Evaluation Of Low-Cost Pumpable Concrete Using Waste Foundry Sand

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Abstract – *This paper exhibits the evolution of an economical and eco-friendly concrete by usage of waste foundry sand which is discarded from foundry industries at a very large scale annually. In this paper experimental analysis had been done to determine the feasibility of waste foundry sand as replacement of fine aggregates. In the present research, an M-25 grade pumpable concrete is prepared with various percentages (10%, 20%, 30%, 40%, 50% and 60%) of replacement of fine aggregates with waste foundry sand and its compressive strength was tested. Also, the split tensile strength of concrete was analyzed for different percentages (30%, 40% and 50%) at which we got satisfactory results for compressive strength. The properties are then compared with that of conventional concrete and also the cost of same was analyzed. Several properties of fresh concrete like slump and compaction factor of the concrete were also investigated. The paper concludes that the compressive strength increases on increasing the percentage of replacement of fine aggregates with waste foundry sand but only up to a certain percentage of replacement. Post 40% replacement of fine aggregates with waste foundry sand, the compressive strength decreases. Also, the paper deduced that split tensile strength decreases on increasing the percentage of waste foundry sand in concrete.*

keywords: *Low Cost Concrete, Eco-Friendly Concrete, Waste Foundry Sand, Fine Aggregates, Compressive Strength, Split Tensile Strength*

I. INTRODUCTION

The world is advancing very rapidly and in this race of constant development, infrastructure has played a major role. Almost all the structures around the globe have concrete as its key resource. To enable this quest of development it is very prominent that all the constituents of concrete should be available handy at all time. One of the major constituents of concrete is fine aggregates, usually taken as sand, which is a natural resource. The prices of sand fluctuate greatly as per the weather and vicinity of the source. Also, sand is a natural resource which can be extinct some day. So, it's the earnest requirement to find a feasible substitute of fine aggregates.

On the other hand, safe waste disposal is another burning problem that many of our industries are facing today. One such industry is the metal industry that usually dumps its waste i.e. the waste foundry sand, either on the ground or in a land fill. In either of the mode of disposal, the waste poses a serious threat to environment.

In the present research, we have proposed the solution of both the problems by using waste foundry sand as a substitute of fine aggregates. The research initiated by partially replacing the sand by waste foundry sand at different percentages and various properties of fresh and hard concrete were analysed. The research concluded by determining an optimum percentage of waste foundry sand in concrete which gives optimum value of all the properties of concrete and also thus provide us eco-friendly, cost effective concrete with similar properties to that of conventional concrete.

II. MATERIALS

A. *Cement*

Cement act as a binder in concrete and holds together the aggregates. In this experiment, Ordinary Portland Cement, Grade 53, manufactured by Aditya Birla Plus , is used.

Table 1 – Cement Properties

S.	Name of the properties	Value
1	Specific Gravity	3.291
2	Consistency (%)	33%
3	Initial setting time (min)	140
4	Final setting time (min)	490
5	Compressive Strength after 7	27.33
6	Compressive Strength after 28	54.91

B. *Coarse Aggregates*

The aggregates having size greater than 4.75 mm is defined as coarse aggregates.

Table 2 – Properties of Coarse aggregates

S. N.	Name of the properties	Value
1	Specific Gravity	2.84
2	Water Absorption (%)	0.4004%
3	Aggregate Impact Value (%)	23.66%
4	Fineness Modulus	7.29

C. Fine Aggregates

The aggregates which lie in the size range 4.75mm and 0.075 mm are termed as fine aggregates.

Table 3 - Properties of Fine aggregates

S.N.	Name of the properties	Value
1	Specific Gravity	2.525
2	Water Absorption (%)	0.67%
3	Moisture Content (%)	1.729%
4	Fineness Modulus	2.418
5	Zone to which sand belongs	3

D. Waste Foundry Sand

Foundry Sand consists of clean, high quality silica sand which is uniformly sized. The sand is used to make moulds for ferrous and non- ferrous metal castings. The sand is reused up till the point where it cannot be used further and then the sand is discarded and termed as the waste foundry sand. The waste foundry sand is usually dumped to ground due to absence of any other effective means of dumping.

Table 4 - Properties of Waste Foundry Sand

S.N.	Name of the properties	Value
1	Specific Gravity	2.57
2	Water Absorption (%)	0.33%
3	Moisture Content (%)	0.17%
4	Fineness Modulus	2.42
5	Zone to which sand belongs	3

III. MIX DESIGN

The Mix- Design of M-25 grade pumpable concrete was done as per IS: 10262-2009 for water-cement ratio equal to 0.55.

Table 5 – Mix Design proportion of M-25 pumpable concrete for water-cement ratio 0.5

	Water (Kg/m3)	Cement (Kg/m3)	Fine Aggregates (Kg/m3)	Coarse Aggregates (Kg/m3)
By Weight	197.16	358.47	760.34	1117.69
By Volume	0.55	1	2.13	3.123

IV. EXPERIMENTAL RESULTS

Various properties of fresh and hard concrete were tested for several percentages of foundry sand.

Table 6 – Slump & Compaction Factor for water-cement ratio 0.55

Percentage of waste Foundry Sand	Slump (mm)	Compaction Factor
0%	115mm	0.932
10%	105mm	0.954
20%	90mm	0.912
30%	70mm	0.896
40%	70mm	0.874
50%	50mm	0.804
60%	15mm	0.784

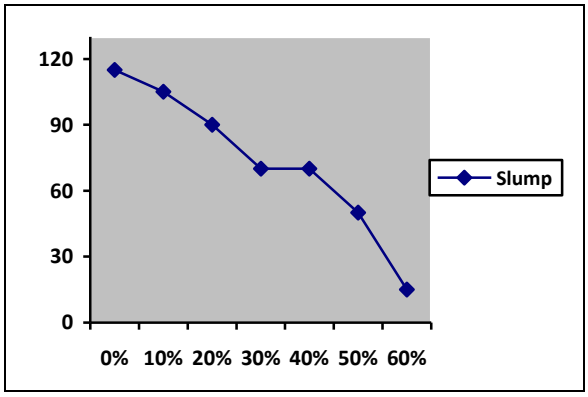

Fig. 3 – Graph of slump value VS various percentages of Foundry sand for water-cement ratio 0.55

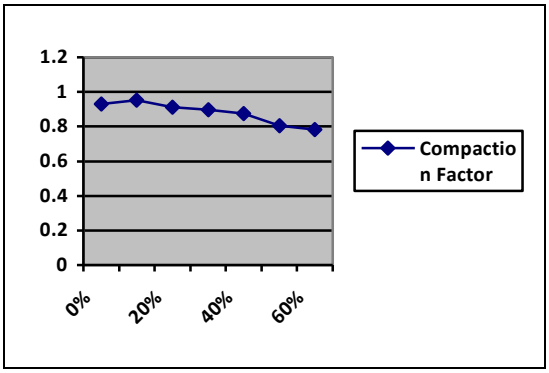

Fig. 4 – Graph of compaction factor VS various percentages of foundry sand for water-cement ratio 0.55

Table 7 – Ultimate compressive strength of cubes after 7 and 28 days curing for water-cement ratio 0.55

Percentage of waste foundry sand in concrete	Average ultimate compressive strength at 7 days (MPa)	Average ultimate compressive strength at 28 days (MPa)
0%	28.76	33.84
10%	24.37	32.57
20%	24.28	30.51
30%	24.4	30.57
40%	28.71	34.08
50%	23.88	31.36
60%	22.11	29.56

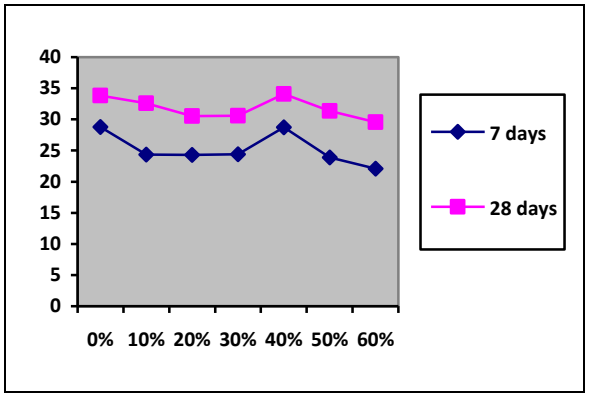

Fig. 5– Graph of Compressive Strength VS various percentages of foundry sand for water-cement ratio 0.55 for 7 and 28 days curing

Table 8 – Split Tensile Strength at 7 and 28 days curing

Percentages of Waste Foundry Sand	Average split tensile strength after 28 days curing
0%	2.83
30%	2.516
40%	2.02
50%	1.96

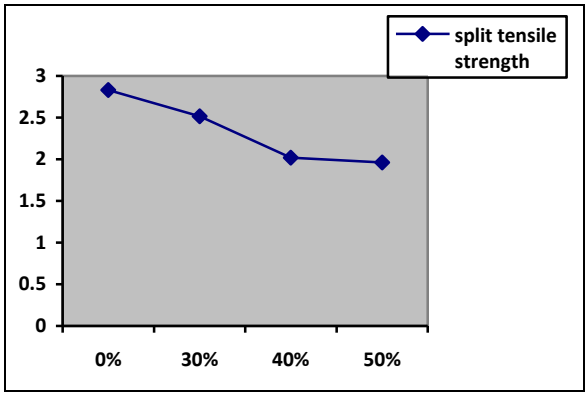

Fig. 6– Graph of split tensile Strength VS various percentages of foundry sand for water-cement ratio 0.55 for 28 days curing

V. COST ANALYSIS

As waste foundry sand is a discarded product from metal casting and foundry industries, its price is far less than normal sand.

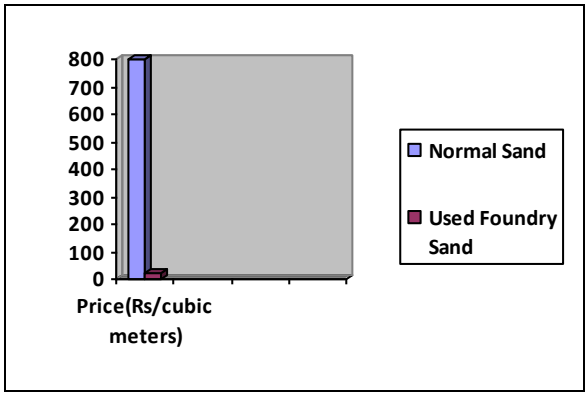

Fig. 7– Bar graph of cost comparison of normal sand vs. used foundry sand.

Table 9 – Costs of Normal sand and used foundry sand in Rs/cubic meters

Type of Sand	Price in rupees per cubic meters
Normal Sand	800
Waste Foundry Sand	40

VI. CONCLUSIONS

- On addition of used foundry sand in concrete, the compressive strength of concrete first reduces and then increases giving hike at 40% replacement of fine aggregate.

- Split tensile strength lowers with increasing quantity of waste foundry sand in concrete.
- Value of compaction factor and slump reduces on increasing the percentage of replacement of waste foundry sand .
- Used foundry sand is a discarded product from foundry industries, so it's far cheaper than normal sand**.**
- Usage of waste foundry sand provides an economical and eco-friendly solution of disposal problem of foundry industries.

REFERENCES

[1] Smit M. Kacha1, Abhay V. Nakum2, Ankur C. Bhogayata (2014). Use of used foundry sand in concrete: a state of art review, IJRET: International Journal of Research in Engineering and Technology.

[2] Tarun R. Naik, Viral M. Patel, Dhaval M. Parikh, Mathew P. Tharaniyil (1994). Utilisation of used foundry sand in concrete, Journal of Materials in Civil Engineering, Vol. 6, No. 2.

[3] Han-Young Moon, Yun-Wang Choi, Youg-Kyu Song and Jung-Kyu Jeon (2005). Fundamental properties of Mortar and Concrete using waste foundry sand, Journal of the Korea Concrete Institute, Vol.17, No.1, Pg. 141-147.

[4] Rafat Siddique, Geert de Schutter, Albert Noumowe (2009). Effect of used-foundry sand on the mechanical properties of concrete, Elsevier, Construction and Building Materials 23, Pg. 976–980.

[5] J. M. Khatib, S. Baig, A Bougara and C Booth (2010), Foundry sand utilization in concrete production, Second International Conference on Sustainable Construction Materials and Technologies, ISBN 978-1-4507-1490-7.

[6] Naik, T. R. (1989). Foundry Industry By products Utilization, Center for by products Utilization, College of Engineering and applied Science, University of Wisconsin-Milwaukee.

[7] Indian standard Recommended guidelines for Concrete Mix Design, IS 10262: 1982, 5th Reprint 1998, Bureau of Indian Standards, New Delhi.

[8] M S Shetty (1987, Concrete Technology Theory and Practices, Chand & Company, New Delhi.

[9] IS: 10262-1982, Indian Standards – Concrete Mix Proportioning. IS 456:2000, Plain and Reinforced concrete - code of practice (Fourth Revision).