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Experimental Study on Reuse of Waste Foundary Sand in Light Weight Bricks, Paver Block, Tiles, Kerbstone, Roofing Tiles and Cover Block

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ABSTRACT: The main aim of paper is usage of alternative materials in concrete which helps to changes the technology of concrete that help the way to utilize some of the alternative materials that can be utilized as a composition to the ingredients of concrete that can be partially and Fully replaced the materials. This research paper covers the applications of the waste foundry sand in concrete. For using of waste foundry sand materials in concrete as the alternative of fine aggregate and changes their compressive strength, tensile strength, water absorption, heat resistance, flexural strength parameters with different composition of mixture concrete and usage of manufacturing of in light weight bricks, paver block, tiles, kerbstone, roofing tiles and cover block.

KEYWORDS: *Waste founder sand, quarry dust, coarse aggregate, cement.*

I. INTRODUCTION

Waste Foundry sand creates a very big serious issue in solid waste management problem, in worldwide due to the high volumes produced, necessitating alternatives to landfilling. A possible route is its use in concrete so mixing of concrete were prepared in which waste foundry sand is replaced the fine aggregate(sand) partially and completely sand is high quality silica sand with uniform physical characteristics. It is a by- product of ferrous and non-ferrous metal casting industries, whereas fine aggregate (sand) has been used for centuries as a molding material because of its their thermal conductivity. The chemical and physical properties of waste foundry sand will depend upon the process of casting and the sector of industries from which it originates. In the modern foundry practice, sand is typically reused and recycled through different production cycles. Industry estimates that approximately 250 million tons of fine aggregate (sand) is used in production annually of that 8 - 12 million tons annually it isdiscarded, and it is available to be recycled into different products and in the industry. The automotive industries and their parts are the mostly generators of foundry sand. Waste Foundries sand have high quality s silica sands for uses in their operation of molding as well as casting. In the process of casting and molding sands are reused and recycled multiple times. The recycled sand degrades the point that it can't longer be reused in their process of casting. In the World Scenario There are about 38,520 foundries in the world with 1200 million tonnes of annual production. In terms of number the foundries in Chinahave the highest scores (9867), then followed by in our country India (6880). The maximum share of Iron foundries is almost 59%, followed by steel with 14% and then the non-ferrous ores with 31%.

II.METHODOLOGY

A. Properties of materials:

[A] Waste foundry sand: Foundry waste sand is a by-product of ferrous and non-ferrous metal casting industries. Foundries industries successfully reuse and recycle the sand many times in the foundry. When the sand can no longer be reused in the foundry, then it is removed from the foundry and is termed as foundry waste sand.

Salient Features of Using waste foundry sand:

- Contain high % of Sio2
- Easily available
- It is economical and has good bonding quality with concrete.

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(1) Chemical properties of waste foundry sand

Characteristics of Materials	Value percentage
Sio2	83.94
Al2O3	0.023
MgO	1.78
CaO	1.04
Fe2O3	0.957

(2) Physical properties of waste foundry sand

Property	Results	Test Method
Specific Gravity	2.39 - 2.56	ASTM D854
Bulk Relative Density, kg/m^3 (lb/ft^3)	2590 (160)	ASTM C48/AASHTO T84
Absorption, %	0.43	ASTM C128
Moisture Content, %	0.1 - 10.2	ASTM D2216
Clay Lumps and Friable Particles	1 - 45	ASTM C142/AASHTO T112
Coefficient of Permeability (cm/sec)	10^{-3} - 10^{-6}	AASHTO T215/ASTM D2434
Plastic index	Non-plastic	AASHTO T90/ASTM D4318

Waste foundry sand

[B]Cement: Cement is the one of important binding material. In the research paper we are using to bind the concrete to make the mortar more durable In this research paper we are using ordinary Portland cement (OPC) :53 grade cement so that the quality of cement is checking by following physical properties.

Physical properties	Value
Specific Gravity	3.04
Initial setting time	30 Min
Final setting time	220Min
fineness	8% reside on IS90-micro sieve

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Ordinary Portland cement (OPC)

[C]Fine Aggregate: Fine aggregate is basically sand from the river, pond or the marine environment. Fine aggregate generally has natural sand or crushed stone with most of particles passing through (8.5-9.5) mm sieve. It is one of the essential rawmaterials of mortar. For a good concrete mixing, the aggregate should be need hard, clean and particles free from absorbed coating or Chemical of clay and another fine material that could cause the concrete deterioration. so that the quality of fine aggregate is checking by following physical **properties**

Physical properties	Value
Density (gm/cc)	1.62
Finenessmodules	3.07
Specificgravity	2.54
Void ratio	056

Fine aggregate (sand)

[D]Quarry Dust: It is a byproduct of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into various sizes; during this process, the dust is generated called quarry dust and it is formed as waste. A quarry is the same thing as a mine of open pit from which minerals are extracted. The only nontrivial difference between the two is that open pit mines that12produce building materials and dimension stone are commonly referred to a quarry. It can be used as substitute to sand fully or partially. It offers a comparatively good strength compared to sand with or without admixtures in concrete. Basically, the quality of Quarry dust is checking by following physical properties.

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Physical properties	Value
Density (gm/cc)	1.83
Finenessmodules	2.42
Specificgravity	2.58
Void ratio	0.42

Quarry dust

[E]Coarse Aggregate: Construction aggregate, or simply aggregate, is a broad category of coarse- to medium-grained particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates. Aggregates are the most mined materials in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. Due to the relatively high hydraulic conductivity value as compared to most soils, aggregates are widely used in drainage applications such as foundation and French drains, septic drain fields, retaining wall drains, and roadside edge drains. Aggregates are also used as base material under foundations, roads, and railroads. In other words, aggregates are used as a stable foundation or road/rail base with predictable, uniform properties (e.g. to help prevent differential settling under the road or building), or as a low-cost extender that binds with more expensive cement or asphalt to form concrete. It is passing through 12mm sieve and retained on 10mm sieve and it is tested as per Indian standard specification IS:383-1970. The coarse aggregate is checking by following physical properties are

Physical properties	Value
Bulk Density (gm/cc)	1.43-1.60
Aggregate impact value(%)	14.50
Specificgravity	2.65
Aggregate abrasion value(%)	28.09

MIX RATIO

The test specimens for a pavement of M25 in mix design of the ratio (1:1:2) which is prepared as per Indian IRC: SP:102-2014, IS-15658-2006 and IS 456:2000 standardfor the test as well as experimental. All Mixing was done in a mechanical mixer. Cement, coarse aggregate, sand, and other materials was mixed dry in the required proportions to obtain a color uniform. The required quantity of water was added, and the mortar mixed to produce a workable consistency. mechanical mixing process was mixed for more than three minutes after addition of water; if we are doing of hand mixing, the mortar shall be hold back and forth for 5 to 10 minutes with addition of water the whole mixing was done in concrete mixer machine based on a volumetric basis and the mix design ratio was 1:1:2 as per IS 15658:2006 and IS 456-2000. The paver block was cured in water tub and then testing process were started on Days 7, 14 and 28.

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The following parameters were used for mix design
Grade of concrete = M25
Type of Cement = OPC-53 Grade
Brand of Cement =REMCO
Admixture Used = RHEOPLAST SP-550
Fine Aggregates =Zone III
Specific Gravity of Cement = 3.04
Specific gravity of FA = 2.58
Specific Gravity of C.A
10mm = 2.67
6mm =2.64
Moisture content of FA =4%
The design mix adopted for M25 grade mix is given in table

Mix Proportion for M25 grade Concrete

Unit of Batch	Waste foundrySand	Cement (kg)	Fine aggregate(kg)	Coarse aggregate(kg)		Quarry dust	Admixture (ml)
				6 mm	10 mm		
Paver block1	15	50	25	70	20	10	100
Paver block2	30	50	20	70	20	10	100
Paver block3	45	50	5	70	20	10	100

II. RESULTS AND DISCUSSION

Testing of Concrete
After molding and casting, the specimens were tested after the days of 7, 14 and 28 days of water curing. In this research paper the procedure adopted for testing of specimens for various properties like, water absorption test, flexural strength test, compressive strength, and split tensile strength have been discussed.

Compressive Strength: To evaluate the compressive strength of concrete, paver block which size is (225x112.5x80) mm specimens were used. The test was performed according to IRC: SP:102-2014 and IS 516-1959. Specimens were placed in curing tank for a period. Specimens were then taken out of tank after 7, 14 and 28 days of curing and surface dried. It was dried under shade not under direct sunlight or in oven. Specimens were then placed in Compression Testing Machine (CTM). The loading rate was t set at 140Kg/m3/minute or 5.2 KN per second. The load was applied and the peak load at which the specimen fails was noted.

Compressive strength = P/A
Where, P = load in KN and A = Area of cross section

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❖ **Data of Compressive strength**

Mix Name	*7 days strength(N/MM2)*	*14days strength(N/MM2)*	*21 days strength(N/MM2)*
Paver block1	25.2	27.9	31.5
Paver block2	27.3	31.8	33.1
Paver block3	28.8	32.3	35.6

Split Tensile Strength: The tensile strength is obtained by placing the cylinder in the CTM, so that the compressive force acts horizontally. The failure occurs along the vertical axis due to the tension developed in transverse direction. It was also tested for 7 days, 14 days and 28 day. The loading rate was 2.2 KN per second.

The Split Tensile Strength can be calculated as

$\sigma c = 2P/\pi DL$

where,

P = load in KN

D= diameter of cylinder

L= Length of cylinder

σt=split tensile strength of specimen in N/mm2

❖ **Data of Split Tensile strength of concrete**

Mix Name	*7 days strength(N/MM2)*	*14days strength(N/MM2)*	*21 days strength(N/MM2)*
Paver block1	2.38	2.72	2.78
Paver block1	2.47	2.56	2.86
Paver block1	2.51	2.59	2.56

Flexure Strength: The flexure strength test is obtained for the beams. The beams were placed in CTM, but the arrangement for that is different. Additional setups were installed in the CTM. it includes 4-point load setup, two at bottom side and two at upper side. The rate of loading was 0.1KN/second.

The flexure strength of the beam can be determined by using formulae

σc= 3PL/4bd2} if crack occurs at the middle third span of the beam,

or σc= 3Pa/4bd2} if the crack occurs at the outer third span of the beam

Where, P = load in KN, L= length of the specimen b= width of specimen, d= depth of specimen, and a = distance between crack and the nearest support.

❖ **Data of Flexure strength:**

Mix Name	*7 days strength(N/MM2)*	*14 days strength(N/MM2)*	*21 days strength(N/MM2)*
Paver block1	3.09	4.47	4.58
Paver block2	4.12	4.52	4.67
Paver block3	4.32	5.41	4.49

WATER ABSORPTION TEST : it is one of the important parameter when we consider the durability of structures. The water absorption test was conducted as per IS 1124-1974.The paver blocks were placed in the oven. It was dried in the oven and it is controlled in temperature at 110ºC for 72 hours. The gap was the paver block is 25 mm to 30mm. After removal from the oven the paver was put an airtight container. The weight of each paver block was noted. Then after the pavers were immersed in water for 30 hours. Then paver block removed from the water tank and shake it to remove excess water. Further paver was wiped with soft cloth to make it dry.

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Sample of paver	Wet weight	Dry weight	Water absorption%
Paver1	5.498	5.121	7.36
Paver2	5.456	5.209	4.71
Paver3	5.432	5.213	4.20

III. CONCLUSION

Foundry waste sand can be effectively used as palace of fine aggregate (Sand) in concrete. At 45% replacement of fine aggregate sand gives maximum compressive strength at the age of 28 days. But The flexural strength gives the maximum result at 30% and at the age of 28 days. After which it shows decrease in the strength. The price of paver block decreases with increase in waste foundry sand in paver block. When we increase the waste foundry sand then the water absorption % decreases. It is environment friendly concrete.it helps to prepare green concrete.

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REFERENCES

IS 3812 (Part 1): 2003 Specification for pulverized fuel ash: Part 1For use as pozzolana domain cement mortar and concrete (second revision)
IS 12269:1987 Specification for 53 grade ordinary Portland cement
IS 12119 :1981 General requirements for pan mixers for concrete
IS 9013 :1978 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
Tarun R. Naik, Viral M. Patel, Dhaval M. Parikh, Mathew P. Tharaniyil, “Utilisation of used foundry sand in concrete”, Journal of Materials in Civil Engineering, Vol. 6, No. 2, May, 1994.
Foundry Industry Recycling Starts Today (FIRST), Foundry Sand Facts for Civil Engineers, Federal Highway Administration Environmental Protection Agency Washington, DC; 2004.
Han-Young Moon, Yun-Wang Choi, Youg-Kyu Song and Jung-Kyu Jeon, “Fundamental properties of Mortar and Concrete using waste foundry sand”, Journal of the Korea Concrete Institute, Vol.17, No.1, pp.141-147, February 2005.