A Review on Experimental study on Concrete by Partially replacing sand with Steel Slag

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Abstract- *Due to growing environmental awareness, as well as stricter regulations on managing industrial waste, the world is increasingly turning to researching properties of industrial waste and finding solutions on using its valuable component parts so that those might be used as secondary raw material in other industrial branches. Although 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 steel 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 constructional elements.*

Keywords- construction, cement, steel, slag, civil etc..

I. INTRODUCTION

India is one of the fast developing countries in the world and therefore industrialization needs a growth. Industries growth is one of the biggest sign of growth of Indian economy but the saddest part is many of industries in view of its growth are neglecting our mother environment and thus polluting it by not taking proper care of waste management. A modern lifestyle, alongside the advancement of technology has led to an increase in the amount and type of waste being generated, leading to a waste disposal crisis. In developing countries, accumulation of unmanaged industrial waste has resulted in an increased environmental concern.[1]

Recycling of such industrial wastes is the viable solution not only to pollution problem, but also the problem of land filling. The problem of waste accumulation exists worldwide, specifically in the densely populated areas. Most of these materials are left as stockpiles, landfill material or illegally dumped in selected areas. Large quantities of this waste cannot be eliminated. However, the environmental impact can be reduced by making more sustainable use of this waste. This is known as the “Waste Hierarchy’’. Initiatives are developing worldwide to control and regulate the supervision of sub-products, residuals and industrial wastes in order to preserve the environment from contamination. A good solution to the problem of recycling industrial excess would be by burning them in a controlled environment and use the ashes (waste) for more polite means. The use of industrial waste produced by industrial processes has been the attention on waste reduction. For years, scientists and researchers have been searching for possible solutions to environmental concerns of waste production and pollution. Many have found that replacing raw materials with recycled materials reduces our dependency on raw materials in the construction industry. Its aim is to reduce, re use, or recycle waste, the latter being the preferred option of waste disposal. A waste management plan directs the construction activities towards an environmentally friendly process by reducing the amount of waste materials and their discard in landfills. The environmental and economic advantages that occur when waste materials are diverted from landfills include:
a) Conservation of raw materials;
b) Reduction in the cost of waste disposal; and
c) Efficient use of the materials
d) Availability of land for public use

In view of utilization of industrial waste in concrete, the present paper experiments the utilization of steel slag in different compositions that were added to the raw material at different levels to develop sustainable concrete. Concrete being widely used construction material has went through lots of developments and in terms of its per capita consumption, it is second most consumed material in the country, next only to water. The most important part of concrete is cement. Cement manufacturing is a highly energy intensive process, which involves intensive fuel consumption for clinker making and resulting in emission of Greenhouse gases like carbon dioxide (CO_2) in large amount ,which is very harmful for the environment. In order to minimize this problem we use the concept of supplementary cementations material. The concrete industry is one of two largest producers of carbon dioxide (CO_2), creating up to 5% of worldwide man-made emissions of this gas. Since the early 1980’s, there has been an enormous demand for the mineral admixture and in future this demand is expected to increase even more .Also in this modern age every structure has its own intended purpose and hence to meet this purpose modification in traditional cement concrete has become essential. This situation has led to the extensive research on concrete resulting in mineral admixture to be partly used as cement replacement to increase workability in most structural application. If some of raw material having similar composition can be replaced by weight of cement in concrete then cost could be reduced without affecting its quality. This paper focus on utilization of industrial waste produced by industrial processes steel slag for waste reduction research for economic, environmental, and technical reasons.[2]

Slag is a by-product generated during manufacturing of pig iron and steel .It is produced by action of various fluxes upon gangue materials within their own ore during the process of pig iron making in blast furnace and steel manufacturing in steel melting shop. Primarily, the slag consists of calcium, magnesium, manganese and aluminium silicates in various combinations. The cooling process of slag is responsible mainly for generating different types of slags required for various end-use consumers .Although, the chemical composition of slag may remain unchanged, physical properties vary widely with the changing process of cooling. The blast furnace(BF) is charged with iron ore, fluxing agents (usually limestone and dolomite) and coke as fuel and the reducing agent in the production of iron. The iron ore is a mixture of iron oxides, silica, and alumina. From this and the added fluxing agents, alkaline earth carbonates, molten slag, and iron are formed.

Oxygen in the preheated air blown into the furnace combines with the carbon of the coke to produce the needed heat and carbon monoxide. At the same time, the iron ore is reduced to iron, mainly through the dioxide. The oxides of calcium and magnesium combine with silica and aluminate form slag. The reaction of the carbon monoxide with the iron oxide yields carbon dioxide (CO2) and metallic iron. The fluxing agents dissociate into calcium and magnesium oxides and carbon dioxide. The oxides of calcium and magnesium combine with silica and alumina to form slag. Depending on the cooling method, three types of BF slag are produced: air-cooled, expanded, and granulated. Allowing the molten slag to cool slowly in air in an open pit produces the air- cooled slag. Air- cooled blast furnace slag is defined in ASTM standardC-125 (American Society forTestingandMaterials,1999) as “the material resulting from solidification of molten blast furnace slag under atmospheric conditions. Subsequent cooling may be accelerated by application of water to the solidified surface.”The solidified slag has a vesicular structure with closed pores.

The rough vesicular texture of slag gives it a greater surface area than smoother aggregates of equal volume and provides an excellent bond with Portland cement, as well as high stability in asphalt mixtures. Expanded slag is formed through controlled rapid cooling of molten slag in water or in water with combination of steam and compressed air. Steam and other gases enhance the porosity and vesicular nature of the slag, resulting in a lightweight aggregate suitable for use in concrete. Quenching the molten slag in to glass granules by using high-pressure water jets produces granulated slag. Quenching prevents the crystallization of minerals constituting the slag composition, thus resulting in a granular, glassy aggregate. This slag is crushed, pulverized, and screened for use in various applications, particularly in cement production, because of its pozzolanic (hydraulic cementations) characteristics. Slags are also co products of steelmaking processes.[3]

II. LITERATURE SURVEY

The objective of steel slag concrete. Also to study comparison of compressive strength of steel slag concrete for 20%, 40%, and 60% replacement of fine aggregate by steel slag. The concrete specimen cubes are cured in normal potable water for 7,14 and 28 days. Then tests will give us results of variations in compressive strength and these variations can be effectively shown by graphs.

Lots of research is carried out over the past several decades. To figure out the exact method and procedure of the project, many research papers are taken into consideration. With the rapid growth in construction activity, the consumption of concrete is increasing every year, which results in excessive extraction of natural aggregates. The use of these materials is being constrained by urbanization, zoning regulations, increased cost and environmental concern. It is becoming necessary to use alternative methods for aggregates in concrete which include recycled aggregates, industrial steel slag, fly ash, etc. The use of such materials not only results in conversation of natural resources but also helps in maintaining good environmental conditions.

Sanjayan, J.G., Sioulas, B., says that Ground-granulated blast-furnace slag blended cements are beneficial in high-strength concrete for reducing hydration temperatures that are problems in concretes with high cement contents. Strength development of slag cement, however, is highly sensitive to curing conditions. This study reports the strength development of 16 full-scale columns containing 0-70% slag as the binder, with compressive strengths ranging from 40 MPa to 100 MPa.[1]

Monshi and Asgarani(1999) producing Portland cement from iron and steel slags after magnetic separation are mixed with lime stone of six different compositions. Samples with higher lime saturation factor developed higher C3S content and better mechanical properties. Blending 10% extra iron slag to a cement composed of 49% iron slag, 43% calcined lime, and 8% steel slag kept the compressive strength of concrete above standard values for type I ordinary Port and cement. From the six different mixtures of limestone, blast-furnace slag, and converter slag, samples M3,M5 and M6 showed relatively good mechanical properties. Cement M3 was blended with 10% iron slag as in the Portland blast furnace cement, and compressive strengths of 140.3,193.8,333.3 kg/cm2 were obtained after 3,7,and 28days respectively. The bare minimum compressive strength of concrete for type Portland cement according to ASTMC150-86 for 3,7,and 28 days are 12,19,and28MPa respectively (about120, 190, and 280 kg/cm 2).[2]

Raietal.(2002)investigated the possibility of using high MnO and low MnO metallurgical slags on samples obtained from an alloy plant of Maharashtra. Electros melt Ltd., Chandrapur, India, could be used as a partial replacement for ordinary Portland cement to make Portland slag cement sin India. Low MnO granulated slag was used in making blended slag cement with common Portland cement(OPC).Addition of slag lowered the compressive strength of the blended cement as compared to that of OPC used. The results, as seen from Table2.1,clearly show that by increasing the slag content, there is a fall in compressive strength, yet the 50:50 composition shows 22MPa and 33MPa at 7and 28days,respectively,of wet curing to conform to IS 455:1989. The rising the slag content beyond 50% causes lowering of the minimum.[3]

Binici et al. (2006)studied the effect of the fineness on the compressive strength for blended and plain Portland cement (PPC) was in vestigated. The grinding time of both clinker and additives were also studied. The result indicated that ground basaltic pumice (GBP) and clinker had lower grind ability compared to ground granulated blast furnace slag (GGBFS).Blended cement had higher strength values, particularly at later ages, compared to PPC for the same Blaine values. It was observed, from the results shown in Table2.2 that the finer ground blended cement specimens had higher compressive strength, compared to the coarser blended cement and PPC.[4]

Bilimetal.(2008) studied artificial ln rural networks and predicted the compressive strength of ground granulated blast furnaces lag concrete. A data set of a laboratory work, in which a total of 45 concretes were produced, was utilized in the ANNs study. The concrete mixture parameter were three different water– cement ratios (0.3, 0.4,and0.5), three different cement dosages (350, 400, and 450kg/m 3) and four partial slag replacement ratios (20%,40%,60%, and 80%).Compressive strengths of moist cured specimens were measured at 3,7,28,90,and 360 days.[5]

Ismail and Hashmi (2008) reported that the waste iron were used to partially replaced sand at 20%,40%,and 60% in a concrete mixtures. The tests performed to assess waste-iron concrete quality included slump, fresh density, dry density, compressive strength, and flexural strength tests. This work is functional for 3,7,14, and 28days curing ages forth concrete mixes. The result show that the concrete mixes made with waste iron had higher compressive strengths. The compressive strengths of the concrete mixes made of 20% waste-iron aggregate increase by 22.60%,15.90% and 17.40% for the 3,7 and 28 days curing periods.[6]

Pellegrino and Gaddo(2009) investigated natural aggregates of traditional concrete with Black/Oxidizing Electric Arc Furnace (EAF) slag. The concrete made with EAF slag as aggregate showed good strength characteristics in normal conditions and strength properties of the conglomerate containing EAF slag are totally comparable than those observed for traditional concrete. The compressive strength of cubes specimen with traditional and EAF slag aggregates after 7,28and 74 days. It is significant to observe that compressive strength stabilizes, after the first 28 days for traditional conglomerate where as it continues to improve for the EAF slag one and thus EAF slag conglomerate aging appears to develop on a longer time than traditional conglomerate.[7]

III. CONCLUSIONS

The strength and Characteristics of concrete mixtures have been carried out in the present work by replacing 20%, 40% and 60% steel slag with the sand. On the basis of present work, following conclusions are drawn.

Compressive Strength

- After adding 20% steel slag in the mix, the result the was obtained after7days was 15.26 N/mm2,after 14 days the result increased by 3.5% after 28 days the result was increased by 9.25%.
- After adding 40% steel slag in the mix, the result the was obtained after 7days was 13.92 N/sq.mm, after 14 days the result that was decreased by 6.75% After 28 days the result was decreased by 9.62%.
- After adding 60% steel slag in the mix, the result the was obtained after 7days was 13.22 N/mm2, after 14

days the result that was decreased by 20.55%after 28days the result was decreased by 27.35%.

- The Compressive strength ends to increase with increase percentages of steel slag in the mix. The early age strength gain is higher as compared to later age 20% of fine aggregate is replaced by steel slag.
- The Compressive strength tends to decrease with increase percentages of steel slag in the mix. The early age strength gain is higher as compared to later ages if 40% and 60% of fine aggregate is replaced by steel slag.

In the present study only up to 20 percent replacement of sand by steel slag has been considered. The other percentages i.e. 60 need investigation. In the present study only0.45 w/c ratio have been considered. The other ratios i.e. 0.50 and0.55 need investigation. Sulphate resistance of concrete containing steel slag needs to be investigated for larger exposure time.

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