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Experimental study on mechanical properties of concrete with various fine aggregates

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Abstract: The widely used construction material worldwide is concrete. It is a properly proportioned mixture of cement, water, fine and coarse aggregate. In India progressing to increase the investment in the infrastructure construction, the demand for concrete has increased largely. It results in a scarcity of local natural river sand in most of the areas and also lot of environmental and social problems due to overexploitation. Hence, it is necessary to carry out the research to identify suitable alternative to the natural river sand. Therefore, researchers are trying to evolve alternates for sand. Some of the alternates being Robo sand, marble sand etc. In the current work an attempt is made to study the mechanical properties of concrete by replacing local natural river sand with Robo sand, Ennore sand and marble sand. It was found that concrete made out of Robo sand yields more strength followed by Ennore sand and marble sand. The reason being Robo sand has more angular particles when compared with other sands as it is a manufactured under controlled conditions.

Index Terms: Mechanical properties, Local natural river sand, Ennore sand, Robo sand, Marble sand

1. INTRODUCTION

The Robo Sand as used in the building and construction industry is synonymous with fine aggregate which is the material with a particle size less than 5mm. Coarse sand is defined as the material comprising particles of size less than 5mm and with less than 10% being finer than 0.15mm. Fine sand is generally regarded as the material finer than 1.0mm. The particle size distribution of the sand determines its particular use such as roofing tile sand, plaster sand, concrete fine sand, concrete coarse sand, masonry sand, fill sand, grout sand, bedding sand, filter sand and so on.

The river beds are the main sources for the natural sand. These natural resources are being depleted very fast, due to over exploitation and contamination by chemicals and waste from nearby industries. This causes scarcity of natural sand. The natural sand is transported from available places to the construction sites. Transporting river sand to the construction sites increases its sale price significantly. Specifications which are generally guided by Australian and International Standards require sand to have particular physical and chemical characteristics such as particle size distribution limits, hardness, inertness, water absorption limits, density, mineral type, durability and to be free of deleterious matter.

2. LITERATURE REVIEW

ManjuPawar et.al (2014) a study has been conducted on Periodic Research, The Significance of Partial replacement of Cement with WastePowder. They found that the effect of using marble powder as constituents of fines in mortar or concrete by partially reducing quantities of cement has been studied in terms of the relative compressive, tensile as well as flexural strengths. Partial replacement of cement by varying percentage of marble powder reveals that increased waste marble powder (WMP) ratio result in increased strengths of the mortar and concrete .Leaving the waste materials to the environment directly can cause environmental problem. Hence the result, The Compressive strength of Concrete are increased with addition of waste marble Powder up to12.5 % replace by weight of cement and further any addition of WMP the compressive strength decreases. The Tensile strength of Concrete are increased with addition of waste marble powder up to 12.5 % replace by weight of cement and further any addition of WMP the Tensile strength decreases. Thus they found out the optimum percentage for replacement of MDP with cement and it is almost 12.5 % cement for both compressive & tensile strength.

V.M. Sounthararajan et.al (2013) a study has been conducted on Effect of the Lime Content in MDP for Producing High Strength Concrete. They found that the MDP up to 10% by weight of cement was

investigated for hardened concrete properties. Furthermore, the effect of different percentage replacement of MDP on the compressive strength, splitting tensile strength and flexural strength was evaluated. It can be noted that the influence of fine to coarse aggregate ratio and cement-to total aggregate ratio had a higher influence on the improvement in strength properties. A phenomenal increase in the compressive strength of 46.80 MPa at 7 days for 10% replacement of MDP in cement content was noted and also showed an improved mechanical property compared to controlled concrete.

Corinaldesi V et al., (2010) Marble as a building material especially in palaces and monuments has been in use for ages. However the use is limited as stone bricks in wall or arches or as lining slabs in walls, roofs or floors, leaving its wastage at quarry or at the sizing industry generally unattended for use in the building industry itself as filler or plasticizer in mortar or concrete. The result is that the mass which is 40% of total marble quarried has reached as high as millions of tons. This huge unattended mass of marble waste consisting of very fine particles is today one of the environmental problems around the world.

3 MATERIALS AND PROPERTIES

3.1 Cement

Cement plays vital role in concrete. One of the important criteria tricalcium aluminate (C_3A) content, tricalcium silicate (C_3S) content, dicalcium silicate (C_2S) content etc. It is also necessary to ensure the compatibility of chemical and mineral admixtures with cement.

In this study, Ultratech53 grade Ordinary Portland Cement conforming to IS: 12269–1987 was used for the entire work. The cement was purchased from single source and was used for casting of all specimens. The physical properties of cement are furnished in Table 1.

Table 1 Physical properties of cement

S. No	Characteristics	Test Results	Requirements as per IS 12269-1987
1	Fineness (retained on 90-µm sieve)	6%	<10%
2	Normal Consistency	33%	--
3	Initial setting time of cement	50 min's	30 minutes (minimum)
4	Final setting time of cement	480 min's	600 minutes (maximum)
5	Expansion in Le Chatelier's method	4 mm	10 mm (maximum)
6	Specific gravity	3.15	3.10 – 3.25

3.2 FINE AGGREGATE

The natural sand taken for this investigation is the locally available natural river sand. It was collected and cleaned for impurities, so that it is free from clayey matter, salt and organic impurities. Particles passing through IS sieve of 4.75 mm conforming to grading zone-II of IS: 383-1970 was used in this work. Properties such as gradation, specific gravity, fineness modulus, bulk density had been assessed. The physical properties of sand are furnished in Table 2.

Table 2 Physical properties of Fine Aggregate

S.No.	Tests Conducted	Results Obtained		Permissible Limits as per IS 383-1970
1	Specific gravity	2.62		2.5 to 3.0
2	Fineness modulus	3.05		--
3	Bulk density	Loose State	1450 kg/m^3	1400 to 1750 kg/m^3
		Compacted State	1520 kg/m^3	
4	Water absorption (%)	1.09		Max 3%
5	Sieve Analysis	Zone – I		--

3.3 COURSE AGGREGATE

Locally available machine Crushed angular granite, retained on 4.75mm I.S. sieve of maximum size of 20mm confirming to I.S: 383-1970 was used in the present experimental investigation. It is free from impurities such as dust, clay particles and organic matter etc. The coarse aggregate is tested for its various properties such as specific gravity, fineness modulus, elongation test, flakiness test, sieve analysis, bulk density in accordance with in IS 2386 – 1963. The physical properties of Coarse Aggregate are furnished in Table 3.

Table 3 Physical properties of Coarse Aggregate

S.No.	Tests Conducted	Results Obtained		Permissible Limits as per IS 383-1970
1	Specific gravity	2.67		2.5 to 3.0
2	Fineness modulus	7.52		--
3	Bulk density	**Loose State**	1480 kg/m^3	1400 to 1750 kg/m^3
		Compacted State	1560 kg/m^3	

4	Water absorption (%)	1.09	Max 3%
5	Elongation Index	20%	Max 25%

3.4 WATER

Water used for mixing and curing shall be clean and free from injurious quantities of alkalies, acids, oils, salts, sugar, organic materials, vegetable growth (or) other substance that may be deleterious to bricks, stone, concrete, or steel. Potable water is generally considered satisfactory for mixing.

Water acts as a lubricant for the fine and coarse aggregates and acts chemically with cement to form the binding paste for the aggregate and reinforcement. Less water in the cement paste will yield a stronger, more durable concrete; adding too much water will reduce the strength of concrete and can cause bleeding. Impure water in concrete, effects the setting time and causing premature failure of the structure.

To avoid these problems quality (potable) water must be proffered in construction works and PH value of water should be not less than 6. And also Quantity of water to be taken is important

3.5ENNORE SAND

Ennore sand was collected from Ennore, Tamil Nadu. The Physical and Chemical Properties are listed below in table 4.

Table 4 Physical and Chemical Properties of Ennore Sand

S.No.	Property	Value
1	Colour	Grayish White
2	Specific Gravity	2.64
3	Absorption (in 24 Hours)	0.80%
4	Shape of grains	Sub Angular
5	SiO_2	99.30%
6	Fe_2O_3	0.10%

3.6 Marble sand

Marble Sludge Powder (MSP) / Marble Dust is obtained in wet form directly taken from deposits of Marble factories. Wet marble sand was dried before the sample preparation. The properties are given in Table 5.

Table 5 Physical Properties of Marble sand

S.No.	Property	Value
1	Specific Gravity	2.14
2	Bulk Density (Kg/m^3)	1680
3	Fineness Modulus	1.90

3.7 Robo Sand

Robo Sand is procured from Machine Crushed nearby Quarry and its properties are listed below in Table 6.

Table 6 Physical Properties of Robo Sand

S.No.	Property	Value
1	Specific Gravity	2.84
2	Bulk Density (Kg/m^3)	1768
3	Fineness Modulus	2.84

3.8 MIX PROPORTIONS

Various mix proportions of M 25 and M 35 are shown in table 7 and 8.

Table 7 Quantities of Ingredients per Cum of M 25 Grade Concrete

S.No.	1	2	3	4
Concrete Combination	CC	CC+RS	CC+ES	CC+MS
Robo Sand (Kg)	0	587.6	0	0
Ennore Sand (Kg)	0	0	623.7	0
Marble Sand (Kg)	0	0	0	566.2
Coarse Aggregate (Kg)	1190	1309	1309	1309
Fine Aggregate(Kg)	714.5	0	0	0
Cement(Kg)	327	327	327	327
Water(Lit)	163.5	163.5	163.5	163.5

Table 8 Quantities of Ingredients per Cum of M 35 Grade Concrete

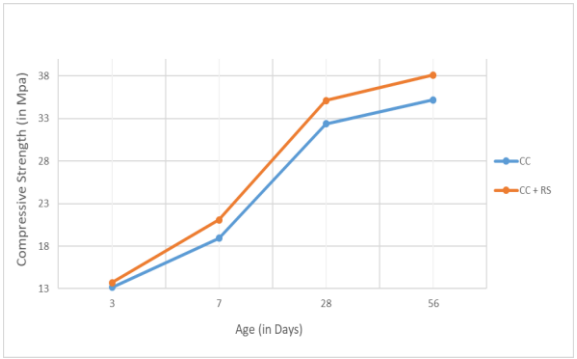
S.No.	1	2	3	4
Concrete Combination	CC	CC+RS	CC+ES	CC+MS
Robo Sand (Kg)	0	557.05	0	0
Ennore Sand (Kg)	0	0	591.2	0
Marble Sand (Kg)	0	0	0	536.7
Coarse Aggregate (Kg)	1181.6	1297.8	1297.8	1297.8
Fine Aggregate(Kg)	680.3	0	0	0
Cement(Kg)	370.6	370.6	370.6	370.6
Water(Lit)	166.7	166.7	166.7	166.7

4 RESULTS AND DISCUSSIONS

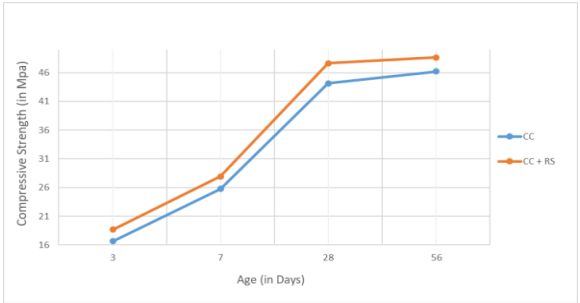
4.1 TEST RESULTS FOR M 25 GRADE OF CONCRETE

4.1.1 COMPRESSIVE STRENGTH

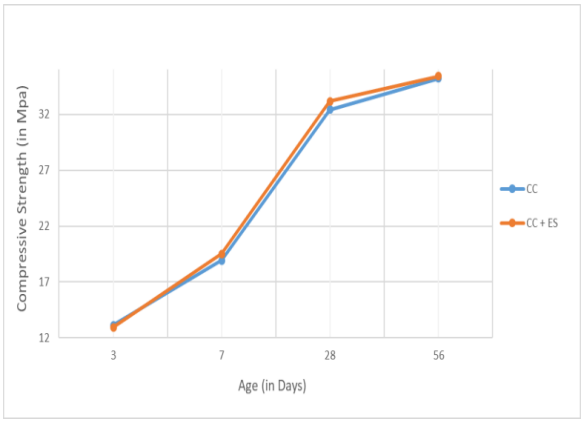
It can be observed that the compressive strength of concrete prepared by replacing Marble Sand, Robo Sand and Ennore Sand as Full replacement of Fine Aggregate exhibits improved Compressive Strength individually. It is observed that concrete with 100% replacement with Ennore Sand shows 0.57% increase in Compressive Strength and replacement of 100% Marble Sand exhibits 2.58% improvement and Full Replacement of Fine Aggregate with Robo Sand (100%) of shows 8.23% improved Compressive Strength compared to Controlled Concrete. The Graphical Representations of the above results are shown below with various Combinations are shown in Fig No. 1.



(i) Marble Sand



ii).Robo Sand



(iii) Ennore Sand

Fig No.1 Variation of Cube compressive strength of Control Concrete and Concrete with Marble Sand, Robo Sand and Ennore Sand

4.1.2 SPLIT TENSILE STRENGTH

The Split tensile strength of Control concrete is 3.48 MPa. It is observed that all the replacements except Marble Sand exhibits improved Strength Characteristics compared to Control Concrete, But the Optimum mix of Concrete with 100% Robo Sand resulted in significant improvement with 4.02% more than Control Concrete. The same is represented graphically in Figure No. 2.

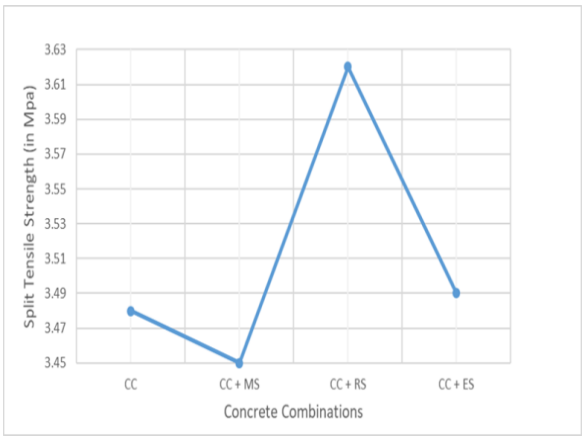


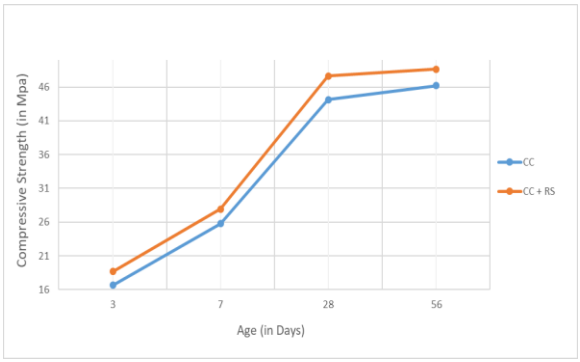
Fig No.2 Variation of Split Tensile Strength of Control Concrete and Concrete with Marble Sand, Robo Sand and Ennore Sand

4.2 TEST RESULTS FOR M 35 GRADE OF CONCRETE

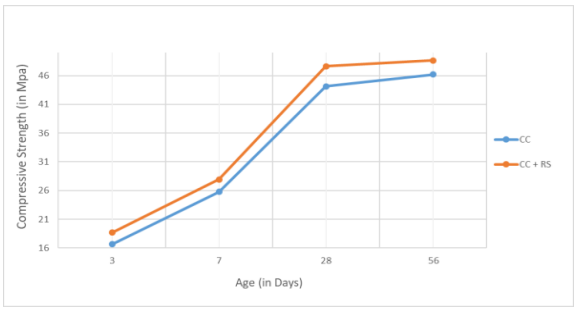
4.2.1 COMPRESSIVE STRENGTH

It is observed that Concrete with Ennore Sand shows 4.54% decrease in Compressive Strength, 100% Marble Sand exhibits 1.21% improvement and 100% replacement with Full Replacement of

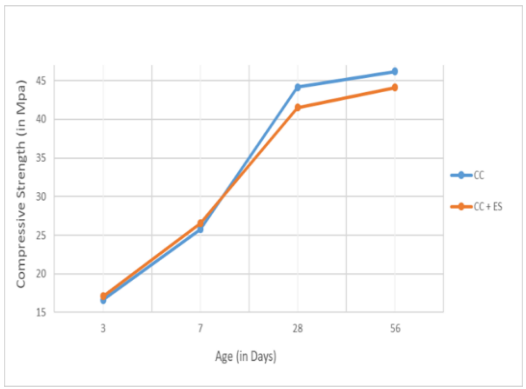
Fine Aggregate with Robo Sand (100%) of shows 5.21% improved Compressive Strength compared to Controlled Concrete. The Graphical Representations of the above results are shown with various Combinations in Fig No. 3



(i) Marble Sand



(ii) Robo Sand



(iii) Ennore Sand

Fig No.3Variation of Cube compressive strength of Control Concrete and Concrete with Marble Sand, Robo Sand and Ennore Sand

4.2.2 SPLIT TENSILE STRENGTH

The Split tensile strength of Control concrete is 3.97 MPa. It is observed that all the replacements except Marble Sand exhibits improved Strength Characteristics compared to Control Concrete, But the Optimum mix of Concrete with 100% Robo Sand resulted in significant improvement with 4.79% more than Control Concrete. The same is represented graphically in Figure No. 4

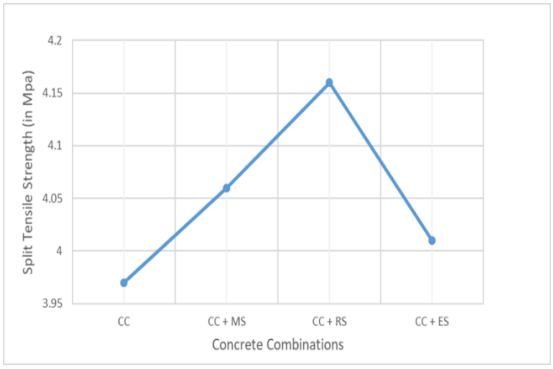


Fig No.4Variation of Split Tensile Strength of Control Concrete and Concrete with Marble Sand, Robo Sand and Ennore Sand

5 CONLUSIONS

5.1 Compressive Strength:

1. For M_{25} Grade of Concrete – It is observed that Fine Aggregate replaced with 100% Marble Sand exhibits 2.58% improvement and 100% replacement with Ennore Sand shows less than 1% increase in Compressive Strength Full Replacement of Fine Aggregate with Robo Sand (100%) of shows 8.23% improved Compressive Strength compared to Controlled Concrete
2. Similarly in M_{35} Grade of Concrete – It is observed that Concrete with 100% Marble Sand exhibits 1.21% improvement and 100% replacement with Ennore Sand shows 4.54% decrease in Compressive Strength Concrete with Robo Sand (100%) of shows 5.21% improved Compressive Strength compared to Controlled Concrete

5.2 Split Tensile Strength:

1. For M_{35} Grade of Concrete - It is observed that all the replacements except Marble Sand exhibits improved Strength Characteristics compared to Control Concrete, But the Optimum mix of Concrete with 100% Robo Sand resulted in significant improvement with 4.79% more than Control Concrete.
2. Similar trend is observed in M_{25} Grade of Concrete – Concrete with 100% Robo Sand resulted in significant improvement with 4.02% more than Control Concrete

From the above research – It is concluded that Fine Aggregate can be replaced with Robo Sand for

improved Mechanical Properties such as Compressive Strength and Split Tensile Strength.

REFERENCES

1. Bouziani Tayeb (2011) ―Effect of Marble Powder on the Properties of Self Compacting Sand Concrete", The Open Construction and Building Technology Journal, 2011, 5, 25-29
2. Prof P. A. Shirulea (2012) ―Partial Replacement of Cement with Marble Dust Powder, International Journal of Advanced Engineering Research and Studies EISSN2249–897.
3. Hsu, L. S., and Hsu, C. T. T., 1994, "Complete stress-strain behavior of high-strength concrete under compression" Magazine of Concrete Research., Vol. 46(169), pp.301–312.
4. Ilangovana. R., Mahendrana. N. and Nagamani. K., 2008, "Strength and Durability Properties of Concrete Containing Quarry Rock Dust as Fine aggregate", ARPN journal of Engineering and Applied Sciences, Vol. 3(5), pp. 20 – 26. Hwang C-L, Hung M-F. Durability design and performance of self-consolidating lightweight concrete. Constr Build Mater 2005; 19(8):619-26.
5. M.S. Shetty, Concrete Technology Theory and Practice, 5thedition,S.Chand& Co. Ltd., New Delhi
6. B.P.Hudson, Manufactured sand for concrete, The Indian Concrete Journal, May 1997, pp237-240.
7. M.S.Jaafar, W.A.Thanoon, M.R.A.Kadir and D.N.Trikha, Strength and Durability characteristics of high strength autoclaved stone dust concrete, The Indian concrete journal, December 2002 , pp771-774.
8. A.K.Sahu, Sunil kumar and A.K.Sachan, Crushed stone waste as fine aggregate for concrete, The Indian Concrete Journal, January 2003 pp845-847.
9. Tasnia Hoque, "Influence of Stone Dust as Partially Replacing Material of Cement and Sand on some Mechanical Properties of Mortar", International Journal of Advanced Structures and Geotechnical Engineering SSN 2319-5347, Vol. 02, No. 02, April 2013.
10. M.Thanigai Selvan, ―Utilization of granite powder waste as fine aggregate in high performance concrete‖, International Journal of Engineering Research and Advanced Technology, Vol. 2 (2), 46-65,2014.
11. Er.Rohin Kaushik, ―Study of Self Compacting Concrete Using Brick Dust and Marble Powder", International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 3, Issue 3, May-Jun 2013, pp.1283-1286.