Chemecal composion of rice husk ash biology essay

Science, Biology

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PROJECT TITLE IN CAPITAL LETTER

TITLE TO BE THE SAME AS FRONT COVER

ABSTRACT

This paper presents a study on the strength properties of rice husk ash concrete of certain grade. Adding the optimum amount of RHA is important for achieving high strength, however, being cellular in nature, the use of RHA tends to increase the water requirement. The results reveal the influence of RHA on the workability of concrete and its strength performance (compressive and tensile strength) by replacing ordinary Portland cement (OPC) with different replacement levels of RHA. In this study, concrete mixtures were prepared; in which three series comprise of control mix (OPC concrete) incorporating different proportions of RHA (25%, 30% and 35%). The water/binder ratio for these mixes were fixed at 0. 63, 0. 65 and 0. 70 and designed to achieve slump in the range of 40 mm to 50 mm. The results of this study is to show that the combined effects of incorporating partial replacement of OPC with RHA can provided higher compressive strength compared. But the tensile strength at the later ages may better than the normal OPC concrete.

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CHAPTER 1

INTRODUCTION

Background

With the increase growth of population in the country, the need to provide a decent and affordable accommodation to the people as part of the national economic strategy, i. e eradication of poverty and improving the living quality of the people is seriously looked into. However, in the building of houses (low-cost), the availability of building material which is cheap and abundant is of paramount importance. To overcome this problem, the development of new construction materials, which must be inexpensive and require very little energy to produce, must be researched. One of such material is rice husk ash (RHA) which is a by-product of agriculture. Rice husk ash having pozzolanic properties would reduce the demand of Portland cement and thus it should reduce unit cost of concrete. Disposal of rice husk ash is an important issue in these countries which cultivate large quantities of rice. Rice husk has a very low nutritional value, also take very long to decompose and are not appropriate for composting or manure. Therefore tons of rice husk produced globally begins to impact the environment if not disposed of properly. One effective method used today to rid the planet of rice husk is to use it to fuel kilns. These kilns help to produce bricks and other clay products that are used in daily life. Burning the rice husk is an efficient way to dispose of the rice cultivation byproduct while producing other useful goods. After the kilns have been fired using rice husk, the ash still remains. As the production rate of rice husk ash is about 20% of the dried rice husk, the amount of RHA generated yearly is about 20 million tons worldwide (Hwang, 1985). The rice husk ash is a highly siliceous material that can be used in concrete if the rice husk is burnt in a specific manner. The characteristics of the ash are dependent on the components, temperature and time of burning (Hwang, 1985). During the burning process, the carbon content is burnt off and all that remains is the silica content. The silica must be kept at a non-crystalline state in order to produce an ash with high pozzalonic activity. The high pozzalonic behavior is a necessity if you intend to use it as a substitute of cement in concrete. It has been tested and found that the ideal temperature for producing such results is between 600 °C and 700 °C. Rice is a heavy staple in the world market as far as food is concerned. Therefore, rice can be considered the leading crop produced for human consumption in the world. The leading region of the world which produces rice is Asia, especially South-East and East Asia. Rice can easily be grown in tropical regions on any type of terrain. It is well-suited to countries and regions with low labor costs and high rainfall, as it is very labor-intensive to cultivate and requires plenty of water for cultivation. The plains in South-East Asia provide the perfect accommodations. For countries where rice production is abundant, the use of RHA to partially substitute cement is attractive because of its reactivity. It is reported that the chemical properties of rice husks depends on the burning conditions and are similar to silica fume in which the SiO2 content is about 90% to 95%, 1% to 3% K2O, carbon content of 5. 91% and less than 5% unburnt carbon. The specific gravity of RHA is 2. 05, lower than that of cement which is 3. 15 and its specific surface area is about 20 m^2/g to 50 m^2/g. In general, the average particle size of RHA is between 5 to 10 µm while that of cement is approximately 13 µm. The rice husk has a large dry volume due to its low bulk density (90-150 kg/m^3) and possesses rough and abrasive surface that are highly resistant to natural degradation. It is a very fine pozzolanic material which forms cementitious compound when reacts with lime and water. Table 1. 1 shows typical chemical composition of RHA obtained from various references.

Table 1. 1: Chemecal Composion of Rice Husk Ash Constituent

% compositionFerric oxide (Fe2O3)1. 38Silicon dioxide (SiO2)90. 20Aluminum oxide (Al2O2)0. 85Calcium oxide (CaO)1. 18Magnesium oxide (MgO)1. 12Loss on ignition3. 95RHA has the potential as a cheap cementing material since rice husks are essentially waste material having high silica (SiO2) content, highly porous morphology, lightweight, angular and have a very high external surface area. Its absorbent and insulating properties are useful to many industrial applications, and the ash has been the subject of many research studies. Consequently, the tremendous amount of cost could be saved by partially replacing OPC with RHA. There are main three biomass by product comes from rice viz. rice straw, rice husk and rice bran. Rice straw and rice bran are used as feed for cattle, poultry, fish etc. and the rice husk is used for energy production. (Karitini K, 2006). In some comtries eg. Bangladesh, there are so many small rice mills, where rice husk is burned in uncontrolled manner. After burning a huge amount of rice husk ash is produced and dumped it as waste which creates an environmental problem. For increase the cost of construction materials and raising environmental concerns urge, considerable efforts are being taken worldwide to utilize local natural waste and by product materials to improve the performance of construction materials. Conventional building materials are beyond the reach of a majority of the world population due to their poor affordability. Rice husk is one of the major agricultural by product and available all parts of the world except Antarctica (FAO, 2002). During growth, rice plants absorb silica from the soil and accumulate it into their structures. It is this silica, concentrated by burning at high temperatures removing other elements, which make the ash so valuable. The annual production of paddy rice globally was 579, 500, 000 tones in 2002. Assuming a husk to paddy ratio of 20% (Beagle, 1978), and a ash to husk ratio of 18% (Velupillai, 1997), the total global ash production could be as high as 21, 000, 000 tones in 2002. The use of rice husk ash in concrete was patent in the year 1924 (P. Stroven et. Al, 1999). Up to 1972, all the researches were concentrated to utilize ash derived from uncontrolled combustion (Deepa et. Al, 2006). Controlled combustion influence the surface area of RHA, so that time, temperature and environment to be considered to produce ash of maximum reactivity (Nehdi et. Al, 2003). However, from the review of literature, it was found that some works already done to find out the effect of RHA in cement mortar and they collect the RHA by burning the rice husk under a controlled temperature and atmosphere to produce a highly reactive ash (Zhang et Al, 1996. Malhotra, 1997. Mehta, 1994).

1. 2 Aims and Objective

The aim of this project is to optimise the use of RHA in concrete mixture by selecting the optimum amount / persentage to be as cement replacement and the effectiveness of the concrete at various experimental test in order to obtain the largest possible strenght. Review of different amount / persentage of RHA in concrete will be carried out in order to select the one with the highest increment of strength. Different categories of samples will be looked at, both cubic and cylindrical . Calculations and exprerimental procedure will done in accordance to the british standard (BS-1881)Focus mostly on the mehcanical property of the concrete. Limit the work to only the compresion and tesile strength of the concrete.

CHAPTER 2

LITERATURE REVIEW

2. 1General

Concrete is the most widely used construction material in the world at present situation, The most common form of concrete is Ordinary Portland Cement (OPC) concrete, which consists with coarse aggregate, fine aggregate, cement and water. The earth's crust is the source of concrete making materials. Thus, it depletes the natural resources every year creating ecological strains. On the other hand, human activities on earth produce solid wastes such as industrial wastes, agricultural wastes and wastes from rural and urban societies in considerable quantities of over 2500 million tons per year. Among the solid wastes, the most prominent materials are fly ash, blast furnace slag, rice husk ash, silica fume and materials from construction demolition. Portland cement is mostly and commonly used in the production of concrete. As a construction material, concrete can be cast in almost any shape desired, and once hardened, can become a structural (load bearing) element. Users may be involved in the factory production of pre-cast units, such as panels, beams, road furniture, or may make cast-in-situ concrete such as building superstructures, roads, dams. These may be supplied with concrete mixed on site, or may be provided with " ready-mixed" concrete made at permanent mixing sites. Portland cement is also used in mortars (with sand and water only) for plasters and screeds, and in grouts (cement/water mixes squeezed into gaps to consolidate foundations, road-beds, etc.). When water is mixed with Portland Cement, the product sets in a few hours and hardens over a period of weeks. These processes can vary widely depending upon the mix used and the conditions of curing of the product, but a typical concrete sets in about 6 hours and develops a compressive strength of 8 MPa in 24 hours. The strength rises to 15 MPa at 3 days, 23 MPa at 1 week, 35 MPa at 4 weeks and 41 MPa at 3 months. In principle, the strength continues to rise slowly as long as water is available for continued hydration, but concrete is usually allowed to dry out after a few weeks and this causes strength growth to stop.

2. 2 Introduction

In this century, the utilization of rice husk ash (RHA) as cement replacement is a new trend in concrete technology. Besides, as far as the sustainability is concerned, it will also help to solve problems otherwise encountered in disposing of the wastes (Chandra, 1997). Disposal of the husks is a big problem and open heap burning is not acceptable on environmental grounds, and so the majority of husk is currently going into landfill. The disposal of rice husks create environmental problem that leads to the idea of substituting RHA for silica in cement manufactured. The content of silica in the ash is about 92-97%. Research had shown that small amounts of inert filler have always been acceptable as cement replacements, what more if the fillers have the pozzolanic properties, in which it will not only impart technical advantages to the resulting concrete but also enable larger quantities of cement replacement to be achieved. There are many advantages in using pozzolans in concrete, and they are; improved workability at low replacement levels and with pozzolans of low carbon content, reduced bleeding and segregation, low heat of hydration, lower creep and shrinkage, high resistance to chemical attack at later ages (due to lower permeability and less calcium hydroxide available for reaction), and low diffusion rate of chloride ions resulting in a higher resistance to corrosion of steel in concrete [Krishna, 2008]. Studies by Kartini (2010, 2009); Gambhir (2006); Hwang and Chandra (1997); Mehta (1992) had showed the outstanding technical benefit of incorporating cement replacement materials (RHA) in which it significantly improves the durability properties of concrete. These properties are difficult to achieve by the use of pure Portland cement alone. 2. 3

Influence of size of specimen on strength

The size of test specimens for strength testing is prescribed in the relevant standards, but occasionally more than one size is permitted. Moreover, from time to time arguments in favour of use of smaller specimens are advanced. This point out their advantages: smaller specimens are easier to handle and are less likely to be accidentally damaged; the moulds are cheaper; a lower capacity testing machine is needed; and less concrete is used, which in the laboratory means less storage and curing space, and also a smaller quantity of aggregate to be processed. On the other hand, the size of the test specimen may affect the resulting strength and also the variability of test results. For these reasons, it is important to consider in detail the influence of the size of specimen on strength test results. Concrete composed of elements of variable strength is reasonable to assume that the larger the volume of the concrete subjected to stress the more likely it is to contain an element of agiven extreme (low) strength. As a result, the measured strength of a specimen decreases with an increase in its size, and so does the variability in strength of geometrically similar specimens. Because the influence of size on strength depends on the standard deviation of strength. It follows that the size effects are smaller the greater the homogeneity of the concrete. Thus, the size effect in lightweight aggregate concrete should be smaller, but this has not been confirmed with any degree of certainty, although there is some support for this suggestion in theavailable data. In the case of tests on the strength of concrete, we are interested in the averages of extremes as a function of the size of the specimen. Average values of samples chosen at random tend to have a normal distribution, so that the assumption of this type of distribution, when average values of samples are used, does not introduce serious error, and has the advantage of simplifying the computations. In some practical cases, a skewness of distribution has been observed; this may not be due to any 'natural' properties of concrete but to the rejection of poor quality concrete on the site so that such concrete never reachesthe testing stage.

Size effects in tensile strength tests

Direct tension tests on cylinders of concretes with compressive strengths between 35and 128 M Pa (5000 and 18 500 psi) were performed by Rossi et al. They confirmed the decrease in tensile strength and also in variability of test results with an increase in size: the decrease in strength is larger the lower the strength of concrete. The coefficient of variation also decreases with an increase in size of the specimen, but there is no apparent effect of the strength of concrete on this relation. Rossi et a1. explain this influence of strength in terms of the heterogeneity of the mix components. Specifically, the size effect is a function of the ratio of the specimen size to the maximum size of aggregate and of the difference in strength between the aggregate particles and the surrounding mortar. This difference is small in very high strength concrete and also in lightweight aggregate concrete. Splitting tension tests on 150 mm diameter by 300 mm high (6 by 12 in.) cylinders and 100 mm diameter by 200 mm high (4 by 8 in.) cylinders have given an average ratio of the strength of the former to the latter of 0. 87; the average splitting tension strength of the larger cylinders was 2. 9 MPa (415 psi). The standard deviation for the larger cylinders was 0. 18 M Pa (26 psi) and, for the smaller, 0. 27 MPa (39 psi). The coefficients of variation were, respectively, 6. 2 and 8. 2 per cent. It is worth observing that the coefficient of variation of the splitting tension strength of 150 by 300 mm cylinders had nearly the same value as the coefficient of variation of the modulus of rupture determined on beams with a 150 by 150 mm (6 by 6 in.) cross-section made of the same concrete. The influence of the cylinder size on splitting tension strength was confirmed by Batant et al. on the basis both of their own tests on mortar discs and also on the basis of tests on concrete cylinders performed by Hasegawa et al. In both these series of tests, the size effect disappears in large-size specimens. This topic is discussed in the next section. Cement compacts have also been found to show the size effect when tested in splitting tension. The same applies in the case of the ring test.

Size effects in compressive strength tests

It is interesting to note that the size effect disappears beyond a certain size so that a further increase in the size of a member does not lead to a decrease in strength, both in compression and in splitting tension. According to the U. S. Bureau of Reclamation, the strength curve becomes parallel to the size axis at a diameter of 457 mm (18 in.), i. e. cylinders of 457 mm (18 in.), 610 mm (24 in.), and 914 mm (36 in.) diameter all have the same strength. The same investigation indicates that the decrease in strength with an increase in size of the specimen is less pronounced in lean mixes than in rich ones. For instance, the strength of 457 mm (18 in.) and 610 mm (24 in.) cylinders relative to 152 mm (6 in.) cylindersis 85 per cent for rich mixes but

93 per cent for lean (167 kg/m3 (282 lb/yd3))These experimental data are of importance in refuting a speculation that, if the size effect is extrapolated to very large structures, a dangerously low strength might be expected. Evidently this is not so because local failure is not tantamount to collapse. The various test results on the size effect are of interest because size effects have been ascribed to a variety of causes: the wall effect; the ratio of the specimen size to the maximum aggregate size; the internal stresses caused by the difference in temperature and humidity between the surface and the interior of the specimen; the tangential stress at the contact surface between the platen of the testing machine and the specimen due to friction or bending of the platen; and the difference in the effectiveness of curing. In this con nection, Day and Hague showed that the relation between the strength of 150 by 300 mm (6 by 12 in.) and 75 by 150 mm (3 by 6 in.) cylinders is not affected by the method of curing

2. 3 Subsequent Research On Rice Husk Ash

Extensive studies have been carried out and have indicated that the RHA can be beneficially utilized; however, in Malaysia the utilization of this ash is not routinely practiced or mandated. In order to have the confidence in the use of this ash, comprehensive studies have to be carried out based on Malaysia environment.

Table 2. 1 Researches on RHA

Name of journalPercentage of rice husk ash replacement10%20%25%30%35%40%Karitini K, Mahmud HB, Hamidah, MS 2006, strength propertise of grade 30 rice hask ash concrete

Kartini. K. 2010, absorption and permeability performance of Selangor rice husk ash blended grade 30 concrete.

Kartini. K. 2011, Rice Husk Ash –pozzolanic material for sustainability.

Marthong. c 2012, effect of rice husk ash as a partial replacement of cement on concrete properties,

MD NOR ATAN*, HANIZAM AWANG (decemeber 2011) 'the compressive and flexural strength of self compacting concrete using raw rice husk ash.

D. Brindha , S. Nagan (2011) 'Durability studies on copper slag admixed concrete

THIS RESEARCH

2. 3. 1Highlights of Recent Related Rice Husk Research

Since western-style buildings have become prevalent in SE Asia, elevated indoor temperature due in part to solar heat gain has become a widespread problem, often remedied with energy-intensive air conditioning. In 2007, C. Lertsatitthanakorn and S. Atthajariyakul of Mahasarakham University, and S. Soponronnarit of King Mongkut's University of Technology Thonburi (Thailand) studied the thermal performance of RHA based sand-cement blocks as insulating thermal mass. They built a small room (5. 75 square meter floor) out of standard commercial clay brick, and another out of blocks composed of RHA, sand, and cement at a ratio of 544: 320: 40. They took continuous temperature measurements inside both for the Thai summer month of March, and found that the RHA blocks allowed 46 W less heat transfer than the clay bricks. Also included in the study was an economic analysis of potential energy savings. In 2008, Sumin Kim of Soongsil University, (Seoul, Republic of Korea) Investigated the effect of combining rice husk itself (not ash) with gypsum in the manufacture of drywall boards. Kim found that at rice husk levels up to 30%, the modulus of rupture and modulus of elasticity increased, but decreased at levels over 40%. Internal bonding strength increased for RH levels up to 20%, but decreased at higher levels. At higher rice husk content, the product absorbed less moisture, and became slightly more combustible, but up to 30% RH still met Japanese Standards Association first class incombustibility requirements. The author concluded that 20% rice husk by weight is the ideal mixture for improving gypsum boards while lowering costs and helping reduce the rice husk disposal issues. A method has been developed by which the pozzolanic activity of a batch of ash can be measured in 28 hours (as opposed to 7 or 28 days) by mixing a sample with Portland cement, measuring the electrical conductivity of the solution, and comparing it to values from the reaction of a solution with a known pozzolanic activity level. (Sinthaworn, Waste Management, 2009)Rice husk can be co-combusted with coal to help clean up coal-fired power plant emissions. 10% to 30% biomass appears to yield the lowest overall pollutant per unit of energy ratio, though the co-firing may produce more ultra-fine particles, and increase problems of " slagging, fouling and formation of clinker" in conventional systems. (Chao, Bioresource technology, 2008)RHA can be added to soil to aid in compactibility. According to Basha and Muntohar (Electronic Journal of Geotechnical Engineering, 2003), the plasticity of soil is reduced when rice husk ash and/or cement is added, as is the maximum dry density, and the optimum moisture content is increased. They state that considering plasticity, compaction, and economy, the ideal soil additive mix is within 6-8% cement and 10-15% RHA. produce more ultra-fine particles, and increase problems of " slagging, fouling and formation of clinker" in conventional systems. (Chao, Bioresource technology, 2008)RHA can be added to soil to aid in

compactibility. According to Basha and Muntohar (Electronic Journal of Geotechnical Engineering, 2003), the plasticity of soil is reduced when rice husk ash and/or cement is added, as is the maximum dry density, and the optimum moisture content is increased. They state that considering plasticity, compaction, and economy, the ideal soil additive mix is within 6-8% cement and 10-15% RHA.

2. 4`Availability of Materials

Waste material obtained from the industrial waste, shall be used in this project rice husk ash waste, volume of the materials will vary from 50% to 100%. It is expected that all materials are easily avaliable in the commercial market.

CHAPTER 3

METHODOLOGY

3. 1 Materials Used

3. 1. 1Cement

Ordinary Portland cement (OPC) of 53 grade obtained from a single source was used in this experiment. Properties of the cement is believed to be at standarts of comercially sold cement i. e in respect to the IS: 4031 (1988).

3. 1. 2Rice Husk Ash

Commercially available rice husk ash was procured and used in the experimental investigation Physical and Chemical properties of the rice husk ash obtained from kilang Beras BERNAS bhd are given in Table 1. 1

3. 1. 3 Fine Aggregate

Natural mining sand was used in the experiment with the maximum size of about 5mm, which the fineness modulus of the sand was 2. 61 with a sepecific gravity of 2. 6

3. 1. 4 Coarse Aggregate

Crushed granite of aroud 12mm minimum to 20 mm maximum size was used in the experiment having the specific gravity of 2. 8 and fineness modulus of 4. 61.

3. 1. 5Water

Normal tap water was used in the entier process and duration of the experiment.

3. 2 Mix Propotion

The mix proportion of M40 grade concrete mixes were designed based on the recommendations of BS: 1881 without rice husk ash or any super plasticizer. The identification of mix proportions and quantity of materials taken for each bach of concrete mixes are given in Table 3. 1. Concrete mixes were prepared with cement replacement levels of 0, 25, 30 & 35% by rice husk ash.

3. 3Preparation of Test Samples

The ingredients for various mixes were weighed and mixes prepared by using a tilting drum type concrete mixing machine. Precautions were taken carefully to ensure uniform mixing of ingredients. The specimen were cast in steel / plastic mould and compacted on a table vibrator. The specimens of

150x150x150 mm size of cube, 100mm diameter x 200mm high cylinder specimens were cast for different tests.

Table 3. 1 Mix propotion

Mix desingnationBach 1Bach 2Bach 3Bach 4persentage of RHA (%)0253035w/c Ratio0. 440. 60. 650. 7Cement (kg)20151413Rice husk Ash (kg)0567Sand (kg)37373737Coarse Aggregate (kg)50. 850. 850. 850. 8Water (kg)8. 812. 613. 614Note: Bach 1-control concrete, bach 2- 25% RHA, Bach 3- 30% RHA, Bach 4-35% RHA.

3. 4Mechanical Property Testing Method

3. 4. 1Compresive Strength Test

The compressive strength was calculated using the formula given by BS 1881 and tested on 150 mm cubes at ages of 3, 7, 14 and 28 days, after curing in water. Total Cube specimens are 48 in numbers each sized of approximatly 150 mm× 150 mm × 150 mm for each set of concrete it was cast and tested under compressive load at various ages. All the specimens were tested in dry condition. For each mix combination, three identical specimens were tested at the ages of 3, 7, 14, and 28 days using Compression Testing Machine Fig 3. 1 (CTM) of 2000 kN capacity under a uniform rate of loading of 2. 4 kN/s. and the compressive strength was calculated as per BS 1881.

3. 4. 2 Split Tensile Test

Split tensile test for the concrete was carried out according to the BS 1881: Part117: 1983. Concrete cylinders of 100 mm diameter and 200 mm height were casted by using concrete . Mechanical table vibrator fig 3. 2 was used to compact the concrete during casting. The moulds were removed after 24 hours and placed in curing tanks until the testing dates which was each at 28days. The specimens were tested after 28 days with the loading rate of 2. 4kN/s. The average value of tensile strength was obtained by testing of three specimens for each bach of mix. a total of 12 cylinder specimen . 3. 4. 3WorkabilityWorkability is a complicated concept for fresh concrete and embodies various properties including consistency and cohesiveness. There is still not a single test method that can fully reflect workability. Since the slump represents the ease with which the concrete mixture will flow during placement, and the slump test is simple and quantitative, most mix design procedures rely on slump as a crude index of workability. Sometimes, the Vebe time may be employed. Workability test in terms of slump test on the fresh mixes with the accordance to BS in achieving constant approrate workability was carried out. Fig 3. 1 Collapse slumpFig 3. 2 True slump Fig 3. 3 Shear slumpThree different kinds of possible slumps exist, true slump, shear slump, and collapse slump. Conventionally, when shear or collapse slump occur, the test is considered invalid. However, due to recent development of self compact concrete, the term of collapse slump has to be used with caution. Slump test (BS 1881: 102)

CHAPTER 4

RESULTS AND DISCUSSION

4. 1Scope

A total of four concrete mixtures was made, i. e. normal concrete containing no RHA while the others concrete mixtures contains levels in percentage of RHA. For each set of concrete mixtures three cubes are tested in different times (28 days , 14 days, 7days and 3 days of curing in water), one control concrete mixture and three RHA concrete mixtures were made. The control concretes is the one using the portland cement only, and nothing else as replacement for cement. The RHA concretes included concretes incorporating 25%, 30%, and 35% of RHA as replacement for cement. All concrete mixtures were made with a water from the tap as the materials section 3. 1 prescribed ratio (W/CM) of 0. 44 for the normal concrete. For each concrete mixture, the properties of the compressive strength at 1, 3, 7, and 28 days, and the tensile spliting at 28 days of the concrete were determined following the relevant BS standards. For the tests done on the concrete, same curing mode were used. The curing method which was used is more representative of the field curing of concrete. i. e deeping it in curing tank for the required amount of period.

Workability

It is noticed that an with the increase in the percentage of RHA in the mix resulted in an increased amount of water to obtain the targeted workability of the concrete, As tabulated in Table 3. 1, The amount of w/b ratio required in maintaining the workability of the mixes increases from 0. 44 to 0. 70 in order to enhance the fluidity and consistency of the mix. This reasons being becuase concrete containing RHA require more water for a given consistency due to its adsorptive character of cellular RHA particles and its high fineness, this increases its specific surface area. while maintaining the w/b ratio in order to maintain the workability in term of slump of 40 mm to 50 mm. The results obtained are also in line with studies conducted by Zhang (1996), Mehta (1993), Hwang (1997), Nehdi (2003), Shimizu (1990), and Mehta (1973, 1992).

4. 2 Compressive Sstrength

The result of the compressive strength for the various mixes is shown both graphcally and tabulated in fig 4. 1, and table 4. 1 respectively. For RHA concrete , it shows that the compressive strength increases much more at 25% replacement, however, at 30%, 35% replacement the strength was not as high as that of the 25% at 28 days, but also shows comparability to OPC control concrete strength. The reason is due to the higher water content in the mix to maintain similar workability. And also it is indicated that large amounts of RHA have an adverse negative effect and reduced the strength of concrete. cook (1984). Nevertheless, it shows that all the RHA concrete were able to reach the target strength of 30 N/mm2 at 28 days. it is expected that the optimum can go more than 30% replacement. also showed that prolong curing of these concretes resulted in increased in strength.

4. 3 Split tensile test

The tensile strength of the concrete was tested according to the BS 1881 by using the concrete cylinder. The experimented results are as follows. The tensile strength of the concrete specimens i shown in Table 4. 2 and Figure 4. 2.

CHAPTER 5

CONCLUSION AND DISSCUSSIONS

The 7-day strength activity index increased marginally with an increase in the grinding time. Based upon the above and taking into account the limited nature of the study, it was decided to allow further more experiment to a later time or future experiments. Such ground RHA would have a median particle size of ~ 8 µm, a water requirement of ~ 104% and a pozzolanic activity index of ~ 100% in the mortar used for determining the pozzolanic activity of the RHA. RHA when used as an alternative of cement or just in partial replacement of cement can reduce the cost of material for construction as well as solving the disposal problemsIn the case of the splitting-tensile tests, it can be concluded that the nature of the failure mode is directly affected by the rate of loading. For a relatively low load rate, the failure mode manifests itself as a single crack propagating along the vertical centerline of the cylinder. However, for increasingly higher load rates, the mode of failure is characterized by several bifurcations in the primary crack pattern. The higher the load rate, the more pronounced are the bifurcations. In the case of the direct-tension tests, the results of the linear analyses indicate high stress concentration factors in the vicinity of the notches. These results suggest a failure in a transverse plane passing through the notches. The nonlinear analyses, however, predict failure in a transverse plane near the end of the specimen next to the incident bar. The reason for this is that the load rate is so high, that the tensile limit of the material is reached at the end of the specimen (adjacent to the incident bar) before any significant stresses can develop on the transverse plane passing through the notch.

5. 2Recommendations

Investigations should be undertaken to determine the effect of increasing the RHA content (for up to 40% or more) on the properties of concrete, since such sample of RHA seems to not significantly increase the dosage of water for the concrete to achieve a certain slump. Research is needed to develop data on the mechanical properties and durability characteristics of the concrete using such sample of RHA, before drawing any general conclusions on the performance of this RHA sample in the concrete. The failures predicted in both the splitting-tensile tests and the direct tension tests are highly sensitive to the rate of loading. Therefore it is recommended that additional analyses be conducted at a wide range of load rates to quantify the relationship of load rate to mode of failure. It is also apparent from the results of the analyses that material strain rate effects will delay the time of failure, allowing the specimen to be subjected to a higher load, thus possibly affecting the failure mode. Therefore, it is further recommended that additional numerical analyses be conducted to investigate material strain rate effects on the mode of failure. Finally, the notches in the direct tension specimens analyzed in this study were relatively shallow. It is recommended that specimens with deeper notches be analyzed, both experimentally and numerically, to quantify the effect of notch depth on the mode of failure.