TO STUDY THE PROPERTIES OF SELF COMPACTING CONCRETE USING IRON SLAG AS PARTIAL REPLACEMENT OF FINE AGGREGATE

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Abstract: This review has been done to study the effect of iron slag on self-compacting concrete both as fine and coarse aggregate. To study the properties of concrete like strength, workability, segregation, bleeding etc. properties of concrete having iron slag as partial replacement of fine and coarse aggregates. It is generally found that the compressive strength and tensile strength of concrete increases. Iron slag has some cementitous properties which increases the strength of concrete. But the workability of concrete decreases due to increase of friction of iron particles and their rough surface. The iron and steel rolling mills are the main source of the production of iron slag. The results on an experimental program carried to explore the possibility of use of iron slag as partial replacement of fine aggregate (sand) in self-compacting concrete (SCC). SCC mixes were designed and fine aggregates were replaced with 0, 10, 25, and 40% iron slag.

Keywords: Iron Slag, Granulated Blast Furnace Slag, Electric Arc Furnace Slag, Self Compacting Concrete, Strength, Workability

INTRODUCTION

Iron slag is the co-product from the reduction of iron ores to produce molten iron and molten slag. In India annual iron slag production is about 17thousand tons. Large volume of iron slag disposed off in open land in near-by areas which pose great threat to living beings. Use of iron slag in the manufacturing of concrete is the good overture to its disposal. With continuous increase in the production of iron slag; it is necessary and appropriate to use it in concrete rather than disposal. The main properties of concrete, such as strength, durability and serviceability, depend mainly on the properties and the quality of the materials that are used in preparing it. Therefore, the use of waste materials, such as iron slag, in concrete may have positive effect.

LITERATURE REVIEW

Shahir Rehman , Shahid Iqbal, Ahsan Ali (2018) SCC may be developed by replacing major portion of cement and natural fine aggregates by waste materials i.e. glass powder and granular steel slag, without compromising of mechanical properties of concrete. The workability of concrete increases with increase in glass powder portion and reduces by increasing the portion of granulated blast furnace slag, which may be due to improved packing density with incorporation of glass powder (GP) and of GBFS may be attributed to the porous and rough texture of steel slag. The combined use of glass powder and granular steel slag disadvantageous, because the huge decrease in workability at higher replacement levels of fine aggregate (FA) by granular steel slag is supplemented by increase in workability with increase in glass powder content, making is possible to achieve self-compaction. Compressive strength, split tensile strength, flexural strength and modulus of elasticity increase with the increase in granular steel slag content at constant level of glass powder which may be due to the pozzolanic action of steel slag aggregates or difference in hardness of steel slag and replaced aggregates. This phenomenon may be further investigated. Compressive strength, splitting tensile strength, flexural strength and modulus of elasticity reduces with increase in glass powder content at constant level of steel slag aggregates.

Sayed Imran Ali, Ranjan Kumar, Mukesh Kumar Yadav (2018) The slump Value increases with increase in percentage of ground granulated blast furnace slag (GGBS) content in the mix, but there is slight reduce with increase in the content of Kota stone powder. Even by reducing cement content by 40% and replacing it by GGBFS, the compressive strength of M 40 Grade concrete does not decrease (at the age of 56 days) and it is observed to be almost similar to the control concrete (without GGBFS). In the mixes with 40% GGBFS, if fine aggregate is partially replaced by Kota stone slurry powder in the range 10% to 20%, then also, compressive strength does not decrease (hardly variation of 1 to 3% was observed at the age of 56 days). At the age of 7 days and 28 days, the compressive strength of concrete with cement replaced by GGBFS by 40% is observed to be lesser than the control mix (without GGBFS). In the mixes with 40% GGBFS, if fine aggregate is partially replaced by Kota stone slurry powder in the range 10% to 20%, then flexural strength does not decrease (hardly variation of 1 to 3% was observed at the age of 28 days). But the strengths of the mixes with 20% and 30 % GGBFS with the same range of Kota stone slurry powder content were observed to be lesser than the control mix (without GGBFS).

A. Santamaría, A. Orbe, M.M. Losañez, M. Skaf, V. Ortega-Lopez, Javier J. González (2017) The reuse of electric arc-furnace slag in the manufacturing of pumpable structural concrete is a useful, affordable, and viable solution. It is possible to prepare self-compacting mixes using electric arc furnace slag as coarse and fine aggregate, using appropriate doses and compatible chemical admixtures. The numerical simulation of the viscous flux of these self-compacting mixes using a suitable model leads to very acceptable results. The analysis of these self-compacting concretes in the hardened state points to a cohesive internal structure with reasonably good mechanical properties. SEM (Scanning Electron Microscopy) observation of the fracture surfaces in the SCC-EAFS (Electric Arc Furnace Slag) concrete showed significant features to understand their structure and their mechanical behavior.

Flora Faleschini. Amaia Santamaria. Mariano Angelo Zanini. Jose´-Toma´s San Jose´. Carlo Pellegrino (2017) The use of Electric Arc Furnace (EAF) slag as coarse aggregate allows compressive strength enhancement up to 30% when it is used as substitution of natural roundish aggregate, and up to 17.5% when it replaces crushed natural one. This behavior can be observed in concretes prepared with low w/c ratio, where ultimate strength is not affected by poor cementitious matrix quality. Strength gain can be assigned to both the slag shape and texture, and to its enhanced mechanical properties and chemical composition, which improve the quality of the Interfacial Transition Zone, as observed also in other literature works. Bond strength between concrete and ribbed steel bars (mean, ultimate and residual frictional) is higher when crushed aggregates are used, referring to low w/c concretes. The highest bond strength is observed in specimens including EAFS (Electric Arc Furnace Slag), with an increase of +41 and +30% in the peak stress, if compared respectively to NAT and CRU mixture. Concerning concretes manufactured with high w/c ratio, few differences are observed between the tested mixtures. Concerning bond with plain bars, higher scatter of results is obtained than with ribbed ones. Also in this case a substantial increase in the ultimate strength is displayed by mixtures with crushed aggregates if compared to NAT mixture. The existing equations for ultimate bond strength prediction with ribbed bars are typically conservative for (relatively) high strength concretes, whereas they fit better for low strength concretes.

Gurpreet Singh, Rafat Siddique (2016) Workability of self-compacting concrete (SCC) mixtures decreases due to the increase of iron slag percentage may be because of multi-angle and rough surface of iron slag aggregates. Compressive strength of SCC mixtures increases with the increase of iron slag content. Iron slag SCC performs better in sulphate attack. Iron slag SCC mixture gives good resistance to chloride ion penetration. It was also found that internal structure of concrete gets denser after the inclusion of iron slag. Water absorption of iron slag mix is less as compared to normal SCC at stages of curing.

Gurpreet Singh, Rafat Siddique (2016) The results show that slump values, U-box values and L-box values decreased with the increase in level of iron slag. V-funnels test value of time is increased as the iron slag content dose. The rough texture and complicated shape of particles of iron slag, which plays a significant role in increasing the interparticle friction. The above factor contributed lowering the slump, L-box and U-Box and increase passing time in V-funnel values. Therefore, it can be concluded that decrease in workability of SCC on use of iron slag. Compressive strength, splitting tensile strength and flexural strength increase with increase of iron slag percentage. The maximum increase in compressive strength is 20% at all ages (7, 28 and 91 days) with 40% replacement. Splitting tensile strength of SCC improved at all the curing ages on use of iron slag as fine aggregate in partial replacement of river sand. At early curing age of 7 days, splitting tensile strength and compressive strength ratio increased with the increase in levels of sand replacement with iron slag in SCC. However, with the progress of curing age of 28 days, the effect of inclusion of iron slag in SCC on splitting tensile strength and compressive strength ratio is not so predominant. Again at 91 days, splitting tensile strength and compressive strength ratio increased with the increase in levels of sand replacement with iron slag in SCC. The modulus of elasticity of iron slag concrete mixtures was higher than that of control SCC mixture at all the curing ages. Images of SEM show the well crystal formation with increase in iron slag content and age and microstructure gets denser due to
the formation of ettrinigite in void spaces.

G.C.Behrera, R.K. Behera(2016) The slump value slag SCC decreases with increase in percentage of slag, which shows decrease in workability of concrete. The compressive strength of slag SCC increases with the increase in percentage of slag contain. The split tensile strength of slag SCC increases with increase in the percentage of slag but the increase is not so much as compare to compressive strength. The flexural strength of slag mix also increases with the increase in slag percentage.

Yeong-Nain Sheen, Duc-Hien Le, Te-Ho Sun(2015) Stainless steel reducing slag (SSRS) is used as partial replacement of ordinary Portland cement (OPC).Up to some lower extent (20%), percentage replacement of OPC with SSRS, workability of concrete increases with increase of slag but at higher percentage(>20%) replacement workability of concrete decreases with increases in SSRC. Viscosity and passing ability of concrete also decreases. Strength of concrete decreases with increase of slag as SSRS have less cementitous strength as compare to OPC. Compaction of concrete increases by use of slag. The SCC shows a less resistivity of corrosion prevention for embedded reinforcements.

Gaurav Singh, SouvikDasa, Abdulaziz Abdullahi Ahmeda, Showmen Sahab, Somnath Karmakar (2015) The compressive strength of concrete increases with increase in Granulated Blast Furnace Slag (GBFS) percentage up to a certain percentage and after that it decrease. For normal condition most optimum percentage of GBFS for both strength and economy is 40%-50% and for marine condition it is 50%-60%.The long term strength development of GBFS concrete is almost double of normal concrete in both normal and marine conditions.

Ahmed S. Ouda, Hamdy A. Abdel-Gawwad (2015) The Physico-mechanical characteristic for mixes improves. The compressive strength of iron slag mixes increases as the percentage of iron slag increases. Mortar sample of full sand replacement exhibited the highest compressive strength. Percentage iron slag can fully replace sand in cement mortar. Mortar having 100% iron slag as fine aggregate has significant effect on shielding efficiency. Workability of slag mixes decreases as increase in iron slag percentage.

Chetan Khajuria, Rafat Siddique (2014) With the increase of percentages of iron slag in the concrete mix, the compressive strength of concrete also increases. At earlier age strength gain was higher than the later age. As percentage of iron slag increases workability of concrete decreases with increase in iron slag percentage.

Zainab Z. Ismail, Enas A. AL-Hashmi (2007) The flexural strengths of waste-iron concrete mixes increases. The compressive strengths of the concrete mixes increases with increase in percentage of iron slag. Density of concrete increases as the value of iron slag increase. Workability of concrete decreases with increase in iron slag percentage.

Juan M. Manso, Javier J. Gonzalez, Juan A. Polanco (2004) Oxidizing electric arc furnace slag taken from the making of plain and low-alloy carbon steels can be efficiently and systematically used in the production of concrete. The conditioning of the slag for its use as an aggregate in concrete requires it to be crushed, homogenized, weathered, and aged. Special attention must be paid to the mixes of concrete in order to achieve a suitable fine aggregate. This must be obtained by mixing fine slag and filler material in a proportion which needs to be studied in each case. The concretes obtained with oxidizing slag as aggregate have good properties in both the fresh and the hardened state, and have a wide range of possible uses. The durability of the EAF slag concrete is acceptable, especially in the geographical region for which its use is proposed, where the winter temperature hardly ever falls below 0°C.

CONCLUSION

The use of iron slag or granulated blast furnace slag or electric arc furnace slag in concrete as fine or coarse aggregate has many positive effect. All these slag has some cementitious properties which may help in increasing the strength of concrete. Compressive strength of SCC increases by using iron slag as partial replacement of both fine and coarse aggregate which may be due to the cementitious property of slag. Split tensile strength of concrete increases by using iron slag as partial replacement of both fine and coarse aggregate. Workability of SCC reduces by using iron slag as partial replacement of fine aggregate, and in case of, iron slag as replacement coarse aggregate it depends on shape and surface of aggregate. Density of concrete increases by increasing the value of iron slag. The Physico-mechanical characteristic for mixes improves.
Stainless steel reducing slag (SSRS) is used as partial replacement of ordinary Portland cement (OPC).Up to some lower extent (20%), percentage replacement of OPC with SSRS, workability of concrete increases with increase of slag but at higher percentage(>20%) replacement workability of concrete decreases with increases in SSRC. Viscosity and passing ability of concrete also decreases with increases in SSRC.

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