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Experimental analysis on concrete with the partial replacement of foundary waste sand and coconut shell

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ABSTRACT

Casting industries produce millions of tons of by-product in India. In tamilnadu, million tons of waste foundry sand is produced yearly. Waste foundry sand major by-product of casting industry and it creates land pollution. The river fine aggregate will be replaced with waste foundry sand and M-Sand (WFS 0%, 15%, 20%, 25%) in concrete. So that the land pollution can be reduced and the demand for the river sand can be minimized. Research has being carried out to know the exact percentage of waste foundry sand (WFS) in M-Sand for concrete. Concrete manufacturing involve consumption of ingredients, aggregates, water and admixture(s). Among all the ingredients, coarse aggregates form the major part. Two billion tons of coarse aggregate are produced each year in United States. Production is expected to increase to more than 2.5 billion tons per by the year 2020. Similarly, the consumption of the primary aggregate was 110 million tons in U.K in the year 1960 and reached nearly 275 million tons by 2006. The properties of coconut shell by using partial replacement of coarse aggregate in concrete. The coconut shell by using (10%) in coarse aggregate. The project paper aims at analyzing flexural and compressive strength characteristics of with partial replacement using M20 grade concrete. Compression test has been done to find out the compressive strength of concrete at the age of 7, 14, and 28 days. Test result indicates in increasing compressive strength of plain concrete by inclusion of WFS as a replacement of fine aggregate and partial replacement of coarse aggregate.

Keywords: Waste foundry sand, M-Sand, coconut shell, 43 grades of cement, Construction materials and Concrete testing equipment's.

INTRODUCTION

General

Waste foundry sand

In foundry industry during the casting process a large amount of by-product material is produced. The metals which usually cast in foundry industry are cast iron, steel, aluminum, copper, brass and bronze. Over two third of the total by-product materials consists of silica and the one third of the total by-product materials consists of metals which is casted on the Green sand. In foundry industry they use high quality silica sand for moulding the metals and also for casting purposes. Due to this, it is used as a partial replacement for fine aggregate in concrete the compressive strength of the concrete can be increased, land pollution due to waste foundry sand can also be reduced to a greater extent, and the demand for the fine aggregate can also be reduced. Classifications of foundry sand mainly depend upon the binding properties of metals used for casting. Clay-bonded (Green) sand is usually composed of naturally occurring materials, such as high-quality silica sand (84–94%), clay (3.5–9.5%), additives of various properties (3–11%) to improve the casting. It is black in color due to carbon content. The chemical traces mostly found on clay-bonded sand are MgO,

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K_2O, and TiO_2. Chemically bonded sand is usually composed of silica 93-98% and chemical binder 1-3%. The color of chemically bonded sand will be light brown. There are many Gas Catalyzed processes including furan / SO_2, acrylic / SO_2, sodium silicate / CO_2, and phenolic urethane / amine vapor [1-5].

M-sand

Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the word. Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed [6-10].

Thus, the cost of construction can be controlled by the use of manufactured sand as an alternative material for construction. The other advantage of using M-Sand is, it can be dust free, the sizes of m-sand can be controlled easily so that it meets the required grading for the given construction. The cost of construction is reduced [11-13].

Coconut shell

Infrastructure development across the world created demand for construction materials. Concrete is the premier civil engineering construction material. Concrete manufacturing involves in consumption of ingredients, aggregates, water and admixture(s). Among all the ingredients, aggregates form the major part. Two billion tons of aggregates are produced each year the United States. Production is expected to increase to more than 2.5 billion tons per by the year 2020. Similarly, the consumption of the primary aggregate was 110 million tons in U.K in the year 1960 and reached nearly 275 million tons by 2006.Use of natural aggregate in such a rate leads to a question about the preservation of natural aggregates sources. In addition, operations associated with aggregate extraction and processing are the principal causes of environmental concerns. Apart from above mentioned waste materials and industrial byproducts, few studies identified that coconut shells, the agricultural by product can also be used as aggregate in concrete. According to a report, coconut is grown in more than 86 countries worldwide, with a total production of 54 billion coconuts per annum. India occupies the premier position in the world with an annual production of 13 billion coconuts, followed by Indonesia and also in Philippines. . In developed countries, many natural materials like Pumice, Scoria and Volcanic debris and man-made materials like expanded blast-furnace slag, vermiculite and clinker are used in construction works as substitutes for natural stone aggregates. In India, commercial use of non-conventional aggregates in concrete construction has not yet started. Coconut shells thus get accumulated in the mainland without being degraded for around 100 to 120 years. Disposal of these coconut shells is therefore a serious environmental issue. In this the study on use of coconut shells as a substitute or replacement (10%) for coarse aggregates in concrete is gaining importance in terms of possible reduction of waste products in the environment and finding a sustainable alternative for non-renewable natural available aggregates.

METHODOLOGY

The material required and determining their various properties has been carried out in this phase. The Constituents of concrete viz. cement, fine aggregate, and coarse aggregate are procured and their various properties are determined.

Testing of Cement

The type of cement is important mainly through its influence on the rate of development of compressive strength of concrete. The choice of the type of cement depends upon the requirements of performance at hand. The most commonly used cement is ordinary Portland cement. Cement used throughout the experimental work is ordinary Portland cement 53 grade conforming to IS 269-1967, manufactured by Ultratech Company. It is stored in laboratory under proper conditions. The following standard tests have been carried out as per IS recommendation.

1. Fineness
2. Consistency of cement
3. Initial setting time
4. Final setting time
5. Soundness of cement Test result of properties of cement

Property	Average value for OPC used in present investigation	Standard value for OPC
Fineness (%)	3.87	<10%
Consistency (%)	30	-
Initial setting time (min)	32	>30
Final setting time (min)	570	<600

Testing of Aggregates

About 70% of volume of concrete is composed of aggregate and hence properties of aggregate affect the properties of concrete such as workability, strength, durability and economy.

Coarse Aggregate

Crushed stone aggregate has been used. It is a locally available with sharp, angular aggregate, with maximum size of aggregate 20 mm and 10% of coconut shell also mixed. The following tests have been carried out on the coarse aggregate sample.

a. Fineness modulus
b. Specific gravity
c. Water absorption

Test results of physical Properties of Coarse Aggregate

SI. No	Property	Average value
1	Specific Gravity	2.806
2	Water absorption	1.56%
3	Sieve analysis	4.60

Fine aggregates

The sand used for the experimental works was locally procured and conformed to grading zone III. Sieve Analysis of the Fine Aggregate (waste foundry sand and M-sand) was carried out in the laboratory as per IS 383-1970. While the fine aggregate shall conform to the grading zone III. The following tests have been carried out on the fine aggregate sample.

a) Specific gravity
b) Water absorption
c) voids ratio

Test results of Physical Properties of Fine Aggregate in waste foundry sand

SI. No	Property	Average value
1	Specific gravity	2.63
2	Water absorption	1.79%
3	Voids ratio	0.62

Test results of Physical Properties of Fine Aggregate in M-sand

SI. No	Property	Average value
1	Specific gravity	2.63
2	Water absorption	1.11%
3	Moisture content	0.34

Water

Fresh and clean water is used for casting the specimens in the present study. The water is relatively free from organic matter, silt, oil, sugar, chloride and acidic material etc. as per Indian standard. The pH value not less than 6.

RESULTS AND DESCUSSION

Compressive Strength (N/mm2)

SI.NO	% REPLACED		7 days	14 days	28 days
	MFS	M-S			
1	0%	100%	14.43	19.64	21.92
2	15%	85%	13.70	18.53	21.70
3	20%	80%	14.63	20.26	22.51
4	25%	75%	13.29	18.69	21.68

Workability of Concrete

Slump cone test

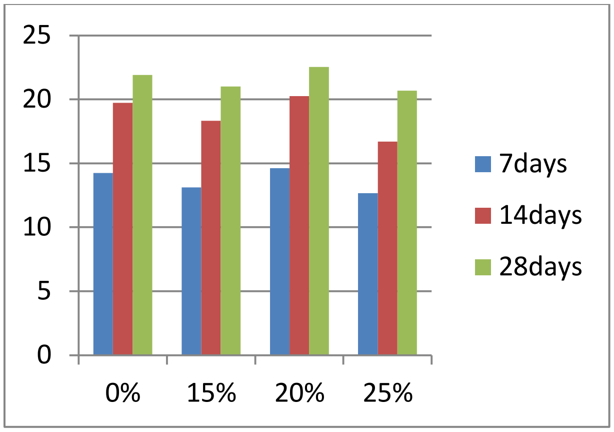
The slump test is the most simple workability test for concrete, involves low cost and provides immediate results. Due to this fact, it has been widely used for workability tests since 1922. The slump is carried out as per procedures mentioned in ASTM C143 in the United States, IS: 1199 – 1959 in India and EN 12350-2 in Europe.

Generally concrete slump value is used to find the workability, which indicates water-cement ratio, but there are various factors including properties of materials, mixing methods, dosage, admixtures etc. also affect the concrete slump value

SI. No	% of replacement		Slump (mm)
	Foundry sand	M-sand	
1	0%	100%	150
2	15%	85%	132
3	20%	80%	140
4	25%	75%	125

Compressive strength

Compressive strength at various percentage of replacement of fine aggregate with waste foundry sand and M-sand. The cube specimens were tested for compression and the ultimate compressive strength was determined with the help of compressive testing machine (CTM). The average value of compressive strength of three specimen for each percentage replacement at the age of 7, 14, 28 days were studied. The graph shows the difference between compressive strength of the specimen at various percentage replacements.



From the above graph there is a considerable improvement in the compressive strength of concrete with increase in the percentage of waste foundry sand up to 20%. The above graph shows that the compressive strength at the 20% replacement is higher than another percentage. It shows that the foundry sand is more effective for compressive strength at replacement of 20%.The graph shows that the strength also goes on increasing with age of curing. The maximum compressive strength was achieved with 20% replacement of fine aggregate with waste foundry sand.

Compressive testing machine (CTM). The tests were carried out confirming to IS: 516-1959(8). The specimen was tested under two point loading. The average value of 2 specimens was calculated at the age of 7, 14, 28 days There is considerable increase in the compressive strength of concrete. The percentage of waste foundry sand up to 25%. However there was decrease in the strength compared to normal concrete mixture.

DISCUSSION

Based on various researchers, it is observed that 20% replacement generally gives higher strength compared to normal concrete. Above which it is equal to or below the normal concrete. Some papers show the positive as well as negative changes in the properties. The changes in the concrete will be differing with the change in manufacturing process and resources of foundry sand. It gives that within this limit we can use foundry sand as a replacement of fine sand. So we can make concrete effective and environment friendly.

Effect of the following parameters are studied to find the influenced of waste foundry sand on strength properties of plain concrete. Workability of the concrete goes on increasing with increase in the percentage of waste foundry sand. As the foundry sand contains more fine particles which increase the fineness of the concrete which results in the increase in the workability.

CONCLUSION

Based on the experimental study undertaken the following conclusion are drawn. Waste foundry sand can be effectively used as fine aggregate in concrete. Replacement of fine aggregate with waste foundry sand gives optimum strength at 20% (and 10% coconut shell replacement)then there was a marginal decrease in the strength at 25%(and 10% coconut shell replacement). Thus the waste foundry sand is the good replacement of fine aggregate. Achieved economy, strength with the use of waste foundry sand and 10% coconut shell replacement. It gives the environment friendly concrete.it helps in preparing green concrete.

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