to complete the project. Every step must be followed one by one and must be done carefully. If some errors occurs, it can make the project probably could not operate or do not look neat and perfect. Before the project finish, various processes needs to be done according to proper procedures to ensure that projects do not have any problems.

3.1 Flow Chart Process

3.2 Product Making

Using methodology by using (sample making in laboratory method)

- Location: proposed Politeknik Sultan Salahuddin Abdul Aziz structure lab.

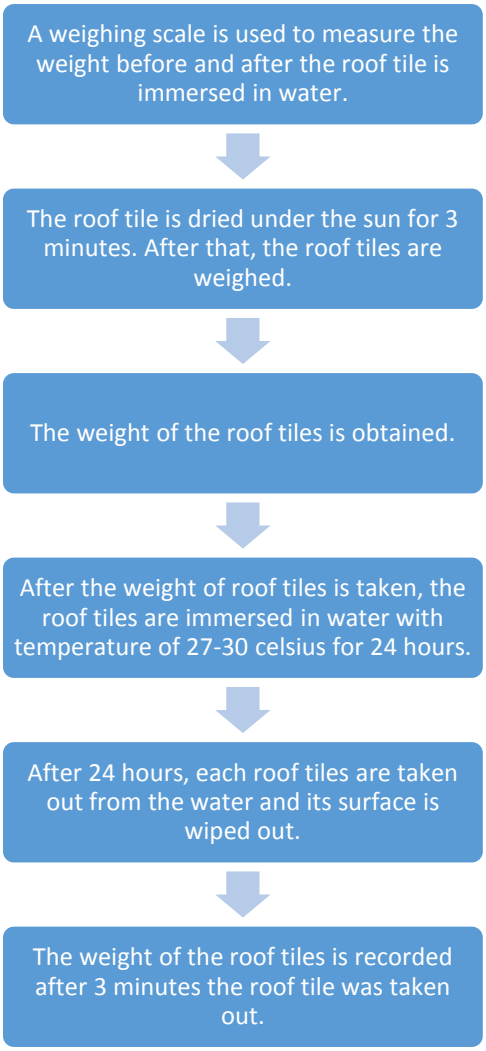


3.3 Testing

3.3.1 Water absorption

Water absorption test is conducted to determine the amount of water that is absorbed by the roof tiles. A detailed analysis is also presented in order to establish useful relationship between them. Concrete specimens of different water absorption were prepared through different curing conditions, and results indicated that curing condition can significantly affect the surface water absorption.

The samples of roof tiles will be weighed in a dry condition. Curing is the maintaining of an adequate moisture content and temperature in concrete at early ages so that it can develop properties the mixture was designed to achieve. Curing begins immediately after placement and finishing so that the concrete may develop the desired strength and durability. Later, the samples will be immersed in water for 24 hours. (krishnan, 2018)



The percentage of water absorption test is obtained by the formula below:

$$W = \left[\frac{M2 - M1}{M1}\right] X\ 100$$

W: The absorption of water by the roof is done as a percentage.
M1: Original weight (dry roof).
M2: The weight of the roof after 24 hours is soaked.
(standard test method for measurement of rate of absorption of water , 2018)

CHAPTER 4

Results and Analysis

4.0 Introduction

The results section should aim to narrate the findings without trying to interpret or evaluate, and also provide a direction to the discussion of our final year project. The results are reported and reveal the analysis. To achieve the objective of study, we use water absorption test. (tom, 2015)

4.1 Compressive Strength Test

$$Calculations:\ compressive\ strength = \frac{Maximum\ Load}{(Cross\ Sectional\ Area\ )} = \frac{P}{A}$$

Equation 4.0 Calculations of Compressive Strength

Curing Day	0%	5%	10%	15%
7 days	22.4	25.8	28.6	29.5
14 Days	28.5	26.2	29.2	30.8

Table 4.0Results of Compressive Strength of Coconut Coir Fibre Roof Tiles

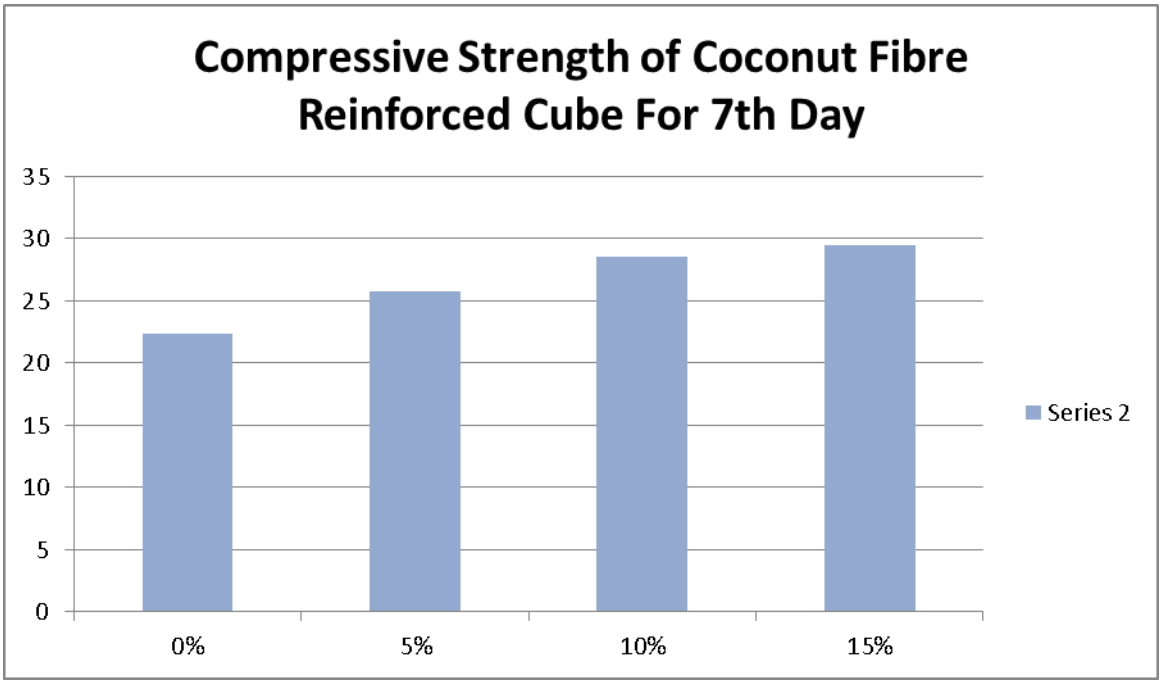


Figure 4.0Compressive Strength of Coconut Fibre Reinforced Cube for 7th Day

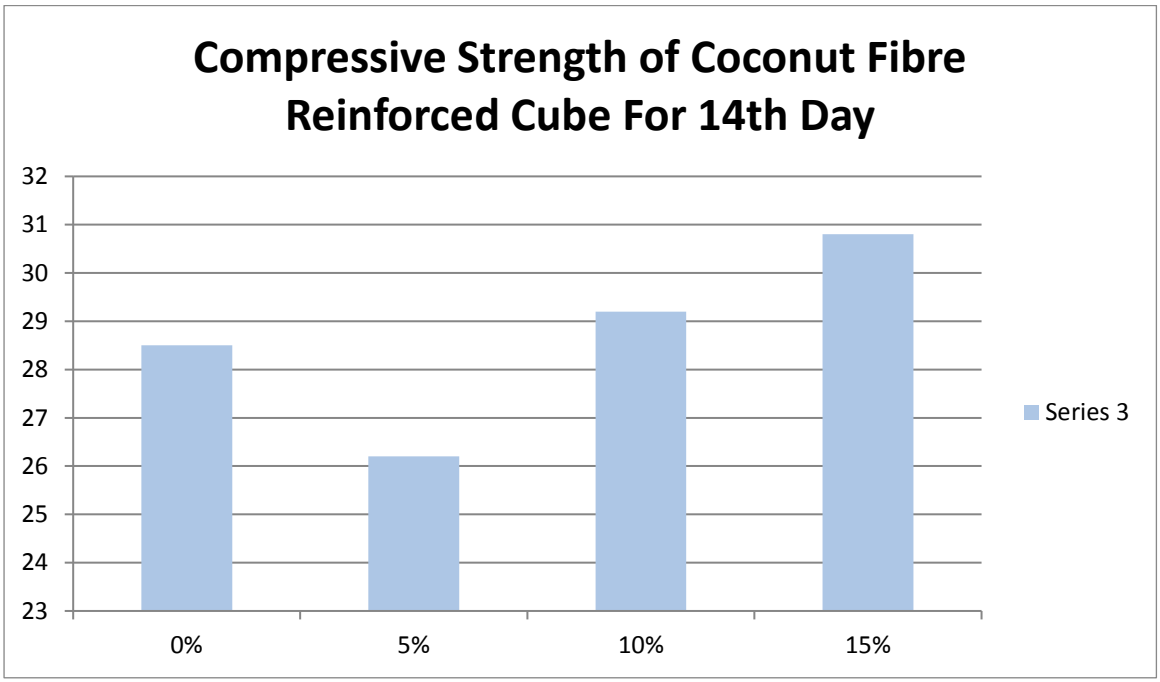


Figure 4.1Compressive Strength of Coconut Fibre Reinforced Cube for 14th Day

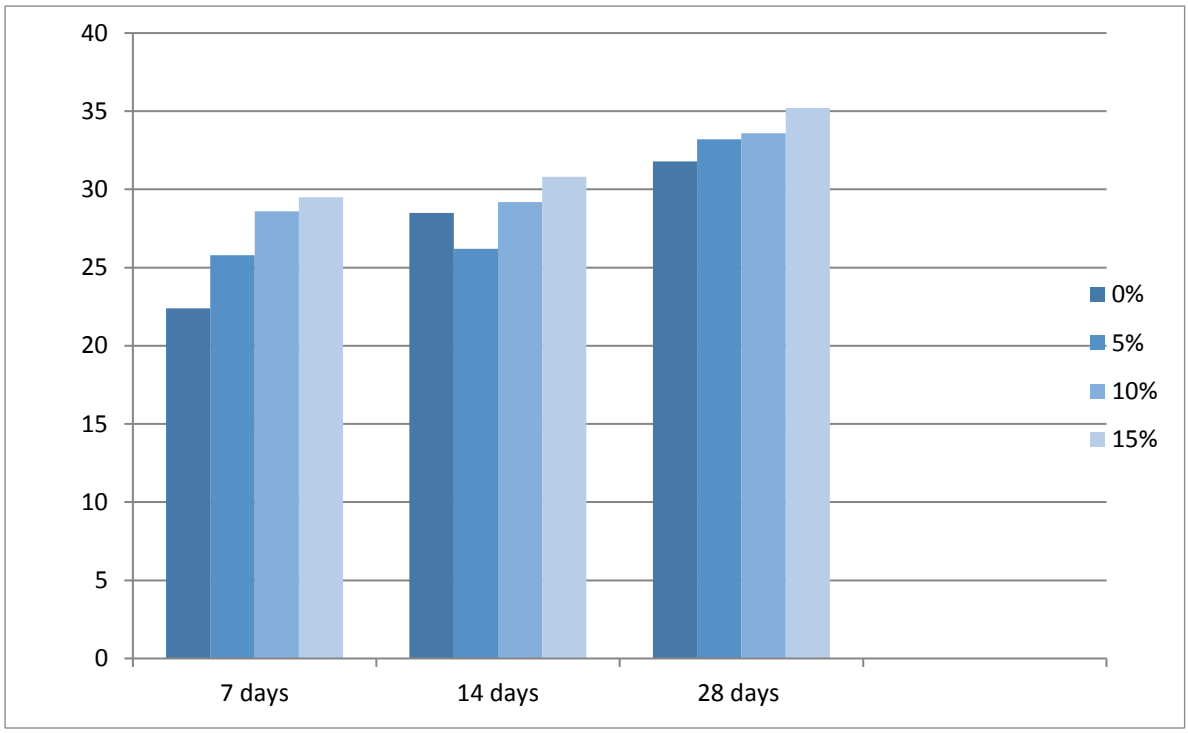


Figure 4.2Overall Compressive Strength Test for Coconut Coir Reinforced Cube for 28 days

From the testing above, when the percentage of weight of coconut coir increases, the compressive strength of concrete increases. The optimum percentage which is 15% is selected to produce the roof tiles.

4.2 Water Absorption Test

Water absorption test is to determine the rate of water absorption for the roof tiles which added with composite materials. This test is also conducted to determine the best roof tiles in terms of less water absorbed. The test results are shown are calculated in percentage (%).

Roof tiles	Dry weight (kg)	Wet weight (kg)	Percentage of water absorption (%)
1	1.04	1.09	4.8
2	1.07	1.13	5.61
3	1.04	1.10	5.77
Average	**1.05**	**1.11**	**5.40**

Table 4.1 Analysis of Water Absorption Test for Standard Roof Tiles

Roof tiles	Dry weight (kg)	Wet weight (kg)	Percentage of water absorption (%)
1	0.95	1.00	5.3
2	0.93	0.97	4.3
3	0.96	1.02	6.25
Average	**0.95**	**0.99**	**5.28**

Table 4.2 Analysis of Water Absorption Test for 5% of Coconut Coir fibre Roof Tiles

Roof tiles	Dry weight (kg)	Wet weight (kg)	Percentage of water absorption (%)
1	0.86	0.89	3.49
2	0.89	0.92	3.37
3	0.85	0.89	4.70
Average	**0.87**	**0.9**	**3.85**

Table 4.3 Analysis of Water Absorption Test for 10% of Coconut Coir Fibre Roof Tiles

Roof tiles	Dry weight (kg)	Wet weight (kg)	Percentage of water absorption (%)
1	0.78	0.87	11.53
2	0.78	0.86	10.26
3	0.75	0.84	12
Average	**0.77**	**0.86**	**11.26**

Table 4.4 Analysis of Water Absorption Test for 15% of Coconut Coir Fibre Roof Tiles

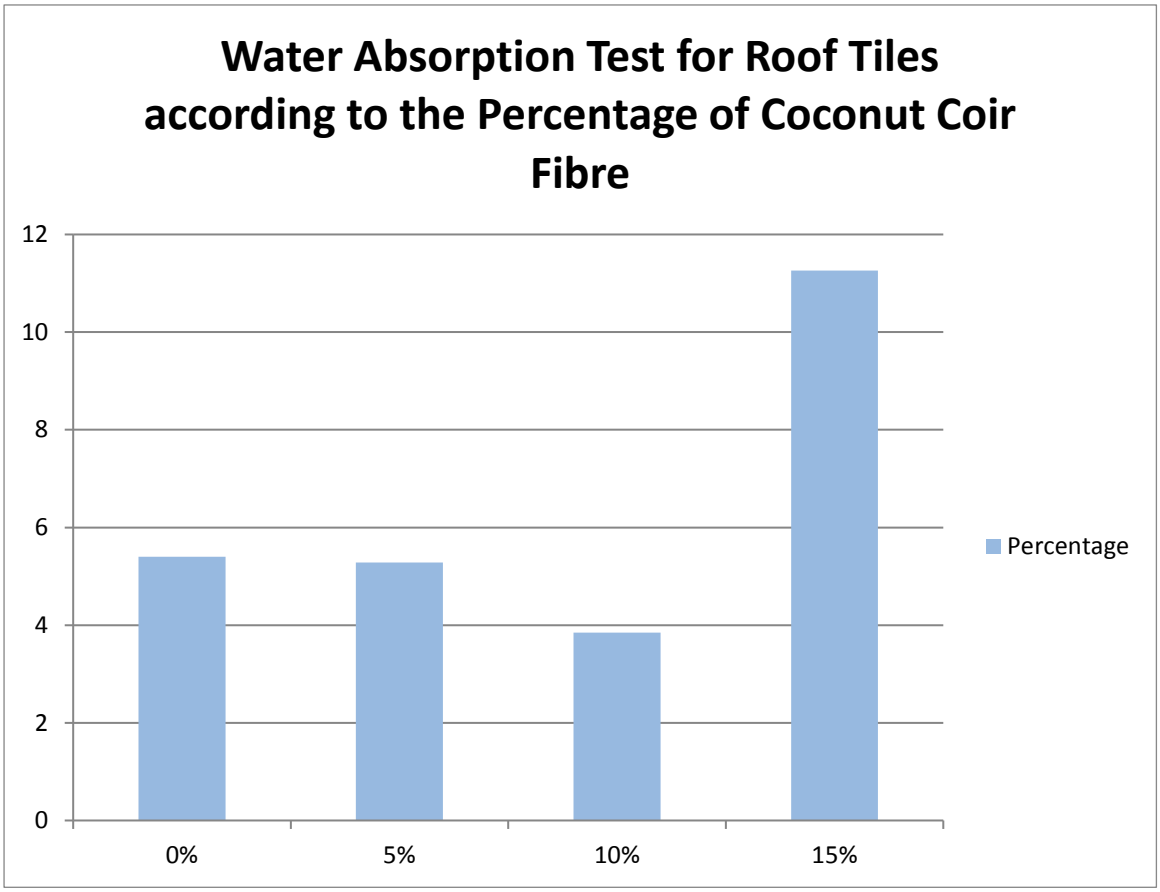


Figure 4.1Water Absorption Test for Roof Tiles According to the Percentage of Coconut Coir Fibre Roof Tile

In terms of compressive strength test, 15% of Coconut Coir is selected to be substituted with sand in terms of weight because it obtains higher compressive strength compared to other percentage. The use of coconut fibre in cement has increased the flexural strength and consequence improves the crack resistance. Coconut fibre alters the behaviour of concrete when cracks occur across the structure and thus can provide a residual strength of the concrete.

In terms of water absorption percentage of 10% of CCR Tiles is chosen because the water absorption rate is lower compared to 15% of CCR Tiles. The roof tile that we produced with substituting 15% of coconut obtained higher water absorption rate. In terms compressive strength the 10% of CCR Tiles still obtained high compressive strength and its water absorption rate also still considerable. Although the roof tile with 5% of coconut coir has almost the same water absorption rate with the roof tile with 10% of coconut coir fibre, the compressive strength of 10% of CCR Tiles is high compared to 5% OF CCR tiles. So 10% of Coconut Coir is selected as the optimum percentage of weight of Coconut Coir Fibre to be substituted with sand in this project.

Chapter 5
Discussion and Conclusion

5.0 Discussion

In implementing this final project, it is not impossible for every individual to have problems. To achieve a sound and unanimous decision, it may be necessary to do some discussion. The findings are obtained as well as some of the problems that arise, and the discussions are gathered to make a solid discussion of the solution in relation to all the problems that occur. Through the discussion, a new alternative or approach can be established to provide a clue to ensure that all problems arise can be resolved with cautiousness and intelligence. The results of the discussions between members of the group will be referred to the supervisor for advice and addition if necessary.

5.0.1 Choosing of Concept

Discussions are conducted from time to time and the latest developments in the implementation are discussed. All issues need to be addressed as soon as possible and hold discussions among group members and refer to project supervisor.

At first, our project was to design coconut shell roof tiles. It cannot be executed because coconut shell is heavy and requires fine-crushing so that it can be added to the mixture of the roof tiles.

After group discussion, we generate new ideas and found the solution by making the coconut coir fibre roof tiles. It also saves time cost of the reinforcement construction. In this process, we designed and created the project Coconut Coir Fibre Roof Tiles based on the objectives set in the beginning of the project. We have made comparison between coconut coir fibre roof tiles and standard roof tiles in water absorption.

After choosing the concept, design and suitable materials, we have proceeded with the execution of the project.

5.0.2. Problem Solving

Each project that is to be developed should not be missed from encountering problems during the implementation of processes. Our group encountered problems when the material we initially planned is not suitable for the construction of roof tiles. We overcome the problem by choosing an alternate material which is coconut fibre.

5.0.3. Testing and Results

The testing of the project is conducted to determine the efficiency of the project. The testing is done by comparing coconut fibre roof tiles with standard roof tiles as agreed in the scope of the project.

The project is completed with water absorption test to analysis the characteristics of the coconut coir fibre roof tiles. The data are presented in suitable form for the viewing of panels, supervisors and other individuals.

5.0.4. Ideas of Improvement

After conducting test and research on the project, we have found that there are several disadvantages and weaknesses during the development of this Coconut Coir Fibre Roof Tiles. These weaknesses can still be fixed and enhanced to produce a higher quality project. Among the suggestions that can be used to improve the product quality are by reduce the weight by changing the mixture composition, by reduce the water absorption rate of the roof tiles and also by increase the strength of the roof tiles.

5.1. Conclusion

The observable conclusions from this project we have found is that the construction or steps to complete a project should be done with caution in order to get a perfect and precise result. In the event of any negligence or carelessness being found, the project to be produced as expected will not last long and the use of the components must also be correct with its use.

In collaboration with members of the group, this project will be successful and well-crafted according to the desired concept and set. This will be proven after the final project can be implemented perfectly and works well. Through the final project entitled Coconut Coir Fibre Roof Tiles, it is stated that in the light of our planning we should carefully select the appropriate materials and equipment before making a connection, test the components before it is used to ensure the product safe to use as well as make a thorough study of the project to be developed.

This project is realized to reduce the support of roof reinforcement. It is found out that the weight of coconut coir fibre roof tiles is lighter than standard roof tiles. In addition, the water absorption rate of coconut coir fibre roof tiles is better than standard roof tiles.

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APPENDIX

Figure 2.0: wood shingles being replaced by wooden shingles

Figure 2.1: example of bituminous tiles that has been fixed in a roof of the house

Figure 2.2: example of concrete roof tiles

Materials for the making the product is prepared.

Materials are mixed according to the ratio and poured into the mould.

The concrete mixture is compacted.

The product is left for 72 hours for drying process.

A weighing scale is used to measure the weight before and after the roof tile is immersed in water

The roof tile is dried under the sun for 3 minutes .After that, the roof tiles are weighed.

The weight of the roof tiles is obtained.

After the weight of roof tiles is taken, the roof tiles are immersed in water with temperature of 27-30 celsius for 24 hours.

The weight of the roof tiles is recorded after 3 minutes the roof tile was taken out.