© 2017 IJEDR | Volume 5, Issue 4 | ISSN: 2321-9939

Viability of Slag on The Strength Of Concrete, A Review

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Abstract - Due to strict rules and regulations by the Government on the management of industrial waste, it has become very difficult for industries to survive in the market while producing waste which leads to numerous environmental problems. Slag is one of the industrial wastes which is hugely produced by the Steel Industries and Iron industries in the world as well as in India which is still considered as the waste. But recycling of steel and iron slag in the process of concrete strength is one of the viable alternatives so that the waste of slag can be used and the natural resources are preserved up to a certain limit. Because the direct use of natural material in the process of concrete strength emits large amount of green house gases, carbon dioxide etc. In order to overcome from these problems use of slag is one of the best alternatives for concrete strength without environmental problems. Slag is also referred as the by-product of the concerned industries. Slag is used in the process of concrete strength up to a certain limit as a partial replacement. This paper is based on existing review of literature; an attempt has been made to study the use of slag as a partial replacement in the process of concrete strength.

Keywords - Steel Slag, Iron Slag, Concrete Strength etc

Introduction

Slag is a waste material which is generated from different processes of industries such as smelting, welding, metallurgical and combustion processes. Slag is mainly composed of two types i.e., Steel Slag and Iron Slag. Steel slag is a waste material which is acquired within the process of basic oxygen steel (BOS) where high pressure is blown in to the vessel containing molten iron steel scrap and lime and electric arc furnace (EAC) where high voltage of current is utilised to generate the heat for the acquisition of steel slag. Where as Iron slag is also a waste material which is acquired through the process of blast furnace where pig iron is obtained and is produced by the blend of down to earth constituents of iron ore with the flux of lime stone. The chemical properties of the slag is same while as they vary each other in physical properties due to different cooling methods. The waste material of steel slag is produced annually in India and worldwide by 19 million metric tonnes and 50 million metric tonnes respectively. Steel slag is eco-friendly and readily available alternative for concrete strength. Due to the availability of limited natural resources and the peak demand of concrete, as the 70-75% of volume of concrete is composed of aggregates, alternative sources like slag are used which will result in the well being of the planet and its sustainability for future development.

Objectives

1. To study the slag.
2. To study the viability of slag on the strength of concrete.

Review of Literature

Chetan (2014), after adding 10% iron slag in the mix, there was an increase of 26% after 7 days, 50% increase after 28 days and 43% increase after 56 days as compared to the control mix. By adding 20% and 30% iron slag , there was large amount of increase in percentage i.e. 68%, 91%, 78% and 125%, 113% , 87% after 7, 28 and 56 days respectively. With the increase of percentages of iron slag in the concrete mix, the compressive strength also increases. The early age strength gain is higher as compared to later ages if 30% of fine aggregate is replaced by iron slag.

Pankaj (2016), workability decreases as the percentage replacement of fine aggregate by steel slag increases. This is due to the higher water absorption property of steel slag (3%) as compared to natural fine aggregate. The compressive strength of concrete increased by 7.90% for 20% replacement of steel slag and nearly 3.29% rise for 40% replacement of steel slag as compared to the compressive strength obtained for 0% replacement of steel slag. For 60%, 80% & 100% replacement proportions, fall in compressive strength of about 9.91%, 16.50% and 25.08% respectively is noticed. The increase in strength is due to shape, size and surface texture of steel slag aggregate, which give better adhesion between the particles and cement paste. As the steel slag is porous, higher replacement of fine aggregate gives poor results. For spilt tensile strength, all proportions satisfied the minimum criteria as per Indian standards, there was highest increment of about 21.52% in spilt tensile for 20% replacement proportion. For flexural strength, all proportions satisfied the minimum criteria as per Indian standards, there was highest increment of about 32.59% in flexural strength for 20% replacement proportion. The use of steel slag concrete on higher replacement percentage may lead to an efficient use of waste material and solve various environmental issues. As in this research work, if steel slag concrete of 60% replacement is used, it may solve the shortage issues of deficit natural sand and also lead to economical construction as steel slag is freely and readily available. But the disadvantage is increase in the density of concrete at higher replacement as the specific gravity of natural sand is lower as compared to steel slag. At 60% replacement, the increase in density of concrete is 4.92% and the actual value obtained is 26.34 kN/m3. Further study is required to be carried out to sort this disadvantage of increment in density of concrete. May be the use of lighter coarse aggregate is the solution of this issue.

Shriver P (2016), compressive strength and tensile strength of concrete increased with increase in steel slag quantity as a replacement to fine aggregates (25% cement was replaced by fly ash). Concrete mix showed maximum value of compressive and tensile strength for 30% replacement of fine aggregate by steel slag. The 30% replacement performed better in strength than 40% replacement (25% cement was replaced by fly ash). Metakoalin addition of 10% as a replacement to cement to a steel slag concrete further resulted in increase in strength of concrete, the reason being metakoalin and fly ash form a strong adhesive bond. Capillary rise and water absorption increased with increase in steel slag content but decreased with the addition of metakoalin in a concrete mix. Experimental results concluded that concrete sample with cement replacement of 15% and 10% by fly ash and metakoalin respectively, 40% replacement of fine aggregates by steel slag performed best than all other mixes.

A I Tamboli (2015), got an increase in compressive strength at 20% of replacement ratio with 100% of replacement of natural sand with artificial sand in concrete. The enhancement in compressive strength was observed to be 1.1 times than that of our convectional concrete at 28 days of curing. Such type of combination can be used in our construction as its giving good strength and also supports green engineering concept.

Khalid R (2014), after adding 10% iron slag in the mix, there is an increase of 2.7% after 7days, 2.56% increase after 14 days and 5% increase after 28 days as compared to the control mix. By adding 20%, 30%, 40% iron slag, there is large amount of increase in percentage i.e. 17.27%, 12.82%, 13.73% and 30%, 23.64%, 21.36% and 6.16%, 1.87%, 2.97% after 7, 14 and 28 days respectively as compared to the control mix design concrete at 0% replacement of coarse aggregate . After adding 50% Iron slag there is decreases in concrete. Up to 50% replacement. The Compressive strength tends to increase with increase percentages up to 30% of iron slag in the mix. At 30% replacement of coarse aggregate with Iron slag aggregate gives desirable compressive strength. At 20% of replacement of coarse aggregate with iron slag aggregate gives desirable flexural strength which can be can accounted for the construction practices. After adding 30%, 40% and 50% iron slag in concrete there is decreases in hardened concrete.

Hence, it could be recommended that the Iron slag aggregate could be effectively utilized as coarse and fine aggregate in all concrete applications either as partial or full replacements of normal coarse and natural fine aggregate.

Research Model

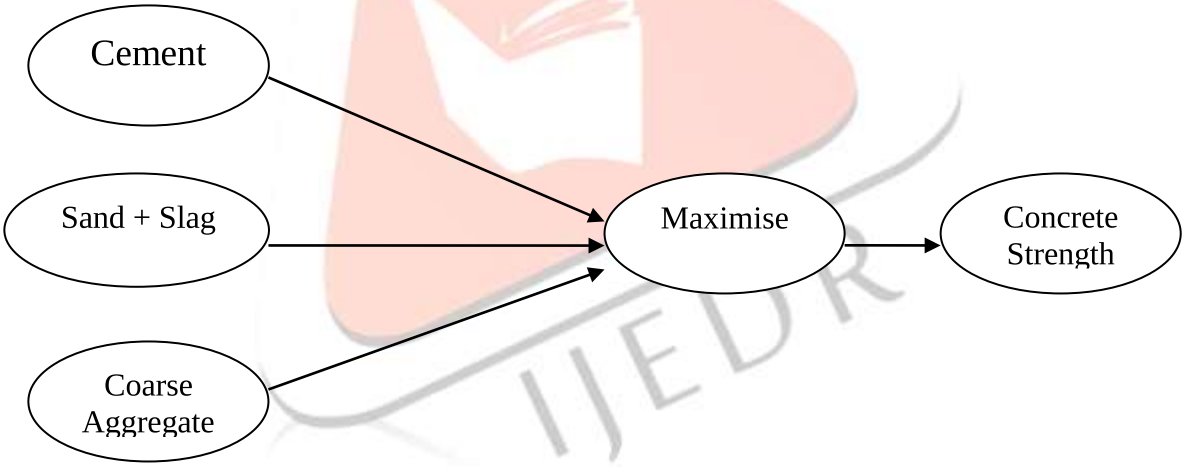

Figure: 1.1

On the basis of the present review of literature the researcher developed the research model which clearly depicts that the use of slag as a partial replacement of aggregate increases the strength in concrete than the normal concrete.

Conclusion

On the basis of the existing review of literature it can be concluded that the strength increases at an increasing rate up to 30% use of slag and increases at decreasing rate after 30% use of slag. But the highest level of strength is attained at 30% replacement of aggregates in compressive strength. While in case of split tensile and flexural strength, highest level is attained at 20% replacement by increasing 20% & 30% strength respectively. The optimal average strength level in all the cases is achieved at 25% use of slag. Slag is positively as well a negatively correlated with the concrete strength. Slag can be replaced with all of the ingredients (cement, fine aggregate and coarse aggregate) in separate mixes because the slag contains cement clinker like C_2S and C_3S.

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