Use of Durian Pectin, Rice Husk Ash (RHA) and Eggshell Powder (ESP) in Concrete

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Abstrat
Cement is one of the important materials in concrete mixture and use for building construction. High demand for cement usage due to the rapid development of construction in the country needs to be addressed. Therefore, the use of alternative cement such as fly ashes is being boosted by the increasing focus on reducing carbon emissions and also increasing owing to the extensive use of green cement. The objective of this study is to identify the optimum ratio of durian pectin to rice husk ash and durian pectin to eggshell powder as partial replacement of cement. Compressive strength and water absorption test were carried out at concrete laboratory on hardened 150mm^3 concrete cubes for 7, 14 and 28 days of curing. Concrete made with 5%, 7.5% and 10% were replaced with durian pectin, RHA and ESP by the weight of cement. The results show that the sample consist of 5% of durian pectin and 5% of RHA is the best ratio replacement of cement in concrete because it achieved a good result in workability (slump test), compressive strength and water absorption are 85mm, 27.5 N/mm^2 and 6.5% respectively.

Keywords: durian pectin, eggshell powder, rice husk ash

1.0 Introduction

Concrete is a mixture of cement, gravels, sand and water. These materials are the most consumed material in building construction compared to steel and wood. The concrete properties are depending on the choice of materials and proportions for a particular application. Concrete has ability to be casted to any desired shape and configuration which is an important characteristic that can be offset other shortcomings. The demand of concrete cause the usage of raw materials to be increased. In manufacturing of cement, more amount of limestone is used and in future, it will be a great shortage of limestone. This almost leads to the extinction of the raw materials. So, this causes the cost of concrete production to be increased.

As a remedy for that, researchers have played their role by replacing these raw materials. For an example, aggregate had been replaced with scrap tire rubber and paper pulp, sand had been replaced with quarry dust and washed bottom ash. Lastly, fly ash (Goud & Soni, 2016), coconut shell ash and eggshell ash (Prakash, Satyanarayana, & Veerottam Kumar, 2018) have been used to replace cement. These that waste materials can be as a replacement for raw materials if these materials have suitable properties which can adapt with the natural raw materials.

Concrete is the most widely used synthetic material in the world but also one of the most environmentally unfriendly. Its manufacture alone is responsible for about 5% of global carbon dioxide (CO2) emissions (IEA, 2009). Nearly every aspect of its production, from mining and transporting the raw materials, to heat them to over 1,400°C in a kiln (often using fossil-fuel-based energy), and the subsequent chemical process of turning limestone into small rocks of cement called clinker, releases huge amounts of carbon dioxide. In fact, the International Energy Agency (IEA, 2007) estimated that for every kilogram of cement produced, around the same amount of CO2 is released into the atmosphere. Searching for new alternative available material is important for conservation of natural resources because increasing demand in cement leads to the extinction of natural resources and the environmental pollution of the production.

In this research, durian pectin has been added in order to reduce the usage of cement partially due to same characteristics where it tend to hydrate and form a paste when water is added. RHA and ESP contains the same properties as cement, which are Calcium Oxide (CaO), Silica Dioxide (SiO_2), Aluminium Oxide (Al_2O_3), Magnesium Oxide (MgO), Iron Oxide (Fe_2O_3), and Sulfur Trioxide (SO_3) and it also can increase the strength and helps in reducing the voids in concrete (Abu Bakar, Putrajaya, & Abdulaziz, 2010). Usage of RHA in concrete exhibit's the same or better results compared to a standard concrete and reusing RHA would not only get rid of dumping but also decreases the CO_2 emission to atmosphere by bringing down the cement production (Khan, Jabbar, Ahmad, Khan, & Mirza, 2012). ESP is one of the waste material that increase continuously in recent years due to disposal problem and reusing ESP in concrete is a better solution to reduce the environmental problem (Hut, 2014).

The objective of this study is to identify the optimum ratio of durian pectin to rice husk ash and durian pectin to eggshell powder as partial replacement of cement by conducted the workability (slump test), compressive strength and water absorption tests.

2.0 Material and methods

The norminal mix design was used in this study is 1:2:4 ratio for cement, sand and coarse aggregate. That means, the proportion of every ratio was respective measured by weight. Total percentage for replacement of cement are 10% to 15% by weight. The replacement ratio between durian pectin with RHA and ESP as shown in Table 1 and Table 2. Three test were carried out in this study, which are slump, compressive strength and water absorption test. Slump and water absorption test were been done

accordance to BS EN 12350-2: 2009 and BS 1881-122: 2011. Based on BS EN 12390-4: 2009, the size of concrete cube of 150mm x 150mm x 150mm was used. Nine (9) cubes of each sample was prepared for 7, 14 and 28 days compressive strength test as required.

Table 1: Replacement ratio between durian pectin and RHA

Sample	Ratio of Durian Pectin to RHA (%)
A	5 : 5
B	10 : 5
C	5 : 10
D	7.5 : 7.5
E	5 : 5
F	Standard Concrete

Table 2: Replacement ratio between durian pectin and ESP

Sample	Ratio of Durian Pectin to ESP (%)
AA	5 : 5
BB	10 : 5
CC	5 : 10
DD	7.5 : 7.5
EE	5 : 5
FF	Standard Concrete

3.0 Results and discussion

3.1 Result of slump test

In order to determine the workability of the concrete, the slump test been done. Table 3 shows the result of degree of concrete workability. All samples had a medium degree of workability where the concrete is suitable for manually compacted for flat slab and normal reinforced concrete and heavily reinforced sections with vibration.

Table 3: Degree of concrete workability

Durian Pectin : RHA		**Durian Pectin : ESP**		**Degree of Workability**
Sample	Slump (mm)	Sample	Slump(mm)	
A	87	AA	90	**Medium (50-100 mm)**
B	85	BB	85	Medium
C	90	CC	94	Medium
D	93	DD	91	Medium
E	86	EE	88	Medium
F	95	FF	95	Medium

3.2 Result of water absorption

Based on Figure 1 and Figure 2, all the samples within water absorption limits which is between 5% to 7%. For mixture of durian pectin and RHA, sample E had the highest average water absorption which is 6.8%

while sample C had the lowest average water absorption of 6.0%. For mixture of durian pectin and ESP, sample AA has the highest average water absorption which is 6.5% while sample CC has the lowest average water absorption of 6.0%.

Figure 1: Result of water absorption test (ratio of durian pection: RHA)

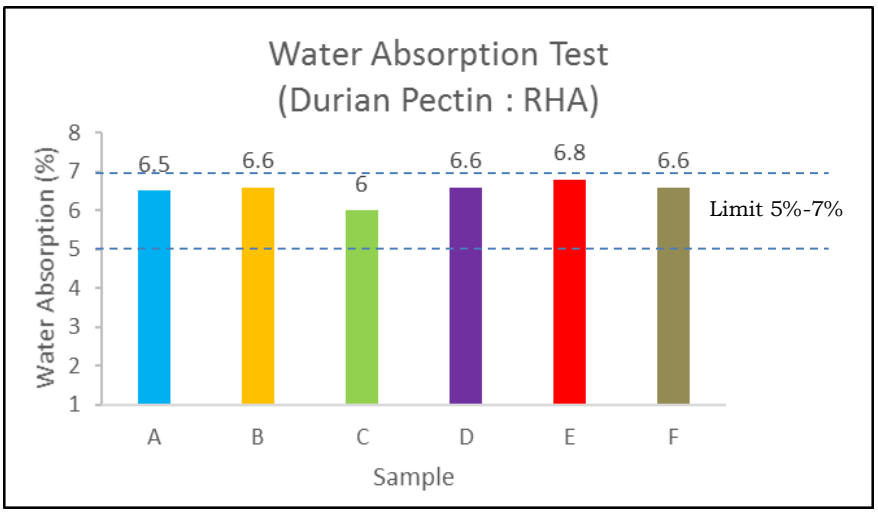
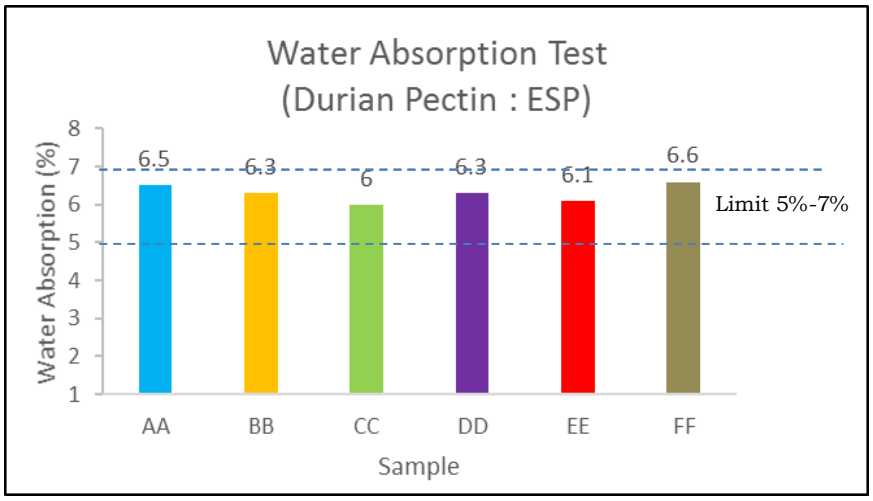


Figure 2: Result of water absorption test (ratio of durian pection: ESP)



3.3 Result of compressive strength test

The compressive strength tests on the samples have been carried out for 7, 14 and 28 days. All the samples had an average compressive strength higher than 20.00 N/mm². The result of this test tabulated in Table 4 and llustrated in Figure 3. This figure shows that sample A has the highest average compressive strength following as compared to sample C, D, E, and B which are 27.50 N/mm², 27.10 N/mm², 26.95 N/mm², 26.50 N/mm² and 24.20 N/mm² respectively for 28th day of curing. Sample F is standard concrete has been reached the acquired strength which is 20 N/mm². Its shows that sample A which is consist of 5% of durian pectin and 5% of RHA give a good result in order to replace the cement partially.

Table 4: Result of compressive strength test (ratio of durian pection: RHA)

Sample	**Compressive strength (N/mm^2)**			**Results (compare to standard strength)**
	7th	**14th**	**28th**	
A	26.52	26.96	27.50	> 20 N/mm^2
B	22.30	23.70	24.20	> 20 N/mm^2
C	23.63	26.00	27.10	> 20 N/mm^2
D	26.00	26.58	26.95	> 20 N/mm^2
E	25.57	25.85	26.50	> 20 N/mm^2
F	14.47	18.10	20.00	Same

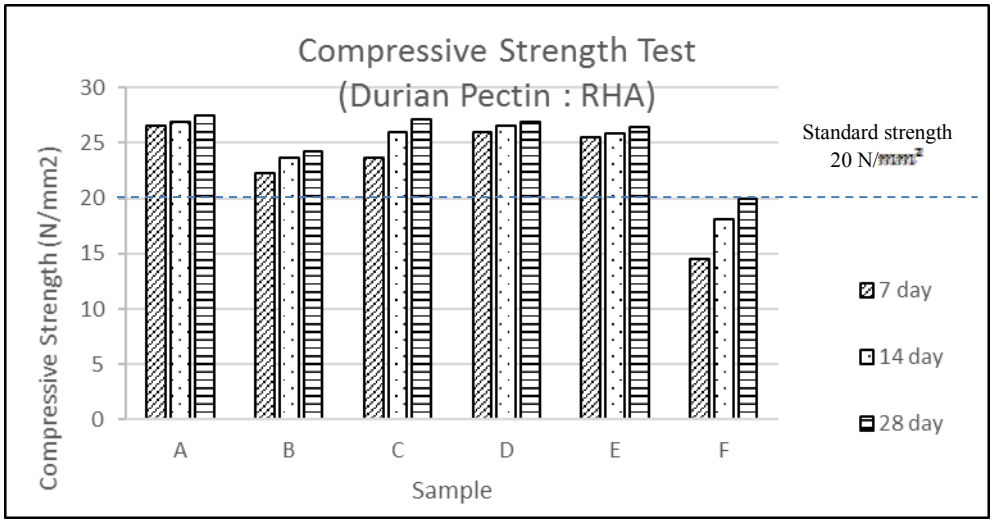


Figure 3: Result of compressive strength test (ratio of durian pection: RHA)

Table 5 and Figure 4 show sample AA has the highest average compressive strength followed by sample EE, CC, DD, and BB which are 26.60 N/mm², 26.55 N/mm², 26.50 N/mm², 26.25 N/mm² and 23.15 N/mm² respectively for 28th day of curing. Sample AA which consist of 5% of durian pectin and 5% of ESP show the best result for this test.

Table 5: Result of compressive strength test (ratio of durian pection: ESP)

Sample	**Compressive strength (N/mm^2)**			**Results (compare to standard strength)**
	7th	**14th**	**28th**	
AA	20.50	24.80	26.60	> 20 N/mm^2
BB	21.50	22.65	23.15	> 20 N/mm^2
CC	23.45	25.10	26.50	> 20 N/mm^2
DD	23.68	24.83	26.25	> 20 N/mm^2
EE	21.95	24.65	26.55	> 20 N/mm^2
FF	14.47	18.10	20.00	Same

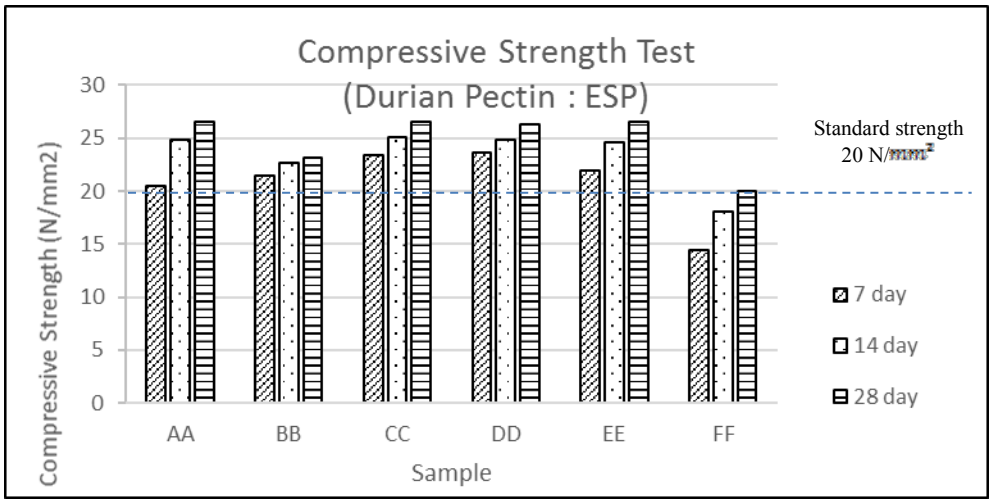


Figure 4: Result of compressive strength test (ratio of durian pection: ESP)

4.0 Conclusion

As a conclusion, sample A consist of 5% of durian pectin and 5% of RHA is the best ratio replacement of cement in concrete because it achieved a good result in workability (slump test), compressive strength and water absorption which are 85mm, 27.5 N/mm² and 6.5% respectively. Stronger bonds occur when durian pectin is added to the concrete. Meanwhile, RHA and ESP can increase the strength and help in reducing the voids in concrete. It also can replace the cement by maximum 10% as supplementary cementitious materials in concrete.

However, there are some of recommendation for further study improvement, such as:

i. Pectin cannot be extracted in a large number of quantity where it takes time by using homemade method. For example, it takes 2 days to get 320g of pectin powder from 1kg durian rinds. Therefore, the extraction method of pectin should be study deeper.
ii. From a recent study, citrus peels followed by apple pomace serve as the major source for extraction of pectin. So pectin extracted from apple pomace can be tested to replace in cement partially.
iii. Need more research on others additive material which may be used to improve the fire resistance of concrete which is one of the importance characteristic

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