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Investigation on Strength of Concrete by Partial Replacement of Coarse Aggregate with Steel Slag

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Abstract: This paper investigates the partial replacement of the coarse aggregate and improves the mechanical properties of concrete. The effective manner is to use slag in concrete by replacing natural coarse aggregate. In this study, the replacement was done with coarse aggregate by steel slag for different proportions of 10%, 20%, 30%, 40% and 50% for a M30 grade of concrete is used for a water cement ratio of 0.43. Tests for compressive strength at 7 days and 28 days are conducted on specimens. The optimum strength is obtained on 30% replacement of coarse aggregate by steel slag.
Keyword: Experimental, Investigation, Coarse Aggregate, Steel Slag, Concrete.

I. INTRODUCTION

Slag is a partially vitreous by product of the process of smelting ore. Slag is usually a mixture of metal oxides and silicon dioxides. One of the most beneficial uses for furnace slag is in concrete. Because of its chemical and physical properties, it is a very reactive aggregate. Concrete containing slag can have very high strength and can be very durable. So Slag is can be used in concrete. When it is used in concrete, it acts as filler and as a strengthening material. The furnace slag also combines with calcium oxide and iron oxide. Both of these actions result in a denser, stronger and less permeable material. In this slag concrete we have replaced coarse aggregate up to 50, 60 and 70 percent by furnace slag. Slag has been used as an addition to concrete up to 70 percent by weight of coarse aggregate. It increases the water demand in a concrete mix; however, dosage rates of less than 5 percent will not typically require a water reducer. High replacement rates will require the use of a high range water reducer. The waste material was substituted for replacement of coarse aggregates and for the preparation of concrete blocks. In this project, we have followed Indian standard methods and arrived at the mix design for M30 grade concrete. The preliminary studies were conducted by mixing the slag with the cement concrete cubes of standard sizes.

II. LITERATURE REVIEW

Harsh Gupta et al (2017) The purpose of this study was to study the effect of steel slag such as changing the positive part by 0%, 10%, 20%, 30%, and 40% testing the concrete level of M25 & M30 after 7, 14, 28 and Days 50 water treatments. A rough amount of 20mm is selected and trained with a 10mm filter, a good amount of more than 4.75mm with a filter and stored in a filter of 600 microns used, compressive strength test, solid separation test, flexible test, steel slag was tested. The result shows that the maximum energy exchange rate combined is a slag metal for 7, 14, 28 days and 50 days for water healing. Comparison of compression strength, flexibility and strength to separate ordinary concrete and concrete with Slag Steel as part replacement Results show that normal concrete strength is slightly lower than steel replaced Slag. An increase in compressive strength is approximately 31.47% in 7 days treatment 20% in 14 days cures 18% 28 days and 40% slight decrease in 4.2% noted in 7 days and 3.4 days % 28 days of treatment compared to 30%. Increased M 30 concrete pressure increase of approximately 24.9% 7 days of healing 17.5% 14 days of healing and 15.5% 28 days of healing while 40% slight decrease of 3.6% noted 7 days and 2.5%. 28 days of treatment compared to 30%. The strength of the separated slag increases by increasing the percentage of iron slag to 30% by weight of fine aggregate. Increased tensile strength was approximately 16.7% in 28 days healing M25 concrete range and increased by 15.6% in 28 days of M2 treatment. 30th level concrete. Flexural strength increases within the percentage of iron slag up to 30% by weight of fine aggregate. Increased flexibility strength test approximately 36.7% with 28 days healing M 25 grade concrete and 24.7% 28 days treatment M M concrete floor.

Liwu mo et al (2017) in their studies entitled Accelerated carbonation and the use of steel slag concrete as binding materials and aggregates. Experimental study, 60% of slag metal powders containing high free CaO content, 20% Portland cement up to 20% active magnesia and lime mixed to fix binding compounds. Binding mixtures were then used to cast concrete, when up to 100% of the natural composite material (limestone and river sand) was replaced with steel slag aggregates. Concrete was exposed to carbonation healing with a concentration of 99.9% CO_2 and a pressure of 0.10 MPa at different times (1d, 3d, and 14d). Carbonation front, carbonate products, compressive strength, microstructure, and strength of concrete volume were investigated. The effects of CO_2 treatment on carbonation depth, compressive strength, and volume stability of steel slag concrete as binding materials and aggregates were investigated.

Ramesh et al. (2017) in this investigation entitled use of furnace slag (FS) and welding slag (WS) as a replacement of fine aggregates in concrete. The aim of this study is to examine the behavior of the WSA in HPC. For mixtures containing WS, the 7 d compressive strength of concrete cubes increased from 10 to 15% and 28 d compressive strength increased from 5 to 15%. It was concluded that 5% of WS and 10% FS replacement with fine aggregates is effective for practical purpose. On the basis of the above literature, weld slag was potentially used in the manufacture of bricks and as a replacement of fine aggregate in concrete.Six mixture proportions were made. Control mixture (CM) without weld slag was prepared and for other five mixtures, weld slag was replaced to fine aggregates at 10, 20, 30, 40 and 50%, respectively. To recognize the mixtures, each mixture was titled as CM, WSA 10, WSA 20, WSA 30, WSA 40 and WSA 50. WSA 20 denotes that the HPC mixture made with 20% WSA replacing the fine aggregate.

Ismail et al (2015) in this experiment entitled Reuse of waste iron as a partial replacement of sand in concrete the test of these waste –iron concrete mixes revealed that this method performed efficiently to improve the properties of the waste iron concrete mix. In this paper waste iron were partially replaced sand at 10%, 15% and 20% in total 1730 kg concrete mixtures. This test performed to evaluate waste iron concrete quality slump. The flexural strength of waste iron concrete mixtures at all curing periods tends to increase above the reference concrete mixes with an increasing ratio of waste–iron aggregate. The highest flexural strength was that of the concrete specimens containing 20% waste –iron aggregate at 28 days of curing, which is 27.86%higher than the reference mix at the same curing period. The compressive strength of the concrete mixes made of 20%waste-iron aggregate increase above the reference concrete mix by 22.60%, 15.90%, and 17.40% for 3,7 and 28 days curing periods. Both the fresh and dry density values of waste– iron concrete mixes at each age tend to increase above their reference values.

Rosales.j et al (2017) in this document entitled effect of stainless steel slag waste as a replacement for cement in mortars. In this studies replacing cement by stainless steel slag waste and improving the mechanical properties of the slag waste by using different types of treatment. The cement was replaced with different substitution percentage of untreated stainless steel slag and waste slag that was proceed to the crushing, burning, and both treatment to determine the optimum replacement ratio according to the mechanical properties. In this case based on multivariate factor analysis wasdeveloped to compare these proceed waste according to their mechanical behavior. A mortar sample with a mix proportion of 0.5:1:3(water; cement; sand) was designed as the control mix. To compare SW with cement made using common addition, three sets of cement with FA were manufactured with different substitution percentages (10%,20%,and 30%). samples with different substitution percentages for the manufacture of cement mortar were created to analyze the cement capacity of the stainless steel slag waste. The hardened mortar was characterized according to the six properties: bulk density, porosity, water absorption, compressive and flexural strength and dimensional instability. he shrinkage age was similar to or lowers than that of control OPC cement in mixes with a minimum substitution percentage in the manufactured of cement and concrete with steel slag. In cement mortar made with 20% and 30% SW, the shrinkage age value increased. Multivariate analyses were applied on compressive strength, flexural strength and shrinkage because they are main parameters to evaluate the possibility of using new cement. In this analysis were performed on the result of parameters used at 28 days of FS and CS and at 90 days for SH from cement mortar. The porosity of the material was observed using SEM analysis at 28 days. It indicates the high –resolution images of the fractured surfaces of different samples. The cement mortar with the addition of SW did not present large pores. The cursed and burned slag had lower values of loss relative to the control. Replacing cement with stainless steel slag waste for the manufacture of mortar improves the mechanical properties up to a certain degree of substitution. In these studies showed that replacing up to 20% of cement with crusted SW recommended.

III. MATERIALS USED

A. Cement

Ordinary Portland cement, 53Grade conforming to IS: 269 – 1976.Ordinary Portland cement, 53Gradewas used for casting all the Specimens. Different types of cement have different water requirements to produce pastes of standard consistence. Different types of cement also will produce concrete have a different rates of strength development. The choice of brand and type of cement is the most important to produce a good quality of concrete. The type of cement affects the rate of hydration, so that the strengths at early ages can be considerably influenced by the particular cement used. It is also important to ensure compatibility of the chemical and mineral admixtures with cement

Table 1:Properties of cement

Property	Value
Fineness Test	7.5%
Specific gravity of cement	3.15
Initial setting time	38 min
Final setting time	480 min

B. Fine Aggregate

Locally available river sand conforming to Grading zone I of IS: 383 –1970.Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens.

Table 2:Properties of Fine Aggregate

Property	Value
Specific Gravity	2.63
Water absorption	1.5%

C. Coarse Aggregate

Crushed granite aggregate with specific gravity of 2.77 and passing through 4.75 mm sieve and will be used for casting all specimens. Several investigations concluded that maximum size of coarse aggregate should be restricted in strength of the composite. In addition to cement paste – aggregate ratio, aggregate type has a great influence on concrete dimensional stability.

Table 3:Properties of Coarse Aggregate

Property	Value
Specific gravity	2.70
Water Absorption	2.0%
Size of Aggregates	20mm
Impact Test	15.2%

D. Slag

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

Table 4:Physical Properties of Slag

Composition	Value
Specific gravity	3.12

IV. MIX PROPORTION

The fundamental requirement of concrete mix is that, it should be satisfactory both in fresh as well as in hardened state, possessing certain minimum desirable properties like workability, strength and durability. Mix design is the process of selecting suitable ingredients of concrete of concrete, determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. There are number of methods of concrete mix design. In this project work, the concrete mix design recommended by is 10262-2019 is adopted.

We had used the following mix ratio of 1:1.89:3.37 with the water cement ratio of 0.43 to prepare the M30 grade concrete.

V. CASTING OF CONCRETE SPECIMEN

The concrete mixes have been prepared as per mix design arrived at for M30 concrete. The weight batching was adopted. The various ingredients have been measured using a weighing balance and spread in a mixing try. First dry mix was prepared by mixing coarse aggregate, fine aggregate, cement and steel slag in required quantities.

Fig.1 Concrete Cube Specimen

VI. HARDEN CONCRETE PROPERTIES

A. Compressive Strength

Compressive test is carried out on cube specimens prepared with and without steel slag. The compressive tests on hardened concrete cubes were carried out at 7 days and 28 days.

Mix Proportion	7 Days (N/mm^2)	Average	28 days (N/mm^2)	Average
Conventional Concrete	20.89 21.33 21.56	21.26	32.22 32.89 33.78	32.96
Mix 1 (10%)	19.56 19.78 19.11	19.48	31.56 31.33 30.89	31.26
Mix 2 (20%)	21.33 22.00 22.22	21.85	33.78 34.44 34.22	34.14
Mix 3 (30%)	24.89 25.11 25.78	25.26	37.78 38.22 38.89	38.29
Mix 4 (40%)	24.67 24.22 24.89	24.59	35.78 36.00 35.33	35.70
Mix 5 (50%)	25.11 24.00 24.22	24.44	36.89 37.11 36.22	36.74

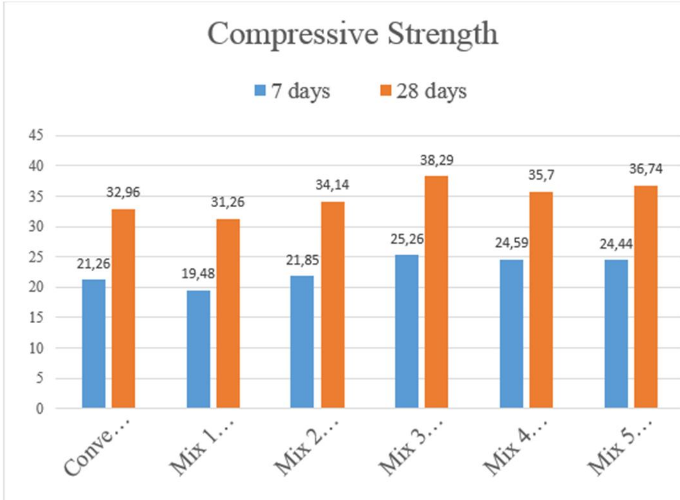


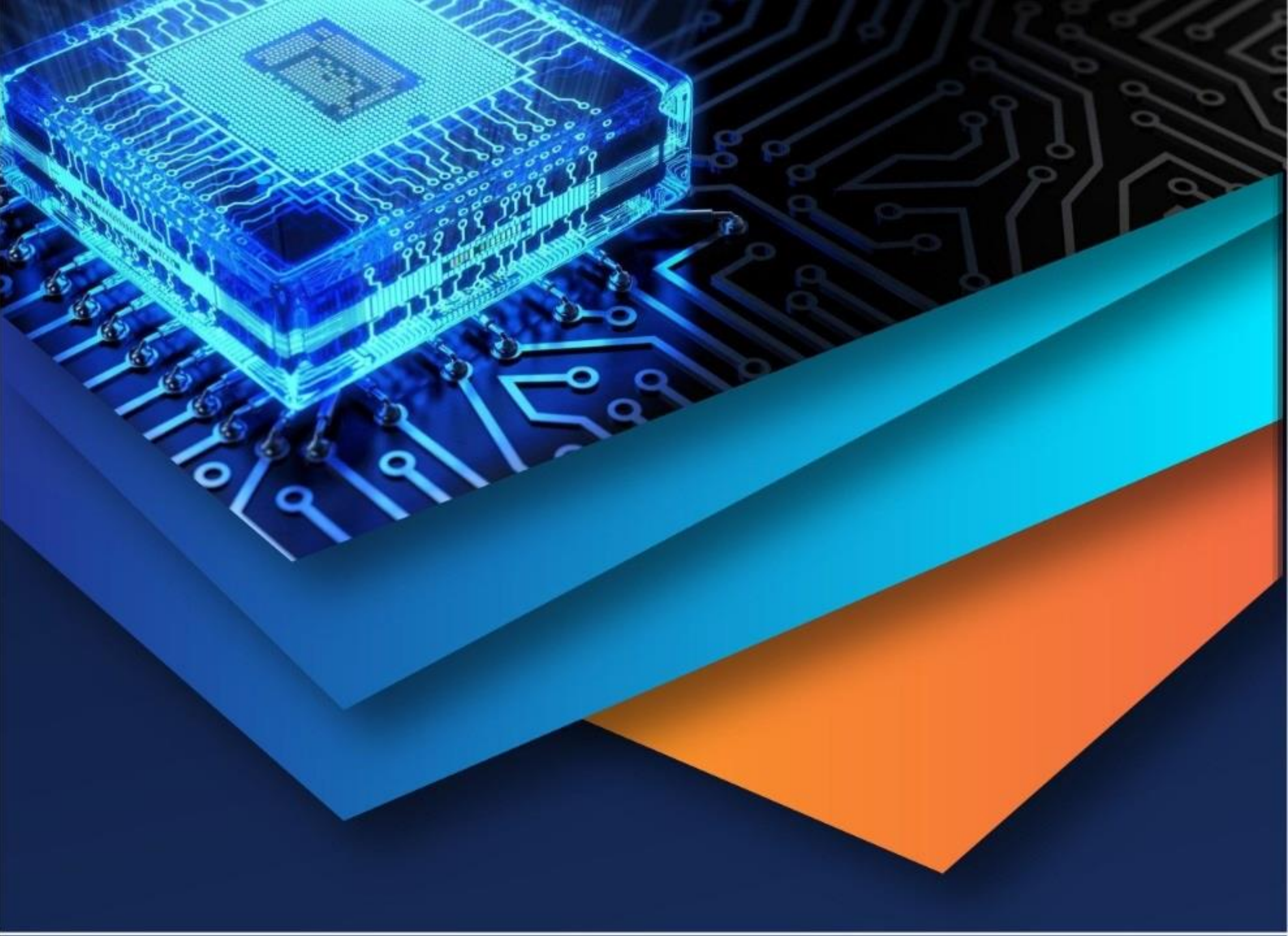
Fig. 2 Compressive Strength at 7 and 28 Days

VII. CONCULSION

The Optimum Compressive strength of concrete optain at 30% of steel slag replaced in coarse aggregate and then gradually decreases after further increment.

REFERENCES

[1] Book of ASTM Standard, Vol. 04.02, 2001
[2] BQSF; "Report of the Visit of the Slag Study Group of the Japan Iron and Steel Federation of BQSF", British Quarrying and Slag Federation Limited, June 29, 1978
[3] CMI, Use of Steel Slag in Civil Engineering Issues, Technical Report, NO.3, Construction Material Institute, Faculty of Engineering, University of Tehran, 2001 (in Persian)
[4] CMI, Use of Steel Slag in Civil Engineering Issues, Technical Report, NO.3, Construction Material Institute, Faculty of Engineering, University of Tehran, 2001 (in Persian)
[5] Geiseler, J., Slag-Approved Material for Better Future, Proceeding of International Symposium on the Utilization of Metallurgical Slag (ISUS99),Beijing,China,1999
[6] Subramani, T. "Experimental Investigations on Coir Fibre Reinforced Bituminous Mixes" International Journal of Engineering Research and Applications, Vol.2, Issue.3, pp 1794-1804, 2012.
[7] Subramani,T, Krishnan.S. And Kumaresan.P.K., Study on Exixting Traffic condition in Salem City and Identify the transport facility improvement projects, International Journal of Applied Engineering Research IJAER, Vol.7,No.7, Pp 717 – 726, 2012.
[8] Subramani.T, Sharmila.S, "Prediction of Deflection and Stresses of Laminated Composite Plate with Artificial Neural Network Aid", International Journal of Modern Engineering Research, Volume 4, Issue 6(Version 1), pp 51 -58, 2014
[9] Subramani.T, Senthilkumar.T, Jayalakshmi.J, "Analysis Of Admixtures And Their Effects Of Silica Fumes, Metakaolin And Pfa On The Air Content",International Journal of Modern Engineering Research, Volume 4, Issue 6 (Version 4), pp 28-36, 2014.
[10] Subramani.T, SakthiKumar.D, Badrinarayanan.S "Fem Modelling And Analysis Of Reinforced Concrete Section With Light Weight Blocks Infill " International Journal of Engineering Research and Applications, Volume. 4, Issue. 6 (Version 6), pp 142 - 149, 2014.
[11] Liwu mo, Feng zhang, Min deng (2017)"Accelerated carbonation and performance of concrete made with steel slag as binding material and aggregates″, journal of cement and concrete composites, vol83,pp.138-145.
[12] B.kgnaavel, V. Subathradevi (2014), "properties of concrete manufactured using steel slag″, journal of procedia engineering, vol. 92, pp.95-104.
[13] Harsh gupthaanil Kumar (2017)," strength properties of steel slag in concrete″ , journal of internal journal of engineering research and technology , vol .6,pp. 93-97



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