Comparative Study of Replacement of Natural Sand to Waste Tiles Sand in Concrete

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Abstract - Due to continuously increase in development in construction field, the use of natural material is high and at same time production of waste tile from construction sites and shops is also very high. Because of these reasons the reuse of waste tiles came into picture to reduce solid waste and to reduce the load from natural materials. Crushed waste tiles sand were replace in place of natural sand by 20%, 40%, 60%, 80% and 100% foe M30 grade of concrete and also replacing cementious material by 20% using fly ash in concrete. Experimental study like Workability Test, Characteristic Strength of Concrete and Durability Test for different concrete mix after 28 days curing period. It is observed that, replacement of waste tile sand to natural sand gives good result for concrete.

Key Words: Waste tiles sand, Natural Sand, Fly ash, Workability Test, Characteristic strength, Durability Test.

1. INTRODUCTION

In past decade, variable cost of natural sand used as fine aggregate in concrete increased the cost of construction. In this situation research began for inexpensive and easily available alternative material to natural sand. Some alternative materials have already been used as a part of natural sand e.g. slag limestone and siliceous stone powder were used in concrete mixtures as a partial replacement of natural sand. However, scarcity in required quality is the major limitation in some of the above materials. Now a day's sustainable infrastructural growth demands the alternative material that should satisfy technical requisites of fine aggregate as well as it should be available abundantly. On this basis, crushed tile sand offers viable alternative. Crushed tile sand has to satisfy the technical requisites like workability and strength of concrete. Since the data on this aspect of concrete using crushed tile sand is scarce, it is necessary to investigate the concrete produced with crushed tile sand.

The wastage related to tiles are created due to different reasons like errors in construction, human activities, careless handling, etc., also some of produced in transportation and distribution. Also the most of waste is produced due to the demolition of building. This waste is not recycled in any form at present time. So they are useless and causes an environmental and disposal problem.

The tiles are durable, hard and highly resistance to atmospheric, chemical, physical and biological actions. This properties of tiles is good and suitable for concrete. Hence this project aims to study the utilization of tiles waste as replacement of fine aggregate in concrete. This may help to improve the quality of concrete, make it economical and also solve the disposal problem.

2. LITERATURE REVIEW

A work done by Sunilaa [1] was focused on replacement of river sand using manufactured sand and quarry dust in cement concrete. The materials used to prepare concrete was Ordinary Portland Cement (OPC – 43 Grade), river sand, quarry dust, quarry stone. Concrete design was prepared for proportion of 1:1.23:2.58 at water cement ratio of 0.43. River sand was replaced with quarry sand by 100% and 50%; and conducted Compression Test, Tensile Test, and Flexural Test. The concrete block has been casted for curing days of 7 days, 14 days, 28 days and 56 days. The result suggested that 50% of river sand can be replaced by quarry dust and manufactured sand to achieve strength of concrete which also improves the quality of concrete.

Daniyal [2] the focus was on using waste ceramic tile aggregate in concrete. Waste ceramic tiles, the grading were done by natural aggregate to control concrete with compactable with ceramic tile aggregate as per I. S. Code 383-1970. Then the experiment were done on natural aggregate with ceramic aggregate as per I. S. 2386 (Part-VIII) 1960. The ceramic tiles aggregate is replaced with 0%, 10%, 20%, 30%, 40%, and 50% with natural coarse aggregate with water cement ratio of 0.4, 0.5 and 0.6 sample and optimum percentage of ceramic tile aggregate as well as water cement is determined. Then tests were conducted and checked. The result of the test suggests that the workability, density, compressive strength and flexural strength of concrete with ceramic tile aggregate were achieved satisfactorily.

An experimental study carried by Usha [3] was focused on replacement of sand with crushed brick in concrete. Quarry stone sand was used as alternative to river sand. Use of an artificial sand instead of river sand in concrete saves the 40% cost. The aim of experiment was to assess the properties of concrete made with crushed brick and study various important properties such as Compression Strength, Tensile Strength and Flexural Strength of concrete. The crushed bricks were used in sand with partially replacement of natural sand. The grade was M25 and the proportion of crushed brick was 15%, 20% and 25% in concrete and used to cast cubes, beams and cylinders with curing of 7, 28 and 56 days. The workability of concrete was checked by Slump Test. The results obtained were satisfactory comparing to regular concrete.

Another classical work done by Manasseh [4] was focused on replacement of river sand with crushed fine granite. M35 grade concrete was used for casting blocks and cured for 7 days, 14 days and 28 days. The Compression and Tensile Test were conducted and the result shows that concrete produced from Granite crushed fine aggregate has some less physical and mechanical characteristic strength and more economical than conventional concrete.

Shehden [5] the granite powder and iron powder (by-product of crushed polish granite and steel production respectively) is used for partially replacement of sand in concrete. Due to replacement of sand, properties of concrete were improved. The Compression, Tensile and Flexural Strength Tests are conducted on concrete. The concrete mix includes the cement, sand, granite powder, iron powder, aggregate super plasticizer and water. The high strength for concrete was obtained as a result.

Nagraj [6] are used concrete mixes with rock dust as fine aggregate" has conducted investigation to identify which of the aspects of proportioning of concrete mix would be affected by using rock dust partially and fully to replace sand. He observed that the rock dust reduces workability of concrete markedly; however compressive strength is not affect. He concluded that rock dust can be advantageously used as fine aggregate with appropriate use of super plasticizer.

Prakash [7] investigate on concrete with stone crusher dust as fine aggregate" carried out the tests on stone crusher dust as fine aggregate and concluded that the concrete cubes with crusher dust developed about 17% higher strength in compression, 7% more split tensile strength and 20 %more flexural strength than the specimens of concrete with river sand. According to them the higher strength can be attributed to the sharp edges of stone dust providing stronger bond with cement as compared to the rounded shape of the river sand. The reinforced concrete beams with crusher dust sustained about 6% more load and developed smaller deflections and smaller strains than the beam with river sand.

3. MATERIAL & MIX DESIGN

Ordinary Portland cement confirming to IS: 8112-1989 of 53 grade having specific gravity 3.15 is used. The fine aggregate, natural coarse aggregate which was locally available is used. The Waste Tiles Sand used as shown in Figure 1 in the experimental material which is obtained by crushing wastes tiles collected from the locally nearby available construction sites and tile's shops. The waste tiles sand was screened and size of below 4.75 mm is used.

Table 1: Physical Properties of fine Aggregate

Sr. No.	Test	Natural Sand	Waste Tile Sand
1.	Specific Gravity	2.54	2.49
2.	Water Absorption	1.2%	1.62%
3.	Sieve Analysis	Zone II	Zone II
4.	Silt Content	1.96%	0.56%

Figure 1: The waste tiles sand

Mix design carried out for M30 grade concrete by using IS 10262:2009 for following properties of ingredients.

Table 2: Concrete Mix Design

Super Plasticizer (%)	Cement (kg)	Mix Proportion	Slump (mm)	28 Days Comp. Strength Achieved (MPa)
15	350	1.0:2.4:3.4:0.45	100	36.58

Following table shows the various abrasions used for different mix design of concrete. This norms are as follow:

Table 3: Mix Proportion

Norm	Description of Mix Design
DC1	0% Waste Tile Sand and 100% Natural Sand
DC2	20% Waste Tile Sand and 80% Natural Sand
DC3	40% Waste Tile Sand and 60% Natural Sand
DC4	60% Waste Tile Sand and 40% Natural Sand

DC5	80% Waste Tile Sand and 20% Natural Sand
DC6	100% Waste Tile Sand and 0% Natural Sand

4. RESULTS AND DISCUSSIONS

For Mix DC3 replacement of natural sand to waste tile sand increases the Compressive Strength up to 13.04%, after that it decreases, Tensile Strength up to 22.63%, after that it decreases and Flexural Strength up to 2.49% after that it decreases.

For DC4 (60% replacement of natural sand to waste tile sand) increases the Shear Strength up to 38.07% after that it decreases. For Mix DC3 increases the Impact Strength up to 65.41% after that it decreases. Up to 40% replacement of natural sand to waste tile sand increases the Durability of concrete up to after that it decreases.

Table 4: Fundamental Strength of Concrete Mix

Mix No.	Compressive Strength (MPa)	Tensile Strength (MPa)	Flexural Strength (MPa)
DC1	36.58	3.35	6.56
DC2	38.96	3.67	6.71
DC3	42.07	4.23	6.69
DC4	38.07	4.10	6.30
DC5	36.51	4.05	6.45
DC6	35.55	4.02	6.33

Table 5: Shear Strength, Impact and Durability of Concrete Mix

Mix No.	Shear Strength (MPa)	Impact energy in N-m for		RCPT (mA)
		First Crack	Final Crack	
DC1	11.35	3912.48	3960.45	3719.44
DC2	15.75	6139.38	6166.79	2553.84
DC3	18.32	9261.72	9312.65	2448.42
DC4	16.20	7352.19	7393.30	2885.49
DC5	15.37	1493.73	1534.84	3741.84
DC6	14.34	1219.85	1308.72	4173.55

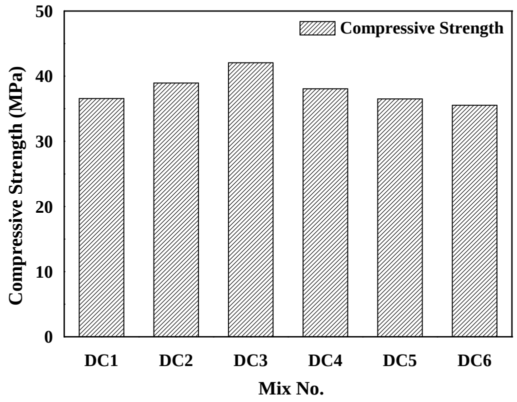

Figure 2: Average 28 Days Compressive Strength

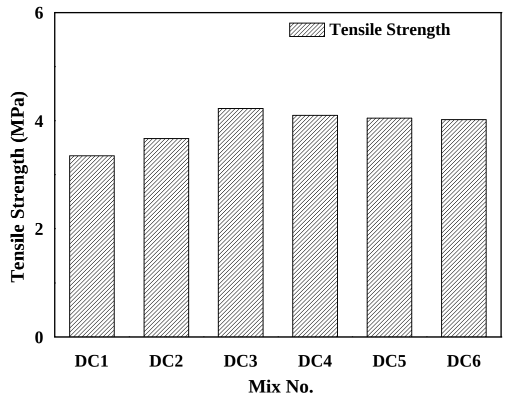

Figure 3: Average 28 Days Tensile Strength

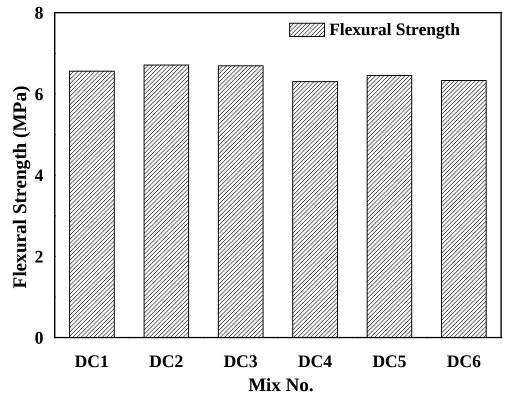

Figure 4: Average 28 Days Flexural Strength

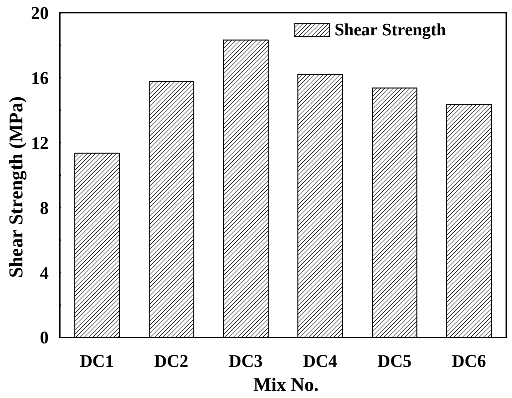

Figure 5: Average 28 Days Shear Strength

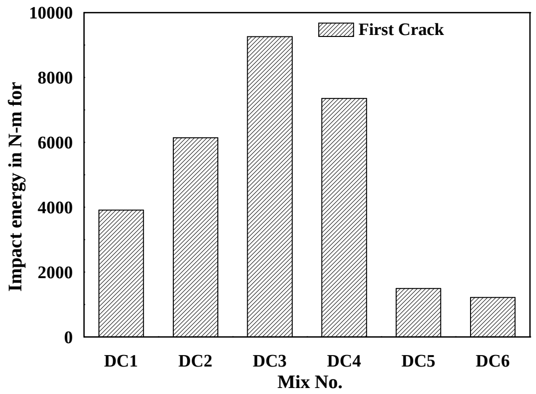

Figure 6: Impact Energy at First Crack

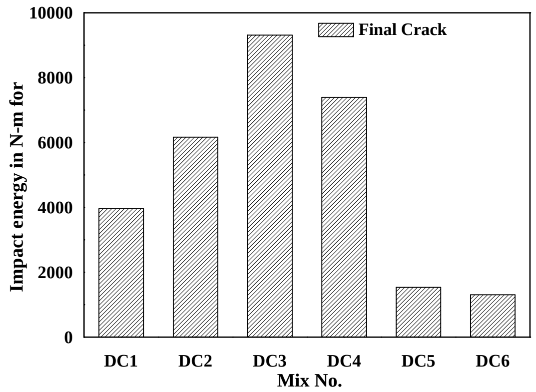

Figure 7: Impact Energy at Final Crack

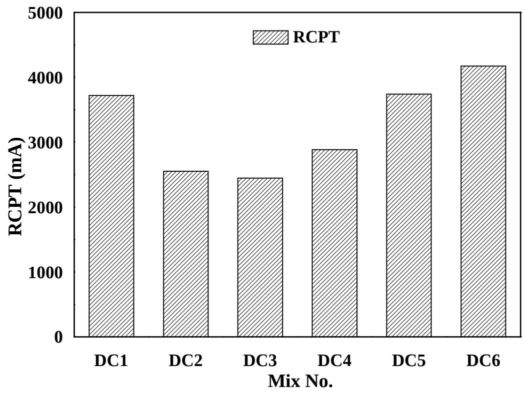

Figure 8: Rapid Chloride Penetration Test

5. CONCLUSION

The optimum strength for concrete is obtained at 40% replacement of natural sand to waste tiles sand. Waste tiles sand gives better durability with reference to natural sand. Use of 100% waste tiles sand for concrete is advisable.

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