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EXPEREMENTAL INVESTIGATION ON PERFORMANCE OF CONCRETE BY INCORPORATING STEEL SLAG

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ABSTRACT

Slag is plays a vitalrole in the design and development of high strength concrete.The main parameter investigated in this study is M25 grade concrete withthe addition of fine aggregate and steel slag by 10% 15% and 20%.This paper presents the result of an experimental investigations caring out to find sustainability of steel slag in concrete and compressive strength,split tensile strength is attained at the age of 7 days, 14 days and 28 days.Test results indicates that use of steel slag in concrete has improved the performance of concrete in strength as well as durability aspects. Slag,the by-product of steel and iron production process, has been used in Civil Engineering for more than 100 years.The cost optimization is find out by comparing $1m^3$ of conventional concrete and slag concrete resulting high strength of slag with fine aggregate added. In this project,a study was made to obtain low cost building materials using industrial waste(steel slag). The objective of the study is to use this waste in low cost construction with adequate compressive strength. The knowledge on the strength and permeability of concrete containing steel slag could be beneficial in the utilization of these waste materials in concrete work.

INTRODUCTION

Concrete is the most widely used material on earth in construction industry. Many aspects of our daily life depend directly or indirectly on concrete. Concrete is prepared by mixing various constituents like cement, aggregate, water, etc. which are economically available. Concrete is unique among major construction materials because it designed specifically for civil engineering projects. Concrete is a composite material composed of granular material like coarse aggregate bound together with cement or bind which fills the space between the particles and glues them together. Concrete plays critical role in the design and construction of the nation's infrastructure. Almost three quarters of the volume of concrete is composed of aggregate. To meet the global demand of concrete in the future, it's becoming a more challenging task to find suitable alternatives to natural aggregate for preparing concrete.

Therefore the use of alternative sources of natural aggregate is becoming increasingly important. Slag is co-product of the iron and steel making process. Iron cannot be prepare in the steel slag without the production its co-product; it is known as steel slag. The use of steel slag in concrete by adding the natural aggregate is a most promising concept. Steel slag products have been used successfully in virtually all phases of bridge construction.

Slag is partially vitreous by product of the process melting ore. Slag is usually mixture of metal oxides and silicon dia oxide. One of the most beneficial uses for slag is in concrete because of its chemical and physical properties, it is very reactive aggregate. Concrete containing slag can very high strength and very durable. So slag is can be used in concrete. When it is used in concrete, it acts as filler and as the strengthening materials. The steel slag also combines with calcium oxides and iron oxides. Both of these actions results in a denser, stronger and less permeable material. In this slag concrete, we have additional added fine aggregate up to 10, 15 and 20% by steel slag. The waste material was incorporate in fine aggregate and for the preparation of concrete blocks. In this project, we have followed Indian standard methods and arrived at mix design for M25 grade concrete. The preliminary studies were conducted by mixing the slag with the cement concrete cubes of standard sizes.

PREVIUOUS RESEARCHERS

E. Anastasiou, K. GeorgiadisFilikas, M. Stefanidou (Jan 2013), Steel slag is a waste metallic material which might have long term delayed reactions, further experiments would be necessary to evaluate the durability of concrete made by steel slag aggregates. In this paper properties of steel slag where experimentally studies to be used has aggregates in normal and high strength concrete.

Ha-won song, Velusaraswathy (July 2006), The partial substitution of sand with granulated slag presence the double interest, its results in the improvement of compressive strength at different ages and the same time the reduction of stocks of the granulated slag one can correct the very fine sand with the coarse granulated slag materials.

Mohammed Nadeem, (2006), The study concluded the compressive strength of concrete improved by 4 to 7% at all the incorporating in normal fine aggregate. In case of replacements of fine aggregates, the strength improvements were notably observed at 30 to 50%. Incorporating level by 4 to 6%.

P.E.Tsakiridis, G.D .Papadimitriou , S. Tsivilis , C. Koroneous (2007), It could be said that full substitution of slag aggregate with normal fine aggregate improved the compressive and tensile strength at all replacements by 10.5% to 8% and incase of replacing fine aggregate with slag the strength improvement was at 30 to 50%replacemen levels by 5 to 6%.

Samir I. Abu-Eishah, Amr S. EI-Dieb, Mostafa S. Bedir (July 2012), this research aims to investigated the effect of using steel slag as fine aggregate in concrete. Replacement levels by 10 to 20% of fine aggregate. Strength will be achieved in 40 to 50%

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CONSTITUENT MATERIALS USED

Materials that are used for making concrete for this study will be tested before casting the specimens. The preliminary tests will be conducted for the following materials.

- Cement
- Fine aggregates
- Coarse aggregates
- Water

STEEL SLAG

Slag is one of the artificial lime stone and silica, commonly used has coarse aggregate in HPC. Slag IS A partially vitreous by product of the process of smelting ore. Slag is usually a mixture of oxides and silicon dioxides. One of the most beneficial uses for steel slag in concrete.

COMPRESSIVE STRENGTH TEST

At the time of testing, each specimen must keep in compressive testing machine. The maximum load at the breakage of concrete block will be noted. From the noted values, the compressive strength may calculated by using below formula. Compressive Strength = Load / Area

Size of the test specimen = 150 mm x 150mm x 150mm

COMPRESSION TEST

SPLIT TENSILE TEST

The size of cylinders 300mm length and 150 mm diameter are placed in the machine such that load is applied on the opposite side of the cubes are casted. Align carefully and load is applied, till the specimen breaks. The formula used for calculation.

SPLIT TENSILE TEST

TEST RESULT

RATIO FOR SPECIFIC CONCRETE

RATIO – I

Steel slag – 10% by replacement of coarse aggregate

RATIO – II

Steel slag – 15% by replacement of coarse aggregate

RATIO – III

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Steel slag – 20% by replacement of coarse aggregate

Above all ingredients are added by weight of cement

TEST RESULT AT AGE OF 7 DAYS

Compressive Strength of Cube

Fig 10 Cube

(A) (B) (C)

Specimen for 7 Days Curing

A – Compression testing of specimen 10% of slag

B – Compression testing of specimen 15% of slag

C – Compression testing of specimen 20% of slag

COMPRESSIVE STRENGTH AT 7 DAYS

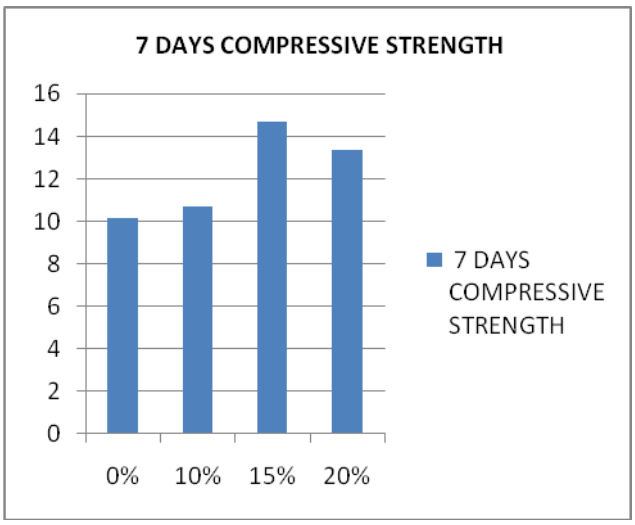


TABLE 8 COMPRESSIVE STRENGTH OF CUBE 7 DAYS

Control Mix	7 days Compressive Strength in N/mm^2			
M25	CC (0%)	10%	15%	20%
	10.15	10.67	14.67	13.33

SPLIT TENSILE TEST FOR CYLINDER

(A) (B) (C)

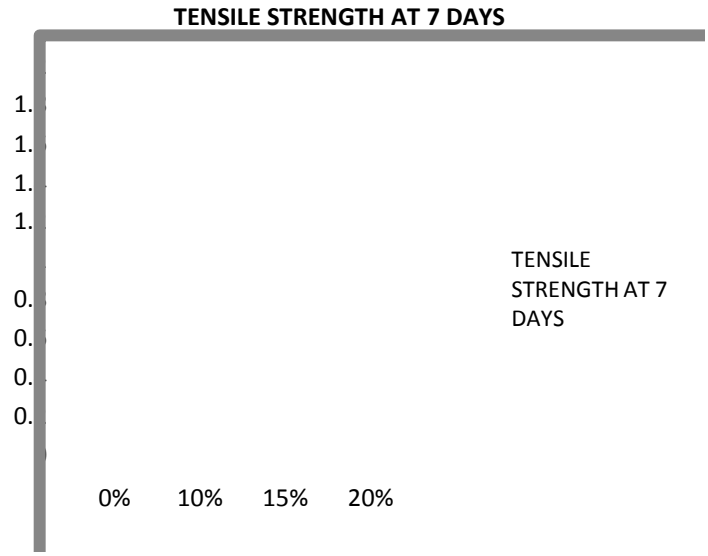
Cylinder Specimen for 7 Days

A - Split tensile testing of specimen 10% of slag

B - Split tensile testing of specimen 15% of slag

C - Split tensile testing of specimen 20% of slag

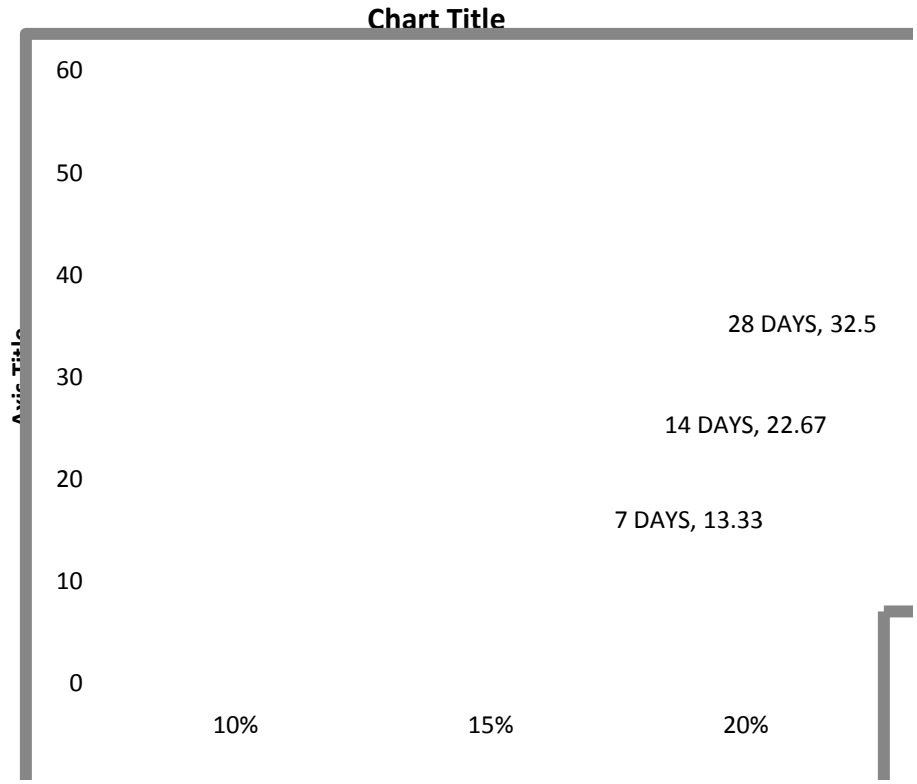
TENSILE STRENGTH AT 7 DAYS



TOTAL COMPRESSIVE STRENGTH (N/mm^2)

% Of steel slag	7 Days	14 Days	28 Days
10%	10.67	18.67	29.56
15%	14.67	24.89	48.89
20%	13.33	22.67	32.5

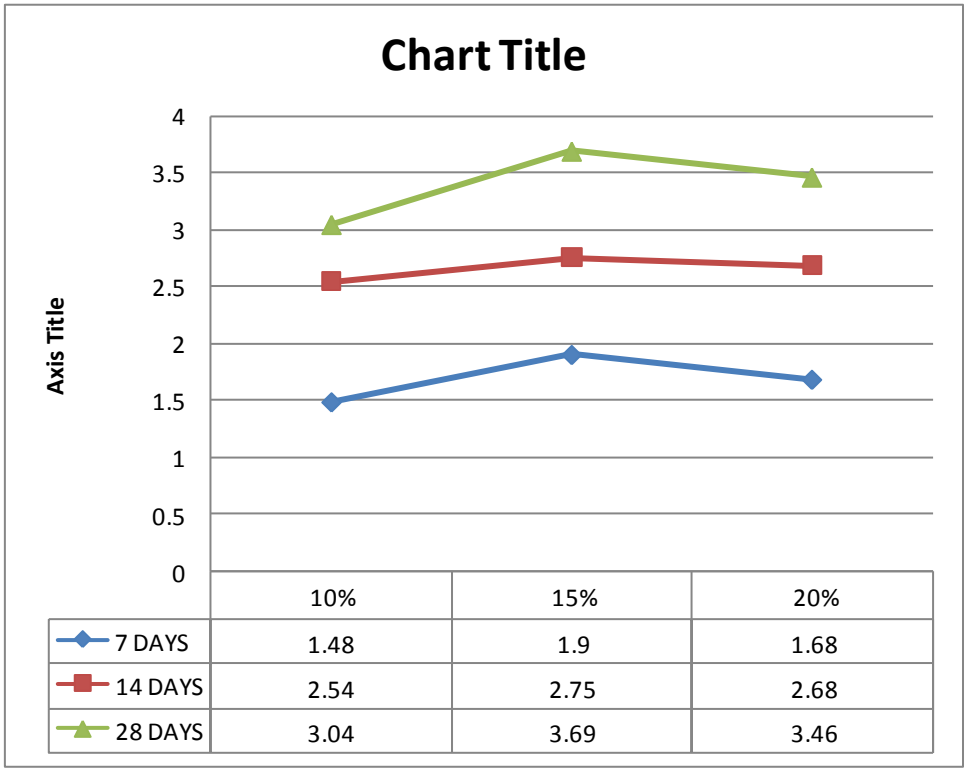
TOTAL COMPRESSIVE STRENGTH



TOTAL TENSILE STRENGTH (N/mm$^{2)}$

% Of steel slag	7 Days	14 Days	28 Days
10%	1.48	2.54	3.04
15%	1.90	2.75	3.69
20%	1.68	2.68	3.40

TOTAL TENSILE STRENGTH



	10%	15%	20%
7 DAYS	1.48	1.9	1.68
14 DAYS	2.54	2.75	2.68
28 DAYS	3.04	3.69	3.46

CONCLUSION

- The conclusions drawn from these experimental investigations are as follows
- The strength of concrete containing steel slag of 15% was high compared with that of the other conventional mix
- The coefficient of permeability was found to be negligible in all the samples of concrete mixes containing steel slag whereas the coefficient of permeability was more in concrete mixes without steel slag
- The presence of steel slag in concrete mixes acts as pore fillers and cause reduction in the pores, resulting fine and discontinuous the pore structures and thereby increases the impermeability of concrete.
- Fine aggregate level of 15% slag in concrete mixes was found to be the optimum level to obtain higher value of strength and durability at the age of 28 days.

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