



International Journal of Intellectual Advancements and Research in Engineering Computations

Effect of replacing fine aggregate with cast iron slag on strength of concrete

Ms.P. Karthika.M.E¹ R. Prakash², R.Vidhyapathi², B.Arun Kumar², S.Mahakrishnan²

¹Assistant Professor, Department of Civil Engineering, Nandha Engineering College, Erode

²UG Student, Department of Civil Engineering, Nandha Engineering College, Erode

ABSTRACT

Conservation of natural resources and preservation of environment is the essence of any development. The problem arising from continuous technological and industrial development is the disposal of waste material. Due to growing environmental awareness, as well as stricter regulations on managing industrial waste, the world is increasingly turning to researching properties of industrial waste and finding solutions on using its valuable component parts so that those might be used as secondary raw material in other industrial branches. If some of the materials are found suitable in concrete making not only cost of construction can be put down, but also safe disposal of waste materials can be achieved. Although cast iron slag is still today considered as waste and is categorized in industrial waste catalogues in most countries in the world, it is most definitely not waste, neither by its physical and chemical properties nor according to data on its use as valuable material for different purposes. Our study is to preserve the environment by replacing sand partially with cast iron slag in concrete. After the moulding of cast iron, the dust surrounding the cast iron specimens are collected which are named here as cast iron slag. In our project, these fine particles are used to replace sand in concrete of grade M30. The cast iron slag and river sand are tested for analysing their physical properties. Fresh concrete is prepared for various percentage replacements in concrete grade of M30 and their workability is analysed. The replacement is done at the rate of 0% to 15% in the increment of 5. Various cubes are casted by replacing river sand with cast iron slag in concrete and compressive strength is determined after 7 and 28 days of curing. Finally, the optimum percentage replacement of cast iron slag in concrete is determined.

INTRODUCTION

General

Concrete is the mixture of cement, water, sand, and gravel that hardens into a super-strong building material. Aggregates are the important constituents in the concrete composite that help in reducing shrinkage and impart economy to concrete production. Physical as well as chemical properties of fine aggregate affect the durability, workability and also strength of concrete, so fine aggregate is a most important constituent of concrete and cement mortar. Generally river sand or pit sand is used as fine aggregate in mortar and

concrete. Together fine and coarse aggregate make about 10- 15 % of total volume of concrete and hence it is very important to fine suitable type and good quality aggregate. In general, consumption of natural sand is high due to the large use of concrete and mortar. Hence the demand of natural sand is very high in developing countries to satisfy the rapid infrastructure growth [1].

The developing country like India facing shortage of good quality natural sand and particularly in India, natural sand deposits are being used up and causing serious threat to environment as well as the society. Rapid extraction of sand from river bed causing so many

problems like losing water retaining soil strata, deepening of the river beds and causing bank slides, loss of vegetation on the bank of rivers, disturbs the aquatic life as well as the agriculture due to lowering of water table in the well, etc. The heavy exploitation of river sand for construction purposes leads to various harmful problems. Therefore, construction industries of developing countries are in stress to identify alternative materials to replace the demand for river sand [2, 3].

Hence, partial or full replacement of river sand by the other compatible materials like crushed rock dust, quarry dust, glass powder, recycled concrete dust, and others are being researched from past two decades, in view of conserving the ecological balance. The reuse of these wastes will help to save cost, conserve limited resources and ultimately protect the environment. On the other hand, lack in required quality is the major limitation in some of the above materials. Now a day's sustainable infrastructural growth requires the alternative material that should satisfy technical requisites of fine aggregate as well as its availability of large amount in local areas [4].

Cast Iron Slag

Cast iron is primarily composed of iron (Fe), carbon (C) and silicon (Si), but may also contain traces of sulphur (S), manganese (Mn) and phosphorus (P). It has a relatively high carbon content of 2% to 5%. Cast iron slag is a form of waste produced during the manufacture of cast iron. These wastes are dumped in surroundings and are not used for any purpose [5].

Slag Formation Process

After the molding of cast iron specimens, lots of dusts are seen surrounding the specimens. In order to clean the specimens and to provide good finishing, these are sent to a huge cylinder where high pressure is given to the specimens and the dusts surrounding the specimens are removed. These dusts are collected and in our study, are used to replace sand in concrete.

Objective of the Research Work

The objective of the present work is to study the effect of partial replacement of cast iron slag and to find the optimum percentage replacement of cast iron slag in concrete.

It is proposed to partially replace fine aggregates with cast iron slag and find its effect on the strength characteristics of concrete. Eight percentage levels of replacement i.e. 0 to 15 percent in the increment of 5 percent are considered for partially replacing sand with cast iron slag and the optimum percentage replacement can be found.

PRELIMINARY TESTS

Sieve Analysis

The sieve analysis test result shows that the aggregates are well graded in all the percentage replacements. The 0% and 5% replacements are in zone II, 10% and 15% replacements.

Fineness Modulus, Specific Gravity and Water Absorption Tests

Fineness modulus obtained from sieve analysis, specific gravity and water absorption values for all percentage replacements of sand with cast iron slag is listed in table 1.



Fig 1 Specific gravity test

Table 1: Fineness modulus, Specific Gravity and Water Absorption for various % replacements

% Replacement (%)	Fineness Modulus	Specific Gravity	Water Absorption
0	2.88	2.65	0.8
5	2.6	2.7	0.86
10	2.55	2.75	0.92
15	2.48	2.8	0.98

MIX PROPORTIONS

IS 10262 2009 is used for calculating mix design for the concrete [4]. Mix design is prepared for M30 grade concrete with varying percentage replacements of sand with cast iron slag in concrete. From the mix design, it is found that the water/cement ratio, quantity of cement and water remains same for all the percentage replacements.

Since 0% and 5% replacements are in zone II, 10%, 15% replacements the fine aggregate content

varies based on the specific gravity obtained for each percentage replacements. The quantity of sand and cast iron slag varies based on the percentage replacements.

The following are the final values obtained from mix design for the remaining percentage replacements of cast iron slag in concrete.

- Cement – 102.53kg
- Water/Cement – 0.5
- Water – 41.01lit

Table 2: Coarse and Fine aggregate contents for various % replacements

Percentage Replacements (%)	Sand (kg)	Cast iron slag (kg/m ³)	Coarse aggregate (kg/m ³)
0	47.45	0	54.96
5	44.72	2.74	37.95
10	41.96	5.5	35.19
15	39.22	8.23	32.45

TEST FOR WORKABILITY

The slump test result shows that the concrete with all percentage replacements have very low

workability and so it is better to perform compacting factor test for analysis.

The compacting factor test result shows that the compacting factor value is low for 0% and 5%

replacements, medium for 10%, 15% replacements and high for 10% and 15% replacements.

Table 3: Workability test result

% Replacements (%)	Slump (mm)	Compacting factor
0	25	0.9
5	24	0.89
10	24	0.88

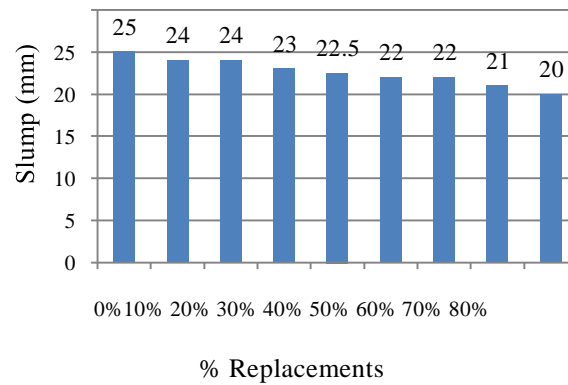


Figure 2 Chart representing slump value

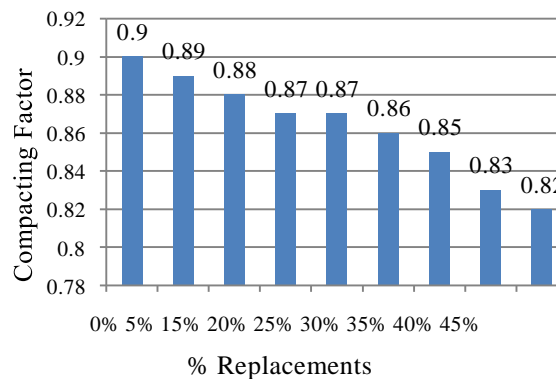


Figure 3 Chart representing Compacting factor

TEST FOR COMPRESSION STRENGTH

After the testing of various replacements of concrete for their workability, nine cubes of size 150mm x 150mm x 150mm are casted for each percentage replacements of concrete. The cube

moulds are removed after 24 hours and are kept under water for curing. Three cubes are tested for compressive strength at every 7, 28 days of curing and the average compressive strength is noted for 7, 28 days curing.

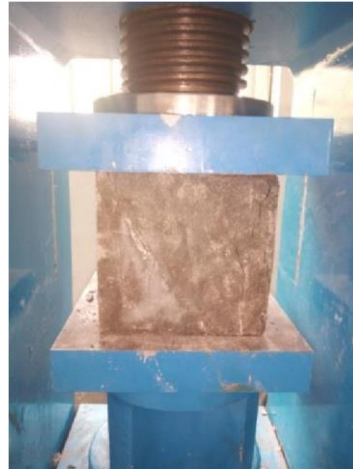


Figure 4 Compression Strength test

The average compressive strength at 7, 14 and 28 days for various percentage replacements of cast iron slag in concrete are shown in figure 6.

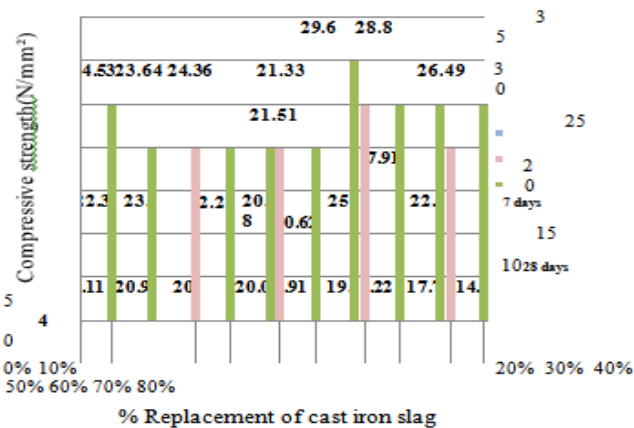


Figure 5 Compressive Strength test result

CONCLUSION

From the above results, 7days compressive strength is maximum at 15%replacement of cast iron slag in concrete. The chart shows rapid increase until 28 days curing. But, after 28 days curing, the strength increment is very less and becomes 28.8N/mm² at 28 days of curing which is 9.38% more than that of conventional concrete. But, the maximum 28 day compressive strength is found to be 29.6N/mm² at 10% replacement of sand with cast iron slag. This strength is 12.42%

higher than the compressive strength of conventional concrete.

Thus, the optimum percentage replacement of sand with cast iron slag in concrete is 10%

Acknowledgement

. The authors wish to acknowledge their parents. First author is grateful to the second author for helping him in this research and has been a constant source of inspiration throughout this work.

REFERENCE

- [1]. Journal of Innovative Research in Science, Engineering and Technology, 3, 11585-11592.
- [2]. Suganthy.P., Dinesh Chandrasekar, Sathish Kumar. P. K. 'Utilization of Pulverized Plastic in Cement Concrete as Fine Aggregate', International Journal of Research in Engineering and Technology, 2, 2013, 1015-1019.
- [3]. R. R. Chavan and D. B. Kulkarni, 'Performance of Copper Slag on Strength Properties as Partial Replace of Fine Aggregate in Concrete Mix Design', International Journal of Advanced Engineering Research and Studies, 2013, 95-98.
- [4]. Rachit Saxena, Abhishek Singh Kushwaha and Shilpa Pal, 'Effect on Compressive Strength of Concrete with Partial Replacement of Sand using Iron Slag', Journal of Civil Engineering and Environmental Technology, 2(6), 2015, 510-513.
- [5]. Tomas U. Ganiron Jr (2013), 'Use of Recycled Glass Bottles as Fine Aggregates in Concrete Mixture', International Journal of Advanced Science and Technology, 61, 2013, 17-2.