COMPARATIVE STUDY ON COMPRESSIVE STRENGTH OF CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE WITH MILL SCALE AND COMBINATION OF MILL SCALE WITH RICE HUSK ASH

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Abstract: Concrete plays a vital role in construction. Tons of natural materials are excavated and processed every year to be used in concrete. It is creating harmful effect to environment. Till now most of the experiments done on substitutes for concrete aggregate such as recycled concrete aggregate, tile waste, glass waste, tires, metakolin, brick waste, fly ash etc. But one waste material which has not been widely tested yet is mill scale. Mill scale is a flaky hazardous solid waste formed on the steel's surface during the steel manufacturing processes and another widely available cheapest product is rice husk ash.

This activity directs to assess the use of mill scale and rice husk ash in Portland cement concrete, as a replacement to fine aggregate. This present study has been investigated in two phases. In the first phase discuss about effect of mill scale on compressive strength of concrete and in the second phase the effect of rise husk ash on strength behaviour of mill scale mixed concrete was investigated and mil scale was added at optimum percentage which was obtained in first phase. The optimum mill scale percentages is obtained from the 10%, 15%, and 20% and 25% in the replacement of fine aggregate and again adds the rice husk ash 5%, 10% and 15% to optimum mill scale percentage and determine the compressive strength at 7,14 and 28 days curing.

IndexTerms **- Fine aggregate, Mill scale, Rice husk ash, Compressive strength, 7, 14 and 28 days curing.**

1. INTRODUCTION

Concrete is one of the most important materials in building construction works. So, far concrete is been used enormously and it needs sustainable development. Strength is an important parameter which influences the factors like quality of cement, water-cement ratio, grading of aggregates, degree of compaction, curing efficiency, impact and fatigue etc. Compressive strength is used as a qualitative measure for other properties of hardened concrete. In modern days buildings are to be designed by keeping the components like heat isolation which is affecting buildings. Therefore, material selection is very important for constructing building. Sum of the solid waste like fly ash, furnace slag, rice husk ash and iron waste are generated in an enormous quantity. The use of such waste to be made as the partial replacement of conventional construction materials which proved to be an eco friendly. In this study, materials like mill scale and rice husk ash are used as a partial replacement of fine aggregate in concrete mix. Various researches and experimentations have been made to improve the properties of concrete. Anwar et al., 2001 mentioned that it is responsible for approximately 30% of the gross weight of arice kernel and normally contains 80% of organic and 20% of inorganic substances. Rice husk is produced in millions of tons per year as a waste material in agricultural and industrial processes. It can contribute about 20% of its weight to Rice Husk Ash (RHA) after incineration [1]. Al-Otaibi(2008) Investigated the possibility of recycling steel mill scale incementations materials as aggregate, analyzing cement mortars with levels of 0%, 20%, 40%, 50%, 70% and 100% replacement. Values of compressive strength analyzed for all ages (3, 7 and 28 days) increased with the replacement of up to 40% replacement, also with a reduction of drying shrinkage with 70% of mill scale steel [2]. Pereira et al.(2011) mentioned the results of another study conducted on the use of mill scaleas fine aggregate in concrete have shown that mill scale demands greater water content to maintain the workability. The results indicated that concretes with water/cement ratios of 0.55 and 0.65 have higher compressive strength and greater water absorption as the mill scale content increase [3]. Anupam Singhal1, Dipendu Bhunia1, BartikPandel(2015) investigated thepotential for recycling steel mill scale into concrete. The composition of steel mill scale was determined by XRD analysis. For mortar samples, river sand was replaced by 20%, 40%, 60%, 80%and 100% mill scale whereas, for concrete cubes, the replacement was restricted to only 80% as the weight of concrete was increasing at a very fast rate and complete sand replacement did not seem practical. Compressive strength and tensile strength were measured for different specimens of the mortar and concrete samples. The results are promising and encourage further study in applications in concrete, brick and block manufacturing [4].

From the above research, it is concluded by changing the water-cement ratios along with the partial replacement of mill scale and rice husk ash and the strength parameters were studied. The novelty of this study is to find the compressive strength of specimen by replacing partially the mill scale as 0%, 15%, 20% and 25%. The optimum percentage value of mill scale is again mixed with rice husk ash 5%, 10% and 15% to get the maximum compressive strength.

2. OBJECTIVE

- To study the compressive strength of concrete with 10%, 15%, 20% and 25% replacement of mill scale to fine aggregate in M25 grade concrete.
- To find the optimum percentage of mill scale replacement.
- To investigate the optimum percentage of adding rice husk ash with the mill scale.
- To compare the compressive strength of mill scale and rice husk ash with the conventional concrete mix of M25 grade.

3 .MATERIALS USED

The OPC of 53 grade cement, 20mm coarse aggregate in angular shape, river sand of size of 4.75mm were used for preparing the concrete to the experimental study. The rice husk ash and mill scale were the substitute materials to replace fine aggregate at various percentages for the study.

4. PROPERTIES OF MILL SCALE AND RICE HUSK ASH

The mill scale was collected from Vishakhapatnam steel plant, Andhra Pradesh, India and chemical properties are tabulated in table 1.

Table1: Chemical Properties of mill scale

Oxides	**SiO_2**	**Al_2O_3**	**Fe_2O_3**
%	25.73	0.05	73.15

The Rice husk ash was collected from paddy field in Amalapuram; Andhra Pradesh, India chemical properties are tabulated in table 2.

Table2: Chemical properties of rice husk ash

Oxide composition(% by mass)	**Rice husk ash**
SiO_2	91.35
Al_2O_3	0.11
Fe_2O_3	0.58
CaO	1.69
MgO	0.34
SO_3	0.12
Na_2O	0.01
K_2O	0.55
Specific gravity	2.15

The OPC of 53 grade cement, 20mm coarse aggregate in angular shape, river sand of size of 4.75mm were used for preparing the concrete to the experimental study. The rice husk ash and mill scale were the substitute materials to replace fine aggregate at various percentages to the study.

5. EXPERIMENTAL METHODOLOGY

The basic test on materials has been conducted on are tabulated in table 3.

Table3: Material test results

Materials	**Test**	**Result**
Cement	Fineness	92%
	Initial setting time	32min
	Final setting time	9hrs 25min
	Consistency	32%
	Specific gravity	3.05
Fine aggregate	Specific gravity	2.61
	Bulk density	1.54

	Fineness modulus	3.40
Coarse aggregate	Specific gravity	2.78
	Bulk density	1.72
	Fineness modulus	7
	Crushing value	22%
	Abrasion value	34%
Steel mill scale	Fineness	5.85%
	Specific gravity	6.20
Rice husk ash	Specific gravity	2.21
	Mean particle size(micro meter)	10.61

6. MIX PROPORTION

Mix proportion for 1: 1.42: 3.06: 0.45 (w/c ratio) is considered for compressive strength calculation.

7. RESULTS AND DISCUSSIONS

7.1Compressive strength of cubes

The standard concrete cubes of (150mm X 150mm X 150 mm) are casted and tested using 1500 KN capacity compressive testing machine. The effect on compressive strength by partial replacement of mill scale and rice husk ash with optimum mill scale percentage in varying percentages shown in fig: I and fig: II.

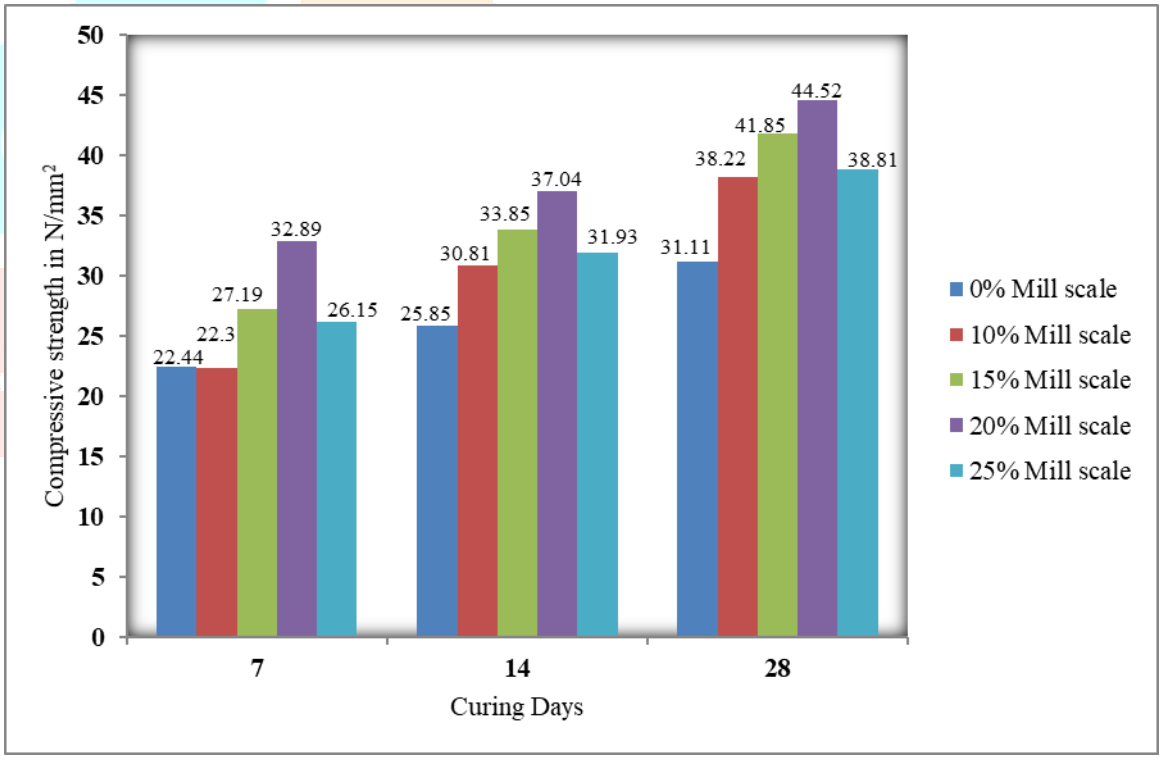

Fig 1: Effect of mill scale on compressive strength of concrete

From figure 1, the compressive strength of 0% mixing mill scale with M25 grade concrete for 7days, 14days and 28 days are 22.44N/mm^2, 25.85 N/mm^2 and 31.11 N/mm^2 respectively.

With 10%, 15%, 20% and 25% replacement of mill scale in fine aggregate in M25 grade concrete the compressive strength obtained for 7days 22.3 N/mm^2, 27.19 N/mm^2, 32.89 N/mm^2 and 26.15 N/mm^2 and for 14days 30.81 N/mm^2, 33.85 N/mm^2, 37.04 N/mm^2 and 31.93 N/mm^{2}consequently for 28days 38.22 N/mm^2, 41.85 N/mm^2, 44.52 N/mm^2 and 38.81 N/mm^2 N/mm^2 and 31.93 N/mm^{2}consequently for 28days 38.22 N/mm^2, 41.85 N/mm^2, 44.52 N/mm^2 and 38.81 N/mm^2.

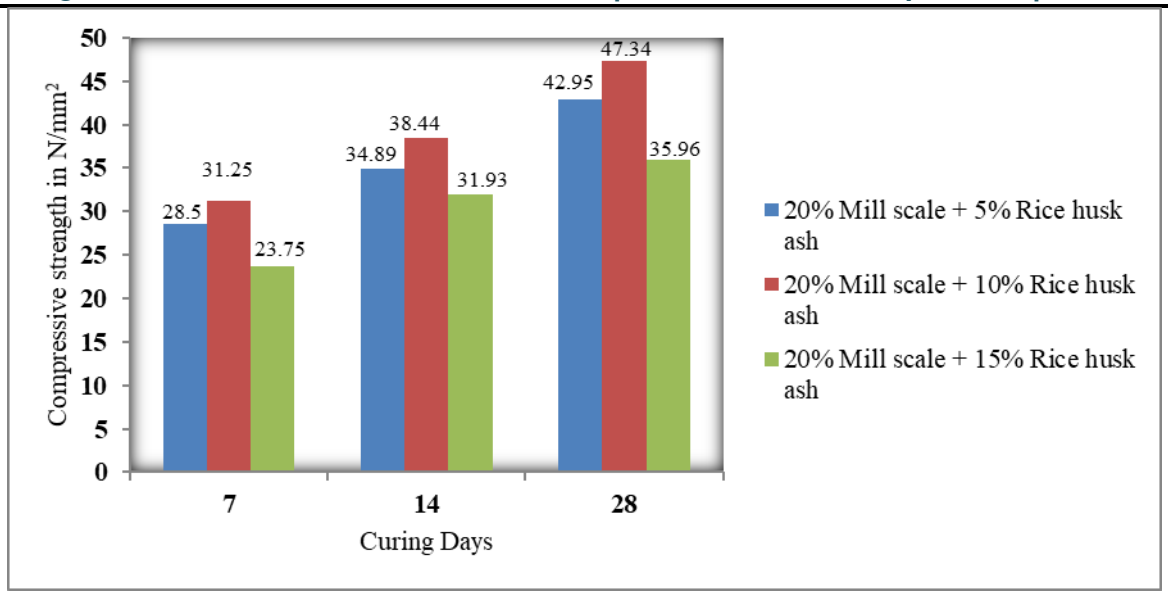

Fig 2: Effect of rice husk ash on optimum percentage mill scale mixed concrete

From figure 1, the compressive strength of 0% mixing mill scale with M25 grade concrete for 7, 14 and 28 days has 22.44N/mm^2, 25.85 N/mm^2 and 31.11 N/mm^2 respectively.

From figure 2, We observed the compressive strength values at 5%10% and 15% rice husk ash with 20% optimum mill scale percentage replacement in M25 grade concrete. So, the compressive strength obtained for 7days has 28.5 N/mm^2, 34.89 N/mm^2 and 42.95 N/mm^2 and for 14 days has 31.25 N/mm^2, 38.44 N/mm^2 and 47.34 N/mm^2 consequently for 28days has 23.75 N/mm^2, 31.93 N/mm^2 and 35.96 N/mm^2.

7.2 Discussions

The optimum values are obtained at 20% mill scale replacement. For 28days there is 16.8% incremental strength when compared to 14days and 26.12% strength increment when compared to 7days.

The optimum values are obtained at 10% Rice husk ash with 20% optimum mill scale percentage. For 28days there is 18.8% incremental strength when compared to 14days and 34% strength increment when compared to 7days.

The strength incremental percentage of 20% optimum mill scale replacement with 10% rice husk ash and 20% mill scale is 5.95% for 28 days comparison.

8. CONCLUSIONS

The physical and chemical properties of all materials are studied. The compressive strength at 20% mill scale is **30% more** when compare to the conventional concrete and at 5% adding of rice husk ash with mill scale is 34.28% with normal concrete for 28days.

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