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PV Rambabu
Research Scholar, Department of Civil Engineering, Andhra University, Vizag, Andhra Pradesh, India.

K Sudeepa
PG Student, Department of Civil Engineering, SRKR Engineering College, Bhimavaram, Andhra Pradesh, India.

GV Ramarao
Professor, Department of Civil Engineering, Andhra University, Vizag, Andhra Pradesh, India.

Correspondence
PV Rambabu
Research Scholar, Department of Civil Engineering, Andhra University, Vizag, Andhra Pradesh, India.

Characteristics study on different types of cement mortars replaced with RHA as an admixture

PV Rambabu, K Sudeepa and GV Ramarao

Abstract
Rice has been the major crop in India and the production of rice has been increasing through years. Many Rice mills have been established across the country for the rice grains to be processed and during this process Rice Husk has been left out as a waste product. It was being used in boilers as fuel and as a result after its burning ash was being left out which was creating serious environmental hazards. For this issue many ideas has been implemented and one of them was using it as a replacement material in the cement as fine particles this is because of the pozzolanic activity of the Rice Husk Ash when mixed with cement resulting in the increase of the strength. And this project gives the detail study of the strength variation of the conventional cement mortar mix to the Rice Husk Ash added mortar in 5%, 10%, 15%, 20% and 25% by weight to the four Grades of cements namely OPC-53, OPC-43, PPC, PSC which were cured for 3, 7, 14, 28 and 56 days respectively. And the conclusions of the experiment showed that the optimum percentage of the Rice Husk Ash for achieving maximum strength that can be 10% for OPC-53 and OPC-43 Grade cement and 5% for PPC and PSC Grade cements after 56 days strength test respectively.

Keywords: Rice husk Ash, compressive strength, grades of cement.

1. Introduction
Many industrial wastes were produced by the agro based industries after processing of the raw material and it was creating a serious environmental hazard to process it further so some of these wastes containing the properties of the cement blending materials like rice husk ash, sugar cane bagasse ash, blast furnace slag, coal fly ash, silica fumes, hazel nut shells and wheat straw ash are being used as supplementary cementitious materials and also adds strength to the cement and hence it is very necessary to use these wastes as a cement blending materials and reduce the environmental effects causing. So in this dissertation work Rice Husk ash is used as replacement material with cement mortar at different percentages and the variation in the compressive strength was analyzed. This work has an objective to find out the strength of the cement mortar conventional mix and when added with Rice husk ash (RHA) as a supplementary cementitious material with reference to mechanical and permeability properties of cement mortar and also to identify the optimal level of replacement in cement mortar mix to provide maximum strength. The variable factors considered in this study were cement mortar strength for a curing period of 56days, 28days, 14 days, 7days and 3days of the casted specimens. The parameter investigated was, the time (in days) for strength calculation for conventional mix and Rice husk ash has been Physically characterized and was partially replaced in the ratio of 0%, 5%, 10%, 15%, 20% and 25%. These test results show that the Rice husk ash is suitable for partial replacement of cement. The work has carried out for the purpose to study the characteristics of the types of cements when stabilized with Rice husk ash. The methodology has been carried out by mixing the Rice husk ash into the cement in some percentages like 5%, 10%, 15%, 20% and 25%.The casted cubes were then cured and have been tested for 3, 7, 14, 28 and 56 days respectively and their strength has been recorded and the variation has been shown in the graphs respectively. Initially cement tests were carried out to find out the fineness, consistency, setting times with and without adding the Rice husk ash and the results were recorded

Respectively. The Rice husk ash which was bought from the Rice mill was grinded and then oven dried to get the fine material like cement and fineness test done to the material.
The scope of this dissertation is to study and analyse the compressive strength of cement mortar and their results, which were obtained by practical investigation on partial replacement of cement by Rice husk ash with different percentages in the four types of cements respectively. Therefore, the results indicate that the maximum compressive strength is obtained for 10% of SCBA for OPC53, 5% for OPC43, PPC and PSC.

2. Experimental Materials

2.1 Types of Cement

The types of cements used for the experimental program were four types namely:

1. Ordinary Portland Cement 53 Grade (OPC 53)
2. Ordinary Portland Cement 43 Grade (OPC 43)
3. Portland Pozzolana Cement (PPC)
4. Portland Slag Cement (PSC)

2.2 Types of Cement on Tests

2.2.1 Initial Tests Consistency Test

The consistency tests were conducted to the cement with and without adding the bagasse ash and similarly the initial and final setting times were also calculated and sieve analysis test was performed. Their values were tabulated below.

3. Experimental Results and Investigations

Table 1: Standard consistency and setting times of OPC 53 grade cement

Standard consistency and setting times of OPC 53 grade cement			
% Replacement	Consistency %	setting times (mim)	
		Initial	Final
0	28	31	310
5	30	34	325
10	31	43	330
15	32	62	345
20	32.66	71	350
25	33	95	355

Table 2: Standard consistency and setting times of OPC 43 grade cement

Standard consistency and setting times of OPC 43 grade cement			
% Replacement	Consistency %	setting times (mim)	
		Initial	Final
0	28.66	30	305
5	29	33	315
10	30	44	325
15	31.66	58	330
20	31.66	72	340
25	32.66	85	350

Table 3: Standard consistency and setting times of PPC

Standard consistency and setting times of PPC			
% Replacement	Consistency %	setting times (mim)	
		Initial	Final
0	28.66	30	305
5	29	38	310
10	29.66	55	320
15	30	66	335
20	31	80	340
25	32	90	360

Table 4: Standard consistency and setting times of PSC

Standard consistency and setting times of PSC			
% Replacement	Consistency %	setting times (mim)	
		Initial	Final
0	28	33	295
5	28	46	315
10	29	55	325
15	31	66	340
20	33	77	355
25	34	89	365

3.1 Rice Husk Ash

Rice milling industry generates a lot of rice husk during milling of paddy which comes from the fields. This rice husk is mostly used as a fuel in the boilers for processing of paddy. Rice husk is also used as a fuel for power generation. Rice husk ash (RHA) is about 25% by weight of rice husk when burnt in boilers. It is estimated that about 70 million tons of RHA is produced annually worldwide. This RHA is a great environment threat causing damage to the land and the surrounding area in which it is dumped.
During milling of paddy about 78% of weight is received as rice, broken rice and bran. Rest 22% of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75% organic volatile matter and the balance 25% of the weight of this husk is converted into ash during the firing process, is known as rice husk ash (RHA). This RHA in turn contains around 85% - 90% amorphous silica.

Fig: Rice Husk Ash

Table 5: Chemical properties of Rice Husk ash.

S. No	Particulars	Percentage
1	Silicon dioxide	85 to 87%
2	Magnesium oxide	0.3 to 0.7%
3	Iron oxide	0.1 to 0.2%
4	Aluminium oxide	0.2 to 0.4%
5	Calcium oxide	05 to 2.5%
6	Sodium oxide	0.3 to 0.9%
7	Potassium oxide	2 to 3%

3.2 Water

Water is the important constituent in the mortar mix because it helps in the participation of chemical reaction with cement. And it helps to form the strength after the mortar is set, so the consistency of the cement is examined carefully and the required

% of water is added to the mortar mix. The standards of the water are required to be looked in to very carefully. The water used for preparation of the mortar mix should not contain undesirable organic substances or inorganic constituents in excessive proportions. The pH value should not be less than 6.

3.3 Fine Aggregates

The standard sand used for the casting of cement cubes was Ennore sand the river sand which will be in light grey or white colour variety and their size will be angular in shape to spherical formation, elongated and flattened grains with very small quantities.

The particle size distribution shall be of following size distribution:

Particle size		Percent
1.	Smaller than 2mm and greater than 1mm	33.33
2.	Smaller than 1mm and greater than 500microns	33.33
3.	Below 500microns and greater than 90microns	33.33

4. Experimental Materials

4.1 Mix proportions

For the experimental program we have followed the procedure for casting of cubes:

Table 6: Casting of cubes with % replacement

S. No	% Replacement	Weight of cement (gms)	Weight of RHA (gms)
1	0%	200	0
2	5%	190	10
3	10%	180	20
4	15%	170	30
5	20%	160	40
6	25%	150	50

4.2 Casting specimens

The experimental program was carried out initially by casting cubes and cubes of standard size were casted of size 7.06cmx7.06cmx7.06cm and then demoulded after 24 hours and kept in curing for 3, 14, 28 and 56 days respectively for compression test.

4.3 Curing

Curing is the process in which the cement cube is protected from loss of moisture and kept within a reasonable temperature range. The result of this process is increased strength and decreased permeability. Curing is also a key player in mitigating cracks in the cement, which severely impacts durability.

For our experimental program we have done curing of the casted cubes for 3, 7, 14, 28 and 56 days respectively.

4.4 Compression testing on cubes

After curing the cast specimens are tested in compression testing machine as per standard procedures.

It was observed clearly that the types of cements used for the experimental program were acting differentially in every series of test when SCBA was added as an admixture to it and their results were as follows:

Table 7: OPC 53 maximum strength in different % of RHA values with curing days.

OPC 53 maximum strength in different % of RHA values with curing days			
S. No	**Curing days**	**Type of %**	**Maximum strength value (N/mm^2)**
1	3	0%	35-.75
2	7	5%	45.81
3	14	0%	46.48
4	28	5%	61.86
5	56	10%	62.19

Table 8: OPC 43 maximum strength in different % of RHA values with curing days

OPC 43 maximum strength in different % of RHA values with curing days			
S. No	**Curing days**	**Type of %**	**Maximum strength value (N/mm^2)**
1	3	5%	26.42
2	7	0%	32.43
3	14	0%	41.8
4	28	5%	48.48
5	56	10%	57.85

Table 9: PPC maximum strength in different % of RHA values with curing days

PPC maximum strength in different % of RHA values with curing days			
S. No	**Curing days**	**Type of %**	**Maximum strength value (N/mm^2)**
1	3	0%	11.70
2	7	0%	26.75
3	14	5%	35.78
4	28	15%	49.15
5	56	5%	57.18

Table 10: PSC maximum strength in different % of RHA values with curing days

PSC maximum strength in different % of RHA values with curing days			
S. No	**Curing days**	**Type of %**	**Maximum strength value (N/mm^2)**
1	3	10%	20.06
2	7	5%	29.43
3	14	0%	38.45
4	28	10%	49.82
5	56	10%	56.84

5. Observations By Experimental

5.1 Results

1. OPC 53 grade has shown maximum strength at 10% for 56 days curing and it has attained strength more than the 0% mortar mix by 7.95 N/mm2
2. OPC 43 grade has shown maximum strength at 5% for 56 days curing and it has attained a strength more than the 0% mortar mix by 9.70 N/mm2
3. PPC grade cement has shown maximum strength at 5% for 56 days curing and it has attained a strength more than the 0% mortar mix by 5.35 N/mm2
4. PSC grade cement has shown maximum strength at 5% for 56 days curing and it has attained a strength more than the 0% mortar mix by 2.67 N/mm2
5. The consistency of OPC 53 for 0% RHA mortar mix was 28% and for that of maximum strength 10% RHA mix was 31%.
6. The consistency of OPC 43 for 0% RHA mortar mix was 28.66% and for that of maximum strength 5% RHA mix was 29%.
7. The consistency of PPC for 0% RHA mortar mix was 28.66% and for that of maximum strength 5% RHA mix was 29%.
8. The consistency of PSC for 0% RHA mortar mix was 28% and for that of maximum strength 10% RHA mix was 29%.
9. The Initial and Final setting times of OPC 53 for 0% RHA mortar mix was 31 minutes and
10. 310 minutes and for that of the maximum strength 10% RHA mix was 43 minutes and 330 minutes.
11. The Initial and Final setting times of OPC 43 for 0% RHA mortar mix was 30 minutes and
12. 305 minutes and for that of the maximum strength 10% RHA mix was 44 minutes and 325 minutes.
13. The Initial and Final setting times of PPC for 0% RHA mortar mix was 30 minutes and 305 minutes and for that of the maximum strength 5% RHA mix was 38 minutes and 310 minutes.
14. The Initial and Final setting times of PSC for 0% RHA mortar mix was 33 minutes and 295 minutes and for that of the maximum strength 10% RHA mix was 55 minutes and 325 minutes.

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Authors Biography

PV Rambabu received his Bachelor of Engineering Degree in Civil engineering from the S.R.K.R. College of Engineering. He received his Master's Degree in M.E. Structural Engineering from the S.R.K.R. College of Engineering, Andhra University. He joined S.R.K.R College of Engineering as a faculty where he is Assistant Professor in Civil Engineering Department. He published 8 International Journals.

K. Sudeepa received her Bachelor of Technology Degree in Civil Engineering from the S.R.K.R College of Engineering. She also worked as Assistant Professor in Civil Engineering Department at Vishnu Institute of Technology. At present she is final year P.G student in M.E Structural Engineering from the S.R.K.R College of Engineering, Andhra University.

Dr. GV Ramarao received his Bachelor of Technology degree in Civil Engineering from the J.NT.U Hyderabad University in 1983. In 1985 he received his Master's Degree in M. Tech Structural Engineering from the J.N.T.U Anantapur University. In 2002 he received his PhD Civil Engineering in Andhra University. At present he is Professor of Civil Engineering from the College of Engineering in Andhra University with a total experience of 29 years. He has published 3 papers in National Journals, 12 papers in International Journals. He has published 18 papers in National Conferences and 14 papers in International Conferences.