To Compare the Compressive Strength of OPC 43 RHA and PPC Concrete

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Abstract - In the present investigation an attempt is made to compare various compressive strength of cement mortar cubes. Mathematical models were elaborated to predict the strength of mortar cubes with 10% replacement of rice husk ash .The strength of cubes with different types of cement (OPC, PPC) after 3,7,28 and 28 days curing and have been analysed to evaluate the effect of addition content, the time of curing and the type of cement on the changes in compressive strength.. The analysis showed that mortar cubes with RHA is characterized by advantageous applicable qualities. The investigation revealed that use of waste materials like fly ash, micro silica, rice husk ash and ground granulated blast furnace slag, which are otherwise hazardous to the environment may be used as a partial replacement of cement, leading to economy and in addition by utilizing the industrial wastes in a useful manner the environmental pollution is also reduced to a great extent. The optimized R.H.A by controlled burn or grinding has been used as a pozzolanic materials in cement and concrete using it provides several advantages such as improved strength and durability properties and the R.H.A greatly reduced the environmental pollution related to the disposal of waste materials and to reduced co_2 emission up to now research has been done to investigate the use of R.H.A as supplementary material in cement and concrete production the main objective of this work is to study the suitability of the rice husk ash as a pozzolonic materials for cement replacement in concrete .however it is expected that that the use of rice husk ash in a concrete improve in strength properties of concrete also it is an attempt made to developed the concrete using rice husk ash as a source materials for partial replacement of cement which satisfies the structural properties of concrete like compressive strength

Key Words: pozzolanic, concrete, R.H.A, materials, cement

1. INTRODUCTION

The greatest challenge before the construction industry is to serve the two pressing needs of human society namely the protection of the environment and meeting the infrastructure requirement of our growing population and consequentially needs of industrialization and urbanization in the past. The concrete industry has met these needs very well. However for a variety of reasons, the situation has been changed now.

Concrete is one of the most widely used construction material it is usually associated with Portland cement as the main component for making concrete. The demand for concrete as a construction material is on the increased it is estimated that the production of cement will increased from about from 1.5 billion tons in 1995 to 4.2 billion tons in 2013

The increasing demand for cement concrete is met by partial cement replacement substantial energy and cost saving can result when industrial by products are used as admixture in concrete is known to impart significant improvements in workability and durability the use of by products is an environmental friendly method of disposal of large quantities of material that would otherwise pollute land water and air .the current cement production rate of the world which is approximately 1,2 billon tons/year ,is expected to growth which is about 4 billion tons/year by 2013

Most of the increased in cement demand will be met by the use of supplementary cementing material as each ton of Portland cement clinker production is associated with a similar amount of co_2 emission rise husk an agricultural waste constitute about one fifth of 300 million ton of rice produced annually in the world by burning the rice husk under a controlled temperature and atmosphere a highly reactive rice ash is obtained in fact the ash consists of Non crystalline silica and produces similar effects in concrete as silica fume however unlike silica fume the particle of rice husk ash possess a cellular structure in this century the utilization of rice husk ash (RHA) as cement replacement is new trend in concrete technology disposal of the husks is big problem and open heap burning is not acceptable on environmental ground and so the majority of husk is currently going into land fill the disposal of rice husk create environmental problem that leads to idea of substituting RHA for silica in cement manufactured the content of silica in the ash is about 92-97% .researches had shown that small amount of filler have always been acceptable as cement replacement what more if the filler have the pozzolonic properties in which it will not only impart technical advantages to the resulting concrete but also enable larger quantise of cement replacement to be achieved there are many advantages in using pozzolons in concrete and they are; improved workability at low replacement levels and pozzolons of low carbon content reduced bleeding and segregation low heat of hydration lower creep and shrinkage high 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.

Rice is heavy staple in the world market as far as food is concerned it is the second largest amount of any grain produced in the world the first largest is corn but is produced fir alternative reasons as Opposed to rice which is produced primarily for consumption in the world .the following table from the Hwang and Chandra as article "the use of rice husk ash in concrete" shows the amount of rice cultivated and the significant amount if rice husk accumulated across the world about 20% of a dried rice paddy is made up the rice husk .The current world production of rice paddy is around 500 million tons and hence 100 million tons of rice husk are produced .china and India are top producers of rice paddy ,but most all other countries referenced in this table are in south- east and east Asia

Table 2.1 world production rate for rice paddy and rice husk million metric tons)

COUNTRY	RICE PADDY	RICE HUSK
Bangladesh	27	5.4
Brazil	9	1.8
Burma	13	2.6
China	180	36
India	110	22
Indonesia	45	9
Japan	13	2.6
Korea	9	1.8
Philippines	9	1.8
Taiwan	14	2.8
Thailand	20	4
Us	7	1.4
Vietnam	18	3.6
Others	26	5.2
Total	500	100

The next table shows the consumption of rice by the world population it was compiled by the united state department of agriculture in 2003-2004 .it shows the demand of rice production the world necessity for rice consumption fuels the need to keep production rice at such a large scale

Table 2.2 world rice consumption

COUNTRY	METRICTON
China	135
India	125
Egypt	39
Indonesia	37
Bangladesh	26
Brazil	24
Vietnam	18
Thailand	10
Myanmar	10
Philippines	9
Japan	8.7
Mexico	7.3
South Korea	5
United state	3.9
Malaysia	2.7

1 DISPOSAL

Disposal of rice husk ash is important issue in these countries which cultivate large quantities if rice .rice husk has a very low nutritional value and as take very long to decompose are not. Appropriate for compositing or manure .therefore the 100 millions 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 if rice husk clay products that are used in daily life burning the rice husk is an efficient way to dispose of the rice cultivation by product while production other use full 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 world wide

SCOPE, IMPORTANCE AND PROPERTIES OF RHA

Scope and importance

To increase the strength and workability of on Concrete

- RHA is good and cost effective alternative.
- It is more beneficial technology in utilization of RHA, which otherwise might be disposal issues
- This RHAC reduces the co_2 emission
- The addition of RHA to a concrete mixture has been increase corrosion resistance.
- RHAC reduces the self weight.

PROPERTIES OF RHA

Rice Husk Ash is a pozzolonic material it is having different physical and chemical properties

Table 5.1. physical properties

PARTICULARS	PROPERTIES
Colour	Grey
Shape texture	Irregular
Mineralogy	Non crystalline
Particle size	<45 micron
Odour	Odourless
Appearance	Very fine

Table 5.2 chemical properties

ELEMENT	AMOUNT%
Silica(so_2)	80-90%
Alumina	1-2.5%
Ferric oxide	0.5%
Titanium dioxide	Nil
Calcium oxide	1-2%
Magnesium oxide	0.5-2.0%
Sodium oxide	o.2-0.5%
Potash	0.2%

2. EXPERIMENTAL WORK AND METHODOLOGY

EXPERIMENTAL WORK

The aim of experimental work is to study the properties of rice husk ash. Considering the test result of partial replacement of RHA.

3. Methodology

The objective of this work is to study the suitability of the rice husk ash as a pozzolanic material for cement replacement in concrete .however it is expected that the use of rice husk ash in concrete improve the strength properties of concrete .also it is attempt made to develop the concrete using rice husk ash as a material for partial replacement of cement which satisfied the various structural properties of concrete like compressive strength

- Sieve analysis
- Type of curing
- Compressive strength test

Locally available coarse aggregates containing a maximum of 20mm 12mm and minimum of 7mm units were used .the aggregates were of good quality and contained well graded cubical shaped units

MIX DESIGN AND PROPERTION

In this experimental work M30 grade concrete of ratio1:2:4 are used .the replacement of RHA used here is 10% of weight of concrete

(a) 1. Cement In this experiment 43 grade ordinary Portland cement (OPC) with brand name ultra tech was used for all concrete mixes. The cement used was fresh and without any lumps IS 8112 The specific gravity of cement was found to be 3.15.

COARSE AGGEREGATE

Which helped in workability of the mass .aggregates at surface dry state were used in making of concrete .the specific gravity of aggregates was found to be 2.68 and water absorption was found to be 2.91%

Determination of specific gravity and water absorption of coarse aggregate

s.no	description	Sample(gm)
1	Weight of sample	1000
2	Weight of sample+sample+water(A)	1518
3	Weight of vassel +water(B)	1158
4	Weight of saturated and surface dry sample(C)	564
5	Weight of oven dry sample(D)	548
6	Specific gravity	2.68
7	Water absorption (C-D)/D)*100 (%)	2.91

SPECIFIC GRAVITY OF COARSE AGGREGATE=D/C-(A-B)

= 548/564-(1518-1158)=2.68

SIEVE ANALYSIS FOR COARSE AGGREGATE FIGURE

Fine aggeregate

Locally available sand in dry state was used as fine aggregate. Fine aggregate was purchased which satisfied the required properties of fine aggregate required for experimental work and the sand conforms as per the specifications of IS 3812 (part I).the specific gravity of fine aggregate found to be 2.55

Determination of specific gravity and water absorption of fine aggregate

s.no	Description	Sample(gm)
1	Weight of sample	500
2	Weight of sample+sample+water(A)	1268
3	Weight of vassel +water(B)	933
4	Weight of saturated and surface dry sample(C)	535
5	Weight of oven dry sample(D)	510
6	Specific gravity	2.55
7	Water absorption (C-D)/D)*100 (%)	4.91

SPECIFIC GRAVITY OF COARSE AGGREGATE=D/C-(A-B)

=510/535-(1268-933)

=2.55

MANUFACTURE OF FRESH CONCRETE AND CASTING

Cubical moulds were first prepared for the compressive strength of the 150 X 150 mm standard moulds were taken for making of concrete. The weighing of the ingredient viz .,RHA, cement ,fine aggregate ,coarse aggregate .this came under recommendation in order to avoid any mix proportioning of the ingredient ,an outcome that would deem the concrete mix design to differ if the contents were mistakenly added concrete mix design to differ if the contents were mistakenly added

CURING OF TEST SPECIMENS

After casting the test specimens were given 24 hours rest. The cubes with moulds were lift undisturbed in the laboratory under ambient conditions the cubes were then cured in the curing tank fully immersed under water bath . the specimens was cured to 28 days .After then the specimens were one put to testing in the compression testing machine

COMPRESSIVE STRENGTH TEST

The cubes were tested at an age of 3,7and 28 days .The compressive strength test was made using CTM (compression testing machine)

CALCULATION: table shows the material required for cube 150x150x150mm using code 10262:2009

B-1 STIPLULATIONS FOR PROPORTIONING

(a) Grade Designation :M_{30}
(b) Type of cement :OPC 43 conforming to IS 8112
(c) Types of mineral admixture :fly ash conforming to IS 3812(part 1)
(d) Maximum nominal size of aggregate:20mm
(e) Minimum cement content :320kg/m^3
(f) Maximum water-cement ratio:0.45
(g) Workability: 100mm(slump)
(h) Exposure condition :severe(for reinforced concrete)
(i) Method of concrete placing : pumping
(j) Degree of supervision :good
(k) Types of aggregate :crushed angular aggregate
(l) Maximum cement (opc)content :450kg/m^3
(m) chemical admixture type : super plasticizer

B-2 TEST DATA FOR MATERIALS

(b) cement used: opc 43 grade conforming to IS 8112
(c) specific gravity of cement :3.15
(d) fly ash :conforming to IS 3812(part I)
(e) specific gravity of fly ash :2.2
(f) chemical admixture :super plasticizer conforming to IS 9103

(g) specific gravity of coarse aggregate :2.68
(h) specific gravity of fine aggregate:2.55
(i) water absorption coarse aggregate:0.5
(j) water absorption of fine aggregate : 1.0 percent
(k) free (surface) moisture coarse aggregate :nil
(l) free (surface) moisture fine aggregate : nil

B-3 TARGET STRENGTH FOR MIX PROPORTIONING

f_{ck} =f+1.65$_s$

Where

f= target average compressive strength at 28 days

f_{ck}= characteristics compressive strength at 28days, and

s= standard deviation

from, table 1 standard Deviation, s=5N/mm^2

therefore ,target strength=30+1.65x5=38.25N/mm

B-4 SELECTION OF WATER CEMENT RATIO

From table 5 of IS 456, maximum water cement ratio (see note under 4.1) =0.5

Based on experience. Adopt water-cement ratio as 0.42

0.40<0.45, hence, ok

B-5 SELECTION OF WATER CONTENT

From table 2, maximum water content

For 12.5mm aggregate =202.5litre (for 25to50mm slump range)

Estimated water content for 100mm slump=202.5(6/100) x 202.5=214.65litre

As super plasticizer is used .the water content can he reduced up 30 percent

Based on trials with super plasticizer water content reduction of 29 percent has been achieved. Hence, the arrived water content =214.65x 0.71=152.40litre

B-6 CALCULATION OF CEMENT AND RICE HUSK ASH CONTENT

Water-cement ratio (see note under 401)=0.42

Cementious materials (cement +rice husk ash) content=152.40/0.42=362.86/kg/m^3

Content for ‘severe’ exposure conditions= 320kg/m^3

362.86kg/m^3>320kg/m^3, hence o.k

Now .to proportion a mix containing fly ash the following steps are suggested:

(a) decide the percentage fly ash to be used based on project requirement and quality of materials
(b) in certain situations increase in cementious materials content may be warranted, the decision on increased in cementious material content and its percentage may be used on experience and trial

NOTE- this illustrative example is with increase of 10 percent cementious materials content
Cementious materials content=362.86x1.10=399.146kg/m^3

Water content=152.40kg/m³
Fly ash @ 10% of total cementious material constant=385x10%=38.5
Cement OPC =399.146-38.5=360.646 kg/m³
Saving of cement while using fly ash =362.86-360.646=2.214
Fly ash being utilized =39.9kg/m³

B-7 PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE CONTENT

Volume of coarse aggregate corresponding to 12.5nn size aggregate and fine aggregate (zone I) for water-cement ratio of 0.50=0.60

In the present case water –cement ratio is 0.40 a

Therefore. Volume of coarse aggregate is required (0 be increased to decrease the line aggregate content. As the water-cement ratio is lower by 0.10. The proportion of volume of coarse aggregate is increased by0.02 (at the rate of -/+0.01 for every +-0.05 change in water –cement ratio), therefore .corrected proportion of volume of course aggregate for the water-cement ratio of 0.40=0.62

NOTE- in case the coarse aggregate is not angular one .then also volume: of coarse aggregate may be required to be increase suitability based on experience for pumpable concrete these values should be reduced by 10%

Therefore, volume of coarse aggregate=0.60

Volume of fine aggregate content=1-0.60=0.40

B-8 MIX CALCULATIONS

The mix calculations per unit volume of concrete shall be follows:

a) volume of concrete=1m³
b) volume of concrete=mass of cement/specific gravity of cement x1/1000=559.24/3.15x1/1000=0.114m³
c) volume of fly ash=mass of fly ash/specific gravity of fly ash x1/1000=(39.9/1/1000=0.39m³
d) volume of water=mass of water/specific gravity of water x 1/1000=(140/1)x1/1000=0.152m³
e) volume of chemical admixture= mass of admixture/specific gravity of admixture x1/10007/1.145x1/1000=0.007m³
f) volume of all in aggregate=[a-(b+c+d+e)]=1-(0.144+0.039+0.152+0.007)=0.668m³
g) mass of coarse aggregate=f x volume of coarse aggregate x specific gravity of coarse aggregate x1000=0.668x0.40x2.68x1000=716kg
h) mass of fine aggregate= fx volume of fine aggregate x specific gravity of fine aggregate x1000=0.688x0.40x2.55x1000=681kg
1m³=0.03325m²
=0.034

B-9 MIX PROPORTIONS FOR TRIAL NUMBER

a) Cement= 399.146x0.034=13.57kg/m³
b) Rise husk ash=39.9x0.034=1.356kg/m³
c) Water =152.40x0.034=5.18kg/m³
d) Fine aggregate =681x0.034=23.154kg/m³
e) Coarse aggregate=716x0.034=24..344kg/m³
f) Chemical admixture=7.7 x0.034=0.26kg /m³
g) Water-cement –ratio=0.42

Table 6.1 material used in making cube

MATERIAL	WEIGHT(KG/M³)
Cement	13.57
Water	5.18
Fine aggregate	23.154

Coarse aggregate	24.344
Chemical admixture	0.26
Water/cement ratio	0.43

Table 6.2 material used in making cube

MATERIAL	WEIGHT(KG/M³)
Cement	12.22
Ash	1.356
Water	5.18
Fine aggregate	23.154
Coarse aggregate	24.344
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CALCULATION FOR PPC

B-1STIPLULATIONS FOR PROPORTIONING

(a) Grade Designation :M_{30}
(b) Type of cement :PPC conforming to IS 8112
(c) Types of mineral admixture :fly ash conforming to IS 3812(part 1)
(d) Maximum nominal size of aggregate:20mm
(e) Minimum cement content :320kg/m³
(f) Maximum water-cement ratio:0.45
(g) Workability: 100mm(slump)
(h) Exposure condition :severe(for reinforced concrete)
(i) Method of concrete placing : pumping
(j) Degree of supervision :good
(k) Types of aggregate :crushed angular aggregate
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Coarse aggregate	24.344
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Water/cement ratio	0.43

COMPRESSIVE STRENGTH CALCULATION:

Note the reading of compression testing machine which is the ultimate load carrying by the cube .use the formulae given below and find the compressive strength of the cube .Take at least reading and find the mean of those three reading

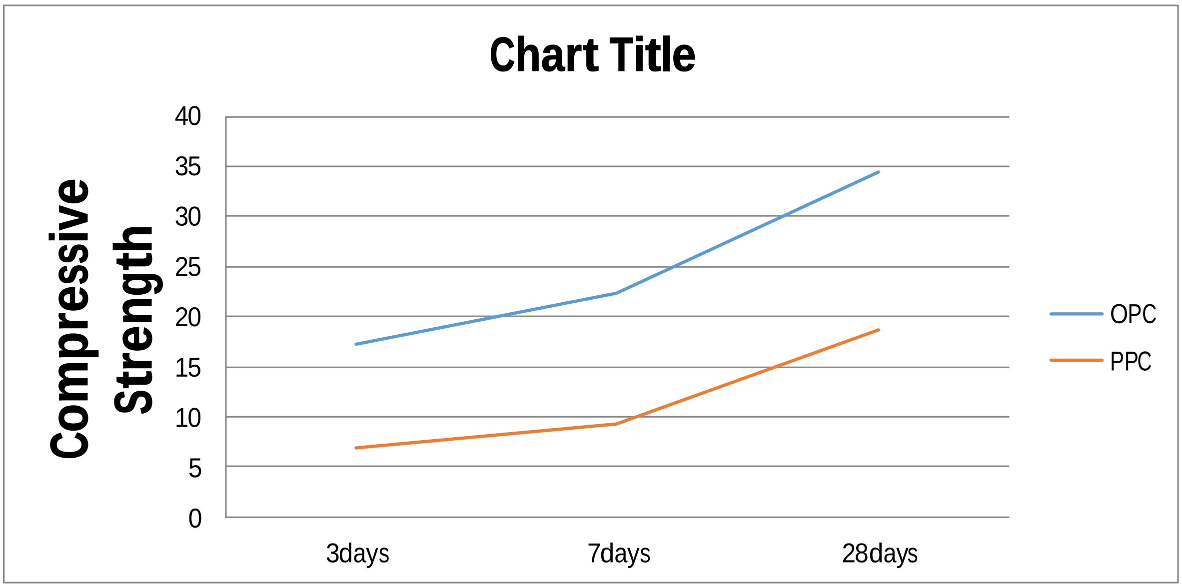
$$\text{COMPRESSIVE STRENGTH} = \frac{\text{ULTIMAMATE}}{\text{AREA OF LOAD}}$$

EXPERIMENTAL RESULTS AND DISCUSSION

Compressive strength: table shows the comparison between the compressive strength of OPC-43concrete and PPC concrete cubes replaced by 10% RHA, mix design M-30 in both the cases at different ages.

Table 3.2 Compressive strength of cube samples

Description	Compressive strength of OPC-43(RHA)			Compressive strength of PPC(RHA)		
Days	3	7	28	3	7	28
Cube	17.2	22.3	34.5	6.9	9.25	18.6



Charts shows the difference between compressive strength of OPC-43 and PPC

CONCLUSIONS

From the experimental and test results on fresh and hardened concrete the following conclusion is drown

1. The compressive strength of OPC-43 is greater than PPC
2. The weight is nearly equal to each other
3. The cost required of OPC is greater than PPC
4. The pozzolonic activity of rice husk ash improve the impremeability characteristics of concrete
5. The use of rice husk ash increase the corrosion resistance and durability of concrete
6. RHA greatly reduce the environmental pollution which causes due to construction
7. The excess use of RHA will such as 15or 20% does not increase the compressive strength
8. The addition of RHA will increase the setting time of cement
9. It reduce the co_2 emission
10. Now a days in cement factory itself the partial replacement is done and it reduce transportation and mixing time
11. It is good for structural concrete at 12% to15% of replacement level
12. It also used in pavement block making and cost less tiles making
13. PPC should be used I foundation work because it gains strength slowly and not used in multi-storey building

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