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Partial Replacement of Cement with Quarry Dust and Rice Husk Ash in Concrete

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Abstract - *At present study we used wastes which are generated from industries in various forms like rice husk ash, granite fines, quarry dust, fly ash, copper slag, steel slag etc.., Among them we preferred quarry dust and rice husk ash. Quarry dust is the waste which is obtained from the rocks, which is also known as industrial waste. Rice husk ash is the agricultural waste which produced by burning the outer shell of the paddy that comes out as a waste product during milling of rice. The main purpose of this investigation is to study the partial replacement of cement by quarry dust of percentages 0%, 5%, 15%, 25%, 35% for M25 grade concrete cubes of 150mm^3 were casted for tests compression test and 100mm*150mm size cylinders were casted for spilt tensile test to find the optimum replacement percentage. To this percentage the rice husk ash is added in certain proportions such as 0%, 5%, 10%, 15% and 20% and the same tests will be conducted on this. Finally, we concluded that replacement of quarry dust has its optimum strength at 25% for this rice husk ash is added. Results obtained from this gives better workability and increased in its hardened concrete properties compare to normal concrete.*

Key Words: quarry dust, rice husk ash, cement, water, aggregates, compressive strength and spilt tensile strength.

1. INTRODUCTION

In progress to develop the construction industry all over the world. Many attempts have also been made by various researchers to reduce the cost of the constituents and hence total construction cost by investigating and ascertaining the waste material which could be classified as local materials. Local materials are agricultural or industrial waste i.e.., quarry dust, sawdust, concrete debris, fly ash, coconut shells among others which are produced from milling stations, thermal power station, and waste treatment plant and so on.

In this project we preferred quarry dust and rice husk ash as partial replacement of cement. Because during the consumption of cement co_2 is produced which causes pollution problems. Quarry dust waste is generated during the crushing process of rock. The waste can cause land disposal, health and environmental problems. To reduce these problems alternative technique is replacing the cement by quarry dust and rice husk ash. Not only reducing the problems but also reducing the cost of cement in construction industry.

A comparatively good strength is expected when cement is replaced partially or fully with or without concrete admixtures and chemical admixtures. It is proposed to study the possibility of replacing cement with locally available waste without sacrificing the strength and workability of concrete.

2. LITERATURE REVIEW

ANOJ et al 2017: The aim of this journal is to investigate the partial replacement of cement as quarry dust are 0%,10%,20%,25%,30%,40% and M30 grade concrete cubes were casted for finding the compressive strength. The analysis of this experiment gives partial replacement 25% quarry dust with cement gives the compressive strength of 41.5N/mm^2 and after that it goes on decreasing when compared to conventional without any replacement of quarry dust. It is clearly observed that addition of quarry dust up to certain extent will increase the compressive strength of concrete.

Er. RAVI BHUSHAN et al (Oct 2017): Rice husk ash is environmental polluting material and is the best supplementary material for cement replacement. The compressive strength of the concrete with partial replacement of rice husk ash increases with increase in the percentage of rice husk. It can be added to cement concrete as partial replacement of cement up to 10% without any significant reduction in any of the property of concrete. This will result in reduction of cost of concrete.

M.MAHA DEVI et al (April 2017):This paper presents the study of concrete mix design using marble powder and quarry dust. This disposal of marble powder from the marble industry is of environmental problem today. Then the used for replacement process 25 grade concrete. The partial replacement of mix design of concrete. As percentage replacement of 20%, 25%, 30% are used in marble powder and quarry dust increases for workability reduce. The specimen cast with 20% gives better compressive strength of 1.1% increased, split tensile strength of 1.06% increased, and flexural strength of 1.29%. When to compare to conventional concrete. The specimen cast with 25% gives better compressive strength of 1.18% increased, split tensile strength of 1.11% increased, and flexural strength of 1.22%. When to compare to conventional concrete. The specimen cast with 30% gives better compressive strength of 1.13% increased, split tensile strength of 1.18% increased, and flexural strength of 1.13%. When to compare to conventional concrete. Comparison to three different percentages of replacements, the strength will not reduce when compare to conventional concrete

AKSHAY S. PACHPOR et al APRIL 2017: This paper summarizes the research work on the properties of Rice Husk Ash (RHA) when used as partial replacement for Ordinary Portland Cement (OPC) in concrete. OPC was replaced with RHA by weight at 0%, 5%, 10%, 15%, 20% and 25%. 0% replacement served as the control. Compacting factor test was carried out on fresh concrete while Compressive Strength test was carried out on hardened 150mm concrete cubes after 7, 14, 28 days curing in water. The results revealed that the Compacting factor decreased as the percentage replacement of OPC with RHA increased. The compressive strength of the hardened concrete also decreased with increasing OPC replacement with RHA. A Series ranging from 5 % to 10 % RHA concrete but better compressive strength at later ages through showing lower compressive strength initially. However, split tensile strength are lower for RHA concrete when compare to normal concrete. The optimum addition of RHA as partial replacement for cement is in the range 0-20%.The compacting factor values of the concrete reduced as the percentage of RHA increased. The Bulk Densities of concrete reduced as the percentage RHA replacement increased. OPC replacement by RHA results in reduction of cost of production of concrete in the range of 7 to 10%.The Compressive Strengths of concrete reduced as the percentage RHA replacement increased. Using RHA as replacement of OPC in concrete, the emission of greenhouse gases can be reduced up to a greater extent. OPC replacement by RHA is environmental friendly due to utilization of waste (RHA is basically a waste obtained from Rice Mill) and replacement of cement (Production of 1 MT cement emerges 1 MT Carbon-dioxide).

3. METHODOLOGY:

3.1 Cement:

Ordinary Portland cement (OPC) of 53 grade was used in which the composition and properties is in compliance with the Indian standard organization. Cement can be defined as the bonding material having cohesive & adhesive properties which makes it capable to unite the different construction materials and form the compacted assembly. Ordinary/Normal Portland cement is one of the most widely used types of Portland cement.

3.1.1 Physical properties of cement:

S.No	Property	Test results
1	Specific gravity	3.15
2	Consistency	31%
3	Soundness	3mm
4	Initial setting time	35 min
5	Final setting time	460 min
6	Fineness	2.5%

3.1.2 Chemical composition of cement:

S.No	Compound	Weight percentages
1	Lime	63%
2	Silica	22%
3	Alumina	06%
4	Iron oxide	03%
5	Gypsum	01 to 04%

3.2 Fine aggregate:

Fine aggregate are basically sands won from the land or the marine environment. Those particles passing through 4.75mm sieve and predominantly retained on the 75 µm (no.200) sieve are called fine aggregates. For increased workability and economy as reflected by use of less cement, the fine aggregate should have a rounded shape. The purpose of fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

3.2.1 Physical properties of fine aggregates:

S.No	Property	Test results
1	Specific gravity	2.4
2	Fineness modulus	2.165%

3.3 Coarse aggregate:

Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and Portland cement, are an essential ingredient in concrete. When the aggregate is sieved through 4.75mm sieve, the aggregate retained is called coarse aggregate. The maximum size aggregate used may be dependent upon some conditions. In general, 40mm size aggregate used for normal strengths and 20mm size is used for high strength concrete. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete.

3.3.1 Physical properties of coarse aggregates:

S.No	Property	Test results
1	Specific gravity	2.7
2	Fineness modulus	6.22%
3	Flakiness index	17.36%
4	Elongation index	41.48%

3.4 Water:

Water used for mixing and curing shall be clean and free from injurious amount of oils, acids, alkalis, salts, sugar and organic materials. Portable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted. The pH value shall not be less than 6. Hydration is a complex process but in simple terms is the reaction between water and the cement in the mix.

3.4.1 Physical properties of water:

S.No	Property	Test results
1	PH value	7

3.5 Quarry dust:

Quarry dust is waste which is generated from rock. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste. The amount of industrial waste is increasing year by year. Industrial waste is defined as waste generated by manufacturing or industrial processes. One types of industrial waste is quarry dust. During the production of aggregates through the crushing process of rocks in rubble crusher units, quarry dust is obtained as a by-product. Quarry dust waste also a waste material that is generated from the stone crushing industry which is abundantly available to the extent of 200 million tons per annum. This will lead to landfill disposal problems, health and environmental pollution. This quarry dust is considered as solid waste material.

3.5.1 Physical properties of quarry dust:

SL. NO	PROPERTY	QUARRY DUST	QUARRY DUST VALUES	TEST METHOD
1	Specific gravity	2.54-2.60	2.3	IS 2386 (Part 3)1963
2	Bulk relative density (kg/m^3)	1720-1810	1680	IS 2386 (Part 3)1963
3	Absorption (%)	1.20-1.50	1.3	IS 2386 (Part 3)1963
4	Moisture content (%)		Nil	IS 2386 (Part 3)1963
5	colour		grey	
6	Particle size		<90 microns	
7	Shape texture		irregular	
8	Mineralogy		Non-crystalline	
9	odour		Odourless	

The chemical composition of quarry dust is SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O, K_2O, TiO_2, LOI

3.6 Rice husk ash:

Rice husk ash is produced by burning the outer shell of the paddy that comes out as a waste product during milling of rice. India is one of the leading producers of Rice. Globally rice paddy of about 600 million tons is being produced, accounting for an annual production of 120 million tons Rice Husk. In most of the cases, the husk produced during the processing of the rice is either burnt or dumped as waste material. Rice husk ash contains 90%-95% of reactive silica. It is estimated that the world rice harvest is about 588 million tons per year and India is the second largest producer of rice in the world with a production of 132 million tons per year annually. Since they are bulky disposal of husk present an enormous problem. Each ton of paddy produces about 200kg of husk and this rice husk can be effectively converted through controlled burning. At around 500ºC a valuable siliceous product that can enhance the durability of concrete in the chemical composition of rice husk ash is obtained.

3.6.1 Physical properties of rice husk ash:

s.no	Particular properties	
1	Colour	Grey
2	Shape texture	Irregular
3	Mineralogy	Non-crystalline
4	Particle size	<45microns
5	Specific gravity	2.37
6	Odour	Odourless

4. MIX DESIGN:

S.no	Particulars	Proportion
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%

4.1 Test data for materials:

Mix design	M25(1:1:2)
Cement	OPC 53 grade
Aggregate size	20 mm
w/c ratio	0.43
sand correspond to zone	Zone -3
Target strength	31.6

4.2 Test results for mix design:

Water	Cement	Fine Aggregate	Coarse Aggregate
0.43	1	1.21	2.272

4.3 MIX PROPORTIONS FOR DIFFERENT REPLACEMENTS OF DIFFERENT MATERIALS:

4.3.1 Mix for quarry dust:

% replacement	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Quarry dust (kg)
0	8.754	10.686	23.874	0
5	8.317	10.686	23.874	0.4377
15	7.441	10.686	23.874	1.313
25	6.561	10.686	23.874	2.184
35	5.676	10.686	23.874	3.06

4.3.2 Mix for rice husk ash:

% replacement RHA	% replacement of quarry dust	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Rice husk ash (kg)
0	25	6.561	10.686	23.874	0
5	25	6.561	10.686	23.874	0.328
10	25	6.561	10.686	23.874	0.6561
15	25	6.561	10.686	23.874	0.984
20	25	6.561	10.686	23.874	1.312

5. TEST PROCEDURE:

5.1Fresh concrete tests:

5.1.1 Slump cone test:

Clean the internal surface of the mould and apply oil. Place the mould on a smooth horizontal non- porous base plate. Fill the mould with the prepared concrete mix in 4 approximately equal layers. Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer. Remove the excess concrete and level the surface with a trowel. Clean away the mortar or water leaked out between the mould and the base plate. Raise the mould from the concrete immediately and slowly in vertical direction. Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested.

RESULTS OF SLUMP TEST ON CONCRETE:

Slump for the given sample= __26___cm

5.2 Hardened concrete tests:

5.2.1 Compression test:

Compressive strength of concrete can be defined as the measured maximum resistance of a concrete to axial loading. Compression test is the most common test used to test the hardened concrete specimens with different percentage of quarry dust replacement can be indicating through the compression test. The specimen used in the compression test is 150*150*150mm (L*B*H). There are three specimens were used in compression testing in every batches. Differences of strength among the different percentage of quarry dust used in age of 7 days and 28 days also indicated through compression test by using compression testing machine.

PREPARATION OF CUBE SPECIMENS: the proportion and material for making these test specimens are from the same concrete used in the field

SPECIMENS: 30 cubes of 15 cm size

PROCEDURE:

SAMPLING:

Clean the mould and apply the oil fill the concrete in the moulds by 5cm thick layers compact each layer with not less than 35 strokes for each layer by tampering rod smoothen top surface by trowel.

CURING: Test specimens are stored in moist air for 24 hours after this period the specimens are marked and removed from the moulds and submerged in clear fresh water until taken out for test.

TESTING:

Remove the specimen from water after specified curing time and wipe out excess water from the surface. Take the dimensions of the specimen. Clean the bearing surface of the testing machine. Place the specimen in the machine in such a manner that the load shall be applied to the opposite side of the cube cast. Align the specimen centrally on the base plate of the machine. Rotate the movable portion gently by hand so that it touches the top surface of the specimen. Apply the load gradually without shock and continuously at the rate of 140kg/cm^2/minute till the specimen fails. Record the maximum load and note any unusual features in the type of failure.

Fig -1: Compression test

5.2.2 Split tensile strength test:

Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces.

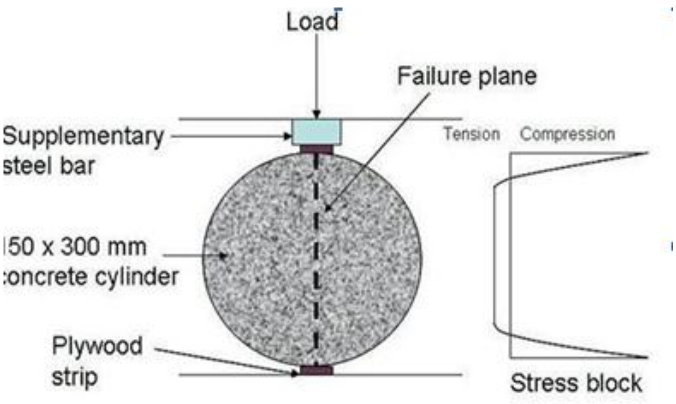

Fig -2: Split tensile strength test

PROCEDURE:

Take the wet specimen from water after 7days of curing. Wipe out water from the surface of specimen. Draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place. Note the weight and dimension of the specimen. Set the universal testing machine for the requires range. Keep are plywood strip on the lower plate and place the specimen. Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate. Place the other plywood strip above the specimen. Bring down the upper plate to touch the plywood strip. Apply the load continuously without shock at a rate of approximately 14-21kg/cm2/minute (which corresponds to a total load of 9900kg/minute to 14850kg/minute). Note down the breaking load.

6. RESULTS AND GRAPHS:

6.1 RESULTS:

6.1.1 Compressive strength values of quarry dust:

% replacement of quarry dust	7days	14days	28days
0	18.45	20.34	27.01
5	19.37	22.36	9.74
15	22.46	24.69	32.5
25	23.6	28.99	37.8
35	18.73	23.36	31.76

6.1.2 Spilt tensile strength values of quarry dust:

% replacement of quarry dust	28 days
0	3.12
5	3.43
15	4.56
25	7.54
35	3.33

6.1.3 Compressive strength values of rice hush ask

%replacement of rice husk ash	7days	14days	28days
0	19.013	22.6	30.65
5	13.01	14.33	22.38
10	18.38	18.44	28.68
15	12.74	13.85	20.20
20	11.36	12.01	19.09

6.1.4 Compressive strength values for quarry dust & RHA

% replacement of quarry dust	%replacement of rice husk ash	7days	14days	28days
25	10	18.65	24.68	36.87
25	10	19.33	27.99	35.88
25	10	21.52	26.83	33.65
Average		19.83	26.50	35.46

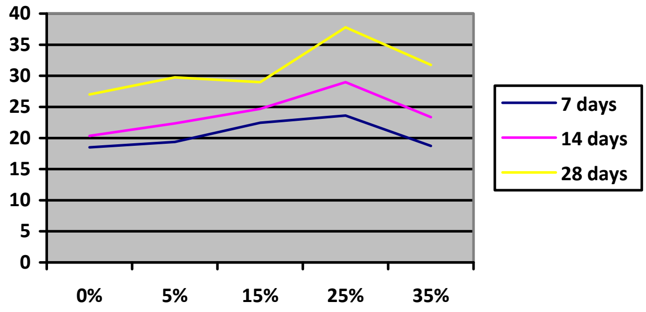

Chart -1: Compressive strength values of quarry dust

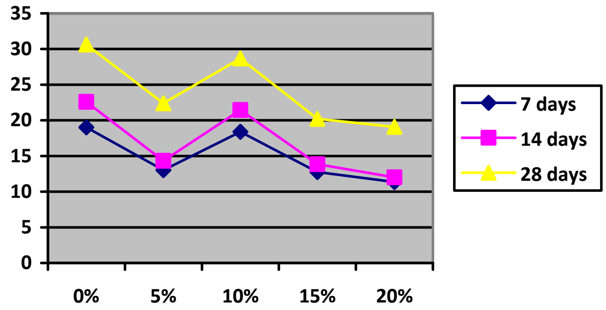

Chart -2: Compressive strength values of rice husk ash

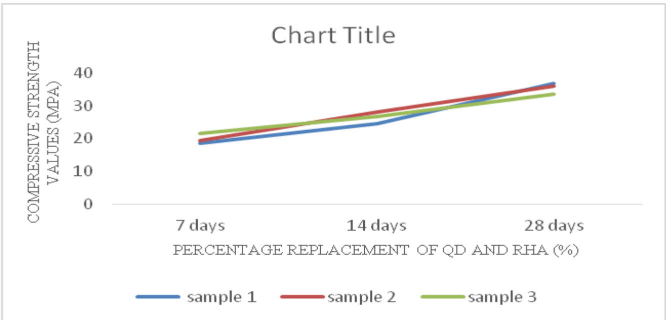

Chart -3: Compressive strength values for quarry dust & RHA

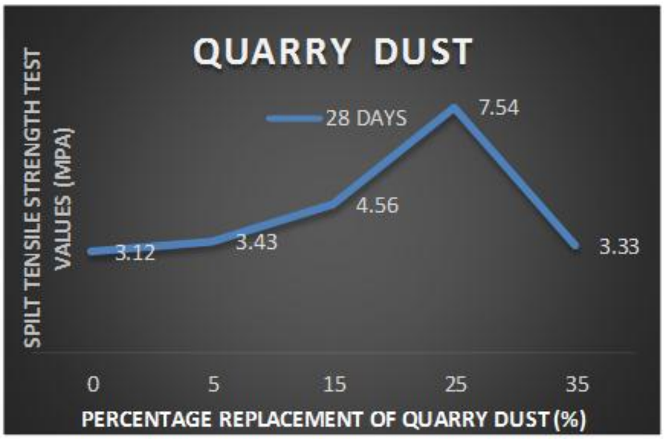

Chart -4: spilt tensile strength for quarry dust

CONCLUSION

Research on the usage of waste construction material is very important due to the material waste gradually increasing with the increased of population and increasing urban development. The reasons that many investigation and analysis had been made on quarry dust and rice husk ash, because quarry dust and rice husk ash is easy to obtained and the cost cheaper than cement. It is analysed that in replacement of cement with quarry dust and rice husk ash as the percentage of replacement increases it also increases the compressive strength of concrete. Density reduced at the increment of percent replacement. Using quarry dust and rice husk ash as cement in concrete reduce cost in construction. It is concluded that increase in percentage of replacement by quarry dust and rice husk ash increases workability of concrete. It is concluded that quarry dust and rice husk ash can be used partial replacement of cement in r.c.c concrete up to 35% for better results.

RECOMMANDATIONS

Further testing and studies on the quarry dust and rice husk ash, concrete is highly recommended to indicate the strength characteristics of quarry dust and rice husk ash, for application in high strength concrete. Below are some of recommendations for further studies: Although by decreasing the water cement ratio quarry dust and rice husk ash, can achieve high strength concrete. Therefore the maintaining w/c ratio to the accurate, we can attained good strength compare to cement. More investigations and laboratory tests should be done on strength characteristics of quarry dust and rice husk ash; it is recommended that testing can be done on concrete slabs, beams and walls. Some mechanical properties such as creeping and abrasion were also recommended. More trials with different waste materials and percentage replacement of cement are recommended to get different outcomes and high strength characteristics in concrete. Up to 25% replacement of quarry dust and 10% replacement of rice husk ash gives equal and more strength when compared to cement.

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