International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com || Volume 03 - Issue 02(S) || PP.19-26

Experimental study on low cost concrete using waste foundry sand and m- sand

S. Sudharshan Swaminathan [1], V. Kissman [2], Dr. V. Sreevidya[3], Dr. I. Padmanaban[4]

[1]*PG student,Department of civil engineeringSri Krishna College of technologyCoimbatore*
[2]*PG student, Department of Civil Engineering, Sri Krishna College of technology Coimbatore*
[3]*Professor,Department of civil Engineering, Sri Krishna college of technology Coimbatore*
[4]*Professor &H.O.D,Department of civil Engineering, Sri Krishna college of technology Coimbatore*

Abstract: In india the conventional concrete is produced using natural sand from river bed as fine aggregate. This paper prescence the optimization of partial replacement by using waste foundrysand and manufactured sand with natural sand, The percentage replacement were 20,40 and 60%by weight of fine aggregate. The test results indicate that there is an increase in compressive strength by 20% and the split tensile, flexural strength increase by 40% respectively**.**

Keywords: Waste foundarys and, M-Sand.

I. Introduction

1.1 General

Concrete is a homogeneous mixture of cement, sand, aggregate and water. It is very strong in carrying compressive force and hence in gaining increasing importance as building materials throughout the world. In a short period concrete has gained so much importance that today more than 65% of the structures coming up in the world are constructed with concrete. Similar to other constituent's coarse aggregate is also one of the important materials.

1.2 Materials Used

Fine Aggregate
Cement
Coarse Aggregate
Foundry sand
Manufactured sand
Water

1.3 Foundry Sand

Foundry sand is high quality sand with uniform physical characteristics. It is a by-product of ferrous and non-ferrous metal casting industries, where sand has been used for centuries as a molding material because of its thermal conductivity. The raw sand is normally of a higher quality than the typical bank run or natural sands used in fill construction sites. The sands form the outer shape of the mold cavity. These sands normally rely upon a small amount of bentonite clay to act as the binder materials. Chemical binders are also used to create sand "cores".

1.3.1 Types of Foundry Sands

Two general types of binder systems are used in metal casting depending upon which the foundry sands are classified as:

- Clay bonded systems (green sand)
- Chemically bonded systems (clay sand)

Both types of sands are suitable for beneficial use but they have different physical and environmental characteristics

Clay Bonded Systems (Green Sand)

Green sand molds are used to produce about 90% of casting volume in The U.S. green sand is composed of naturally occurring materials which are blended together; high quality sand(85-95%), bentonite clay(4-10%) as a binder, a carbonaceous additive (2-10%) to improve the casting surface finish and water (2-5%). Green sand is the most commonly used recycled foundry sand for beneficial reuse. It is black in colour, due to carbon content, has a clay content that results in percentage of materials that passes a 200 sieve and adheres due to clay and water.

Chemically Bonded Systems (Clay Sand)

Chemically bonded sands are used both in core making where high strengths. Most chemical binder systems consist of an organic binder that is activated by a catalyst although some systems use inorganic binder. Chemically bonded sands are generally light in colour and in texture then clay bonded sands. Foundries produce recycled foundry sand (RFS) generally in their overall production volume although there are different sand to metal ratios employed in different casting processes and products

1.3.2 Materials Properties

Foundry sand is typically sub angular to round in shape. After being used in the foundry process, a significant number of sand agglomerations form. When theybroken down. The shape of individual sand grains is apparent. Unprocessed foundry sand green sands are typically black or gray, not green chemically bonded sand is typically a medium tan or off-white colour shows the unprocessed foundry sand and greensand respectively. Green sand is from gray iron industry.

1.3.3 Physical Properties

Typical physical properties of spent foundry sand from green sand systems. The grain size distribution of spent foundry sand is very uniform, with approximately 85mto 95 percent of the material between 0.6mm and 0.15mm (No. 30 and No. 100) sieve sizes. The particle shape is typically sub angular to round. Spent foundry sand has low absorption and is non-plastic. This may preclude its use in applications where organic impurities could be important (e.g., Portland cement concrete aggregate). The specific gravity of foundry sand has been found to vary from 2.39 to 2.55

1.3.4 Chemical Compositions

Chemical composition of the foundry sand relates directly to the metal molded at the foundry. This determines the binder that was used, as well as the combustible additives. Typically, there is some variation in the foundry sand chemical composition from foundry to foundry.

Table1.1 Chemical composition of waste foundry sand

COSTITUENTS	VALUES
Sio_2(silica)	98300mg/l
Al_2o_3(alumina)	268mg/l
Cao(calcium oxide)	26807mg/l
Mgo(magnesium oxide)	3856mg/l
Fe_2o_3(iron oxide)	3473mg/l
Na_2o(sodium oxide)	19901mg/l
K_20(potassium oxide)	1447mg/l

1.4 Manufactured Sand

The manufactured sand (MS) is a by-product of crushing and screening process in the quarries. Quarry generates considerable volumes of quarry fines while crushing the rock into aggregates. It is also referred to as crushed rock sand, stone stand, crusher sand and crushed fine aggregate. Quarry fines consist of a graded mix of coarse sand, medium sand and fine sand sized particles, plus clay/silt fraction known as the ‘filler’ grade .

1.4.1 Type of Manufactured Sand

The manufactured sand is of three types.

- M-Sand for concreting
- M-Sand for plastering
- M-Sand for brick / block work

1.4.3 Physical Properties

The manufactured sand has required gradation of fines, physical properties such as shape, smooth surface textures and consistency which make it the best sand suitable for construction. These physical properties of sand provide greater strength to the concrete by reducing segregation, bleeding, honey combing, voids and capillary. Since manufactured sand (M-Sand) is processed from selected quality of granite, it has the balanced physical and chemical properties for construction of concrete structure. Construction defects during placement and post-concreting such as segregation, bleeding, honeycombing, voids and capillarity in concrete gets reduced by the use of M-sand as it has optimum initial and final setting time as well as excellent fineness.

1.4.4 Chemical Composition

The M-sand is free from elongated flaky particle since it is shaped cubically using VSI shaping machine. The cubically shaped particles give high strength and long life of concrete. It is manufactured strictly adhering to IS 383(1970) zone II grading. Perfect grading and cubical shape of Msand provides 10-15% more compressive strength for concrete and 25-30% more strength for masonry works compare to crusher dust. The M-sand has minus 150 micron less than 10% and 45 micron less than 2% only. This gives good workability for concrete and masonry that helps in easy and quick construction.

Table1.2 chemical composition of manufactured sand

COMPONENTS	PERCENTAGE
Al_2o_3 (alumina)	14.8
Cao(calcium oxide)	5.2
Fe_2o_3(iron oxide)	6.4
Mgo(magnesium oxide)	2.3
Na_2o(sodium oxide)	4.8
Sio2(silica)	60.7

II. Materias & Methodology

2.1 Cement

Cement in concrete acts as a binding material that harden after the addition of water that harden after the addition of water. It plays important role in construction sector. In this study the Portland pozzolana cement of 53 grade is used. The physical properties of cement are listed below.

Table 1 Physical properties of cement

PROPERTIES OF CEMENT	TEST RESULTS
Specific gravity of cement	3.15
Fineness modulus	3.6
Initial setting time(min)	30
Final setting time(hrs)	10
Standard consistency (%)	50

2.2 Fine Aggregate

The materials smaller than4.75mm size is called fine aggregate. Natural sands are generally used as fine aggregate. It may be obtained from pits, river, lakes or seashore but it should free from clay and silt. Sea shore sand may contain chlorides, which may cause efflorescence and may cause corrosion of reinforcement. Angular grained sand produces, good and strong concrete because it has good interlocking property, while round grained particle of sand do not afford such interlocking.

2.3 Waste Foundry Sand

Foundry sand is high quality silica sand with uniform physical characteristics. It is a by-product of ferrous and non-ferrous metal casting industries, where sand has been used for centuries as a molding material because of its thermal conductivity. It is a by-product from the production of ferrous and nonferrous metal castings.The sands form the outer shape of the mold cavity. The physical properties of waste foundry sand are give

2.4 Manufactures Sand

The manufactured sand is found more suitable one to has caught attention of the construction industry and environment alike for its quality and the minimum damages it cause to nature. Usage of manufactured sand can drastically reduce. Manufactured sand become more popular in the construction industry, the demand for river sand and illegal sand-miming would come down. Compared to river sand the manufactured is better quality consistency high strength concrete with significance saving instrument.

2.5 Coarse aggregate

The material retained on 4.75mm sieve is termed as coarse aggregate. Crushed stone and natural gravel are the common materials used as a coarse aggregate for concrete. Coarse aggregate are obtained by crushing various types of granites, schist, crystalline and lime stone and good quality sand stone. The high strength concrete is required a very fine grained granite perhaps the best aggregate. For coarse aggregate crushed 20mm, nominal size graded aggregate was used.

Table 2 Physical properties of Ingredients

Materials	**Specific Gravity**	**Fineness Modulus (%)**	**Water Absorption (%)**
Coarse Aggregate	2.8	1.79	1.36
WFS	2.5	96.6	0.99
Fine Aggregate	2.51	97.1	1.25

2.6 Water

Water acts as lubricants for the fine and coarse aggregate and acts chemical with cement to form the binding paste for the aggregate water is used for curing the concrete after it has cast into the forms. Water used for both mixing and curing should be free from injurious amount of deleterious material.Portable water is generally considered satisfactory for mixing and curing of concrete. If water contains any sugar or excess of acid or salt, it should not be used Ordinary tap water is used for preparation of concrete.

2.7 Concrete Mix Design

Mix Proportion

Cement = 383.2 kg/m^3
Water = 191.6 kg/m^3
Fine aggregate = 861 kg/m^3
Coarse aggregate = 1115 kg/m^3C

Table 3 Concrete mix design M-20 grade for (one cube)

S.N O	TYPE OF CONCR ETE	W/ C rati o	C (k g)	F. A (k g)	C. A (k g)	WF S (kg)	M-SA ND (kg)
1	0%	0.5 0	1.6 8	2.5 2	5.0	-	-
2	20%	0.5 0	1.6 8	2.0 1	5.0	0.252	0.25 2
3	40%	0.5 0	1.6 8	1.5 1	5.0	0.504	0.50 4
4	60%	0.5 0	1.6 8	1.0 0	5.0	0.756	0.75 6

W/C= water cement ratio, C= cement, F.A= fine aggregate, C.A= coarse aggregate, WFS= waste foundry sand, M-SAND= manufactured sand.

2.8 Testing Methodology

2.8.1 Compressive Strength

The evaluation of waste foundry sand and manufactured sand use as a replacement of fine aggregate material beings with the concrete testing. Concrete contains cement, water, fine aggregate and coarse aggregate.

With the control concrete i.e. 20%, 40% and 60% of fine aggregate is replaced with Waste foundry sand and manufactured sand. Three cube samples were cast on the mould size 150*150*150mm for each 1:1.5:3 concrete Mix with partial replacement of fine aggregate with water cement ratio as 0.5% were also cast. After 24 hrs the specimen were de-molded and water curing was continued till the respective specimen were tested after 3, 7 and 28 days for compressive strength tests.

2.8.2 Spilt Tensile Strength

Concrete contains cement, water, fine aggregate and coarse aggregate. With the control concrete, i.e. 20%, 40% and60% of fine aggregate is replaced with waste foundry sand and manufactured sand. Three cylinder samples were cast on the mould size of 150*300mm for each 1:1.5:3 concrete mix with partial replacement of fine aggregate with water cement ratio as 0.50 were also cast. After 24 hours the specimens were de-molded and water curing was continued till the respective specimens were tested after 3, 7 and 28 days spilt tensile strength tests.

2.8.3 Flexural Strength

Concrete contains cement, water, fine aggregate and coarse aggregate. With control concrete, i.e. 20%, 40% and 60% of fine aggregate is replaced with waste foundry sand and manufactured sand. Three beams samples were cast on the mould size of 500*100*100mm for each 1:1.5:3 concrete

TABLE.4 REPLACEMENT OF FINE AGGREGATE

S.NO	PERCENTAGE REPLACEMENT	FINE AGREGGATE REPLACE BY WFS&M-SAND
1	0%	Conventional concrete
2	20%	10% wfs+10%m-sand replaced with fine aggregate
3	40%	20%wfs+20%m-sand replaced with fine aggregate
4	60%	30%wfs+30%m-sand replaced with fine aggregate

Mix with partial replacement of fine aggregate with water cement ratio as 0.50 were also cast. After 24 hours the specimens were de-molded and water curing was continued till the respective specimens were tested after 3, 7 and 28 days flexural strength tests.

2.9 Compressive Strength Test

The test specimens, cubes of size 15cmx15cmx15cm were taken. The maximum load to the specimen is recorded. The strength of the concrete depends on the properties and proportions of the constituent's materials, degree of hydration, and rate of loading, method of testing and specimen Compressive strength of concrete is one of the important and useful properties of concrete.. Concrete containing about 6% of entrained air which is relatively weaker in strength is found to be more durable than dense and strong concrete.

Table 5 Cube result for 3rd day curing

CURING DAYS	RATIO	STRENGTH(N/mm^2)	AVERAGE STRENGTH(N/mm^2)
days	10%WFS+10% MSAND	28.8	29.7
		29.7	
		30.6	
7days	20%WFS+20% MSAND	22.2	22.88
		21.3	
		22.6	
7days	30%WFS+30% MSAND	20.4	20.57
		20	
		21.3	

Table 6 Cube result for 7th day curing

CURING DAYS	RATIO	STRENGTH (N/mm^2)	AVERAGE STRENGTH (N/mm^2)
3 days	10%WFS+10 %M-Sand	19.1	18.8
		18.6	
		18.6	
3 days	20%WFS+20 %M-SAND	17.7	17.9
		18.6	
		17.3	
3 days	30%WFS+30 %M-SAND	18.2	18.2
		17.7	
		18.6	

Table 7 Cube result for 28 day curing

CURING DAYS	RATIO	STRENGTH(N/mm^2)	AVERAGE STRENGTH(N/mm^2)
28days	10%WFS+10% MSAND	52.6	51.9
		51.1	
		52.1	
28days	20%WFS+20% MSAND	43.0	42.3
		41.3	
		42.6	
28days	30%WFS+30% MSAND	45.3	44.1
		43.1	

3.0 Spilt Tensile Strength Test

Table 8 Cylinder result for 3rd curing

CURING DAYS	SPILT TENSILE STRENGTH IN	AVERAGE STRENGTH N/mm^2
3 days	1.69	1.45
	1.4	
	1.27	
7 days	1.83	1.69
	1.55	
	1.69	
28 days	2.54	2.87
	2.82	
	3.25	

Table 9 Cylinder result for 7th day curing

CURING DAYS	RATIO	STRENGTH(N/mm^2)	AVERAGE STRENGTH(N/mm^2)
7 days	10%WFS+10% MSAND	1.69	1.50
		1.41	
		1.41	
7days	20%WFS+20% MSAND	2.12	2.02
		1.83	
		2.12	
7days	30%WFS+30% MSAND	1.69	1.55
		1.41	
		1.55	

3.1 Flexural Strength Result

Table 10 Beam result for 3rd day curing

CURING DAYS	RATIO	STRENGTH (N/mm^2)	AVERAGE STRENGTH(N /mm^2)
3 days	10%WFS +10%M-Sand	3.5	3.08
		2.75	
		3.0	
3 days	20%WFS +20%M-SAND	3.75	3.83
		4.0	
		3.75	
3 days	30%WFS +30%M-SAND	2.75	3.25
		3.5	
		3.5	

Table 11 Beam result for 7thday curing

CURING DAYS	RATIO	STRENGTH (N/mm^2)	AVERAGE STRENGTH (N/mm^2)
7 days	10%WFS+10% MSAND	2.75	2.91
		2.75	
		3.25	
7days	20%WFS+20% MSAND	4	3.66
		3.25	
		3.75	
7days	30%WFS+30% MSAND	3	2.83
		2.5	
		3	

Table 12 Beam result for 28th day curing

CURING DAYS	RATIO	STRENGTH (N/mm^2)	AVERAGE STRENGTH (N/mm^2)
28day s	10%WFS+ 10%MSAND	5.5	7.25
		7	
		9.25	
28day s	20%WFS+ 20%MSAND	8.75	9.75
		9.5	
		11	
28day s	30%WFS+ 30%MSAND	6	7.15
		6.75	
		9	

Conclusion

Foundry sand and m-sand can be used in concrete to improve strength partial replacement of fine aggregate with waste foundry sand and m-sand is used to improve the strength. From this project the following conclusion drawn:

The 20% replacement (i.e. 10% wfs+10%m-sand) achieve higher strength of 51.9N/mm^2 in 28 days curing. Spilt tensile strength increases in 40% replacement (i.e. 20% wfs+20%m-sand) it achieve higher strength of 3.67N/mm^2 in 28 days curing. For flexural strength the strength increases at 40% (i.e.20%wfs+20%m-sand) it achieves higher strength of 9.75N/mm^2 in 28days curing. Use of m-sand reduce the damage cause to nature. Environmental effect from waste and disposal problem of waste can be reduced through this research.

Reference

[1]. T.Shanmugapriya, R.N uma (June 2012) "Optimization of partial replacement of Msand by natural sand in high performance concrete with silica fume". Journal of engineering science Vol 2, No.2, pp, 73-86.

[2]. M.Adams Joe, A. Maria Rajesh, P.Brightson, M.Premanand (2013) "Experimental investigation on effect of Msand in High performance concrete".Journal of engineering research Vol 2, No.12, pp, 46-51.

[3]. M.Ranjitham, B.Piranesh, A.Vennila(January 2014)"Experimental investigation of High Performance Concrete with Partial Replacement of Fine Aggregate By Foundry sand with Cement by Mineral Admixtures". Journal of advance structure Vol.03, No.1.

[4]. Saritachandrakanth, Ajay, A.Hamane"Partial replacement of waste foundry sand and recycled aggregate in concrete". Journal of modern trends in engineering and research.

[5]. AkshayA.Waghmare, Ayushi R. Sharma (2016) "Study of replacement of Natural sand by Artificial sand in concrete". Journal of optimization techniques.

[6]. IS: 383-1970, Specification for coarse aggregate and fine aggregate from natural source for concrete, Bureau of Indian standards, New Delhi, India.

[7]. IS: 10262-1982, recommended guidelines for concrete mix design, Bureau of Indian standard, New Delhi, India.