Experimental Study on Concrete Using Rice husk ash and fly ash as a Partial Replacement of Cement

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Abstract— **Concrete occupies the unique position among the modern construction materials. Concrete occupies a unique position among the modern construction materials. Concrete is a material used in building construction, consisting of a hard, chemically inert particulate substance, known as aggregate (usually made for different types of sand and gravel), that is bonded by cement and water.**

This paper presents an experimental investigation carried out to characterize the optimum percentage of fly ash, rice husk ash in replacement of cement. The concrete industry is constantly looking for supplementary cementious material with the objective of reducing the solid waste disposal problem.

This is done to meet the strength requirements in compression, split tension along with durability of concrete. The use waste materials like rice husk ash and fly ash which are hazardous to the environment may be used as a partial replacement for cement and in addition by utilizing the industrial wastes in the useful manner the environment pollution is reduced to a greater extent and which leads to sustainable development.

Specimens are casted with M30 concrete. The work also focuses on M30 concrete with replacement of cement by fly ash and rice husk ash to find optimum percentage. To save our earth resources and to control the pollution from the manufacturing of cement waste materials like RHA and fly ash production of blended cements results in lower emission and lower energy consumption since less clinker from the energy intensive process is needed to produce such blended results.

Key words— fly ash, rice husk ash, strength requirement;

1 INTRODUCTION

SC Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cementitious materials, water, aggregate and sometimes admixtures in required proportions. Fresh concrete or plastic concrete is freshly mixed material which can be moulded into any shape that hardens into a rock-like mass known as concrete. The hardening is because of chemical reaction between water and cement, which continues for a long period leading to stronger with age. Strength was emphasized without a thought on the durability of structures.

The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete and has no alternative in the construction industry. Use of cement alone as a binder material produces large heat of hydration. Since the production of this raw material produces lot of CO_2 emission. The carbon dioxide emission from the cement raw material is very harmful to the environmental changes. Nowadays many researchers have been carried out to reduce the CO_2.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. The process of selecting suitable ingredients of concrete and determining their relative amounts with an objective of producing a concrete of required strength, durability, and workability as economically as possible is termed as concrete mix design. The Mix Design for concrete M30 grade is being done as per the Indian Standard Code IS: 10262-2009

2 OBJECTIVE

1. To find the optimum percentage of replacement of cement with rice husk ash and fly ash.

2. To study compressive strength, split tensile strength and flexural strength of the specimen.

3. To compare the results of different tests with varying proportions of rice husk ash and fly ash.

4. To study the durability of the specimen by water permeability test.

3 MATERIALS AND METHODOLOGY

3.1 cement

The characteristics of cement are the most essential parameters governing the performance of the concrete because of the higher cement content. Penna super grade 53 grade (OPC) cement has been used throughout this investigation. It is a binder substance that sets and hardens and can bind other materials together. The volcanic ash and pulverized brick supplements that were added to the burnt lime, to obtain a hydraulic binder, were later referred to as cement. It becomes adhesive due to a chemical reaction between the dry ingredients and water. The chemical reaction results in mineral hydrates that are not very water-soluble and so are quite durable in water and safe from chemical attack. This allows setting in wet condition or underwater and further protects the hardened material from chemical attack.

3.2 Fine aggregate

The Fine aggregate used in this investigation was clean river sand passing through 4.75mm sieve with specific gravity of 2.66.

3.3 Coarse aggregate

The coarse aggregates obtained from a local source had a specific gravity of 2.89 for 20mm aggregate. The size fraction of the coarse aggregate is used extremely important for determining the optimum amount of past content to obtain all the necessary characteristic of a flowing concrete.

3.4 Rice husk ash

About 100 million tons of rice paddy manufacture by products are obtained around the world. They have a very low bulk density of 90 to 150kg/m3.This result in greater value of dry volume. The rice husk itself has a very rough surface which is abrasive in nature. These are hence resistant to natural degradation. This would result in improper disposal problems. So a way to use these by product to make a new product is the best sustainable idea. Among all industries to reuse this product cement and concrete manufacturing industries are the ones who can use rice husk in a better way. The rice husk ash has good reactivity when used as a partial substitute for cement. These are prominent in countries where the rice production is abundant. The properly rice husk ashes are found to be active within the cement paste.

Chemical property of rice husk

- Cellulose
- Lignin
- Hemicelluloses
- Silicondioxide
- Holocellulose

Table 3.1.1

Chemical properties of Rice husk ash

S.NO	PARTICULARS	PROPOTIONS
1	Silicon dioxide	86.94%
2	Aluminium oxide	0.2%
3	Iron oxide	0.1%
4	Calcium oxide	0.3-2.25%
5	Magnesium oxide	0.2-0.6%
6	Sodium oxide	0.1-0.8%
7	Potassium oxide	2.15-2.30%

Properties of concrete with rice husk

- The heat of hydration is reduced. This itself help in drying shrinkage and facilitate durability of concrete mix.
- The reduction in the permeability of concrete structure. This will help in penetration of chloride ion thus avoid the disintergration of the concrete structure.
- There is higher resistance in chloride and sulfate attack.

The rice husk ashes in the concrete react with the calcium hydroxide to bring more hydration products. The consumption of calcium hydroxide will enable lesser reactivity of chemicals from the external environment.

Application of rice husk ask

The application of rice husk ash in concrete are

- High performance concrete
- Insulator
- Green concrete
- Bathroom floor
- Industry factory floor
- Concreting the foundation
- Swimming pools
- Water proofing and rehabilitation

3.5 Fly ash

Fly ash is finely divided residue resulting from the combustion of powdered coal and transported flue gases and collected by electrostatic precipitator. Fly ash is the most widely used pozzolanic materials all over the world. In recent time, the importance and use of fly ash in concrete has grown so much that it has almost become a common ingredient in concrete, particularly for making high strength and high performance concrete. Extensive research has been done all over the world on the benefits that could be occurred in the utilization of fly ash as a supplementary cementitious material,

High volume fly ash concrete is a subject of current interest all over the world. The use of fly ash as concrete admixture not only extends technical advantages to the properties of concrete but also contributes to the environmental pollution control. In India alone, we produce about 75 million tons of fly ash per year the disposal of which has become a serious environmental problem. The effective utilization of fly ash in concrete making is therefore attracting serious considerations of concrete technologies and government departments. Production of every ton of cement emits carbon dioxide to the ton of supplementary cementitious materials like fly ash silica fume and slag.

ASTM broadly classifies fly ash into two classes.

Class F: Fly ash normally produced by burning anthracite or bituminous coal, usually has less than 5% CaO. Class F fly ash has pozzolanic properties only.

Class C: Fly ash normally produced by burning lignite or sub-bituminous coal. Some Class C fly ash may have CaO content in excess 10%. In addition to pozzolanic properties, Class C fly ash also possesses cementations about 0.87ton. Expressing it in another way, it can be said that 7% of the world's carbon dioxide emission is attribute to Portland cement industry. Because of the significant contribution to the environmental pollution and to the high consumption of natural resources like limestone etc, we cannot go on producing more and more cement. There is a need to economies the use of cement with properties.

Advantages of flyash

Fly ash from thermal power plants is one of such waste, which can put to different useful purposes. The utilization of fly ash has following advantages:

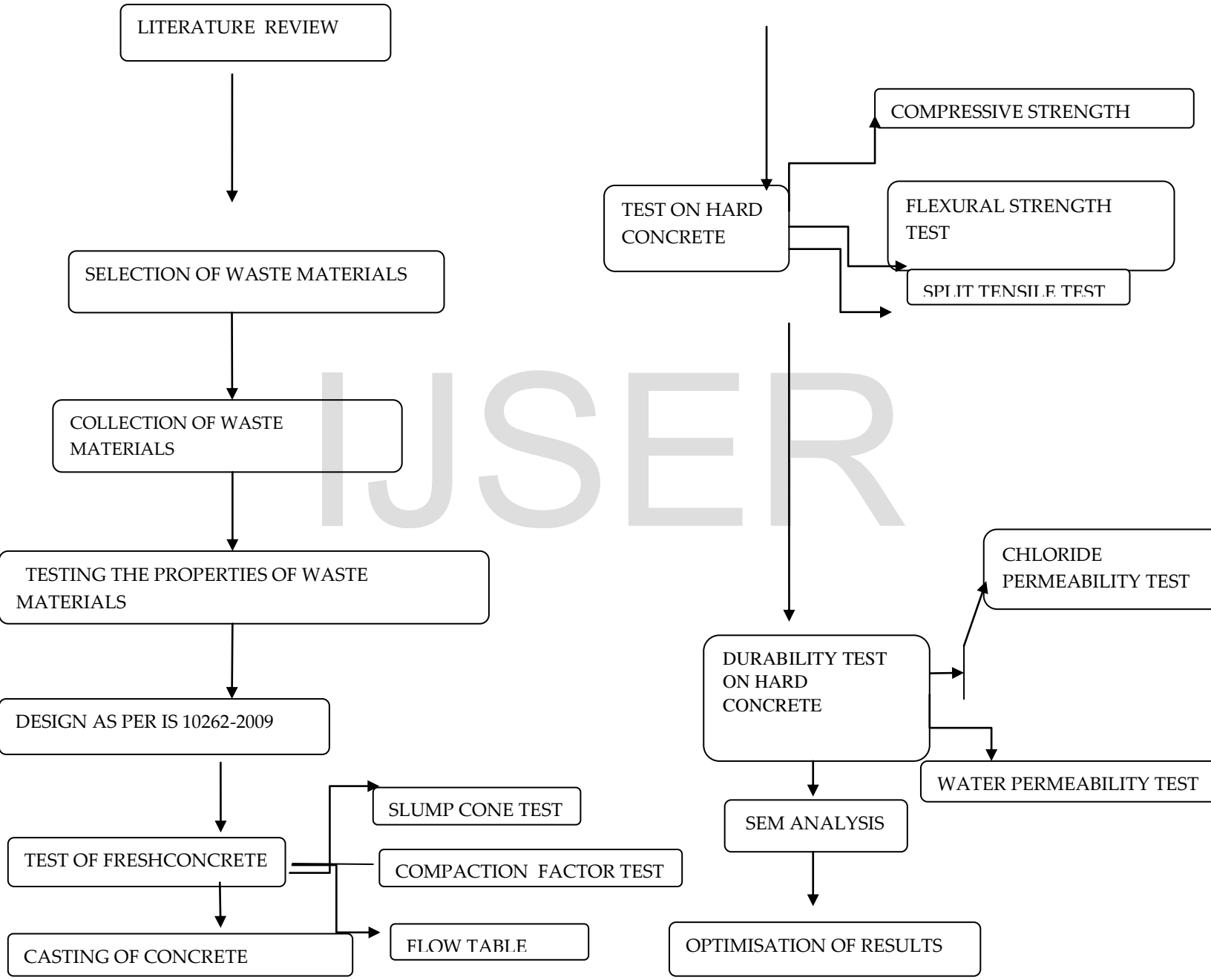
1) Conversion of waste into wealth.

2) Saving in expenditure for disposal

3) Increasing availability of much needed construction materials

4) Reduction in air/water pollution

3.6 Methodology



4. TESTING OF MATERIALS

4.1 TESTING OF CEMENT

Cement is the most important binding material of concrete. The cement used for the experimental study is Ordinary Portland Cement of 53 grade.

Table 4.1.1 Chemical properties of cement

CHEMICAL PROPERTIES	PERCENTAGE
SiO_2	21.8
Al_2O_3	5.1
Fe_2O_3	3.9
CaO	64.8
MgO	<1.7
Cl	<0.03
SO_3	<2.0
L.O.I	<1.3
LnR	<0.65
F.CaO	<1.1
C_3A	<7.5
Total Alkali	<0.7

ORDINARY PORTLAND CEMENT (OPC)

Ordinary Portland cement is most common type of cement and is used around the world as a basic ingredient of concrete. It is usually originates from limestone. It is fine powder produced by grinding Portland cement clinker, a limited amount of calcium sulphate. As per definition sited on the Ethiopian Standard ES Portland cement means the product obtained by grinding clinker with the possible addition of a small quantity of calcium sulphates and or water and it is manufactured by thoroughly mixing together calcareous or other lime bearing materials with argillaceous and other silica, alumina or iron oxide bearing materials burning them at a clinkering temperature and grinding the resulting clinker so as to produce a cement capable of complying with the requirements stipulated in the same standard.

Portland cement is composed of four main oxides, namely: Lime (CaO), Silica (SiO2), Alumina (Al2O3) and Iron oxide (Fe2O3). The Iron oxide added to the raw mixture is to aid in controlling the composition. Minor amounts of other materials, such as Magnesia, MgO and Alkalis, Na2O, K2O are usually present in relatively small amount as impurities. The chemical compounds that make up Portland cement is Tricalcium silicate (3CaOSiO2), Dicalcium silicate (2CaOSiO2), Tricalcium aluminate (3CaOAl2O3) and Tetracalciumaluminoferrite (4CaOAl2O3Fe2O3).

CONSISTENCY TEST

The vicat apparatus consist of a frame to which is attached to a movable rod. The movable rod is provided with an indicator. The indicator moves on a vertical scale and it gives the penetration. The vicat mould is in the form of a cylinder. It can split into two halves. This mould is placed on a non-porous plate. The apparatus consists of three attachments they are:

1. Plunger of 10mm diameter and 50mm long.
2. Needle of $1mm^2$ section
3. Needle with annular attachment

RESULT

The % of water required for obtaining cement paste of standard consistency is 32

SPECIFIC GRAVITY OF CEMENT

Specific gravity of cement = 3.15

INITIAL SETTING TIME OF CEMENT

Initial setting time of cement is 30 minutes

FINENESS OF CEMENT

Average fineness of cement = 4.33

4.2 TESTING OF COARSE AGGREGATE

Machine crushed granite obtained from a local quarry was used as coarse aggregate. The maximum size of the coarse aggregate used is 20mm is chosen and tests to determine the different physical properties as per IS 383-1970.The density of coarse aggregate is 2.55 g/cm^3 and that of bulk density is 1597 kg/m^3.

SPECIFIC GRAVITY OF COARSE AGGREGATE

Specific gravity of CA = 2.89

FINENESS MODULUS OF COARSE AGGREGATE

The fineness modulus of coarse aggregate = 1.4

Table4.2.1 physical properties of coarse aggregate

TEST PARTICULARS	RESULT OBTAINED	REQUIREMENTS AS PER IS 383-1970
Specific Gravity	2.89	2-3
Crushing Value	43.2	40-45
Impact Test	16.9	15-20

4.3 TESTING OF FINE AGGREGATE

Those fractions from 4.75 mm to 150 micron are termed as fine aggregate. The fine aggregate used for the concrete is natural river sand. Fine aggregates are used to make a greater binding strength between cement and coarse aggregate.

SPECIFIC GRAVITY OF SAND

Specific gravity of sand = 2.64

FINENESS MODULUS OF FINE AGGREGATE

Fineness modulus of the fine aggregate = 2.6

Table4.3.1 physical properties of fine aggregate

TEST PARTICULARS	RESULT OBTAINED	REQUIREMENTS AS PER IS 383-1970
Specific Gravity	2.64	2.6-2.9
Finness modulus	2.6	2.6-2.9
Water Absorption (%)	1.8	MAX 3%

Table 4.3.2 physical properties of rice husk ash

Physical Properties of rice husk ash	Results
Specific gravity	2.14
Colour	Black

Table 4.3.3 physical properties of flyash

Physical Properties of fly ash	Results
Specific gravity	2.85
Colour	Brown

5 .CONCLUSION

The interpretation of the results obtained is based on current knowledge available in the literatures as well as on the nature of results obtained. In the following phase the test on fresh concrete and hard concrete will be performed. The durability of this specimen will be found out by water permeability and chloride permeability test.

The specimens undergo SEM analysis and optimization of results will be obtained.

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