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Review on Comprehensive Study of Sustainable Construction Material: Slag Sand

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ABSTRACT: Global material resources are quickly being drained by the demands of global economic development. Simultaneously, the environmental impacts of the massive amounts of waste generated globally every year are also growing exponentially. As such, the implementation of waste recycling through its utilization as a component of a construction material, particularly one with a global demand as high as concrete, is a strategy which acts in both planes: material efficiency and waste generation. Due to ever increasing quantities of waste substances and industrial by-products, strong waste management is the high concern in the world.

In this research work presents a decade review on sustainable concrete with a focus on virgin materials being replaced with waste materials. In this study, the slag sand is replaced with standard sand by 20%, 30%, and 40%, and the relevant properties and strength will be compared. The results show a slight increase in concrete strength and, with a beneficial scheme, a reduced volume of normal sand that is continuously being used and will one day become non-available material. According to this study, the Slag Sand has been tested with a little positive effect on strength and depicts appropriate and acceptable strength properties with no harm to the concrete mix. Furthermore, as the results show, the Slag Sand is highly recommended to be used in construction work.

I. INTRODUCTION

Concrete is a crucial component of structural engineering construction practice, which is critical and influences the stability and efficiency of various structures. The compressive strength of the concrete is a test conducted with the aid of a universal test machine or some other compressive strength machines to find the concrete cube strength. The concrete mix specification is the basic quantity of the various materials used to blend and produce the appropriate concrete properties. The fine and coarse aggregate is the major and prominent ingredients of the concrete and the properties of concrete change by changing its size, texture, and properties. The quality and strength of the concrete solemnly depending upon the adjustment of the water cement ratio. The appropriate water-cement ratio is assumed around 0.5-0.70.

Optimal amounts and sizes of the concrete mix product elements are achieved to produce improved post-concrete performance and to enhance the technique. The aggregate size (uniform graded, distance graded, incorrectly graded) must be tested to build the sample for proper examination. This research procedure includes calculating the size of the fine and coarse aggregate sample, specific gravity, and other tests.

Slag Sand is collected as a byproduct from industries like iron, metal, etc. These Slag waste may be reused in concrete to reduce the fine aggregate by different acceptable amounts. The study includes the replacement of sand by different percentages, and then further, it can be used in large-scale construction works in more beneficial ways.

1.1 ASSUMPTIONS AND LIMITATIONS

For the sake of accurate statistics, the reports are often cross-checked. The key point is that the source of the Slag Sand is satisfactory and can be used for building purposes. It is believed that there is a lot of testing needed to verify the source, and this is performed squarely in large-scale building projects. In this works, we will completely rely upon the industry provider documentation.

Large repositories are available regarding the Slag sand. As already discussed, it is a byproduct of several industries. The advantages of using slag sand as a partial substitute for fine aggregate sand in concrete, particularly regarding the optimal replacement quality or a complete replacement, are discussed in this study.

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As mentioned previously, the mix design is prepared as per standards, but it should be kept in mind that the water-cement ratio is the major to a scheme of concrete strength. The minimum water-cement ratio produces more strength as it is workable and cost-effective. On the other hand, cement is the most expensive component in concrete ingredients.

II. LITERATURE REVIEW

Tarun Naik [1] and their fellows investigated the performance of fresh and hardened concrete containing discarded slag sand in place of fine aggregate. Concrete mixes were proportioned to replace 25% and 35% by weight of regular concrete sand with clean/new slag sand and used slag sand. The results of this investigation showed that mix containing 25% discarded slag sand showed about 10% higher compressive strength at 28 days than the mix containing 35% discarded slag sand. However, the compressive strength of the control mix was about 20-30% higher than the mixes containing discarded slag sands. They added that no marked difference was observed in the density of fresh and hardened concrete.

Han-Young [2] investigated two types of Slag sands like clay bonded sand (CLW) and silicate bonded sand (COW) as a fine aggregate for concrete and basic properties such as air contents, setting time, bleeding, workability and slump loss of the fresh concrete with SL were tested and compared with those of the concrete mixed without SL. Also, compressive strength and tensile strength of hardened concrete of 28 days were measured. The results showed that (1) flow value and compressive strength of mortar is very rapidly decreased with increasing the replacement ratio of COW and CLW; (2)Bleeding of concrete with COW, CLW are decreased according to increasing replacement ratio of COW and CLW, (3) concrete mixed with COW of 30%, compressive and tensile strengths of concrete are higher than those of any other concrete without COW, whereas concrete mixed with CLW, compressive and tensile strengths of concrete are a bit smaller than that of control concrete.

Rafat Siddique [3] investigated the mechanical properties of concrete mixtures in which fine aggregate was partially replaced with used slag sand with three percentages 10%, 20% and 30% by weight. Tests were performed for the properties of fresh concrete, compressive strength, splitting tensile strength, flexural strength and modulus of elasticity were determined at 28,56, 91 and 365 days. Test results showed that increase in compressive strength varied between 8% and 19% depending upon UFS percentage and testing age, whereas it was between 6.5% and 14.5% for splitting tensile strength, 7% and 12% for flexural strength and 5% and 12% for modulus of elasticity.

Saveria [4] investigated the properties of mortars and concretes containing different dosages of used slag sand (UFS) as partial replacement of sand. The results showed that (1) UFS addition gives low slump. (2) mortars containing UFS at water cement ratio equal to 0.5 show a compressive strength lower by about 20-30% compared to that of the reference mix, (3) the modulus of elasticity doesn't vary significantly; (4) Drying shrinkage increases with the decrease of mechanical performances.

Khatib and Baig [5] investigated fresh and hardened properties of concrete containing Slag Sand (SL) replaced with 0 to 100% with fine aggregate. The water to cement for all mixes was kept constant. Testing on hardened properties was mainly conducted at 14, 28 and 56 days. The results show that the incorporation of Slag Sandin concrete causes a systematic decrease in workability, ultrasonic pulse velocity and strength and an increase in water absorption and shrinkage of concrete. They also reported that an acceptable concrete strength can be achieved using slag sand.

Kumbhar [6] investigated the various mechanical properties of concrete containing used slag sand. Concrete was produced by replacing natural sand with UFS in various percentages (10%, 20%, 30% and 40%). Based on the test results they concluded that (1) workability goes on reducing with increase in UFS content; (2) At 28-days, Compressive strength, splitting tensile strength and flexural tensile strength for different replacement levels of UFS is increased whereas flexural tensile strength goes on reducing for UFS content more than 20%; (3) At 28-days, the modulus of elasticity values increases with replacement of UFS up to 20%. They also concluded that the UFS can be utilized as a replacement to regular sand in concrete up to about 20%.

L Da Silva and their team [7] investigated the influence of the use of slag sand (SL) on concrete properties. The properties on the fresh state were evaluated by means of flow table test and the determination of the incorporated air content. On the hardened state, compressive strength tests were performed. Their initial results have shown that the use of SL leads to an increase in the air content and cracking, caused by expansive reactions. As a result of that, a reduction in the compressive strength has been noticed. They added that the application of mixtures made with SL becomes risky

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as to the structural and durability requirements. However, they also added that their work may not be generalized, because the SL composition varies according to the manufacturing process and in all cases, it is advisable to carry out preliminary tests in order to verify the effects caused by the use of SL in the concrete production.

Gurpreet Singh and Rafal Siddique [8] investigated the strength and durability properties of concrete mixtures, in which natural sand was replaced with five percentage (0% 5%, 10%, 15% and 20%) of Slag Sand(SL) by weight. Compression test and splitting tensile strength test were carried out at the age of 7, 28 and 91 days and Modulus of elasticity, ultrasonic pulse velocity and Rapid Chloride Permeability test were conducted at the age of 28 and 91 days. The abrasion resistance of concrete containing SL was also investigated. Based on the results obtained they concluded that (1) Maximum increase in compressive strength, splitting tensile strength and modulus of elasticity of concrete was observed with 15% SL both at 28 and 91 days; (2) SL increases the ultrasonic pulse velocity values and decreased the chloride ion penetration in concrete; (3) Abrasion resistance of concrete increased with the increase in SL content. They also added that SL can be suitably used in making structural grade concrete, as well as for applications where abrasion is also important parameter.

Khatib and Herki [9] investigated the concrete produced by replacing the fine aggregates with 0%, 30%, 60% and 100% SL. The water content, coarse aggregate, cement and the water to cement ratio remained constant. The properties investigated at 7, 28- and 90-days curing times. The results indicate that there is systematic increase in water absorption by capillary action, a decrease in compressive strength and Ultrasonic pulse velocity with increasing amounts of SL in concrete. They also reported that adequate strength can be achieved using an appropriate replacement level of slag sand.

Eknath [10] investigated the comparative study of the properties of fresh & hardened concrete containing ferrous & non-ferrous Slag Sand replaced with four (0% 10%, 20% and 30%) percentage by weight of fine aggregate & tests were performed for M20 grade concrete. Result showed that (1) addition of both slag sand gives low slump mainly due to the presence of very fine binders; (2) Compressive strength at 7 days of both ferrous & nonferrous mixtures increases and maximum increase was observed with 20% SL of both types of sand, at 28 days 30% addition of ferrous SL & 10% addition of nonferrous SL gives same strength as ordinary concrete and goes on decreasing for higher percentages of replacement; (3) Split tensile strength gives maximum values with 20% SL for both types of sand; (4) water absorption is minimum with 20% ferrous SL & with 10% nonferrous SL. They also reported that both ferrous & nonferrous SL can be suitably used in making structural grade concrete.

3. Objectives

- To check the durability of Slag Sand using experiments.
- To check the usage and accessibility of Slag sand.
- Verifying the methodology and mechanical properties of using the Slag Sand using material testing.
- Finding the optimum percentage of replacement of slag sand with normal sand and finding the strength-related property with the help of casting the standard cubes and then testing it. Both the Slag cubes and normal cubes properties will be compared.

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