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Effect of Rice Husk Ash on Split Tensile Strength of Concrete

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ABSTRACT: Rice husk ash was prepared as a pozzolana by a special process such the final product conformed to engineering requirements in terms of physical and chemical properties and the silica remained in an amorphous form with a minor amount of unburnt carbon. Results indicated that such a pozzolana can be produced with varying pozzolanic activity index depending upon degree of grinding and burning temperature. The effect of rice husk ash content as partial replacement of cement on compressive strength and volume changes of different mixes is investigated. Test result showed up to 40 percent replacement can be made with no change in compressive strength with control mix. However the effect on volume changes is within specified limit as Indian standard.

I. INTRODUCTION

Concrete is no longer made of aggregates, Portland cement and water only. Often, if not always it has to incorporate at least one of the additional ingredients such as admixtures, supplementary cementious material or fibers to enhance its strength and durability. During last few decades requirement of high performance and highly durable concrete has been on rise. The use of mineral admixture in combination with chemical admixture has allowed the concrete technologists to tailor the concrete for many specific requirements. Amongst the mineral admixture, silica fume, because of its finely divided state and very high percentage of amorphous silica, proved to be most useful, if not essential for the development of very high strength concretes and concrete of very high durability i.e. high performance concrete. Therefore it is being used on a worldwide scale in concrete, for the making of high performance concrete. In spite of its numerous advantages silica fume suffers from one major disadvantage that it is imported therefore, very costly. In this work an attempt has made to find a suitable alternate of rice husk ash. Concrete has continuously posed challenges to architects, engineers, researchers and constructors all these years. While trying to improve certain properties of concrete, the other properties have suffered, hence maintaining a perfect balance between the various requirements of concrete happens to be the key to successfully use this wonderful material in emerging India. India is fastest growing economy among all developing nation.

So replacement of ordinary Portland cement by pozzolana Portland cement is more efficient in terms of economy in mass construction. Replacement of pozzolana Portland cement by mineral admixtures (slag, silica fume) shows more efficiency in terms of both economy & strength. Industrialization in developing countries has resulted in an increase in agricultural output and consequent accumulation of unmanageable agro wastes. Pollution arising from wastes is a cause of concern for many developing nations such as India, Nigeria. Recycling of such waste into new building materials could be a viable solution not only to the pollution problem, but also to the problem of the high cost of building materials currently facing these nations. Using sawdust ash (SDA) instead of sawdust in its natural form may lead to a cheaper concrete.

II. MATERIAL AND METHODS

Cements. Cement is by far the most important constituent of concrete, in that it forms the binding medium for the discrete ingredients. Made out of naturally occurring raw materials and sometimes blended or inter ground with industrial wastes, cements come in various types and chemical compositions. For general concrete constructions, IS : 456-2000 permits the use of the following types of cement, subject to the approval of the engineer-in-charge:

a. Ordinary Portland cement conforming to IS : 269-1976.

b. Rapid hardening Portland cement conforming to IS : 8041-1978.

c. Portland slag cement conforming to IS : 455-1976

d. Portland pozzolana cement conforming to IS : 1489-1976.

e. High strength ordinary Portland cement conforming to IS : 8112-1989, and

f. Hydrophobic cement conforming to IS : 8043-1978.

Water. Combining water with a cementitious material forms a cement paste by the process of hydration. The cement paste glues the aggregate together, fills voids within it, and allows it to flow more easily. Less water in the cement paste will yield a stronger, more durable concrete; more water will give an easier-flowing concrete with a higher slump. Impure water used to make concrete can cause problems, when setting, or in causing premature failure of the structure. Hydration involves many different reactions, often occurring at the same time. As the reactions proceed, the products of the cement hydration process gradually bond together the individual sand and gravel particles, and other components of the concrete, to form a solid mass.

Reaction:

Cement chemist notation: $C_3S + H_2O \rightarrow CSH(gel) + CaOH$

Standard notation: $Ca_3SiO_5 + H_2O \rightarrow (CaO)\bullet(SiO_2)\bullet(H_2O)(gel) + Ca(OH)_2$

Balanced: $2Ca_3SiO_5 + 7H_2O \rightarrow 3(CaO)\bullet2(SiO_2)\bullet4(H_2O)(gel) + 3Ca(OH)_2$

Aggregates. Fine and coarse aggregates make up the bulk of a concrete mixture. Sand, natural gravel and crushed stone are mainly used for this purpose. Recycled aggregates (from construction, demolition and excavation waste) are increasingly used as partial replacements of natural aggregates, while a number of manufactured aggregates, including air-cooled blast furnace slag and bottom ash are also permitted. Decorative stones such as quartzite, small river stones or crushed glass are sometimes added to the surface of concrete for a decorative "exposed aggregate" finish, popular among landscape designers.

Concrete. Concrete is a construction material composed of cement (commonly Portland cement) as well as other cementations materials such as fly ash and slag cement, aggregate (generally a coarse aggregate such as gravel, limestone, or granite, plus a fine aggregate such as sand), water, and chemical admixtures. The word concrete comes from the Latin word "concretus", which means "hardened" or "hard". Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like material. Concrete is used to make pavements, architectural structures, foundations, and motorways/roads, bridges/overpasses, parking structures, brick/block walls and footings for gates, fences and poles. Concrete is used more than any other man-made material in the world. As of 2006, about 7.5 cubic kilometres of concrete are made each year—more than one cubic metre for every person on Earth. Reinforced concrete and Prestressed concrete are the most widely used modern kinds of concrete functional Extensions

Classification of Concrete Mixes. Concrete mixes are classified in a number of ways, often depending upon the type of specifications, which are broadly of two types; the „prescriptive, specifications where the proportions of the ingredients and their characteristics (namely, type of cement, maximum size of aggregate, etc) are specified, with the hope that adherence to such prescriptive specification will result in satisfactory performance. Alternately, performance, oriented specification can be used wherein. The requirements of the desirable properties of concrete are specified (example - strength, workability or any other property). Concrete is accepted on the basis of these requirements being satisfied, and the choice of materials and mix proportions is with the producer. Based on the above considerations, concrete can be classified either as nominal mix, concrete or "designed mix" concrete as has been specified in IS : 456-2000. According to this, where the mix proportions were fixed by designing, the concrete mixes with preliminary tests were called "controlled concrete" whereas "ordinary concrete" was one where, nominal, concrete mixes were adopted. This might have inadvertently led to a feeling that no quality control was necessary in case of nominal mixes. However, realizing that mix proportioning is only one aspect of quality control of concrete and that quality control really encompasses many other aspects like choice of appropriate concrete materials after proper tests, proper workmanship in batching, mixing, transportation, placing, compaction and curing, coupled with necessary checks and tests for quality acceptance and quality control, the present concrete code IS : 456-1972 makes a significant departure, in that there is nothing like uncontrolled concrete; only the degree of control varies, from very good to poor or no control. Concrete can be classified in many other ways in special situations; by its density (for example, light weight, normal weight or heavy weight concrete), workability (for example, flowing or pumpable concretes) or its durability in specific environments.

Grades of concrete. Among the many properties of concrete, its compressive strength is considered to be the most important and has been held as an index of its overall quality. Many other engineering properties of concrete appear to be generally related to its compressive strength. Concrete is, therefore, mostly graded according to its compressive strength. The various grades of concrete as stipulated in IS : 456-2000 and IS : 1343-19806 are extracted in Table 1. Out of these, two grades, namely, M 5 and M 7.5, are to be used for lean concrete bases valid simple foundations for masonry walls Grades of concrete lower than M 15 are not to be used in reinforced concrete works and grades of concrete lower than M 30 are not to be used for pre-stressed concrete works. Similar grading of concrete on the basis of 28 days characteristic strength has also been adopted by ISO and most of the other codes of practices. Admixtures vary widely in chemical composition, and many perform more than one function. Two basic types of admixtures are available: chemical and mineral. All admixtures to be used in concrete construction should meet specifications; tests should be made to evaluate how the admixture will affect the properties of the concrete to be made with the specified job materials, under the anticipated ambient conditions, and by the anticipated construction procedures.

Table 1: Split Tensile Strength of M30 Grade RHA Concrete.

S.No.	Mix designation	RHA content (%)	Split Tensile Strength in MPa for28 days
1.	BC	0%	4.98
2.	BR1	5%	4.65
3.	BR2	10%	4.16
4.	BR3	15%	3.92
5.	BR4	20%	3.64

III. TESTING

The various tests conducted on concrete specimen are described in two parts;
(1) Tests on fresh concrete and
(2) Tests on hardened concrete.

Split Tensile Strength Test. Since it is very difficult to apply uniaxial tension to a concrete specimen because the ends have to be gripped and bending must be avoided, the tensile strength of concrete is determined by indirect method; the splitting test and the flexural test. In splitting test, a concrete cylinder of 150mm×300mm size is placed, with its axis horizontal, between platens of a testing machine, and the load is applied at constant rate of 2t/min and it is increased until failure takes place by splitting in the plane containing the vertical diameter of the specimen, as shown in Fig. 1.

Fig. 1. Split Tensile strength test.

IV. RESULTS AND DISCUSSIONS

The Failure load for each of the specimen was noted. The magnitude of tensile stress was calculated by 2P/πDL, where P is the applied load, and D and L are the diameter and length of the cylinder, respectively. Average of three specimens was taken as the representative tensile strength of the specimen. Tensile strength test was conducted at the ages of 28 days.

This chapter covers the results of various test conducted on both fresh as well as hardened concrete. Relationship developed between percentage of rice husk ash added, compressive strength, flexural strength and tensile strength of different mixes is also given in this chapter.

Split Tensile Strength of M30 and M60 Grade RHA Concrete. The tests for split tensile strength of concrete were conducted for different concrete mixes i.e. M30 and M60 grade with different rice hush ash content i.e. 0%, 5%, 10%, 15% and 20% at the selected age i.e. 28days.The results are complied in the Table-19 and Table-20 given below. Although, it is very difficult to apply uniaxial tension to a concrete specimen because the ends have to be gripped and bending must be avoided, the tensile strength of concrete is determined by indirect method; the splitting test and the flexural test. The magnitude of tensile stress was calculated by 2P/πDL, where P is the applied load, and D and L are the diameter and length of the cylinder, respectively.

Effect of Rice Husk Ash on Split Tensil Strength. The results of the Split tensile strength test are presented in Tables. From the observation there was reduction in split tensile strength in both the concrete mixes. It varies from 9.77 to 26.69% and 6.62 to 26.90% at 28 days for the variation for rice husk content 5 to 20% for M30 and M60 grade concrete respectively.

Table 2: Split Tensile Strength of M60 Grade RHA Concrete.

S.No.	Mix designation	RHA content (%)	Split Tensile Strength in MPa for28 days
1.	CC	0%	5.32
2.	CR1	5%	4.80
3.	CR2	10%	4.70
4.	CR3	15%	4.10
5.	CR4	20%	3.90

Table 3: Change in Split tensile strength of M30 Grade of Concrete compared with Control Concrete in respective ages.

S.No.	Mix designation	RHA content (%)	Change in Split tensile Strength in MPa for 28 days
1.	BC	0%	-
2.	BR1	5%	4.65 (Decreased by 6.62times)
3.	BR2	10%	4.16 (Decreased by 16.4times)
4.	BR3	15%	3.92 (Decreased by 21.2 times)
5.	BR4	20%	3.64 (Decreased by26.9 times)

Table 4: Change in Split tensile strength of M60 Grade of Concrete compared with Control Concrete in respective ages.

S.No.	Mix designation	RHA content (%)	Change in Split tensile Strength in MPa for 28days
1.	CC	0%	-
2.	CR1	5%	4.80(Decreased by 9.7 times)
3.	CR2	10%	4.70 (Decreased by 11.6times)
4.	CR3	15%	4.10 (Decreased by 22.93 times)
5.	CR4	20%	3.90 (Decreased by 26.6times)

V. CONCLUSIONS

This chapter covers the conclusions for the present study of the performance of rice husk ash added to concrete as a cement replacement material.

The numerous tests performed to check the performance of rice husk ash as a cement replacement material can be concluded by the following points:

(i) There was a significant improvement in Compressive strength of the Concrete with rice husk ash content of 10% for different grades namely M30 and M60 and at different ages i.e. 7 days and 28 days.

(ii) The increase in Compressive strength was of the order of 4.23% to 10.93% for different grades and at different ages.

(iii) There was also significant improvement in Flexural strength of the Concrete with rice husk ash content of 10% for different grades namely M30 and M60 and at the age of 28 days.

(iv) There increase in Flexural strength was of the order of 1.85% to 8.88% for different grades and at the age of 28 days.

(v) There was reduction in Split tensile strength for 28 days at every rice husk content. There was enormous reduction in split tensile strength as the percentage of rice husk ash increased strength decreased enormously from 6% to 26% for both the grades and at the age of 28 days. As the concrete is a brittle material and cannot handle tensile stress as per IS:456-2000 proved to be right and that is why as the percentage of rice husk ash increased strength decreased. So it can be concluded that Split tensile strength test has a little importance for design aspects.

Vi. FUTURE SCOPE OF WORK

Further research is needed to establish the long-term durability of concrete containing mineral admixtures. The microstructure properties of concrete are needed to be further researched. Other innovative low cost locally available materials that can be used, as mineral admixtures are required to be developed. Other levels of replacement of cement can be researched. Some tests relating to durability aspect such as water permeability, resistance to the penetration of Chloride ions, corrosion of steel reinforcement, resistance to Sulphate attack, durability in marine environment etc. needs investigation.

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