International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 08, August 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Comparitive Study of Used Foundry Sand for Rigid Pavements

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ABSTRACT

India has an approximate road network of over 40, 00,000 kilometers. Nowadays, India has changed with major efforts to modernize the country's road infrastructure. Bitumen and concrete are used in road construction as the major type of materials in the country. It is most essential to develop profitable construction materials. The innovative use of used foundry sand in concrete formulation as a fine aggregate replacement material is one such alternative to traditional concrete. The fine aggregate will be replaced by used foundry sand accordingly in the range of 0%, 20%, 30% & 40% by weight for different grades of concrete.

Metal foundries have larger amounts of metal casting processes. Foundries successfully recycle and reuse the sand many times in a foundry and the remaining sand that is termed as foundry sand is removed from foundry. The present study gives the information about the civil engineering applications of foundry sand, which is technically sound and environmentally safe. Foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder and dust. Tests will be performed for compressive strength, split tensile strength and flexural strength for all replacement level of foundry sand for 3, 7 and 28 days curing period

Keywords: Foundry sand, Rigid Pavement, Traffic.

I. INTRODUCTION

1.1 General

India has 4.7 million Length road stretch placed second in the country. This includes 60 percent goods and 85 percent passenger. Road connectivity has been increased from days to now with enormous amount of improvement in the safety and design.

There are two basic types of pavements – flexible and rigid. A flexible pavement consists of various layers . A rigid pavement, on the other hand, consists of cement concrete or reinforced cement concrete included in the structure. Till now, black top pavements has been preferred over cement pavements because of the low initial costs. However, with increasing availability of cement in the country coupled with the rising prices of bitumen, the government's decision to opt for rigid pavement is being perceived as a prudent one.

1.2 Foundry sand

Also called as local or river sand which is rich in silica. They use it reason being it has better thermal

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ISSN (O) 2319 - 8354
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conductivity. The sand used for preparation of moulds is termed as foundry sand. Foundries recycle and reuse this foundry sand many times by washing used foundry sand. When this sand becomes unusable; it is dumped out. Use of foundry sand in various construction engineering applications can solve the environmental problems. It consists of silica sand covered with thick coating. Foundry sand can be used in concrete to improve its strength and other durability factors.

Foundry sand is spotless, consistently measured, excellent silica sand, utilized as a part of foundry throwing forms. The sand is attached to shape forms or examples utilized for ferrous (iron and steel) and non-ferrous (copper, aluminum, metal) metal castings. Shake-out sand from finished metal throwing are regularly recovered over into the foundry sand prepare.

II. METHODOLOGY

2.1.Casting methods

Green Sand is silica sand with minor fixing added substances, for example, bentonite earth, water, and ocean coal. When all is said in done, the kind of metal being thrown decides the minor fixing divides and also the degree of the sand required. The green sand is recovered by a warm procedure that requires cooling the sand before it can be reintroduced into the throwing procedure. The greater part of foundries utilize green sand throwing in their procedure technique.

No heat throwing is another well known strategy used to deliver "center molds" or littler volumes of complex castings for both ferrous and non-ferrous metals. This technique applies a compound fastener/impetus to the sand just before filling the form which experiences a concoction response to solidify the sand and keep up the's shape. As this response is delicate to temperature, it is essential to keep up a predictable and uniform temperature of the sand to upgrade the cast item quality.

2.2. Contents of mix design

The concrete of M30 grade was designed using the IS Code method (IS: 10262 - 1982) for w/c ratio 0.35. Details of mix design are shown in Annexure.

Table 3.1 Mix design contents (kg/m³)

Water	Cement	Fine aggregate	Coarse aggregate
191.58	537.4 kg/m³	556.96 kg/m³	1065.49 kg/m³
Mix proportions of M30 grade concrete			
1:1.04:1.98			

Fresh concrete was prepared using conventional ingredients. Then natural sand was replaced by foundry sand with various percentages. Then it is used to cast cubes, cylinders and beams. They were cured at 3 days 7 days and 28 days and tested.

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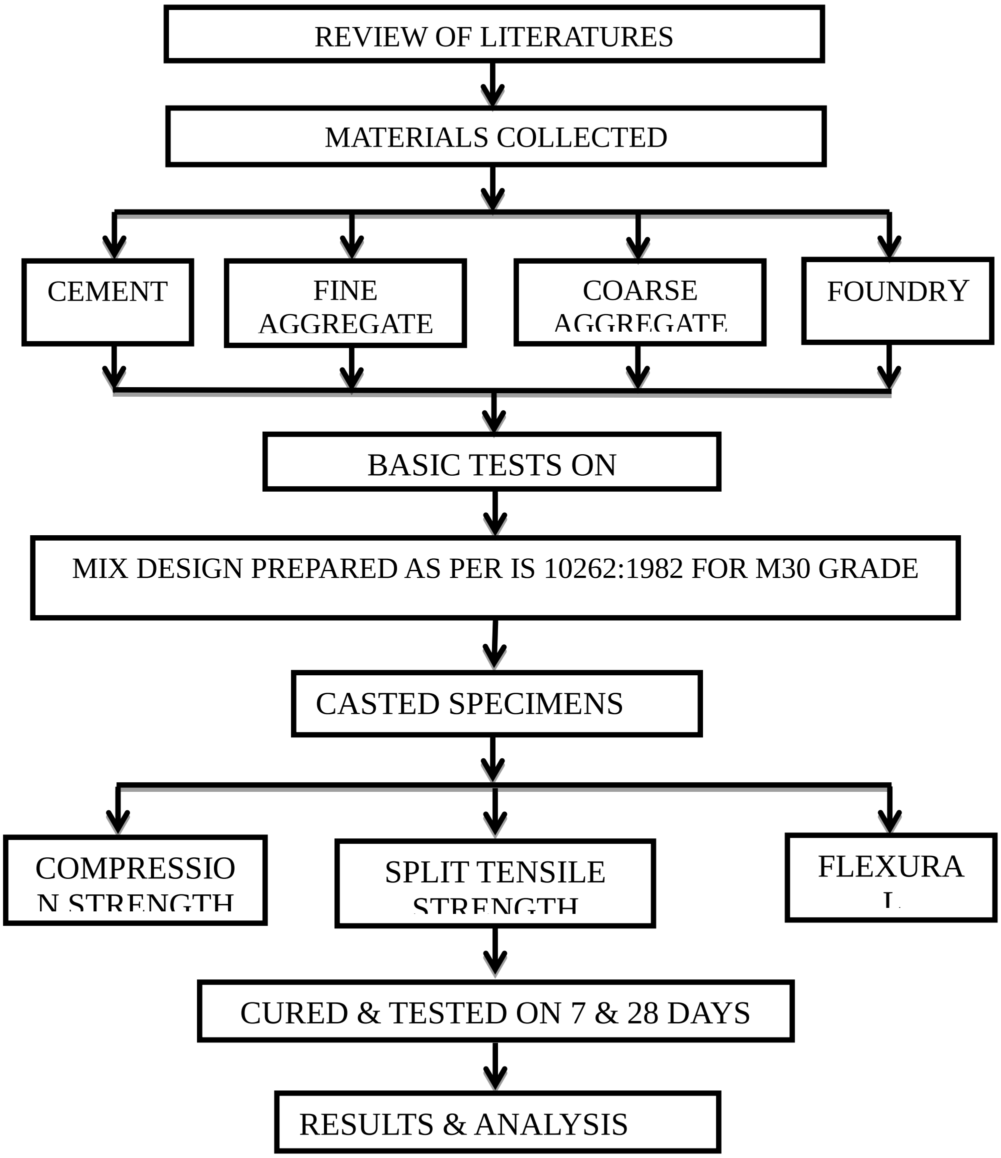

III. RESULTS AND IMPROVEMENTS

3.1 General

The tests results are obtained are discussed in this chapter. The Physical tests of the materials and compressive ,spilt and flexural strength tests were carried out in the sahyadri college of engineering and management , mangaluru.

3.2 Physical properties of materials

3.2.1 Cement (OPC 43 grade)

Cement used is Ordinary Portland Cement (OPC) 43 grade conforming to IS 8112 (1989).

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Table.4.1 Physical processions of Cement

Sl. No.	Test Conducted	Obtained Values
1	Specific gravity	3.12
2	Initial Setting Time	55 min
4	Normal Consistency	33%
5	Fineness	4%

3.2.2 Fine Aggregate

The natural sand used for the experimental work was locally obtained and conformed to grading zone I as per IS: 383-1970.

Table 4.2 Physical processions of Fine Aggregate

SL.NO	Properties	Obtained Values
1	Specific Gravity	2.62
2	Fineness modulus	5.35%
3	Bulking of Sand	41.2% at water content 9%

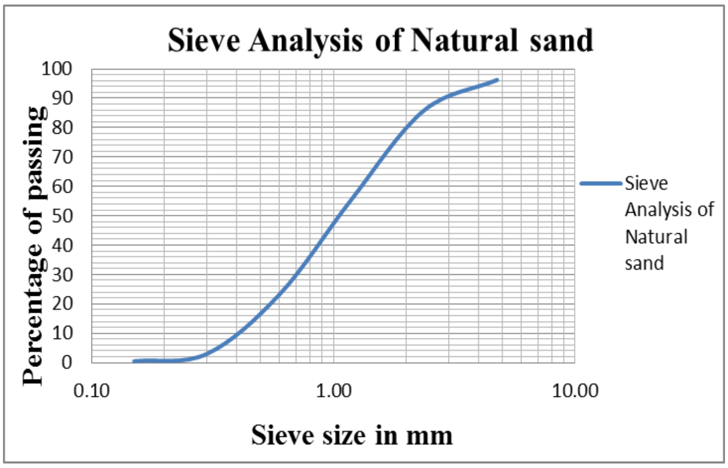

Fig 4.1 Sieve analysis of natural sand

3.2.3 Foundry sand

Table 4.4 Physical Properties of Foundry sand

Sl. No.	Properties	Obtained Values
1	Specific Gravity	2.6
2	Fineness modulus	5.106%
3	Bulking of Sand	17.39% at water content 6%

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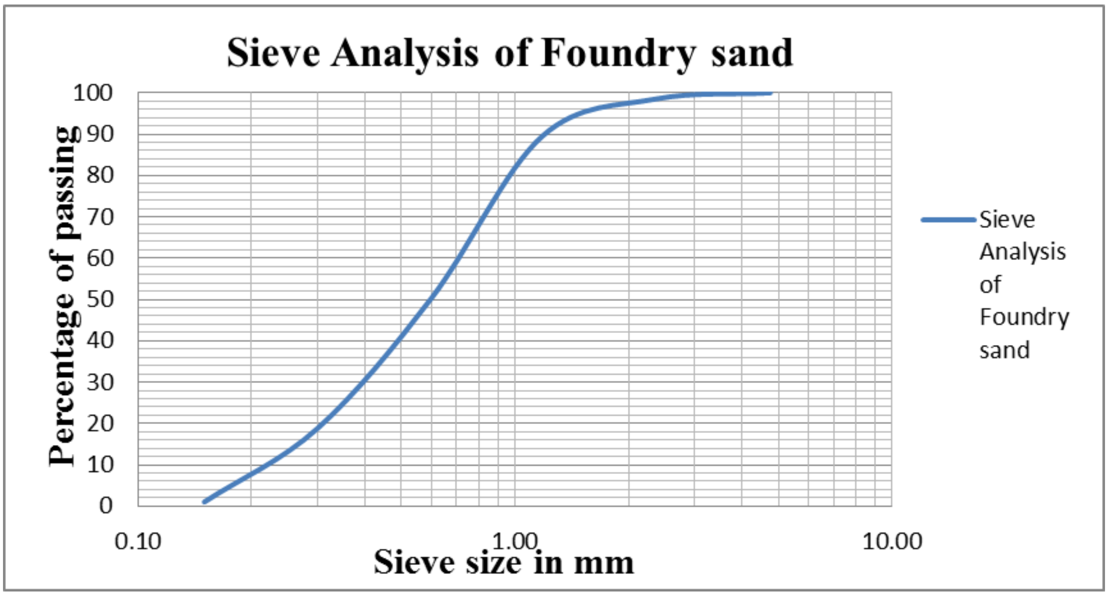

Fig 4.2 Sieve analysis of foundry sand

3.2.4 Coarse Aggregate

Table 4.6 Physical Processions of coarse aggregate

SLNO	Properties	Obtained value
1	Specific Gravity	2.64
2	Bulk density 1. Loose state 2. Compact state	 1.49 gm/cc 1.622 gm/cc
3	Water absorption	0.43 %
4	Fineness modulus	8.03 %
5	Impact value	21.4%
6	Crushing value	27.32%

3.3 Fresh concrete properties

The results of the slump tests and compaction tests are carried out on the fresh concrete, results gives an indication of the workability of the concrete for a water cement ratio of 0.35, a maximum slump of 10 mm is observed.

Table 4.7 Slump and Compaction factor value

Type of concrete	Maximum slum	Compaction factor
NC	10 mm	0.81

3.4 Hardened concrete properties

The hardened properties or mechanical properties of the concrete such as compressive strength, spilt tensile and flexural strength were determined at the ages of 3 days, 7 days and 28days.

The various tests carried out to obtain the properties of hardened concrete are listed below

- Compressive strength
- Split tensile strength
- Flexural strength

3.4.1 Compressive strength

The factual test conducted according to IS : 516-1959. The cubes were tested at the age of 3 days, 7 days and 28 days. The cubes were tested on compression testing machine. The factual strength of concrete with local sand and different percentage of foundry sand replaced in natural sand are listed in **Table 4.8** at the age of 3 days 7days and 28 days. The maximum factual strength is achieved at 30% of substitution of river sand with used foundry sand.

Figure 4.3 shows the average factual strength at 3 days, 7days and 28 days of conventional concrete and substitution of fine aggregate with used local and waste sand .

Table 4.8 Compressive Strength of Cubes (150×150×150mm) at3, 7&28 days

Type of concrete	Average compressive strength (N/mm^2)		
	3 days	7 days	28 days
NC	27.99	33.07	42.38
20 % FS	30.09	36.67	43.44
30 % FS	31.38	37.87	46.57
40 % FS	28.19	32.77	39.39

3.4.2 Split Tensile Strength

The factual strength of concrete with natural sand and different percentage of foundry sand replaced in natural sand are listed in **Table 4.9** at the age of 3 days 7days and 28 days. The maximum split tensile strength is achieved at 20% replacement of river sand with used local sand.

Fig 4.4 shows the average split tensile strength at 3 days, 7days and 28 days of conventional concrete and replacement of fine aggregate with used local sand .

Table 4.9 Split tensile strength of cylinder (150×300) for M30 mix at 3,7,28 days.

Type of concrete	Average split tensile strength (N/mm^2)		
	3 days	7 days	28 days
NC	2.05	2.54	2.98
20 % FS	2.97	3.437	3.84
30 % FS	2.92	3.17	3.56
40 % FS	1.92	2.62	2.9

IJARSE
ISSN (O) 2319 - 8354
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3.4.3 Bend Strength

The bend strength of concrete with local sand and different percentage of local sand replaced in natural sand are listed in **Table 4.10** at the age of 3 days 7days and 28 days. Decrease in bend strength of concrete with increase in used local sand.

Fig 4.5 shows the average flexural strength at 3 days, 7days and 28 days of conventional concrete and substitution of sand with used locally available sand.

Table 4.10 Flexural strength of beam (150×150 ×700) for M30 mix at 3,7,28 days.

Type of concrete	Average flexural strength (N/mm²)		
	3 days	7 days	28 days
NC	2.92	3.25	4.26
20 % FS	2.93	3.37	4.44
30 % FS	2.92	3.20	4.01
40 % FS	2.75	3.02	3.73

3.5 Economic feasibility

Table 4.11 cost of materials

Sl. No.	Materials	Rate (Rs/kg)
1	OPC 43 grade Cement	7.40
2	Fine aggregate	1.50
3	Coarse aggregate	2.25
4	Used foundry sand	0.70

Table 4.12 Total cost of materials for M30 design mix concrete (1:1.04:1.98) per m³

Type of concrete	Consumption of Design Mix Proportions For M30 Concrete (1:1.04:1.98)				Total cost Per m³
	Cement	Fine aggregate	Coarse aggregate	Used foundry sand	
NC	537.40	556.96	1065.96	0.00	7208
20% FS	537.40	455.57	1065.96	111.39	7135
30% FS	537.40	399.87	1065.96	167.09	7088
40% FS	537.40	344.18	1065.96	222.78	7048

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Table 4.13 Relative cost of slab for M30

Type of concrete	Slab thickness (cm)	Cost of 1m×1m slab (Rs)	Relative cost (%)
NC	25	1802	100
20% FS	23	1641	91.06
30% FS	27	1914	106.7

IV. CONCLUSIONS

From present study, the following conclusions are taken out:

1) Increase in compressive and split tensile of concrete with increase in used waste sand up to 30%. The maximum compressive strength is achieved at 30% of substitution of river sand with used waste sand and maximum split tensile strength is achieved at 20% substitution of river sand with used local sand.

2) Local or waste sand literally decreases additive or adhering nature of concrete structure in the long term.

3) Environmental impacts from people or nature produced wastes can be minimized from this research.

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