PERMEABILITY AND STRENGTH PARAMETERS OF CONCRETE USING FLY ASH, RICE HUSK ASH, AND EGG SHELL POWDERS

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ABSTRACT:

Concrete is the most extensively used man-made construction material in the world. Its most important quality is its versatility and the ability to design the concrete of any required properties according to the environment. Human development in today's scenario is impossible without the excessive use of concrete. Cement is the most important component of concrete. Unfortunately, productions of cement emit a very large amount of greenhouse gases and possess a very potential threat to the atmosphere. Thus it is inevitable for the sustainable development of human life that the dependency on cement to obtain strength in concrete should be lowered. This is the main reason to obtain a suitable replacement of cement to obtain high strength concrete at a low cost incurred. Also the modern constructions require very high strength in concrete which is only possible by mixing a suitable quantity of admixtures in the concrete. This research centres around the growth of the strength and permeability attributes of concrete by optimal substitution of cement with joint ratio of Fly ash (FA) and Rice husk ash (RHA) with Synthesis Egg shell powder (ESP). Two categories of ash such as fly ash, rice husk ash with four distinct contents of 5%, 10%, 20%, 30%, and 40% in terms of weight were performed for the substitution of cement and addition of a persistent 5% egg shell powder in every substitution. At first we have evaluated the physical and chemical attributes of fly ash, rice husk ash and egg shell powder. The restraints considered for analysis included compressive strength, splitting tensile power, flexure force, water permeability, sorptivity, total charge- passed acquired from swift chloride permeability test (RCPT) and tempo of chloride ion diffusion according to the diffusion coefficient. However, assessment results accomplished underscore the point that strength and permeability properties of concrete significantly jumping up to 30% of cement substitution by combined FA (15%),

RHA (15%) with additive ESP (5%), and subsequently tends to drop down with every supplementary accumulation of substitution outside this level.

Keywords: Fly ash, Egg shell, concrete aggregate.

1. INTRODUCTION:

Concrete is the most widely used man-made construction material in the world. The utility and elegance as well as the durability of concrete structures, built during the first half of the last century with Ordinary Portland Cement (OPC) and plain round bars of mild steel, the easy availability of the constituent materials of concrete and the knowledge that virtually any combination of the constituents leads to a mass of concrete have bred contempt. Strength was emphasized without a thought on the durability of structures. As a consequence of the liberties taken, the durability of concrete and concrete structures is on a southward journey; a journey that seems to have gained momentum on its path to self– destruction. The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for greenhouse effect and the global warming, hence it is inevitable either to search for another material or partly replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. So for this we need to go for the addition of pozzolanic materials along with superplasticizer with having low water cement ratio.

It is observed that various study reports have been brought to light as regards the assessment of individual efficiency of Fly ash and Rice husk ash blended concrete. Nevertheless, there is a scarcity in respect of the study reports which focused on the joint execution of fly ash and rice husk ash. The underlying reason for the current exploration is to precisely assess Fly ash, Rice husk ash (RHA) and Egg shell powder (ESP) chemically, physically and miner logically differentiated, to explore the feasibility of their employment as a cement- substituting substance in the concrete industry

Fly ash is the utmost general pozzolan and is found extensively applied universally in concrete works. It is universally acknowledged that the employment of fine fly ash upgrades the qualities of mortar and concrete. Even though the porosity of the paste is enhanced on account of the inclusion of fly ash, the average pore size gets decreased, resulting in a minimal porous paste. The interfacial domain of the interface between aggregate and the matrix also gets refined in view of the employment of the use of fly ash. It is estimated that in India, the entire coal ash production exceeded 25 core tons in 2020. With an eye on scaling up the employment of fly ash, and to fine-tune the property of concrete, several investigators have resorted to employment of large volumes of Class F fly ashes in concrete.

The supplementary pozzolanic agent from agriculture by-products like rice husk ash (RHA) are emerging as hot topics of incessant investigation. Rice husk ash consists of high silica substance in the shape of non-crystalline or amorphous silica. Hence, it is a pozzolanic material which can be employed as additional cementitious objects. Rice husk is an agricultural remainder derived from the external covering of rice grains during milling procedure. It comprises 20% of the 500 million tons of paddy generated in the world.

Eggshells are agricultural throw away objects produced from chick hatcheries, bakeries, fast food restaurants among others which can damage the surroundings and as a result comprising ecological issues/contamination which would need appropriate treatment. In the ever soaring tasks to change waste to wealth, the efficiency of adapting eggshells to advantageous application constitutes a concept worth-accepting. It is systematically acknowledged that the eggshell chiefly consists of compounds of calcium. Okonkwo has proficiently proposed that eggshell comprises 93.70% calcium carbonate (in calcium), 4.20% organic matter, 1.30% magnesium carbonate, and 0.8% calcium phosphate. It is estimated that roughly 90 million tones of hen egg are generated throughout the world every year. In India 102.8 billion eggs are produced in the year 2010-2011.

2. Related Study

K. Ganesan, K. Rajagopal , K. Thangavel, has deals that ashes from some agricultural or other biogenic wastes when mixed with appropriate amounts of ordinary Portland cement (OPC) can be used as low-cost, environmentally, more friendly binders for concrete production, than using OPC alone. Experimental determination of requisite properties of the ashes of rice husk, coconut husk, palm leaf, bamboo leaf and peanut shell revealed that they satisfy the essential requirements for pozzolans. Further experimental work was carried out on

OPC/rice husk ash (RHA) and OPC/coconut husk ash (CHA) concretes to determine their essential properties in fresh and hardened states. Although the initial and final setting times of OPC/RHA and OPC/CHA pastes were longer than the setting times of 100% OPC paste, they are all within the limits specified by relevant standards. The workability of fresh concrete produced by partially replacing OPC with either of RHA and CHA was found to be better than with 100% OPC. It was also shown that the porosity of OPC/RHA and OPC/CHA concretes was less than the porosity of OPC concrete. Strength tests using very finely ground RHA and CHA to partially replace Portland cement in concrete production showed that at up to 15% replacement the strength activity index of each of them is greater than 100%, which indicating that they are excellent pozzolans.

A. Onera,T, S. Akyuzb, R. Yildiza, presents a laboratory study on the strength development of concrete containing fly ash and optimum use of fly ash in concrete. Fly ash was added according to the partial replacement method in mixtures. A total of 28 mixtures with different mix designs were prepared. 4 of them were prepared as control mixtures with 250, 300, 350, and 400 kg/m^3 cement content in order to calculate the Bolomey and Feret coefficients (K_B, K_F). Four groups of mixtures were prepared, each group containing six mix designs and using the cement content of one of the control mixture as the base for the mix design. In each group 20% of the cement content of the control mixture was removed, resulting in starting mixtures with 200, 240, 280, and 320 kg/m^3 cement content. Fly ash in the amount of approximately 15%, 25%, 33%, 42%, 50%, and 58% of the rest of the cement content was added as partial cement replacement. All specimens were moist cured for 28 and 180 days before compressive strength testing. The efficiency and the maximum content of fly ash that gives the maximum compressive strength were obtained by using Bolomey and Feret strength equations. Hence, the maximum amount of usable fly ash amount with the optimum efficiency was determined.

This study showed that strength increases with increasing amount of fly ash up to an optimum value, beyond which strength starts to decrease with further addition of fly ash. The optimum value of fly ash for the four test groups is about 40% of cement. Fly ash/cement ratio is an important factor determining the efficiency of fly ash.

Satish H. Sathawanea, Vikrant S. Vairagadeb and Kavita S Kenec, deals with

Portland limestone cement of the UNICEM brand was used as a control sample and was acquired at a cement merchant store in Nsukka, Enugu State. The husks were carefully separated from the bran before being burned in the open air. Following that, the ashes were collected and stored in a dry area of the laboratory for analysis. Chemical analysis of the ashes and cement was performed to identify the elemental composition of each ash. This study also looked at the physical characteristics of RHA and cement, such as density, specific gravity, and particle size distribution. Non-ground RHA particle size distribution findings were comparable to cement. The ashes produced by open-air burning were milky-white in color, with a percentage difference in chemical composition. These compositional differences may be due to differences in soil chemistry at the sampling sites, paddy types, and the type of chemical fertilizers used. Finally, the findings indicated that the pozzolanic properties of RHA vary based on where they are located.

C.S. Poon, L. Lam, Y.L. Wong, The effects of mineral admixture on the internal morphology of concrete were studied and evaluated in this work. Portland cement with five different additives was used in the complex admixture. These includes: extracted silica from corn hob ash, synthetic calcium carbonate, synthetic calcium hydrogen carbonate, white and dark kaolin, each replacing 10% of cement in the concrete formulation. The additives and the pure cements were subjected to intensive mixing to ensure homogeneity prior to water addition, after which each undergoes casting and curing. Elemental characterizations of the additives indicated the presence of some elemental oxides and crystallography studies were carried out on the pure and reinforced concrete. The obtained result indicated crystallographic adjustments of the indigenous concrete which will definitely contribute to modifying its mechanical properties.

Alireza Naji Givi , Suraya Abdul Rashid , Farah Nora A. Aziz , Mohamad Amran Mohd Salleh, This study develops the compressive strength, water permeability and workability of concrete by partial replacement of cement with agro-waste rice husk ash. Two types of rice husk ash with average particle size of 5 micron (ultra fine particles) and 95 micron and with four different contents of 5%, 10%, 15% and 20% by weight were used. Replacement of cement up to maximum of 15% and 20% respectively by 95 and 5 μm rice husk ash, produces concrete with improved strength. However, the ultimate strength of concrete was gained at 10% of cement replacement by ultra fine rice husk ash particles. Also the percentage, velocity and coefficient of water absorption significantly decreased with 10% cement replacement by ultra fine rice husk ash. Moreover, the workability of fresh concrete was remarkably improved by increasing the content of rice husk ash especially in the case of coarser size. It is concluded that partial replacement of cement with rice husk ash improves the compressive strength and workability of concrete and decreases its water permeability. In addition, decreasing rice husk ash average particle size provides a positive effect on the compressive strength and water permeability of hardened concrete but indicates adverse effect on the workability of fresh concrete.

3. METHODOLOGY

Raw materials required for the concreting operations of the present work are Cement, Flyash, Rice husk ash, Egg shell powder fine aggregate, coarse aggregate and water.

CEMENT

The OPC is classified into three grades, namely 33 Grade, 43 Grade, 53 Grade depending upon the strength of 28 days. It has been possible to upgrade the qualities of cement by using high quality limestone, modern equipment's, maintaining better particle size distribution, finer grinding and better packing. Generally use of high grade cement offers many advantages for making stronger concrete. Although they are little costlier than low grade cement, they offer 10-20% saving in cement consumption and also they offer many hidden benefits. One of the most important benefits is the faster rate of development of strength.

FLYASH

Fly ash improves concrete's workability, pumpability, cohesiveness, finish, ultimate strength, and durability as well as solves many problems experienced with concrete today–and all for less cost. Fly ash, sometimes called flue ash, has been a popular supplementary cementitious material (SCM) since the mid-1900s. For most concrete producers, fly ash is an important ingredient in concrete mix designs. Depending on the application, the type of fly ash, specification limits, geographic location, and climate, fly ash can be used at levels ranging from 15% to 25% (most common) to 40% to 60% (when rapid setting time is not required), reducing emissions by roughly the same amount—and helping to keep concrete products at an affordable price.

Fig.1. FLYASH IMAGE

RICE HUSK ASH

Rice husk ash is used in concrete construction as an alternative of cement. The types, properties, advantages and uses of rice husk in construction is discussed. The rice paddy milling industries give the by-product rice husk. Due to the increasing rate of environmental pollution and the consideration of sustainability factor have made the idea of utilizing rice husk.

Fig.2. RICE HUSK ASH.

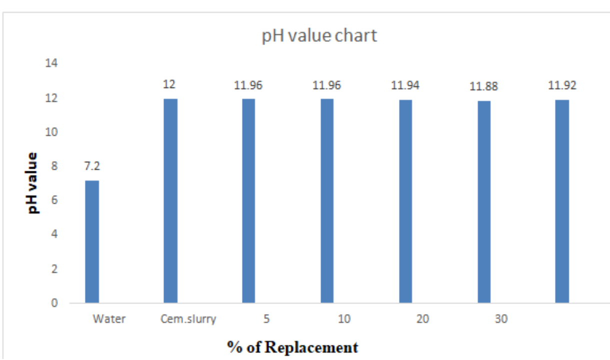
EGG SHELL POWDER

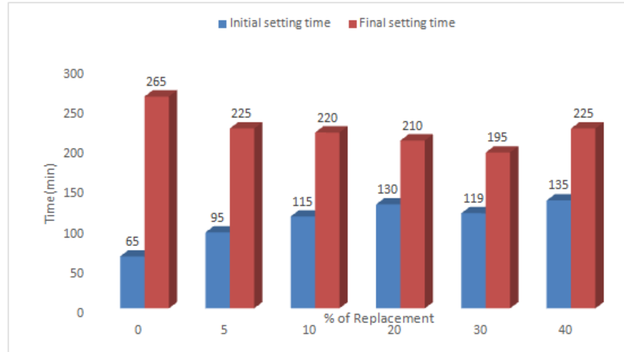
The egg shell wastelands in the poultry manufacturing have been highlighted because of its recovery potential. Egg shell waste is available in huge amounts from the food processing egg breaking and shading industries. The food indulgence industry is in need of investigation to find another method for processing and using egg shells waste in an ecological friendly way. There is a need to find a low cost solution Removal of egg shell waste are usually not income centers but cost centers. Therefore, the least cost of removal is most necessary. Some of the options left should be watched at very critically and the most cost- effective method of recycling are considered.

Fig.3. Image of Egg Shell powder

Results:

The diverse percentage of cement replacement level (CRL) versus standard consistency graph shows that the water needed for standard consistency linearly goes up with an enhancement in substitution (RA_1 – RA_5) content. As ashes are hygroscopic in character and the definite surface area of our composite material (Fly ash, RHA and ESP) is considerably larger than cement, it required additional quantity of water.

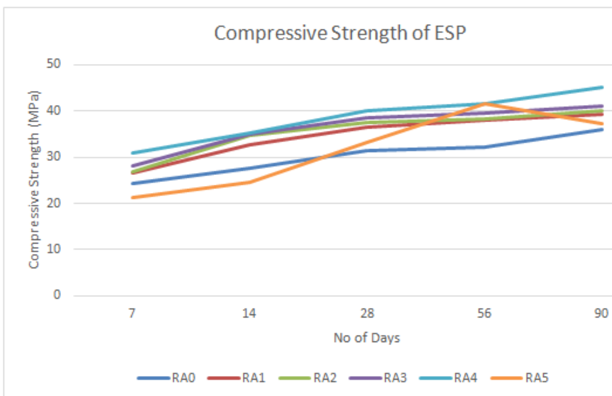




COMPRESSION TEST ON CONCRETE CUBES

The determination of the compressive strength of concrete is very important because the compressive strength is the criterion of its quality. Other strength is generally prescribed in terms of compressive strength. The strength is expressed in N/mm2. This method is applicable to the making of preliminary compression tests to ascertain the suitability of the available materials or to determine suitable mix proportions. The concrete to be tested should

not have the nominal maximum size of aggregate more than 20mm test specimens are either 15cm cubes or 15cm diameter used. At least three specimens should be made available for testing. Where every cylinder is used for compressive strength results the cube strength can be calculated as under. Minimum cylinder compressive strength = 0.8 x compressive strength cube (10 cm x 10 cm) The concrete specimens are generally tested at ages 14 days and 28 days. The cubes are generally tested at 14 & 28 days unless specific early tests are required, for example to remove a concrete shutter safely prior to 14 days.



CONCLUSION

- The subsequent deductions have been made out of the current study:
- Rice husk ash (RHA) and Fly ash-F (FA) is a valuable pozzolanic material loaded fully with unstructured silica content (87.65% and 53.68%) with a moderately negligible diminution on ignition value. The Egg shell powder (ESP) comprises 93.70% calcium carbonate (in calcium).
- The blend portrayal of RA_4 (15%FA+15%RHA+5ESP) improves the power and permeability traits. These properties were distinguished to ensure concrete to substitute concrete as follows:
- Around 56.8% decrease in water permeability
- Approximately 75.55 % decline in Chlorine penetration.
- Roughly 49 % diminution in chloride diffusion
- The above factors of the resilience traits of substitute concrete are considerably better to the OPC concrete. Hence strengthen concrete buildings result in an enhanced plan life
- Compressive and tensile strength improves with the increase in the percentage of Fly ash and Rice Husk Ash up to substitution with additive of Egg shell powder RA_4 (15%FA+15%RHA+5ESP) of 7, 14, 28,56 and 90 days curing.
- In the long run, our study has exposed the fact that RA_4(15%FA+15%RHA+5ESP) may be treated as an finest creation in view of developed value of compressive strength, water permeability, reduced chlorine penetration, superior corrosion inhabiting and desirable functionality

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