Evaluate the Properties of Concrete Prepared Using Iron Slag by Partial Replacement of Sand

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Abstract— Over the period of time people are getting aware about the problem people face due to waste produced from industries as it is non biodegradable and simply dumping it is not the real solution. The world is eagerly is carrying out the research over the properties of the waste produced from industries with an aim of utilizing the valuable component of the waste so that it could be partially or fully used as secondary raw material in other industrial branches. With such aims and such utilization in the construction waste like steel or iron

Although iron and steel slag is still today considered 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. Moreover, since the earliest times of the discovery and development of processes of iron and other metals production, slag as by-product is used for satisfying diverse human needs, from the production of medicines and agro-technical agents to production of cement and construction elements.

Considering the specificity of physical and chemical properties of metallurgical slags and a series of possibilities for their use in other industrial branches and in the field of civil constructions, this report demonstrates the possibilities of using iron slag as partial replacement of sand in concrete.

Index Terms— industry slag, concrete, compressive strength.

I. INTRODUCTION

Iron and steel making slag are by products of the iron making and steelmaking processes. To date, these types of slag have been widely used in cement and as aggregate for civil works. Slag is by-product formed in smelting, and other metallurgical and combustion processes from impurities in the metals or ores being treated. During smelting or refining slag floats on the surface of the molten metal, protecting it from oxidation or reduction by the atmosphere and keeping it clean. In iron and steel production slag phases are generated, formed mainly from the addition of mixture of oxides and fluxes and are also composed of reaction products like those resulting from the oxidation of charge materials and the dissolution of refractoriness. Primary purpose is to refine the liquid metal by removing impurities.

The main slag's are classified in various types: ferrous slag, iron slag generated in blast furnace process, steel slags, non-ferrous slag generated by production non-ferrous metals (Cu, Zn, Pb, Ni) boiler slag obtained by coal combustion plants and incineration slag's generated by combustion of solid waste.

The report presents an investigation of mechanical properties of concrete prepared by adding iron slag as replacement of sand in various percentages.

II. MATERIAL AND METHODS

For this study the various type of materials used in casting for the grade of concrete i.e. M20 are: fine aggregate, course aggregate, cement, water at normal temperature. Before using the material in the design of the mix various test were performed over the materials matching the IS code specification. Cement used for the project is Ordinary Portland Cement (OPC) of 43 Grade (JK cement) from single lot. The physical properties and sieve analysis of both fine aggregate as well as of course aggregate was done as per **IS: 2386 (Part I) – 1963.**

Iron slag from nearby steel plant at Kandrori (hp) was graded and after proper sieve analysis it was used such that only categorized as fine aggregate and could be replace sand as per IS code was used for the project with admixture Magnesium Sulphate.

The mix design for the grade M20 of concrete was prepared using following proportions:

 DOI : 10.35291/2454-9150.2022.0107

Mix Design ation	Water (W) kg/ m^3	Cement (C) kg/ m^3	Fine Aggregates(FA) kg/m^3	Iron Slag (IS) kg/ m^3	Coarse Aggregates (CA) kg/m^3	Ratio of W:C:FA:IS :CA
CM	180	360	577.47	0.00	1233.54	0.5:1:1.59:0:3.42
S1 (10%)	180	360	519.723	57.38	1233.54	0.5:1:1.43:0.15:3.42
S2 (20%)	180	360	461.976	114.772	1233.54	0.5:1:1.27:0.31:3.42
S3 (30%)	180	360	404.229	172.158	1233.54	0.5:1:1.11:0.47:3.42

Table 1.1: Mix Proportion

Method used for testing the properties of concrete are:

COMPRESSIVE STRENGTH TEST AND SPLIT TENSILE STRENGTH

Test specimens of size 150 × 150 ×150 mm were prepared for testing the compressive strength concrete. The mixes for 0%, 10%, 20% and 30% partial sand replacement percentages of iron slag were cast into cubes and cylinders for subsequent testing.

III. RESULT AND DISCUSSION

COMPRESSIVE STRENGTH OF CONCRETE MIXES OF SPECIMEN SIZE 150 × 150 × 150 WITH IRON SLAG:

In this study, to make concrete, cement and fine aggregate were first mixed dry to uniform colour and then coarse aggregate was added and mixed with the mixture of cement and fine aggregates. Water was then added and the whole mass mixed. The interior surface of the moulds and the base plate were highly oiled before concrete was placed. After this the specimens were removed from the moulds and placed in clean fresh water at a temperature of $27^0 \pm 2^0$C for 28 days curing. For testing in compression, no cushioning material was placed between the specimen and the plates of the machine. The load was applied axially without shock till the specimen was crushed. Test results of compressive strength test at the age of 3, 7 and 28 are given in the Table 4.1. The cube strength results of concrete mix are also shown graphically.

Table 1: Compressive strength of concrete mixes with iron slag

Mix	Average Compressive Strength (N/mm^2)		
	3 days	7 days	28 days
CM	7.13	17.5	21.3
10% slag	7.93	17.76	23.33
20% slag	8.26	18.86	24.28
30% slag	8.76	19.35	24.88

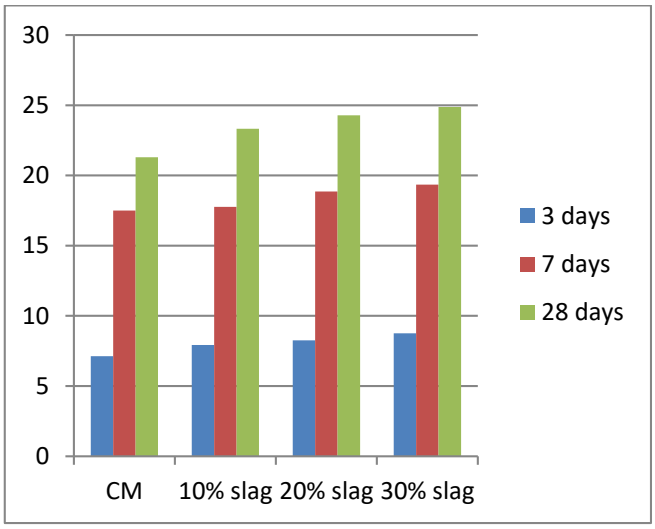

Figure 1.1 Variation of Compressive Strength

Figure 1.1 shows the variation of compressive strength with replacement with iron slag. The compressive strength increases with the increase in percentage of iron slag as compared to control mix. After adding 10% iron slag in the mix, there is increase of 26% after 3 days, 50% increase after 7 days and 43% increase after 28 days.

IV. CONCLUSION

The Compressive strength increase with the increase in percentage of iron slag as compared to control mix. It gives high strength concrete by replacing iron slag with the sand.

REFERENCES

[1] Al-Akhras N.,M, (2006). "Durability of metakaolin concrete to sulfate attack." Cement and Concrete Research Vol. 36 pp 1727-1734.

[2] Aldea C, M., Young, F., Wang, K., and Shah, S. P. (2000). "Effects of curing conditions on properties of concrete using slag replacement." Cement and Concrete Vol. 30 pp 465-472 .

[3] Ameri M., Kazemzadehazad.S. (2012) " Evalution of the use of steel slag in concrete" 25th ARRB Conference – Shaping the future: Linking policy, research and outcomes, Perth, Australia(2012) .

[4] Bakhareva T. , Sanjayana J.G. , and Cheng Y.B. (2001) " Sulfate attack on alkali-activated slag concrete " Cement and Concrete Vol. 32 pp 211-216 .

[5] Bilim C., Atis C. D., Tanyildizi H. & Karahan O. (2008) "Predicting the Compressive Strength of Ground Granulated Blast Furnace Slag Concrete using Artificial Neural Network". Advances in Engineering Software Vol. 40 pp 334–340.

[6] Binici, H., Temiz, H.S., and Kose, M.M. (2006). "The effect of fineness on the properties of the blended cements incorporating ground granulated blast furnace slag and ground basaltic pumice." Construction and Building Material Vol. 21 pp 1122-1128

[7] Higgins, D.D. (2003). "Increased sulfate resistance of ggbs concrete in the presence of carbonate." Cement and Concrete Composites Vol. 25 pp 913-919

 DOI : 10.35291/2454-9150.2022.0107

[8] Ismail, Z.Z., and AL-Hashmi, E.A. (2007). "Reuse of waste iron as a partial replacement of sand in concrete."Waste Management Vol. 28 pp 2048-2053

[9] Maslehuddin. M., Sharif, M. Aifarabi., Shameem, M., Ibrahim, M., and Barry, M.S. (2002). "

a. Comparison of properties of steel slag and crushed limestone aggregate concretes." Construction and building material Vol. 17 pp 105-112

[10] Muhmood , L., Vitta, S., and Ventakeswaran, D. (2009). "Cementious and Pozzolanic behaviour of electric arc furnace steel slags" cement and concrete research Vol. 39 pp 102-109

[11] Mingyu, H., Fumei, L., and Mingshu, T. (2006). "The thaumasite form of sulfate attack in concrete of Yongan Dam." Cement and Concrete Research Vol. 36 pp 2006 -2008 .

[12] Nadeem, M., and Pofale, A.D. (2012). "Replacement Of Natural Fine Aggregate With Granular Slag - A Waste Industrial By-Product In Cement Mortar Applications As An Alternative Construction Materials." International Journal of Engineering Research and Applications Vol. 2 pp 1258 -1264.

[13] Nazari A., Riahi S. (2010) "Splitting tensile strength of concrete using ground granulated blast furnace slag and SiO2 nanoparticles as binder" Energy and Building Vol. 43 pp 864-872.

[14] Ogawa.S., Nozaki, T., Yamada, K., Hirao, H., and Hooton, R.D. (2011). "Improvement on sulfate resistance of blended cement with high alumina slag." Cement and Concrete Research Vol. 42 pp 244-251.

[15] Pellegrino, C., and Gaddo, V., (2009). "Mechanical and durability characteristics of concrete containing EAF slag as aggregate." Cement & Concrete Composites Vol. 31 pp 663-671.

[16] Roziere, E., Loukili, A., Hachem, R.E., and Grondin, F. (2009). "Durability of concrete exposed to leaching and external sulphate attacks." Cement & Concrete Composites Vol. 35 pp 721-730 .

[17] Veiga, K.K., and Gastaldini, A.L.G. (2012). "Sulfate attack on a white Portland cement with activated slag." Construction and Building Material Vol. 34 pp 494-503 .

[18] Zhang, T., Yu, Q., Wei, J., Li, J., and Zhang, P. (2011). " Preparation of high performance blended cements and reclamation of iron concentrate from basic oxygen furnace steel slag." resources .conservation and recyclingVol 56 pp 48-55.

[19] Khajuria, C., Kumar, M. G., & Siddique, R. G. (2013). Effect of Partial Replacement of Sand by Iron Slag on Strength Characteristics of Concrete (Doctoral dissertation).

 DOI : 10.35291/2454-9150.2022.0107