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"STUDY ON HIGH STRENGTH CONCRETE BY USING REPLACEMENT OF METAKAOLIN AND COPPER SLAG IN CONCRETE"

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Abstract - In recent days sustainability and resource efficiency are the major challenges faced by the construction industry. Due to rapid growth in construction, increases demand for cement and fine aggregate. This project involved in finding efficient way of replacing conventional usage by replacing cement by metakaolin and replacing fine aggregate by copper slag. The properties and characteristics of cement, fine aggregate, copper slag and metakaolin was studied through various literatures. In this work planned to use, M40 grade of concrete for concrete mix design for replacing fine aggregate with different proportions like 0%, 25%, 50% of copper slag and 7.5%, 10%, 12.5% of metakaolin with replacement of cement to increase strength and workability of concrete.

Key Words: Copper slag, metakaolin, High Strength, Increased Durability.

1. INTRODUCTION

1.1 GENERAL

Rapid growth of industrialization gives rise to variety of by-products. Disposal of waste materials are quite hazardous. Hence it became essential to find a better way to reuse these by-products. Many researches found that concrete made with wastes and by-products acquires excellent properties than the conventional concrete in terms of strength, performance and durability. In this project, copper slag and metakaolin are taken to investigate its sustainability as a replacement materials while making concrete.

Concrete is a supreme material for the construction which has resulted in large scale manufacturing of cement. Various researchers proven that production of cement produces heavy environmental pollution due to emission of CO2 gas. So metakaolin can be a better alternative for supplementary cementing material which is used to make a high strength concrete and increases the durability of the concrete.

Copper slag is a by-product obtained during smelting and refining of copper which is best suited for replacing sand. The construction field is the only area where the safe use of waste materials like copper slag is possible. Copper slag increases the compressive strength and split tensile strength. It also reduces water consumption as compared with sand.

1.2 OBJECTIVES

The main objective of this study is to determine the best percentage of Metakaolin replacement in cement and best percentage replacement of sand by Copper slag.

1.3 SCOPE

The scope of this project is to make use of Copper slag as a replacement of sand as it has properties similar to sand and also to make use of Metakaolin as a cement replacement material.

2. LITERATURE REVIEW

Guruvignesh. N, Priyanka. K

Metakaolin can be used as a replacement for cement as it has properties similar to cement. Flexural strength of the concrete can be increased with 15% replacement of cement by Metakaolin, 100% replacement of Waste glass and Copper slag for fine aggregate. Usage of copper slag as a replacement for fine aggregate increases the density of the concrete. Replacement by 15% Metakaolin gives 40% more compressive strength when compared with conventional concrete. Replacement of fine aggregate by 100% waste glass and 100% Copper slag gives 12% and 25% more compressive strength than conventional concrete respectively.

Ping Duan, Wei chen, Chunhua shen

With the addition of GGBS and metakaolin, pore structure

In concrete is optimized and pore size distribution is more

Reasonable, ITZ becomes denser, compressive strength of concrete increases gradually and durability aspects are enhanced. The improving effect is in the sequence: compound of metakaolin and GGBS> metakaolin >GGBS.

There are close relationships between microstructure and durability. Concrete with higher ratio of fine porosity, reasonable pore size distribution, and higher microhardness

Has corresponding higher compressive strength, lower carbonation depth, lower chloride migration coefficient,

Lower weight loss and relative dynamic modulus of elasticity.

Rajkumar. R, Akkineni Surya Teja, Pandia Rajan. R

The addition of Metakaolin along with cement has increased the compressive strength of the concrete when compared to the conventional concrete. The more effective percentage of replacement with metakaolin seems to be between 10% and 15%. The replacement of Copper slag in fine aggregates also shows much improved compressive strength when compared to control mix. The more effective percentage of replacement seems to be between 50% and 60%However the flexural strength of the concrete used with Slag shows decreased strength when compared to the control concrete and the reduction is at the order of about around 7.5%.The addition of Slag in concrete has shown increased water absorption percentage when compared to control.

Jagtap. A, Mohan. N

As the metakaolin in concrete increases workability decreases. As there is a reduction in fineness modulus of cementatious material, quantity of cement paste available for providing lubricating effect is less per unit surface area of aggregate. As the percentage replacement of cement with metakaolin increases strength of concrete increases up to 15%.

Kasu Naveena, K. Anantha Lakshmi

The strengths achieved in concrete made with percentage use of GGBS and MK achieved high strengths when compared with cement. Super plasticizer named is used to attain workability and water cement ratio. At 28 days curing, the 30% replacement of cement with GGBS and MK gave very high strength. From the above experimental results, it is proved that GGBS can be used as an alternative material for cement, reducing cement consumption and reducing the cost of construction. Use of industrial waste products saves the environment and conserves natural resource.

P. Dinakar, Pradosh K. Sahoo, and G. Sriram

This study presents the effect of incorporating metakaolin (MK) on the mechanical and durability properties of high strength concrete for a constant water/binder ratio of 0.3. MK mixtures with cement replacement of 5, 10 and 15 % were designed for target strength and slump of 90 MPa and 100 ± 25 mm. From the results, it was observed that 10 % replacement level was the optimum level in terms of compressive strength. Beyond 10 % replacement levels, the strength was decreased but remained higher than the control mixture. Compressive strength of 106 MPa was achieved at 10 % replacement. Splitting tensile strength and elastic modulus values have also followed the same trend. In durability tests MK concretes have exhibited high resistance compared to control and the resistance increases as the MK percentage increases. This investigation has shown that the local MK has the potential to produce high strength and high performance concretes.

M.Narmatha, Dr.T.Felixkala

From the experimental results presented in this study, the following conclusions can be drawn: Compared to the control mix, there was a slight increase in the Concrete density of nearly 5% with the increase of copper slag content, whereas the workability increased rapidly with increases in copper slag percentage. Addition of up to 50% of copper slag as sand replacement yielded comparable strength with control mix.

K.Mahendran, N.Arunachelam

Geopolymer Concrete with copper slag an industrial by-products as a replacement of fine aggregates was studied. The properties of six different proportions with control mix concrete and others were 10 %, 20 %, 30 %, 40 % and 50 % sand were replaced with copper slag are compared and discussed. The mix with Copper slag shows maximum compressive strength and split tensile strength of 71.2 N/mm2 and 4.95 N/mm2 respectively which was cured at 60 °C, while the mixes cured at ambient temperature attains a maximum compressive strength and split tensile strength of 38.90 N/mm2 and 3.87 N/mm2 respectively. The Scanning Electron Microscope (SEM) /Energy Dispersive X-Ray Analysis (EDAX) studies were conducted to investigate the morphology and chemical composition of the fly ash and Geopolymer concrete.

3. MATERIALS TO BE USED

3.1 CEMENT

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is only behind water as the planet's most-consumed resource.

3.2 M-SAND

Manufactured is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of river sand in most part of the world. Due to depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M Sand is its availability and transportation cost.

3.3 COARSE AGGREGATE

Coarse aggregate is mined from rock quarries or dredged from river beds, therefore the size, shape, hardness, texture and many other properties can vary greatly based on location. Even materials coming from the same quarry or pit and type of stone can vary greatly. Most generally, coarse aggregate can be characterized as either smooth or rounded (such as river gravel) or angular (such as crushed stone).

3.4 METAKAOLIN

Metakaolin is the anhydrous calcinated form of the clay mineral kaolinite. Minerals that are rich in kaolinite are known as china clay or kaolin, traditionally used in the manufacture of porcelain. The particle size of metakaolin is smaller than cement particles, but not as fine as silica fume. Considered to have twice the reactivity of most other pozzolans, metakaolin is a valuable admixture for concrete/cement applications. Replacing portland cement with 8–20% (by weight) metakaolin produces a concrete mix that exhibits favorable engineering properties, including: the filler effect, the acceleration of OPC hydration, and the pozzolanic reaction. The filler effect is immediate, while the effect of pozzolanic reaction occurs between 3 and 14 days

3.5 COPPER SLAG

Granulated copper slag (or) copper slag which is a byproduct of metallurgical operations in Sterlite industries (India) Ltd., Tuticorin was used for the experimental investigation. For every tone of metal production, about 2.2 ton of waste slag is generated. During the past two decades, attempts have been made by several investigators and copper producing units all over the world to explore the possible utilization of copper slag. The physical and mechanical properties of granulated copper slag shows that it can be used to make products like coarse and fine aggregates, cement, fill, ballast, roofing granules, glass etc.

4. TESTS TO BE CONDUCTED

Fresh concrete tests such as Slump cone test, L-Box test, V-Funnel test are to be performed. Compressive strength test, Split tensile test and Flexural strength test are also proposed to be conducted. Mix designs are arrived by using IS 10262-2019

5. CONCLUSION

From the above journals it is evident that High Strength Concrete plays a vital role in construction industry. In addition to that the metakaolin and Copper slag are added and works been done

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