International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

An Experimental Study on Partial Replacement of Fine Aggregates with M-sand

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Abstract:
Shortage of good natural sand due to depletion of resources and limitation due to environmental considerations has made concrete manufacturers to look for suitable alternative fine aggregate. One such alternative is " manufactured sand" . Manufactured Sand is a term used for aggregate materials less than 4.75 mm and which are processed from crushed rock or gravel . Due to booming of construction activities in our country, natural sand resources are increasing depleted and its costs is becoming increasing high. Workability strength and Durability of concrete with manufactured sand as replacement to natural sand in proportions of 0%,5%,10%,15%,20% and 25% is studied. This project was, therefore, conducted to study the influence that manufactured sand having compressive strength, split tensile strength of concrete for 7 days ,14 days ,28 days, and to access the prospects of using manufactured sand as a replacement of natural sand. The experiments were conducted on M30 concrete grade. Slump cone test is conducted to determine workability on fresh concrete. It can therefore, be concluded from the finding of the study that when the availability of natural sand is scarce are in cities where the price of natural sand is as expensive as manufactured one, manufactured sand concrete mix is a viable and better alternative to the use of natural sand.

Keywords: M-Sand , Concrete , Coarse Aggregates, Fine Aggregates

1. Introduction

Concrete is the most widely used man-made construction material all around the globe because of its superior specialty of being caste in any desirable shape. It is material synonymous with strength and longevity has emerged as the dominant construction material for the infrastructure needs of the present situation. Around five billion tons of concrete have been used around the world wide every year, in terms of cost it is equivalent to 25 to 30% of the nation budget. It is also inevitable material in human life due to its enormous usage in modern way of construction and now the per capita consumption is reached to more than 2 kg. In every construction aspects it requires concrete, hence concrete plays a vital role in present scenario of construction industries.

Common river sand is expensive due to cost of transportation from natural sources. Also large-scale depletion of these sources creates environmental problems. As environmental transportation and other constraints make the availability and use of river sand less attractive, a substitute or replacement

product for concrete industry needs to be found. River sand is most commonly used fine aggregate in the production of concrete poses the problem of acute shortage in many areas, whose continued use has started posing serious problem with respect to its availability, cost and environmental impact. The increasing demand is also leading to hike in its price and large excavations in river beds. It is in turn posing a problem to the existing water bodies.

In such a situation the Manufactured Sand can be an economic alternative to the river sand. Manufactured Sand can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to from fine particles less than 4.75mm. Usually, Manufactured Sand is used in large scale in the highways as a surface finishing material and also used for manufacturing of hollow blocks and lightweight concrete prefabricated elements. Use of Manufactured Sand as a fine aggregate in concrete draws serious attention of researchers and investigation

M-sand is acquired in required grading to be used for construction purposes as a replacement for river sand, produced from crushing of granite stones. The sizes of M-sand can be controlled easily so that it meets the required grading for the given construction is an added advantage or otherwise the M-sand is defined as a purpose-made fine aggregate produced from quarry fines of certain types of rock through further screening and processing. Some of the general requirements of M-sand are: it should have particles with higher crushing strength, smooth surface texture and without organic impurities. It was reported that 50% replacement of fine aggregate by M-sand gave better strength and durability aspects than the conventional concrete. From the reported literature it can be seen that quarry fines are more suitable for replacement of natural river sand. In Tamil Nadu, stone quarries are found in abundance and are wide spread across the state. They are the good source for the coarse aggregate and manufactured fine aggregate. . Hence to make use of these M-sand in the construction industry, a systematic study has to be carried out on the replacement with Natural River sand in making concrete. The raw material for M-sand production is the parent mass of rock. It is based on the parent rock that the chemical, mineral properties, texture and the composition of sand would change. Experimental investigations carried out on the evaluation of properties of M-sand obtained from different locations (sources) are presented in this paper.

IMPORTANCE OF THE STUDY

The general objective of this study work is to study the influence of manufactured sand on the compressive strength of concrete and to compare the result with that of concrete produced using natural river sand.The specific objectives of this study are:

- To study background information on manufactured sand,
- To find out the optimum quantity of sand required,
- To draw conclusions and give recommendations based on the research findings and indicate areas for further study.

SCOPE OF THE STUDY

- Identification of M- sand with different mineralogical composition in and around Nellore region.
- To determine the effect of replacement of sand by M- Sand on properties of concrete.
- To study the suitability of M-sand by replacing natural sand with 0%, 5%, 10%, 15%, 20%, and 25% M-sand.
- To study workability of fresh concrete.

- To study compressive strength and split tensile strength of hardened concrete

NEED FOR THE REPLACEMENT OF SAND

Large scale efforts are required for reducing the usage of the raw material that is present, so that large replacement is done using the various by-product materials that are available in the present day.

The material that can be used is Manufactured Sand which is made while in the processing of the Granite stone into aggregates, this is formed as a fine dust in the crushers that process the coarse aggregates, which is used a earthwork filling material in the road formations majorly. Many studies are made with several other materials which gave the concrete to be a material made of recycled material but the parameters that are primary for the material was not satisfied. The properties of concrete in fresh and hardened state are studied in the various papers that are used as a reference for this. Some of the properties are workability, compressive strength are the major one that are considered.

BEHAVIOUR OF MANUFACTURED SAND:

Manufactured Sand produced by crushed rock pieces are often made up of particles having rough and angular surfaces. Manufactured Sand, because of their angularity and toughness, produce greater concrete compressive strength for cement even with higher water content than natural sand. However, Manufactured Sand produced with modern equipments behaves almost the same as natural sand.

MATERIALS USED:

The different materials used in this investigation are:

- Cement
- Fine Aggregates
- Manufactured Sand
- Coarse aggregate
- Water

CEMENT

Cement is a binding materials called calcareous and argillaceous materials. K.C.P-53 grade ordinary Portland cement conforming to IS: 12269 were used. There are about 70 varieties of cement and available in powder, paste and liquid form but we are only concerned here with constructional cement commonly known as Portland cement. (Portland is the town in South England where cement was originally made)

Cements having calcium silicates as major constituents are called Portland cement. Cements in which the major constitute- nets are ingredients other than calcium silicates are called non- Portland cement. When making concrete the cement paste acts as a binding medium which adheres to the intermixed sand and stone particles. This binds the mass together which be- comes very hard. Cement used in the laboratory investigations was ordinary Portland cement of 53grade. The properties of cement used in the investigation are presented.

Physical Properties of The Cement:

S.No	Properties	Results	IS : 12269-1987
1.	Specific gravity	3.12	-
2.	Normal consistency	35%	-
3.	Initial setting time	34 Min	Minimum of 30min
4.	Final setting time	410 Min	Maximum of 600min
5.	Fineness	6%	< 10%
6.	Compressive strength A. 7 days strength B. 14 days strength C. 28 days strength	 28.3Mpa 38.9 Mpa 54.6 Mpa	 Minimum of 27 Mpa Minimum of 37Mpa Minimum of 53Mpa

FINE AGGREGATE

The standard sand used in this investigation was obtained from PENNA River in NELLORE. The standard sand shall be of quartz, light grey or whitish variety and shall be free from silt. The sand grains shall be angular; the shape of the grains approximating to the spherical form elongated and flattened grains being present only in very small or negligible quantities. The standard sand shall (100 percent) pass through 2-mm IS sieve and shall be (100 percent) retained on 90-micron IS Sieve and the sieves shall conform to IS 460 (Part: 1): 1985.

Physical Properties of Fine aggregate:

Property	Natural Sand	Test method
Specific gravity	2.48	IS2386(Part III)- 1963
Bulk density (kg/m3)	1720	IS2386(Part III)- 1963
Fineness Modulus	3.33	IS2386(Part VI)- 1963
Absorption (%)	1.20	IS2386(Part III)- 1963
Sieve analysis	Zone-II	IS 383- 1970

MANUFACTURED SAND

The crusher plants located in and Nellore is the source for collecting manufactured sandused in the study. The crusher plants are equipped with roller or jaw type crushed and the crushed stone metals of different sizes are collected after sieving them through rotary sieves, which are cylindrical in shape and placed in an inclined position. Starting from higher end of the screening unit, they have in general openings of 3.2, 9.5, 12.7, and 25.4mm sizes. The material passing through 3.2mm sieve is known as crusher dust or manufactured sandand is collected. manufactured sand is collected from crusher location at the Kanuparthipadu, Nellore district.

Physical Properties of M Sand:

Property	Manufactured Sand	Test method
Specific gravity	2.5	IS2386(Part III)- 1963
Bulk density (kg/m3)	1645	IS2386(Part III)- 1963
Absorption (%)	0.95	IS2386(Part III)- 1963
Moisture Content (%)	1.45	IS2386(Part III)- 1963

COARSE AGGREGATES

According to IS 383: 1970, coarse aggregate may be described as crushed gravel or stone when it results from crushing of gravel or hard stone. The coarse aggregate procured from quarry was sieved through the sieved of sizes 20 mm and 10 mm respectively. The aggregate passing through 20 mm IS sieve and retained on 10 mm IS sieve was taken. Specific gravity of the coarse aggregate is 2.5.

Physical properties of coarse aggregates:

Property	Coarse aggregate	Test method
Specific gravity	2.5	IS 2386-3 (1963)
Impact Test	6.3%	IS:2386 (Part IV)-1963
Water Absorption	0.48	IS 2386-3 (1963)
Fineness	7.02	IS : 383 -1970

CONCRETE MIX DESIGN

MIX PROPORTION FOR M30

Cement	Fine aggregate	Coarse aggregate	Water
440 Kg/m^3	607.75 Kg/m^3	1042.65 Kg/m^3	198 Kg/m^3
1	1.38	2.36	0.45

RESULTS AND DISCUSSIONS

Slump values for M30 grade by addition of M-Sand as partial replacement of fine aggregates

%of M-Sand Added	Slump in " mm" (M30)
0%	77
5%	74
10%	67

15%	62
20%	58
25%	54

DESCRIPTION OF CODINGS FOR M30 GRADE CONCRETE:

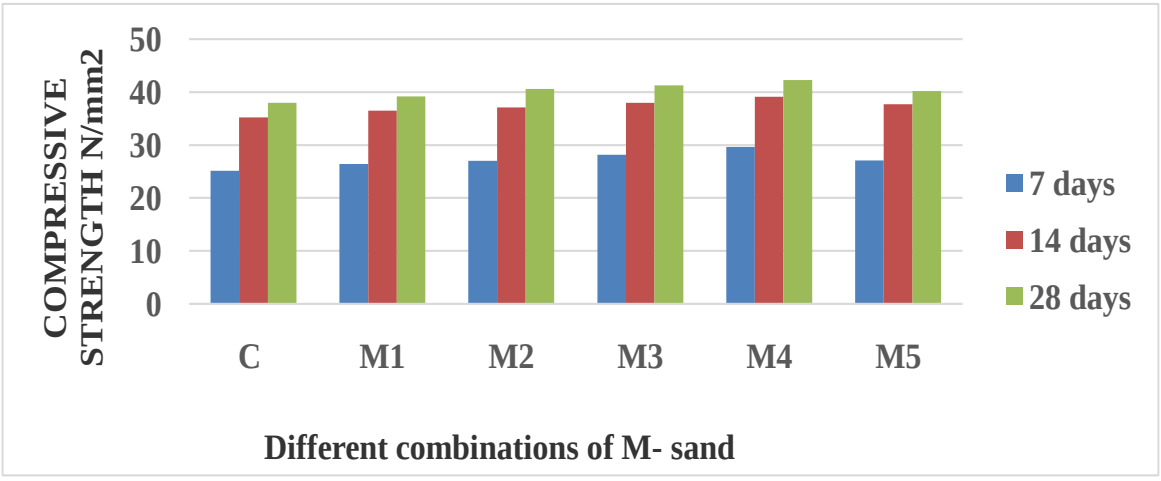
In our project, we are considering the following coding.

C - Conventional concrete
M1 - Combination of 95% of Fine Aggregates with 5% M-sand
M2 - Combination of 90% of Fine Aggregates with 10% M-sand
M3 - Combination of 85% of Fine Aggregates with 15% M-sand
M4 - Combination of 80% of Fine Aggregates with 20% M-sand
M5 - Combination of 75% of Fine Aggregates with 25% M-sand

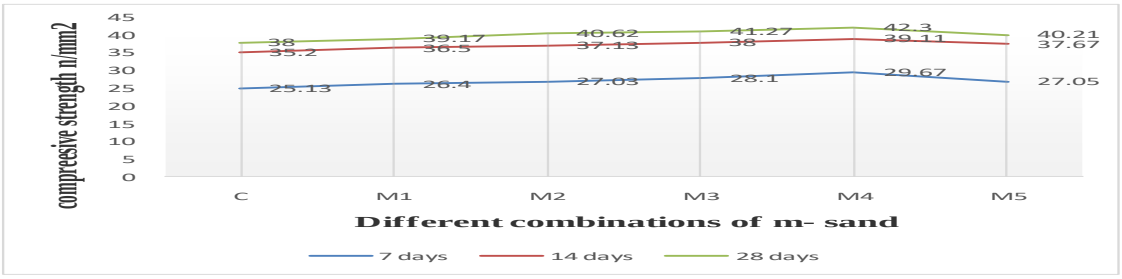
COMPRESSIVE STRENGTH TEST

Compressive strength test values for M30 grade by addition M-sand as partial replacement of fine aggregate

Coding	Compressive strength for 7days(Mpa)	Compressive strength for 14days(Mpa)	Compressive strength for 28days(Mpa)
C	25.13	35.20	38.00
M1	26.40	36.50	39.17
M2	27.03	37.13	40.62
M3	28.13	38.00	41.27
M4	29.67	39.11	42.30
M5	27.05	36.67	40.21



Bar chart showing different combinations of m-sand m30 mix for compressive strength.

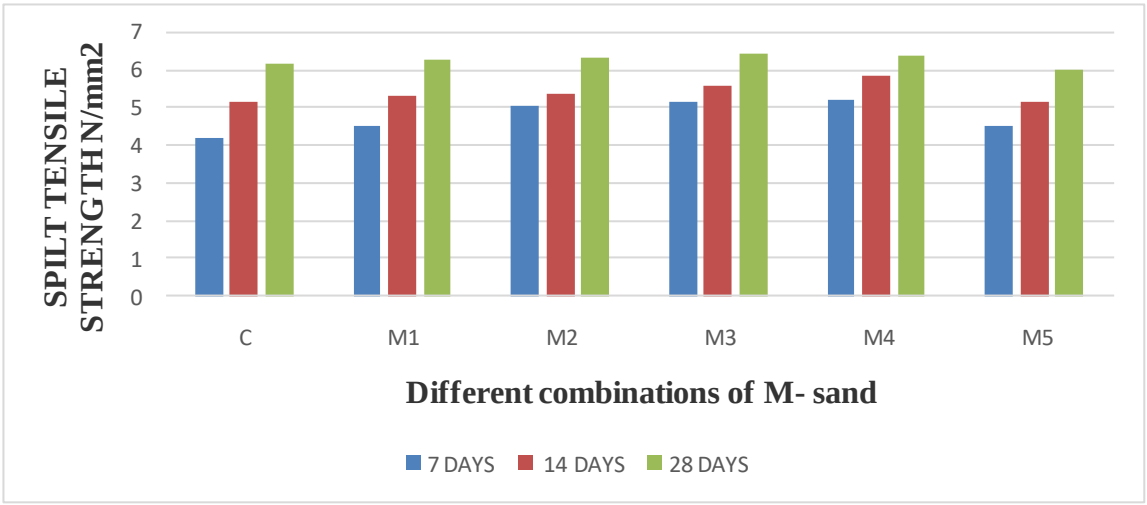


graph sheet showing different combinations of m- sand m30 mix for compressive strength

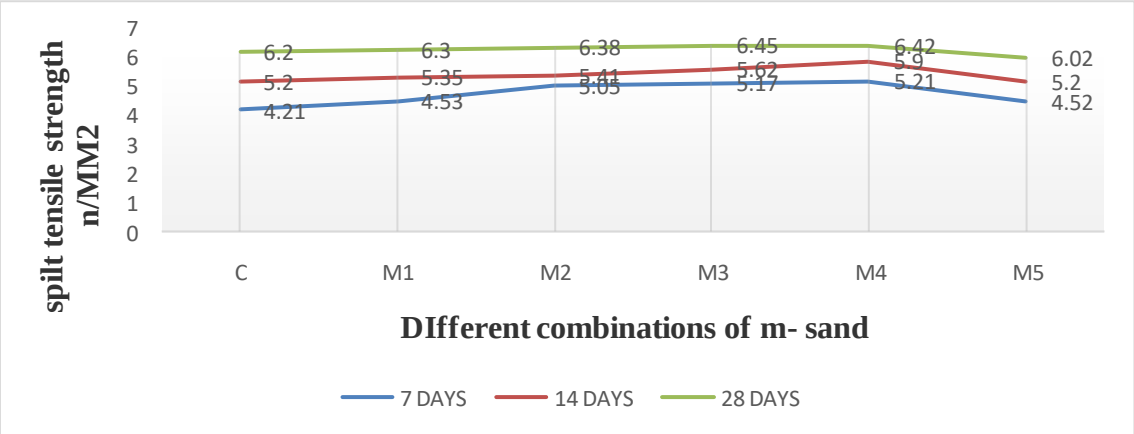
SPILT TENSILE STRENGTH TEST

Tensile strength test values for M30 grade by addition M-sand as partial replacement of fine Aggregate.

Coding	Spilt tensile strength for 7days (MPa)	Spilt tensile strength for 7days (MPa)	Spilt tensile strength for 7days (MPa)
C	4.21	5.20	6.20
M1	4.53	5.35	6.30
M2	5.05	5.41	6.38
M3	5.17	5.62	6.45
M4	5.21	5.90	6.42
M5	4.52	5.20	6.02



Bar chart showing different combinations of m- sand m30 mix for spilt tensile strength.



graph sheet showing different combinations of m- sand m30 mix for spilt tensile strength

CONCLUSIONS

Based on the work carried out the following conclusion have been mentioned below.

1. The strength of concrete is determined by using compressive strength test and spilt tensile strength.
2. The partial replacement of fine aggregate with M- Sand in the M30 grade mix proportion concrete causes the increase in compressive strength and tensile strength.
3. Partial replacement of fine aggregate with M- Sand in M30 grade mix proportion concrete causes the compressive strength, tensile strength increases at 5%, 10% ,15%, 20% and 25% of M- sand proportions.
4. At 25% of m-sand proportion causes the compressive strength and tensile strength reduction in the concrete.
5. Availability of m- sand is plenty available and cost of quarry dust is economical.
6. Availability of M- sand is in places where there is quarries companies but it is reusing in concrete increases strength and decreases the usage of fine aggregate which is economical and eco-friendly. Final conclusion is the 20% of m- sand have high compressive strength and spilt tensile strength.

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