The Effectiveness Fly Ash as Partial Replacement of Roof Tiles Concrete

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ABSTRACT

Roof tiles for a building are one of the most important components in a building construction. Roof tiles concrete are made of mixture of sand, cement and water, which are mould under heat and high pressure. This research will focus on fly ash as partial replacement of concrete roof tiles. The purpose of this research are to produce a prototype of roof tiles concrete by using the different ratio of the fly ash in the concrete roof tiles, to identify the percentage of water absorption by conducted water absorption test and to determine the breaking load of roof tiles by transverse strength test. For checking strength and water absorption effect of replacement by flay ash, 20%, 30%, 40% and 50% fly ash was added in roof tile sample. The roof tiles produce in Zen pattern conforming to Malaysian Standard MS797 and dimensions roof tiles is 330x 420mm. The result show that replacement fly ash show better for 20% and fulfilled the Malaysia Standard (MS797). Observations from the test performed were conducted in laboratory where precise data were gathered and completely attained. As a whole, the research main concern is the environment and the construction and building technology to enhance industrial waste as well as building material

Key Words: Roof tiles, Fly Ash, strength

1. INTRODUCTION

Nowadays, solid waste management has been considered as a vital topic for Malaysian government and owing to major issue. As the result of alarming rate of waste generated due to the increase in population, affluence and changing lifestyles in Malaysia, the environmental restrictions have been encountered which included the stringent control of waste disposal sites, resource restrictions such as emphasizing the awareness of the public about depletion of natural resources, the natural disasters issues such as global warming that caused by the greenhouse effect (Saifudin, 2010).

A waste material extracted from the gases emanating from coal fire furnaces, generally of a thermal plant, is called fly ash. The mineral residue that is left behind after the burning of coal is the fly ash. The worldwide production of fly ash is growing every year. Fly ash is silt – size non-cohesive material having a relatively smaller specific gravity than the normal soils. The disposal of the fly ash is a serious hazard to the environment that consumes millions of money towards the cost of its disposal. Fly ash has been used in variety of construction applications, such as compacted fills, concretes, bricks, liners, construction of embankments in many countries including (B.Naga, 2016)

Roof tiles are important components and to provide shield from rain and heat of the sun. Traditionally, more roof tiles are made from clay or slate. However, nowadays, roof tiles are also made of concrete materials. Mixes of concrete are come out from admixture of sand, cement and water. But, there are a few disadvantages of the concrete roof tiles such as, the concrete tiles easy to break especially when the workers do the installation of concrete roof tiles at the constructions sites. The use of cement also high in producing the roof tiles which is it can contributes in high costing in a construction n works (Robert Schart, 2000).

Due to environmental and economic crisis, this research focus on generating product roof tiles from industrial waste as well develop an alternative construction material that will lessen the social and environmental issues. It also paved the way to the recognition of fly ash as substitute for material in developing concrete roof tiles.

2. METHODOLOGY

The main focus of the research is to produce a prototype of roof tiles concrete by using the different ratio of the fly ash, 3 samples for each of prototypes with 5 different ratio are produced to get average value of samples. The ratio used is 20%, 30%, 40% and 50% replacement fly ash in roof tiles concrete. The samples was tested to evaluate its strength and water absorption, tested conducted at Terreal-Vitage Tile Sdn. Bhd and fly ash was obtained from Kapar Energy Ventures, Stesen Janaelektrik Sultan Salahudin Abdul Aziz. Figure 1 shows the schematic diagram of methodology research.

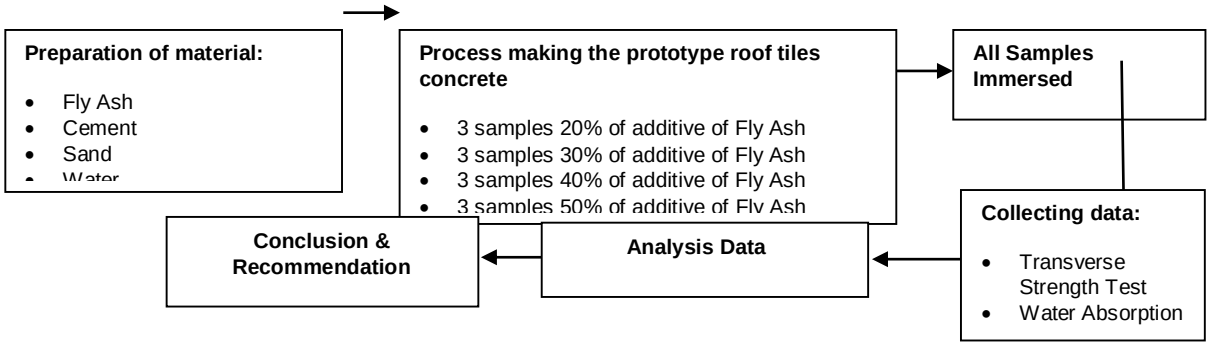

Figure 2: Schematic Diagram of Methodology Research

2.1. Preparation of Materials

The material used for produce roof tiles concrete consist fly ash, cement, sand and water. The all material was prepared based on table 1 shows Ratio Fly Ash and Raw Material

Table 9 : Ratio Fly Ash and Raw Material

Material	Ratio of Fly Ash				
	100% Cement	50% Fly Ash	40% Fly Ash	30% Fly Ash	20% Fly Ash
Fly Ash	-	3.5 kg	2.8 kg	2.1 kg	1.4 kg
Cement	7.0 kg	3.5 kg	4.2 kg	4.9 kg	5.6 kg
Sand	10.6 kg	10.6 kg	10.6 kg	10.6 kg	10.6 kg
Water	2.1 liter	2.1 liter	2.1 liter	2.1 liter	2.1 liter

2.2. Process making the prototype roof tiles concrete

3 prototype were prepared for each ratio with mixture of cement, sand and water and additional of 50%, 40%, 30% and 20% of fly ash on the basis weight of the mixture. In order to get homogeneous mix, proper care was while mixing the sample. Design and size dimension the prototype based on the specification of Terreal-Vitage Tile Sdn. Bhd, produce based Zen pattern conforming to Malaysian Standard MS 797. Figure 2 and table 2 show the detailing design of Zen pattern and specification of prototype.

Figure 2: Zen Pattern

Table 2 Zen Pattern and Specification of Prototype

Technical Specifications	
Dimension (mm)	320 x 420
Weight (kg)	4.75
Length Batten Gauge (mm)	260
Tiles per m^2	10
Minimum Roof Pitch	25
Laid	Cross band

2.3. Transverse Strength Test

Transverse or flexural strength is the ability of the composite material to withstand bending forces applied perpendicular to its longitudinal axis or in the other words to determine the breaking load of roof tile (Al-Asyraf & Sharifuddin, 2014) . Flexural test is performed using 3-point bending method according to ASTM C642-13. All prototypes is immersed in water for 24 hour before conducted the strength test.

Figure 3: Transverse Strength Mechine used Terreal-Vitage Tile Sdn. Bhd

2.4. Water Absorption Test

The main objective water absorption test is to determine percentage of water absorption of roof tiles. Absorption can be described as the ability to take in water by means of capillary suction. All three mechanisms are heavily influenced by the volume of pores as well as the connectivity of the pore network (C.Javier etl., 2011).The mass of each prototype was weighed before the prototypes completely immersed in a bowl of water for 24 hours. After 24 hours mass of each prototype was weighed, excess water was removed from the samples by wiping the samples by using tissue paper. The prototypes were kept in oven at an temperature of 110 ^{o}C for 24 hours, each of prototypes are weighed for data after dried in oven.

3. RESULTS AND DISCUSSION

In this research, total 15 prototypes of roof tiles for each different ratio of fly ash were prepared and conducted test in laboratory at Terreal-Vitage Tile Sdn. Bhd. The test conducted is The data based on transverse strength test and water absorption, which is to determine the breaking load and the percentage of water absorption. The data produce from the testing is analyse and comparison with Malaysian Standard MS 797 has been implemented

3.1. Analysis of Transverse Strength Test

The strength of each prototype was show in table 3. Based on the data, the of prototype E which is 20% replacement fly ash have the second high of average which is 1080 MPa than prototype A 100% cement which is 1096 MPa. According the data, samples E % is the best results and has fulfilled MS 797 for roof tiles concrete because the value exceed 1000 MPa for 24 hours test.

Table 3: Transverse Strength result

No. Prototypes	Strength (MPa)	Average Strength (MPa)
Sample A (100% Cement)	A_1 =1128 A_2 =1080 A_3 =1080	1096
Sample B (50% Fly Ash)	B_1 = 589 B_2 = 540 B_3 = 589	573
Sample C (40% Fly Ash)	C_1 = 785 C_2 = 785 C_3 = 834.5	801.5
Sample D (30% Fly Ash)	D_1 = 982 D_2 =1030,6 D_3 =982	998.2
Sample E (20% Fly Ash)	E_1 = 1080 E_2 = 1080 E_3 = 1080	1080

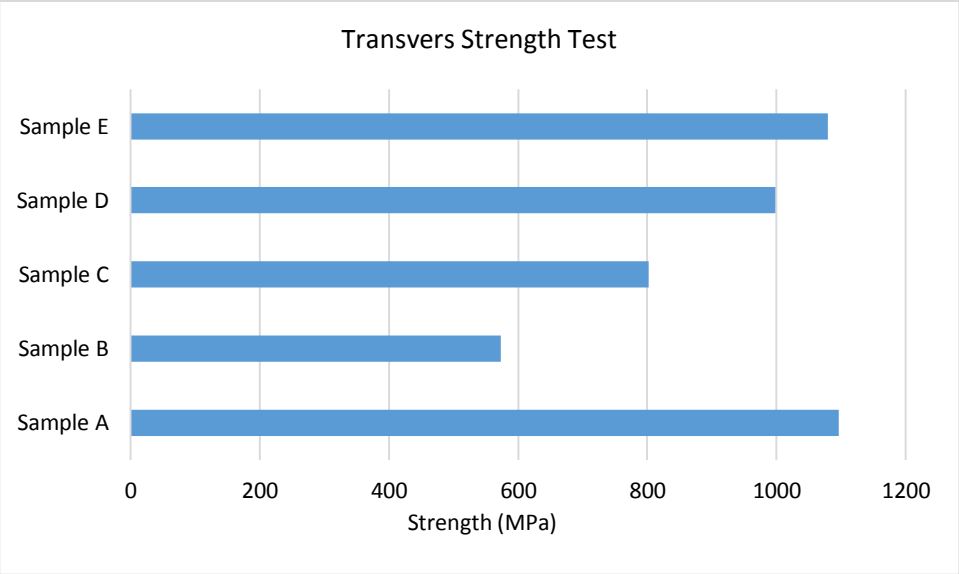

Figure 3: Transverse Strength result

3.2. Analysis of Water Absorption Test

Table 4 shows the water absorption of sample. The percentage of water absorption should not be exceeded than 10% according MS 797. Based on graph in figure 4, it shows that the percentage of water absorption sample E which is 20% fly ash is 7.19% is the best results and has fulfilled MS 797.

Table 4: Water Absorption result

No. Prototypes	Sample A (100% Cement)	Sample B (50% Fly Ash)	Sample C (40% Fly Ash)	Sample D (30% Fly Ash)	Sample E (20% Fly Ash)
Tiles weight after immersions kg	5.11	5.48	5.43	5.38	5.12
Tiles weight after dried kg	4.77	4.79	4.78	4.77	4.78
Water content kg	0.33	0.66	0.65	0.61	0.34
%water absorption	6.99	14.56	13.61	12.78	7.19

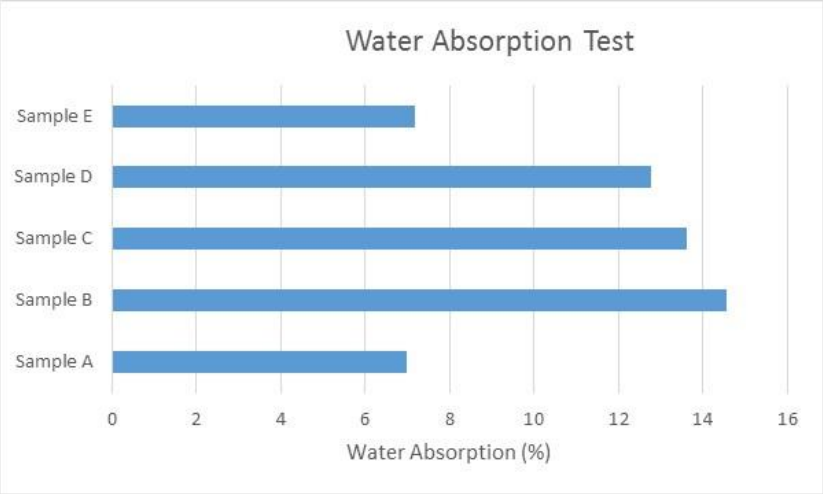

Figure 4: Water Absorption result

4. CONCLUSION

As a conclusion, sample E which consists of 20% fly ash is the best sample in order to replace material in roof tiles concrete. From the analysis, the value for transverse strength is 1080 MPa and water absorption is 7.19% and which has fulfil Malaysian Standard MS797. As a whole, the use of fly ash in the production of roof tiles concrete helps the enhance the structural properties which is strength and water absorption. This also provides a solution to for environmental damage caused by open dumping of fly ash as waste by utilizations fly ash as construction material.

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