

Research Article

Cost Optimization by Utilization of Waste Material (Foundry Sand)

Shubham Pandey* and Akash Agarwal

Shuats Allahabad, India

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Abstract

This paper is carried to Cost Optimization by utilization of waste material (Foundry sand). In Metal industries the metal foundries uses large amount of sand as part of the metal casting process. Foundries satisfyingly reclaim and reuse the sand many times in casting process. When the sand can't be reused in the foundry, it is removing from the foundry and is called as Waste Foundry Sand. Generation of waste foundry sand as by-product of metal casting industries causes environmental problems because of its improper disposal. Thus its usage in building material, construction and in other fields is essential for reduction of cost & environmental problems. Foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder and dust. Foundry sand can be used in concrete to improve its strength and other durability factors. Foundry sand can be used as a partial replacement of cement. In this paper, Cost optimization by foundry sand over Cement with M-20 mix proportion of 1:1.825:2.85 is investigated at replacement were 10-50% at the interval of 10%, by weight of Cement at different curing periods 7 days, 14 days, 28 days at w/c ratio is 0.5.

Keywords: Compressive strength, Waste Foundry sand, Concrete mix, Cost Optimization

Introduction

Concrete as a building material plays an important role in construction sector. In construction the cost of concrete is very expensive so the researcher develops a new thought that some waste material is use for the cost optimization of concrete because the waste material creates the environment problem. They are not disposing very easily. A new idea by which this waste material is use and cost of concrete is optimized.

Concrete is a material which is mixture of some gradients like Cement, Fine aggregate, Coarse aggregate & Water. Each gradient plays a role in its strength, so by practical and percentage replacing of gradient affects the different properties of concrete. The waste material which harms the environment can be used for the cost optimization and eco-friendly structure. In this research paper and experimental investigation is carried out by different percentage of Cement with use Foundry sand to produce low cost and eco-friendly concrete.

Foundry sand is high quality silica sand that is a byproduct from manufacture of both ferrous and non-ferrous metal casting industries. In the metal casting industries million tons of waste material generated every year, they simply used to dispose these waste by product in the nearby land.

Experimental Material

Cement: Cement is a binding material that hardens after the reaction of water. It is very necessary for construction. In this research paper we use the Foundry sand by replacement of cement because cement is an expensive gradient. In this study the Portland Pozzolana Cement (PPC) of 43 grades is used. Various tests were performed on cement they are

Sr. No.	Physical Property	Result
1.	Specific Gravity	3.12
2.	Standard Consistency (%)	30%
3.	Initial Setting Time(min)	78 min
4.	Final Setting Time(min)	320 min

Fine Aggregate: The fractions from 4.75mm to 150 μ are termed as fine aggregates. The fine aggregates were locally available river sand which was passed through 4.75mm sieve. Main uses of fine aggregates are to fill the voids in between Cement and Coarse aggregate. Fine aggregate also effects on the workability & uniformity in mixture.

Sr. No.	Physical Properties	Result
1.	Specific Gravity	2.70
2.	Fineness Modulus	4.50
3.	Coarse Bulk Density(kg/m ³)	1050
4.	Compacted Bulk Density(kg/m ³)	1170
5.	Water absorption (%)	1.25

*Corresponding author's ORCID ID: 0000-0001-6070-4622
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Coarse Aggregate: The fraction from 20mm to 4.75mm is called as coarse aggregate. An origin of coarse aggregate from crushed basalt rock. The graded coarse aggregate is described by its nominal size i.e. 40mm, 20mm, 16mm, 12.5mm etc. 80mm size is the maximum size that could be conveniently used for making concrete.

Sr. No.	Physical Properties	Result
1.	Specific Gravity	2.68
2.	Fineness Modulus	7.8
3.	Coarse Bulk Density(kg/m ³)	1285
4.	Compacted Bulk Density(kg/m ³)	1580
5.	Water Absorption (%)	1.42

Foundry Sand: Foundry sand is clean, uniformly sized, high quality silica sand that is bounded to form moulds for ferrous and non-ferrous metals. Use of waste foundry sand as partial replacement by cement helps to achieve different properties or behavior of concrete and cost optimization.

Sr. No.	Constituent	Value (%)
1.	SiO ₂	83.93
2.	Al ₂ O ₃	0.021
3.	Fe ₂ O ₃	0.950
4.	CaO	1.03

5.	MgO	1.77
6.	SO ₃	0.057

Sr. No.	Physical Properties	Results
1.	Specific Gravity	2.35-2.55
2.	Bulk Relative Density(kg/m ³)	2583
3.	Absorption (%)	0.43
4.	Moisture Content (%)	0.1-9.8

Experimental Results

Design mix proportion for M-20 mix

	Water (liter)	Cement (kg/m ³)	Fine aggregate (kg/m ³)	Coarse aggregate (kg/m ³)
By Weight(kg)	168.82	320.25	584.45	912.71
By Volume(m ³)	0.5	1.0	1.825	2.85

Material Cost

Sr. No.	Material	Rate(Rs/kg)
1.	Cement	6.40
2.	Fine Aggregate(Sand)	1.21
3.	Coarse aggregate(>20mm)	1.29
4.	Foundry Sand	0.15

Compressive strength by using Waste material (Foundry Sand)

Sr.No.	Cube Designation	Quantity					Compressive Strength		
		C	F.A.	C.A.	W	F.S.	7d	14d	28d
1.	A0	1.0	1.825	2.85	0.5	-	22.40	26.44	29.40
2.	A1	0.9	1.825	2.85	0.5	0.1	23.20	27.24	30.40
3.	A2	0.8	1.825	2.85	0.5	0.2	24.10	27.99	31.09
4.	A3	0.7	1.825	2.85	0.5	0.3	18.4	19.24	20.38
5.	A4	0.6	1.825	2.85	0.5	0.4	16.20	18.20	19.32
6.	A5	0.5	1.825	2.85	0.5	0.5	14.50	15.30	17.25

Total cost of material for M-20 design mix concrete per m³

Cube Designation	Consumption design mix proportion for M-20 concrete				Total cost/m ³	% cost saving
	C	F.A.	C.A.	F.S.		
A0	320.25	584.45	912.71	-	3934.18	-
A1	288.225	584.45	912.71	32.025	3734.024	5.08%
A2	256.2	584.45	912.71	64.05	3533.86	10.17%
A3	224.175	584.45	912.71	96.075	3333.71	15.26%
A4	192.15	584.45	912.71	128.1	3133.55	20.35%
A5	160.125	584.45	912.71	160.125	2933.399	25.44%

Conclusion

Based on experimental investigation the following observation is made regarding the properties and behavior of concrete on partial replacement of cement by waste foundry sand:

[1] Compressive strength increases on increase in percentage of waste foundry sand as compare to traditional concrete.

[2] The compressive strength of M-20 grade concrete increases when the replacement of cement with waste foundry sand up to 20% replaces by weight of cement and further replacement of cement with waste foundry sand decreases the compressive strength.

[3] Utilization of waste foundry sand and its application are used for the development of the construction industry, material sciences.

[4] Use of waste foundry sand in concrete reduces the production of waste through metal industries i.e. it's an eco-friendly building material.

[5] The problem of disposal and maintenance cost of land filling is reduced.

References

- Abichou T. Benson, C Edie T., 1998a. Database on beneficial reuse of foundry by-products. Recycled materials in geotechnical applications, Geotech. Spec. Publ.No.79, C. Vipulanandan and D.Elton, eds., ASCE, Reston, Va., 210-223.
- Assistance Prof. Ankit N Patel, Assistance Prof. Jayesh kumar, stone waste as a ground breaking conception for the low cost concrete, ISSN No-2231-5381, Vol IV, Issue IV, April 2013, Pg no 843-849.
- Bemben. S.M. Shulze, D.A. 1995, The influence of testing procedures on clay/geomembrance shears strength measurements. Proc. Geosynthetics 95, IFAI, St.Paul, Minn 1043-1056.s
- D. Lawrence and M. Mavroulido. (2009) Properties of concrete containing foundry sand, London.
- Eknath P. Salokhe, D.B. Desai, Application of foundry waste sand in manufacture of concrete, Kolhapur India.
- IS: 383-1970, specifications for coarse and fine aggregates from natural sources for concrete, Bureau of Indian Standards, New Delhi, India.
- IS: 1489-1991, specifications for 53-grade Portland Pozzolana cement, Bureau of Indian standards, New Delhi, India.
- IS: 516-1959, Indian standard code of practice methods of test for strength of concrete, Bureau of Indian Standards, New Delhi, India.
- IS: 5816-1999, Indian standard code for splitting tensile strength of concrete method of test, Bureau of Indian Standards, New Delhi, India.