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A Study on Partial Replacement of Cement with Rice Husk Ash, Silica Fume and Iron Slag

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ABSTRACT

Nowadays climatic change & environmental degradation are vital issues. Government and business sector have to use more eco-friendly awareness policies and practices. Now it is the crucial time to focus more on sustainable waste & construction materials such as greenhouse reducing agents ,energy saving equipment's ,and more to use renewable source of energy so that the resources and waste can be used more efficiently and recycled it in a new form. The optimum use of waste substances such as (blast furnace slag , rice husk ash , glass pieces or powder, silica fume, iron slag ,etc.) in concrete to boost the engineering financial environment , to gain more ecological benefits. therefore the use of wastes building and construction material is very helpful to achieve the new sustainable goals. So Rice Husk Ash, Silica Fume and Iron Slag can be used as a partial replacement material with cement concrete.

Keywords — Cement, concrete, Rice Hunk Ash, Silica Fume, Eco-friendly.

I. INTRODUCTION

Construction and building materials are the major materials which are responsible for the good interior and exterior aesthetic beauty of structure and gives positive environment impact. It is widely used material and it directly or indirectly affects the environmental and ecological factors through the process used to extract, built, transports and ultimately reuse or dispose them [1-3].

Sustainable construction materials are that materials which can be reused, recycled and be used again to fulfill the future demand it also helps in reducing the effects of harm full gasses such as co_2, greenhouse gasses, etc [4-5]. Such waste materials have a lower environmental impact. Thermally efficient, can be operated with less fuels and energy and better than any conventional method. They are less toxic and can be recycled and reused less toxic emission and they are financially viable [6-7].

In concrete production large quantity of resources such as fuel, sand, aggregates are required [8]. Therefore to minimize these various waste or by product used in researches as potential alternatives in the construction of concretes and industry. In fact use of by product waste such as glass, ash, beads, plastic, slag, etc. in construction is one of the major aims to reach the new goal of achieving sustainable developments [9-10].

II. RICE HUSK ASH

Rice husk debris (RHA) fillers are gotten from rice husks, which are typically seen as agrarian waste and an environmental risk. Rice husk, when expended in outside the rice plant, yields two sorts of flotsam and jetsam that can fill in as fillers in plastics materials. The rice paddy preparing adventures give the outcome rice husk. As a result of the extending pace of environmental defilement and the idea of practicality factor have made utilizing rice husk. The clarifications for the use of rice husk as a possibility for concrete in strong gathering are explained in the going with zones [11]. To have a fitting idea on the introduction of rice husk in concrete, a point by point concentrate on its properties must be finished. Around 100 million tons of rice paddy make reactions are gotten the world over. They have a low mass thickness of 90 to 150kg/m^3. This results in a more vital estimation of dry volume. The rice husk itself has an unforgiving surface which is harsh in nature. These are therefore impenetrable to normal defilement. This would achieve unseemly expulsion issues. Among all dares to reuse this thing, cement, and strong gathering ventures are the ones who can use rice husk in a prevalent way.

Advantages of Rice Husk Ash

- Rice husk flotsam and jetsam invigorates extraordinary compressive.
- It is a reaction; along these lines, it helps in slashing down the natural defilement.
- The high silica content makes it a not too bad significant cementations material or pozzolanic admixture.
- The thickness of concrete containing rice husk flotsam and jetsam resembles the customary weight concrete; consequently, it can in like manner be used for the comprehensively valuable application too.
- The impervious microstructure of rice husk flotsam and jetsam solid gives better insurance from the sulfate attack, chloride passageway, and carbonation, etc.
- Rice body concrete has incredible shrinkage property and extends the strength of concrete.

III. SILICA FUME

Silica fume, also known as micro silica, is a non-crystalline form of silicon dioxide. It is an ultrafine powder that is obtained as a by-product of silicon and ferrosilicon alloy production. With particles smaller than 1 micron and an average diameter of approximately 0.1 microns, it is around

100 times smaller than typical cement particles. The unique behaviour of silica fume can be attributed to its high content of amorphous silica, which exceeds 90%. When high-purity quartz is reduced to silicon at temperatures up to 2,000°C, SiO_2 vapours are produced and subsequently oxidize and condense in the low-temperature zone, forming tiny particles of non-crystalline silica [1].

Significant advancements have been made over the past few decades to enhance the performance of concrete as a construction material. Silica fume and fly ash, either used individually or in combination, are considered indispensable for producing high-strength concrete suitable for practical applications. Silica fume, when used in the appropriate proportion, has garnered worldwide attention as a pozzolanic material due to its ability to improve various properties of both fresh and hardened concrete. These properties include cohesiveness, strength, permeability, and durability. Silica fume concrete is particularly suitable in environments where high abrasion resistance and low permeability are crucial, or when highly cohesive mixes are required to prevent segregation and bleeding.

The history of silica fume usage in concrete is relatively short. The first documented tests of silica fume in Portland cement-based concretes were conducted in 1952. However, it wasn't until the early 1970s that concretes incorporating silica fume began to see limited use. The early work carried out in Norway received significant attention as it demonstrated that Portland cement-based concretes with silica fume exhibited remarkably high strengths and low porosities. Since then, extensive research and development have positioned silica fume as one of the most valuable and versatile admixtures for concrete and cementations products worldwide.

IV. IRON SLAG

As slag is an industrial by- product, its productive use grant an chance to relocate the utilization of limited natural resources on a large scale. Iron slag is a by product obtained in the manufacture of pig iron in the blast furnace and is produced by the blend of down to earth constituents of iron ore with limestone flux. Iron and steel slag can be differentiating by the cooling processing when removed from the furnace in the industry. Mostly, the slag consists of magnesium, aluminum silicates calcium and manganese in various arrangements. Even though the chemical composition of slag same but the physical properties of the slag vary with the varying method of cooling. The slags can be used as cement major constituents as they have greater pozzolanic properties.

The utilization of iron and steel slag has a long history that can be traced back to ancient times. According to the European Slag Association (2006), there are early reports of slag being used by Aristotle as a medicinal substance as early as 350 B.C. Initially, the use of steel slag may not have been prominent due to the abundance of blast furnace slag. However, with growing awareness of environmental concerns and the emergence of the concept of sustainable development, extensive research and development efforts have been undertaken to transform slag into a modern industrial product that is both efficient and advantageous.

In a blast furnace, crude or pig iron is made by stripping the oxygen and other impurities from iron ore by means of high temperature reactions with reducing agents (mainly carbon) and fluxes. The impurities and fluxing agents combine to form a liquid silicate melt called iron or blast furnace slag [12].

The incorporation of iron slag as a partial replacement for fine aggregate contributes to the enhancement of concrete strength. Considering the higher cost of sand, utilizing waste iron slag as a substitute material proves to be a cost-effective solution. Moreover, iron slag not only offers economic benefits but also possesses the potential to significantly increase the concrete's strength, with improvements observed up to 30% when replacing the slag.

Preparation of Iron Slag Aggregate

Iron slag is collected from industrial. It is dried until the moisture is reduced. Then it is manually crushed. i. e. broken into small pieces with hammer or stone after that it is crushed using mechanical process. The iron slag aggregate are sieved. The size of iron slag aggregate taken is 20 mm.

V. CONCLUSIONS

In concrete production large quantity of resources such as fuel, sand, aggregates are required. Therefore to minimize these various waste or by product used in researches as potential alternatives in the construction of concretes and industry. In fact use of by product waste such as glass, ash, beads, plastic, rice husk ash, silica fume, iron slag, steel slag etc. in construction is one of the major aims to reach the new goal of achieving sustainable developments.

Rice husk debris (RHA) fillers are gotten from rice husks, which are typically seen as agrarian waste and an environmental risk. Rice husk, when expended in outside the rice plant, yields two sorts of flotsam and jetsam that can fill in as fillers in plastics materials.

Silica fume, when used in the appropriate proportion, has garnered worldwide attention as a pozzolanic material due to its ability to improve various properties of both fresh and hardened concrete. These properties include cohesiveness, strength, permeability, and durability. Silica fume concrete is particularly suitable in environments where high abrasion resistance and low permeability are crucial, or when highly cohesive mixes are required to prevent segregation and bleeding.

Iron slag aggregate is an industrial product that is manufactured under extensive quality management, and contains no organic impurities, clay, shells, or similar materials. For both fine particles and course particles, the chemical composition is completely uniform.

Cement is replaced by slag from different steel mills, both blast furnace and ladle furnace slag, rice husk ash, silica fume and iron slag. The percentages of slag substitution by cement are 30%, 40% and 50% by weight. Therefore the use of wastes building and construction material is very helpful to achieve the new sustainable goals. So rice husk ash, silica

fume and iron slag can be used as a partial replacement material with cement concrete.

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