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Abstract

Malaysia is a country which its citizens employed rice as their main dishes. For fulfilling this re uirement, Malaysia has harvested paddy in some of its states like Kedah, Perlis, Pahang and Sarawak. So, abundant of rice husk has been produced from this paddy and it has been burnt or thrown away by several farmers. As an alternative, one study has been conducted on utilization of rice husk. In this study, rice husk has been burnt and turned into ash which has been called as Micronised Biomass Silica (MBS). It was found that MBS as cement replacement material has a potential to reduce the water permeability coefficient and depth of penetration of water in concrete. Also, it was revealed that 12 MBS is an optimum uantity as cement replacement material in concrete.

1. Introduction

Construction industry is one of industry which played an important role for country's development. For supporting this development, technology in construction industry is always been enhancing to produce a high quality of concrete structure. Many researches have been conducted as an effort to produce a good concrete. Application of cement replacement material (Shoaib and Waliuddin, 1996), utilization of high cement content (Levy and Helena, 2004) and special method in making concrete (Tam W.Y. and Tam C.M., 2007) were a few examples of researches that have been conducted for ascertain in producing of quality concrete.

Paddy is one of prime crop in Malaysia. This is because, rice is becoming as main meal for Malaysian citizens. On the other hand, paddy is contributing rice husk which containing high silica content when it is burnt at certain temperature and change into rice husk ash (Mehta, 1993).Thus, most of the researcher have an intention to produce concrete which using rice husk ash as cement replacement material. Some of the studies on rice husk ash application had been conducted by Sampaio *et. al.* (2000), Nehdi *et. al.* (2003) and Zhang *et. al.*(1996). From their studies, it was revealed that rice husk ash can increase the compressive strength of concrete and performed better in durability characteristic.

In this study, the rice husk was burned is with rotary furnace at fix temperature 500 ° C and its ash was called as Micronised Biomass Silica (MBS). MBS was used as cement replacement material and its main objective was to achieve a lower water permeability of concrete. Two different methods were used for determining the water permeability of concrete and correlation equation between these two methods was established.

2. xperimental orks

2.1 Materials Selection

a) Ordinary Portland Cement (OPC)
b) Fine Aggregate
c) Coarse Aggregate
d) Superplasticizer

2.2 Micronised iomass Silica (M S)

MBS was produced by burning the rice husk at 500°C. Figure 1 shows the rotary furnace at Universiti Tun Hussein Onn Malaysia (UTHM) which has been used in this study to burn the rice husk. This rotary furnace synthesized the rice husk into white amorphous material and about 15% of MBS was produced by weight of rice husks. White amorphous material which obtained from rotary furnace has particle size diameter at 48 µm. Then, the white amorphous material was micronised by using jar mill for about one hour. MBS was produced with particle size diameter at 25 µm.

Figure 1 Rotary Furnace

2.3 Concrete Mixes

In this study, six concrete mixes were prepared. DOE was adopted as design mix for the concrete mixes and target strength of concrete at 28 days is 25 MPa. Table 1.0 shows the mix proportion for concrete mixes. The concrete mixes were denoted with M0, M4, M8, M12, M16 and M20 for 0%, 4%, 8%, 12%, 16% and 20% of MBS as cement replacement material in concrete mixes. Superplastizer was used in this study to achieve slump value of concrete mixes at 60 – 180mm. Three cubes of concrete were used to determine the water permeability of concrete according to ISO/DIS 7031. Meanwhile, another three were used to measure the water permeability according to modified DIN 1048. After concrete cubes were removed from its mould, they were cured in water until the testing day.

Mix	Cement (kg/m^3)	MBS (kg/m)	Water (kg/m)	Coarse Aggregate (kg/m^3)	Fine Aggregate (kg/m^3)	SP (ml)
M0	450	0	225	823	892	4500
M4	432	18	225	823	892	4320
M8	414	36	225	823	892	4140
M12	396	54	225	823	892	3960
M16	378	72	225	823	892	3780
M20	360	90	225	823	892	3600

Table 1 Mix roportions for Concrete Mixes

2.4 Testing of Fresh Concrete

In this study, slump value test was conducted to determine the workability of concrete mixes. This test was conducted accordance to BS 1881: Part 102: 1983.

2.5 Testing of ardened Concrete

Two different methods were conducted in this study to determine the water permeability of concrete. Three 100mm cubes were used for water permeability test, following ISO/DIS 7031 method. Then, another three 100mm cubes were used for measuring the water permeability according to modified DIN 1048 method.

3. Results and Discussion

3.1 orkability

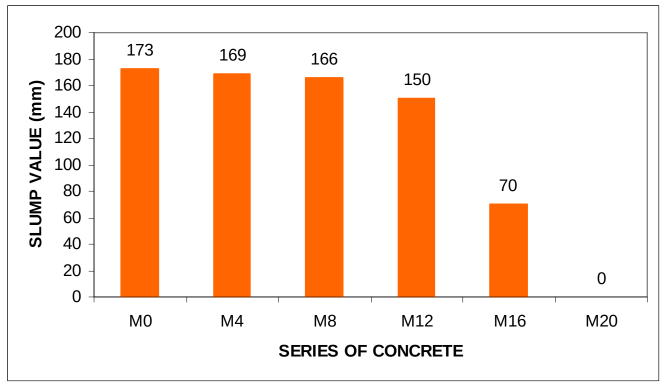

Figure 2 Slump alue for Concrete Mixes

Slump value for various replacements of MBS in concrete mixes is shows in Figure 2. This figure revealed that as MBS content is increase; its slump value is decreasing. This is because MBS have a water absorption characteristic. So, this higher water absorption characteristic leads the concrete mixes become harsh and difficult to compact which contribute to decreasing of slump value.

3.2 ater ermeability

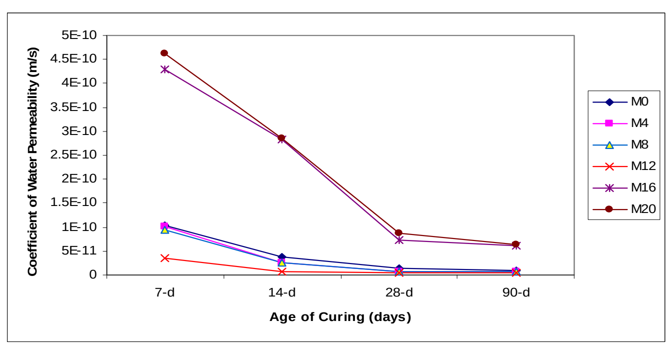

Figure 3 Coefficient of ater ermeability vs Age of Curing

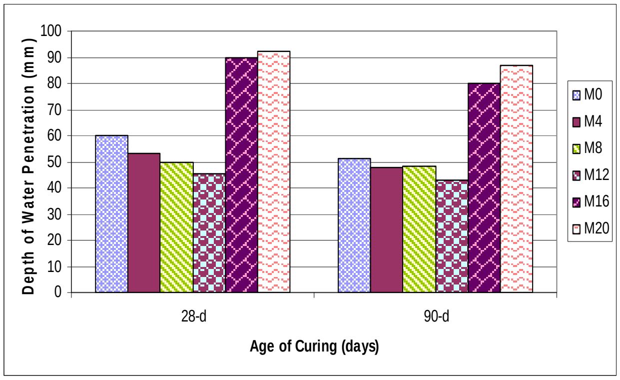

Figure 4 Depth of enetration vs Age of Curing

The effect of various percentage of MBS replacement in cement on water permeability is presented in Figure 3 and Figure 4. The results show that when age of curing is increasing, its water permeability is decreasing. In Figure 3, concrete with 12% replacement of MBS attained lowest in coefficient of water permeability than others. Control concrete obtained higher in coefficient of water permeability except concrete with 16% and 20% of MBS replacement. At 28 days, concrete with 4%, 8%, 12% of MBS obtained 49.93, 58.33 and 69.60 % decreasing in coefficient of water permeability than control concrete, respectively. On the other hand, at 28 days, concrete with 16% and 20% of MBS attained 381.33 % and 474.67 % increasing in coefficient of water permeability than control concrete. At longer curing period, coefficient of water permeability is decreased to 28.18, 36.22 and 55.32 % for concrete with 4%, 8% and 12% replacement of MBS. Contrary result is obtained for 16% and 20% replacement of MBS, its coefficient of water permeability is increased to 534.66 % and 570.15 %. Meanwhile, Figure 4 revealed that concrete with 12% of MBS obtained a lowest in depth of penetration of water in concrete than that of others. At 28 days, concrete with 4%, 8% and 12% of MBS obtained 11.67, 16.67 and 24.17 % decreasing in depth of water penetration than control concrete. But, concrete with 16% and 20% MBS, attained 50% and 53.33% increasing in depth of water penetration than control concrete. In longer curing period, the depth of water penetration is reducing to 5.88%, 4.90%, 15.69% for 4%, 8% and 12% replacement of MBS in concrete compared to control concrete. On the other hand, for 16% and 20% replacement of MBS, the depth of water penetration is increasing to 56.86% and 70.59% than that of control concrete. From these results, 12% of MBS is an optimum cement replacement material in concrete. It also can be noted that 4%, 8% and 12% MBS as cement replacement material have an ability to reduce the water permeability of concrete. In this study, MBS is performed as pozzolanic material and filler which filling the micropores in concrete. Thus, this characteristic is lead to decrease of water permeability in concrete.

3.3 Relationship between ISO DIS 7031 and Modified DI 1048

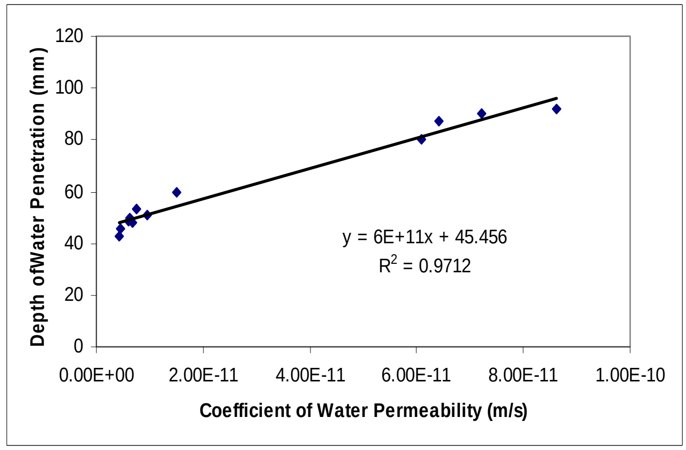

Figure 5 Relationship between ISO DIS 7031 and Modified DI 1048

Figure 5 shows the linear correlation between the coefficients of water permeability which conducted according to ISO/DIS 7031 with depth of penetration which conducted according to modified DIN 1048. The regression correlation of linear is formed for specimens at age of curing 28 and 90 days. Figure 5 demonstrates that at various percentages of MBS in concrete, the coefficient of water permeability increases with increasing depth of water penetration. From the higher correlation regression, it can be assumed that coefficient of water permeability have a close relationship with depth of water penetration. Thus, coefficient of water permeability that obtained according to ISO/DIS 7031 can be used to predict depth of water penetration that obtained according to Modified DIN 1048.

4. Conclusions

i) Water permeability of concrete is decreased at replacement of MBS as cement material up to 12% for all ages.
ii) At longer curing age of period concrete, the lower its coefficient of water permeability.
iii) At longer curing age of period concrete, the lower its depth of water penetration.

iv) Linear relationship is established between coefficient of water permeability and depth of water penetration.

5. Acknowledgement

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