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An Experimental Investigation on Mechanical Properties of Brick Replacing Fine Aggregate with Steel Slag

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***Abstract:** This paper reports the effect of brick using steel slag as fine aggregate. In this project the mix ratio was 1:2. The properties of material for cement, fine aggregate and steel slag were studied. The compressive strength test, water absorption test, efflorescence test of brick was studied for various replacement of fine aggregate using EAF steel slag that are 25%, 50%, 75% and 100%. The maximum compressive strength of brick attained at 50% replacement of fine aggregate at 7 days and 28 days.*
***Keywords:** Steel slag, Compressive strength, efflorescence, water absorption.*

I. INTRODUCTION

Brick, the most important tiny piece for construction works is used by human for many years back. Its history goes back to some of the earliest times in the civilization of men. Many world famous archaeological excavations provide much information about the brick uses in different parts of the world. Many years back, bricks were made at warm places and simply placed in the Sunlight for hardening. The hand-shaped, Sun-dried, mud bricks were made and used during the Pre-Pottery Neolithic Period. Though a common structural material, till now brick is the cheapest one. This small unit is used very systematically by an expert hand for many different types of construction for long time. Technically, clay bricks fall under the category of heavy clay products. Heavy clay products are those that are mainly made from single clay with very little addition of other raw materials. Different types of bricks with different names in different parts of the world are being produced for structural purposes. Generally the classifications were done on the basis of size, color, use and quality. Oxide dusts, sludge, scales, slag and spent refractory are co-products of the iron and steel manufacturing process.

These residues generally represent 6-7% of the whole steel production.Their production arises from the conversion of ores to iron, hot iron to steel, and from melting scrap in an electric arc furnace or from the subsequent treatment of crude steel. These by-products, especially in the past, were classified as “waste” and often stocked and or disposed in landfills, although they could be a valuable secondary raw material when recycled and properly reused. If treated correctly, they can be utilized both in metallurgical processes and in other industrial applications.

Steel slag, a by-product of steel making, is produced during the separation of the molten steel from impurities in steel-making furnaces. The slag occurs as a molten liquid melt and is a complex solution of silicates and oxides that solidifies upon cooling. Virtually all steel is now made in integrated steel plants using a version of the basic oxygen process or in specialty steel plants (mini-mills) using an electric arc furnace process. The open hearth furnace process is no longer used.

Out of the total cost of construction, building materials contribute to about 70% of cost in developing countries like India. Therefore, the need of the hour is replacement of costly and scarce conventional building materials by innovative, cost effective and environment– friendly alternate building materials. The new material should be environment–friendly and preferably utilize industrial wastes generated as a result of rapid industrialization. Brick is widely used construction material for various types of structures due to its durability. Natural resources are depleting worldwide while at the same time the generated wastes from the industry are increasing substantially.

Availability of Natural Sand as Fine Aggregate In the last 15 years, it has become clear that the availability of good quality natural sand is decreasing. Crushed aggregate, bottom ash, copper slag, foundry sand, Steel slag and various by-products are replacing natural sand and gravel in most countries. The research emphasizes on the use of material to be replaced by natural sand which will give new dimension in concrete mix design and if applied on large scale would revolutionize the construction industry by economizing the construction cost and enable us to conserve natural resources.

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II. MATERIALS AND METHODS

A. *Cement*

Cement in concrete acts as a binding material that harden after the addition of water. It plays an important role in construction sector. Portland pozzolona cement (PPC) was used in this study.The properties of cement used are given in Table by using ISIS 4031-1988.

S.no	Descriptions	Value of ppc
1.	Specific gravity	3.1
3.	Initial setting time	30 minutes

B. *Fine Aggregate*

Aggregate that pass through a 4.75 mm IS sieve and having not more than 5 percent coarser material are known as fine aggregate. Main function of fine aggregate is to fill the voids in between coarser particles and also helps in producing workability and uniformity in mixture. In this study fine aggregate is conformed to IS2386 (part-III) 1963 and zone III. Obtained specific gravity and fineness modulus is 2.63 and 2.85 respectively.

C. *Water*

Water plays an important role as it contributes in chemical reaction with cement. Water is used for mixing as well as for curing purpose also it should be clean and free from salts, acids, alkalis and other harmful materials. Potable water is used for mixing concrete.

D. *Steel Slag*

Steel slag is used as an ideal aggregate in hot mix asphalt.It is also used for manufacture of Portland cement.It is used in base application, construction of unpaved parking lot as a shoulder material.It is used in a broad range of fields including in the construction of ports and harbors and other large civil engineering works.It is used as a ground improvement material.

Physical Properties	Steel Slag
Hardness on Mohr's Scale	6
Specific Gravity	2.6
Water absorption	3%
Particle Shape	Irregular
Approximate dry unit weight (kg/m^3)	1680

III. CEMENT BRICK MIX PROPORTION

Mix ratio as per design in this study 1:2

A. *Mix Design*

1) Conventional Bricks – 100 % sand ,0 % Steel slag.
2) 25% replacement – 75 % sand, 25 %Steel slag.
3) 50% replacement – 50 % sand , 50 % Steel slag.
4) 75% replacement – 25 % sand , 75 % Steel slag.
5) 100% replacement – 0 % sand , 100 % Steel slag
6) Size of specimen : 190×90×90 mm

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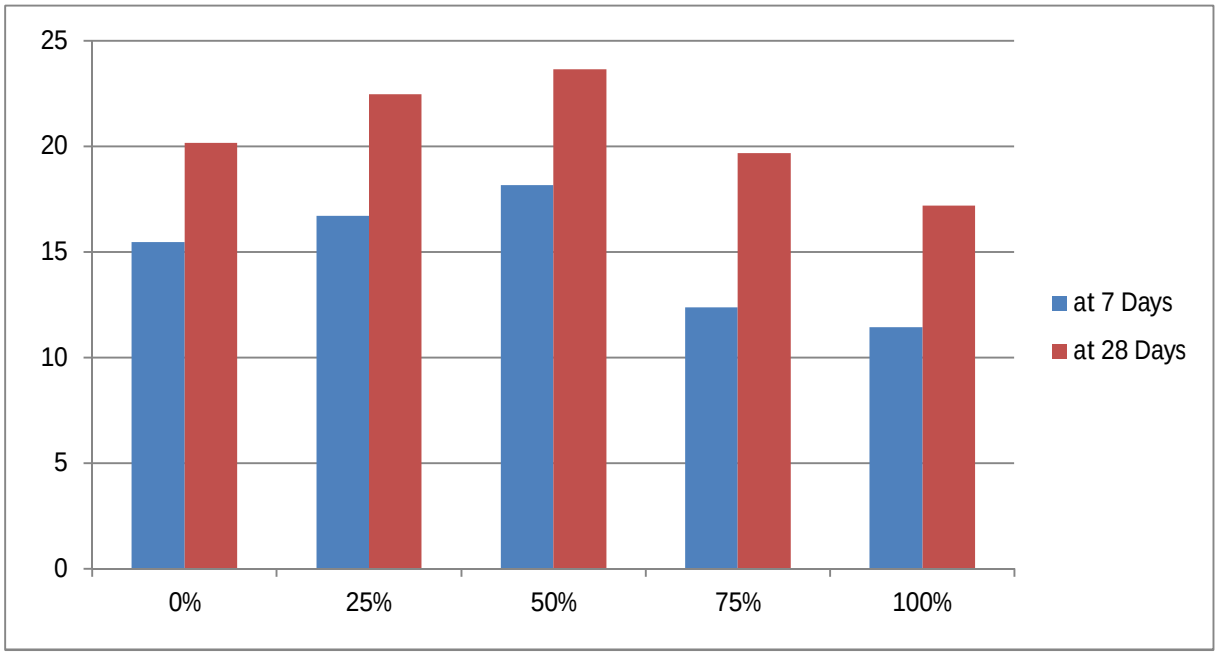
IV. EXPERIMENTAL RESULTS

A. Compressive Strength Test

The determination of compressive strength of the prepared samples was carried out as per standard practiced. The following table shows the compressive strength of various samples after testing. The specimen was tested after 7 and 28 days of curing.

Testing On Specimen

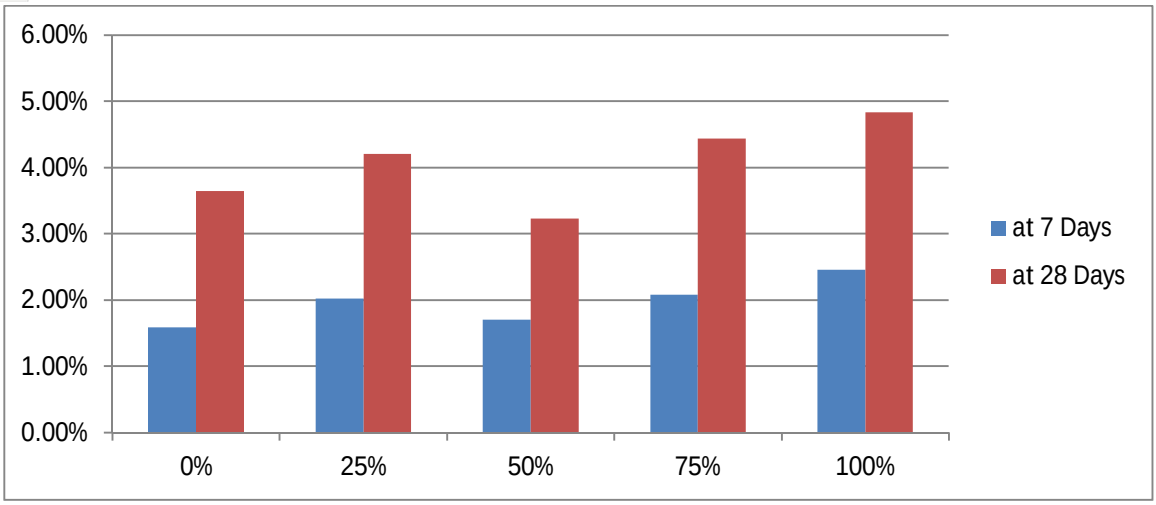
Steel slag Content	Compressive strength at 7days(N/mm²)	Compressive strength at 28days(N/mm²)
0%	15.47	20.17
25%	16.72	22.48
50%	18.18	23.65
75%	12.39	19.69
100%	11.45	17.20



B. Water Absorption Test

The determination of water absorption value of the prepared samples was carried out as per standard practiced. The following tables shows the water absorption value of various samples after testing. The specimen was tested after 7 and 28 days of curing.

Steel slag Content	Water Absorption Value at 7 Days	Water Absorption Value at 28 Days
0%	1.59%	3.65%
25%	2.02%	4.21%
50%	1.70%	3.23%
75%	2.08%	4.44%
100%	2.46%	4.83%



C. Efflorescence Test

The determination of efflorescence test value of the prepared samples was carried out as per standard practiced. The specimen was tested after 7 and 28 days of curing. Deposit of efflorescence test value of various samples after testing showed 0%.

V. CONCLUSION

From the results and discussions, the following conclusions were made

A. The replacement of fine aggregate using steel slag in bricks increases the density of bricks thereby increases the selfweight of the bricks.

B. The workability of bricks increased with the increase in steel slag content of fine aggregate replacements at same water-cement ratio.

C. Form the results of compressive strength of the concrete shown higher value at 25% &50% and slightly decreased at 75% % 100% replacement of fine aggregate using steel slag. So it is recommended that 25% and 50% of fine aggregate can be replaced by steel slag.

D. The water absorption increased with increasing the slag content.

E. The presence of steel slag does not affect the efflorescence.

F. It have better durability and physical, Mechanical properties should have investigated.

G. Steel slag building bricks can be used for construction of non-load bearing walls, partition walls and infilled walls..etc.

H. The construction industry is the only area for safe use of waste materials, which reduces the environmental problems, space problems and cost of construction.

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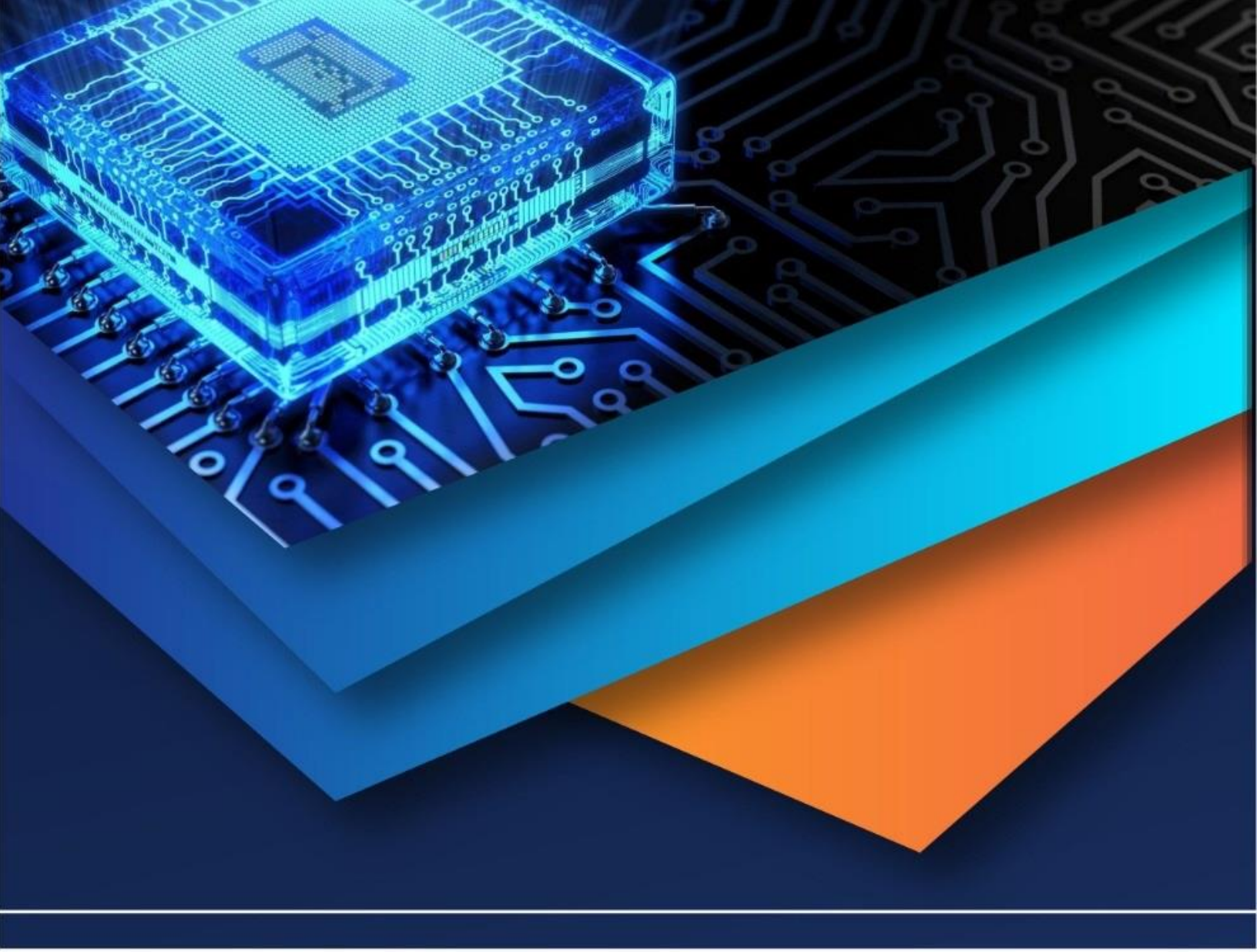

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