ROOFING TILES INNOVATION BASED ON SEASHELLS, COCONUT FIBER AND SODIUM LIGNOSULFONATE

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Abstract: Seashells and Coconut Fiber has many uses other than it's discarded and become waste. The sodium lignosulfonate also can be use as an mixture in the concrete mix in the present and future of construction. In this study, the seashells, coconut fiber and sodium lignosulfonate is presented as improved strength, water reducer and heat resistance additional mixture in innovation of roofing tiles. This product of roofing tiles divided into three sample (30%,60% and 80%) with different ratio of additional mixture. With different ratio of additional mixture it divided again in 3 sample. This study conducted with the aim to produce concrete improvements on the roof tiles by adding new additional materials such as shell powder, coconut fiber and sodium lignosulfonate. The test that been conducted are compression strength test, water absorption test and thermal conductivity test which is the compression strength test sample 1 with 30% additive materials with 10.00 N/mm² is the highest than sample 60% and 80% but this test are not suitable for roofing tiles strength testing. The water absorption result sample 1 with 30% additive materials absorb less water than other sample with 4.2% and standard sample 4.4% which is fulfilled the Malaysian Standard (MS797).For thermal conductivity testing, sample 1 with 30% additive materials has the lowest temperature reading than existing roof tiles nowadays. The overall of the testing shows that the sample 1 with 30% additive materials are the almost succeeded since the water absorption test and thermal conductivity test shows the best reading compared to the existing roof tiles. This study also shows that the additive materials should not be mixed together into one ratio because it will effect the reading result of the testing.

Keywords: additional mixture; compression strength; thermal conductivity test; additive materials

1. Introduction

Nowadays, the construction industry has grown and developed, however, the problems damage in conctruction remains valid, especially on the roofing part. There were several problems or damage on the roof which is mossy and fragile. This study conducted with the aim to produce concrete improvements on the roof tiles by adding new additional materials such as shell powder, coconut fibber and sodium lignosulfonate.

Tiled roof is a roof that is often used in construction. Tiled roof always been characterized as a rugged and durable. As is known, roof tiles commonly used and easily available in the market is a tiled roof made of concrete. This is because the roof of this made long lasting and the cost of produce cheaper from the other roof. Material that researcher will use such as shell powder, coconut fibers and lignosulphonates. Cockle is a living water shelled in the coastal muddy. This habitat can be found near beach around Sabak Bernam. Shells contain calcium carbonate, which can replace cement. Crushed and graded seashells used in concrete displayed a lower porosity/permeability than plain concrete. (Alan E. Richardson, 2013).

Advantages of natural fibers is that it can reduce costs as it is widely available, low density, the strength that can be adopted, a good heat insulator, and can be renewed for recycling without affecting the environment. Coconut fiber offers many advantages such as reducing costs as easy to find, low density, strength can prevail, good thermal insulation, the cause of which can be updated and can for recycling without compromising the environment. (M.Mizanur, 2007).

2. Materials and Methods

In this study, additional materials that will be used in the concrete mix is seashells, coconut fiber and sodium lignosulfonates will be added in a mixture with the corresponding ratio in the manufacture of concrete roof tiles. 9 samples will be generated for each percentage. Each sample will be added additives with different percentages to compare the strength of each sample. For sample A which is consist with 3 sample. Research will use 30% of additive (Cockle shells 15%, Coconut fibers 10%, Sodium lignosulfonates 5%). For sample B, research use 60% of additive (Cockle shells 22%, Coconut fibers 19%, Sodium lignosulfonates 19%) and for sample C, research use 80% of additive (Cockle shells 30%, Coconut fibers 25%, Sodium lignosulfonates 25%).

The test that will be used to test the strength of the roof tiles such as Water absorption test, Compression strength test and Thermal test. At the end of the producing or testing all the sample, research will compare the strongest durability sample with the normal mixture of the concrete roof tiles.

3.0 Results

The test that conducted is Compression Strength Test, Water Absorption Test and Thermal Conductivity Test which is to know the strongest strength, the percentage of water absorption test and also to know the measure of the heat that flow through the roof tiles. The data analysis is very important in bringing off a test, it is possible to compare and identify the results obtained. The data and results obtained will be presented through tables, graphs and diagrams detailing.

3.1 Compression Strength Test

All 9 sample for each of the prototypes with different ratio will be mixed by conventional and is immersed for 7 days before conducted the compression strength test.

- The roof tile with different ratio of the additional is immersed for 7 days.
- After 7 days, the sample will remove from the curing tub with specified curing time and will be weighed before the test.
- Placed the specimen into the machine in such a manner.
- The roof tiles are tested by using the compression strength test machine and the data is recorded.

3.1.1 Comparison of the average value of each sample A (30%), B (60%) and C (80%)

Comparison of the strength test (Compression Strength Test) for each sample A (30%), B (60%) and C (80%). Table 1 and Figure 1 below shows the compression strength test value for comparison of the average value of each sample.

Table 1. Comparative data for each sample of strength test

Sample	Average Strength (N/mm^2)	Standard (N/mm^2)
Sample A (30%)	8.52	18.44
Sample B (60%)	3.85	
Sample C (80%)	4.66	

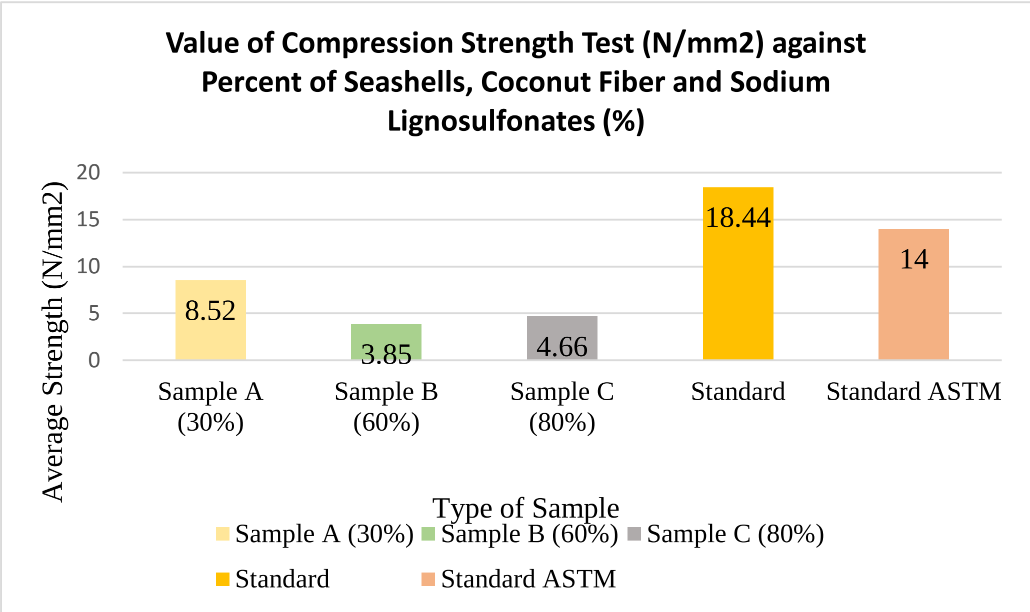

Figure 1. Bar chart comparing the average of sample A (30%), B (60%) and C (80%) for the compression strength test value.

3.1.2 Analysis data of compression strength test

Based on the in the figure 4.4, data shows the value of each sample A (30%), B (60%), C (80%) and standard for compression strength testing. Compression strength test refers to sample of standard cubes and standard strength test for concrete cubes that is 14 N/mm². Line graph in figure 4.1 on sample A for 30% showed the highest value are sample 1 (10.00 N/mm²) and the lowest value are sample 3 (7.56 N/mm²). For sample B with 60% figure 4.2 the compression strength value were highest in sample 1 (4.67 N/mm²), while for the lowest value in the sample 2 (3.33 N/mm²). While for the sample C with 80% based on figure 4.3, the highest compression strength test value in the sample 1 (5.11 N/mm²) and the other sample 2 and sample 3 (4.44 N/mm²) has the same value that make it the lowest value in strength test. Next, the strength test value for standard sample has the highest value with 18.44 N/mm².

The average ratio as in the graph bar chart in figure 4.4 shows the sample 1 with 30% additive materials is the highest than sample 60% and 80%. But the value of the standard sample has a higher value than the other samples 60% and 80% as well as the standard value 14 N/mm² as shown in figure 4.10 with reference JKR Standard.

3.2 Water Absorption Test

The test for water absorption is conducted to get the percentage of the water in the prototype.

- The samples are weighed before immersed into water.
- The roof tiles with different ratio of the mixture (seashells, coconut fiber and sodium lignosulfonate) are immersed for 24 hours.
- After 24 hours, the sample is weighed for each which got 9 sample and 1 for the standard roof tiles to record the data of the sample after immersed into water for 24 hours.
- After weighed the sample, each samples will comparison with the standard roof tiles.

3.2.1 Comparison of the average value of each sample A (30%), B (60%), C (80%) and standard.

Comparison of the Water Absorption Test for each sample A (30%), B (60%), C (80%) and standard. Table 2 and Figure 2 below shows the water absorption test value for comparison of the average value of each sample.

Table 2. Comparative Data of Water Absorption Test

Sample	Average of Water Absorption (%)
A (30%)	4.20
B (60%)	7.10
C (80%)	6.24
Standard	4.40

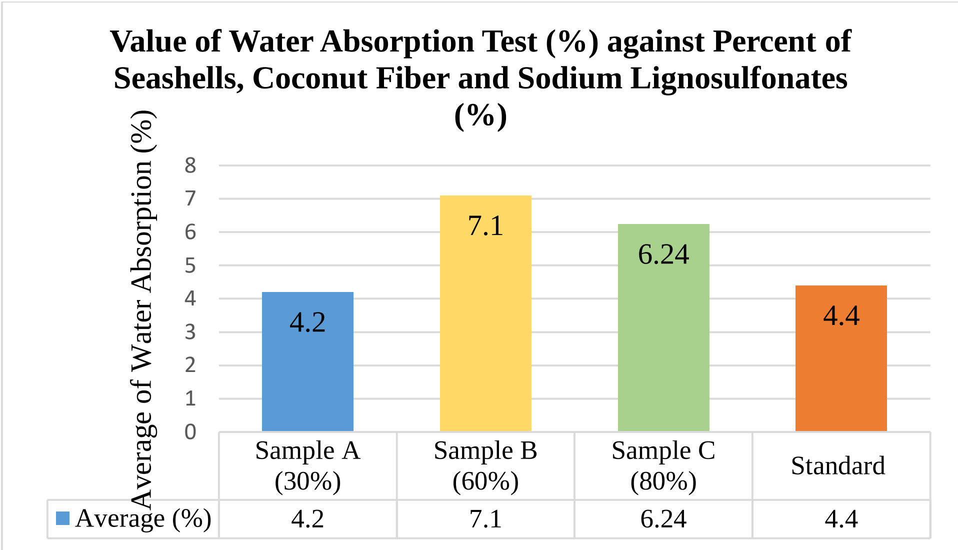

Figure 2. Bar chart comparing the average of sample A (30%), B (60%) and C (80%) for the water absorption test value.

3.2.2 Analysis data of water absorption test

The percentage of water absorption should not be exceeded than 10% for the water absorption test. Data shows the value of each sample A, B, C and standard for water absorption testing. Line graph figure 4.5 shown that the percentage of water absorption on all the sample for sample A (30%) with the value of testing for sample 1 (1.21%), sample 2 (2.38%) and sample 3 (9%) which mean this sample did not be exceeded than 10%. For sample B with 60% of additive materials shown that the percentage value does not be exceeded 10% because the value for sample 1 (9%), sample 2 (6.90%) and sample 3 (5.88). While for sample C with 80% additives also does not exceeded than 10% because the value of sample 1 (6.34%), sample 2 (5.66%) and sample 3 (6.73). The percentage value of water absorption testing for all the sample A (30%), B (60%) and C (80%) is fulfilled the Malaysian Standard (MS 797) for roof tile because the value of all the sample did not exceeded 10% of the percentage of water for 24 hours' test.

The average ratio on the graph bar chart in figure 4.8 shows the sample A (30%) is decreased than the standard sample which means sample A (30%) absorb less water other than standard sample and sample B (60%) and C (80%). In conclusion, the increase the content of sodium lignosulfonate in roof tile the higher the decrease the water absorption of the roof tile.

3.3 Thermal Conductivity Test

Thermal Conductivity Test, is used to measured or map surfaced temperatures based on the infrared radiation given off by an object as heat flows through, to or from that object.

- Put the sample of roof tiles that have been completed under the sunlight.
- After that, the shoot readings using the Infrared Laser as temperature measuring devices during peak hours of the sunny day for about 60 minutes.
- Lastly, it be recorded the readings on the front surfaced and the back surfaced of the roof tiles every 15 minutes in 1 hours.

3.3.1 Comparison of the average value of each sample A (30%), B (60%), C (80%) and standard 1 hour's duration.

Comparison of Thermal Conductivity Test for each sample A (30%), B (60%), C (80%) and standard. this data is an average for 1 hour taken involving 4 readings every 15 minutes. Table 3 below shows the thermal conductivity test values for a comparison of the values of each sample.

Table 3. Comparative Data of Thermal Conductivity Test on the Sample A (30%), Sample B(60%) and Sample C(80%) with Standard

Class Sample	**Sample (1 Hour) Average**			
	Sample1 (Front)	**Sample1 (Back)**	**Standard (Front)**	**Standard (Back)**
Sample A(30%)	35.55^o	34.99^o	50.18^o	50.53^o
Sample B(60%)	37.46^o	35.84^o		
Sample C(80%)	38.75^o	39.38^o		

4.0 Discussion

There are a few recommendations that can be made to improve the roof tile innovation.

- The additives materials suitable to mix with the mixture of concrete roof tiles but in separately method because it contents different function that can generate chemical reactions that can reduce the work ability of the roof tiles innovation.
- Other than that, recommended that the industries of supplying the coconut fiber should be widely to supplied the fiber coconut to the roof tiles factory because the coconut fiber content many advantages to improve the existing concrete roof tiles in category heat insulator.
- The study on the use of seashells, coconut fiber and sodium lignosulfonate should be continued and developed to a higher level in order to achieve progress in terms of industry and construction.
- This product can be used not only for house and building roofing but it also can be use as gazebo roof, covered walkways.

5.0 Conclusion

The conclusion that can be made after the test shows that there are some differences between standard roof tiles and roof tiles mixed with additives. The study found that roof tiles with a mixture of 30% additives achieved satisfactory results in three tests that had been carried out. For the water absorption test results, roof tiles with 30% additive ratio succeeded when the water absorption rate decreased from standard roof tiles, refer to Table 4. Sodium lignosulfonate is used as a water reduction agent in roof tiles. In conclusion, the increase of sodium lignosulfonate, the content of water absorption in the roof membrane decreases, refer to Table 4.

As for the thermal conductivity test results, the heat absorption rate was lower than the existing roof tile absorption rate which was higher during the test. Coconut coir is used as an additive because it is one of the best heat insulating composites. In conclusion, increasing the quantity of coconut coir will cause the rate of heat absorption into the roof tiles to decrease. It makes the roof tiles less hot when exposed to the heat radiation of sunlight refer to Table 5.

For the compressive strength test results, it was found that the strength of roof tiles containing 30% additives is weak according to standard requirements refer to Table 4. All materials are suitable to be mixed as additives to produce concrete roof tiles but the mixing ratio. methods need to be varied because they can produce chemical reactions that can reduce the workability of each material in a concrete roof tile mix and separate methods are appropriate to achieve optimal or best results for each mix.

Table 4. Comparative Data of Water Absorption Test and Compressive Strength Test N/mm^2

Test	Sample	Result	Standard
Water Absorption (%)	A (30%)	4.2	4.4
	B (60%)	7.1	
	C (80%)	6.24	
Compressive Strength Test N/mm^2	A (30%)	8.52	18.44
	B (60%)	3.85	
	C (80%)	4.66	

Table 5. Comparative Data of Thermal Conductivity Test on the Sample

Class Sample	Sample (1 Hour) Average			
	Sample1 (Front)	Sample1 (Back)	Standard (Front)	Standard (Back)
Sample A(30%)	35.55^o	34.99^o	50.18^o	50.53^o
Sample B(60%)	37.46^o	35.84^o		
Sample C(80%)	38.75^o	39.38^o		

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