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A REVIEW ON INFLUENCE OF QUARRY DUST AND METAKAOLIN IN SELF COMPACTING CONCRETE

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Abstract - *Self - Compacting Concrete is a type of concrete that can be placed in the form work and it passes through any obstruction by its own weight and does not require any vibration. It fill all spaces and voids, even in highly congested reinforced concrete members. SCC is produced using high-range water-reducing admixtures (HRWRA), viscosity-modifying admixtures (VMA), and well-graded aggregates. This journals is to find the effect of Quarry dust and Metakaolin in Self Compacting Concrete. The quarry dust is used as a replacement of fine aggregate and it is a by-product from the crushing process during quarrying activities, and this material helps to increase both compression and tensile strength. The metakaolin is used as a replacement of cement and it is obtained from natural Kaolin clay, by heating this clay at a temperature of 650 - 900 degree centigrade. Metakaolin helps to increase the compressive strength, spilt tensile strength, flexural strength and also the fresh properties of SCC.*

Key Words: Self - Compacting Concrete, Quarry Dust, Metakaolin (MK)

1. INTRODUCTION

Self-compacting concrete (SCC) represents one of the most outstanding advance in concrete technology during the last decade. SCC is another sort of concrete with huge deformability and segregation resistance. SCC is a flowing concrete mixture that is able to consolidate under its own weight. The highly fluid nature of SCC makes it suitable for placing in difficult conditions and in sections with congested reinforcement. SCC mixes usually contain superplasticizer, high content of fines and/or viscosity modifying additive (VMA). The use of superplasticizer maintains the fluidity, the fine content provides stability of the mix resulting in resistance against bleeding and segregation. Supplementary cementitious materials (SCM) are finely ground solid materials that are used to replace a portion of the cement in a concrete mixture. These supplementary materials may be naturally occurring, manufactured or man-made waste. Various types of pozzolanic materials that improve cement properties have been used in cement industry for a long time such as Metakaolin. It possesses a high reactivity with calcium hydroxide having the ability to accelerate cement hydration. Metakaolin reacts with the calcium hydroxide during the hydration process of OPC to form the calcium silicate hydrate (C-S-H) gel, it is very effective pozzolanic materials and effectively enhances the strength parameters of concrete Now- a-days due to constant sand mining the natural sand is depleting at an alarming rate. Scarcity of good quality natural river sand due to depletion of resources and restriction due to environmental consideration has made concrete manufactures to look for suitable alternative fine aggregate. One such alternative is Quarry Dust, it is generally considered as a waste material after the extraction and processing of rocks can be used as a replacement for fine aggregate.

1.1Quarry Dust

The increase in population, the demand of river sand for construction is increasing at a very rapid pace. If sand is continuously extracted from rivers it would lead to severe damage to rivers and in turn reducing the filtration property of river that reduces the quality of water available. River sand is available in scare amount, thus to fulfill the demand of construction industry, an alternative material must be proposed which help to prevent the environmental causes associated with the river. Quarry dust can be used for this purpose. Quarry dust being non-biodegradable material, it takes years to decompose, therefore its use in construction industry reduces the space required for landfilling the quarry dust. The chemical composition of river sand and quarry dust are almost similar. In the construction industry, quarry dust is used as an aggregate substitute especially for sand in a concrete mixture. The application of quarry dust can reduce the cost of construction The research done for the cost of construction proved that using quarry dust is cheaper than sand.

Quarry dust is also used in the construction of sub base in highways. Due to its high fines of quarry dust, it provides to be very effective in assuring very good cohesiveness of concrete. As the replacement of the sand with quarry dust increases, the workability of the concrete is decreasing due to the absorption of the water by the quarry dust. The specific gravity is almost same both for the natural river sand and quarry dust. . Quarry dust should be used in construction works, which will reduce the cost of construction and the construction material would be saved and the natural resources can be used properly. Most of the developing countries are under pressure to replace fine aggregate in concrete by an alternate material also to some extent or totally without compromising the

quality of concrete. Quarry dust has been used for different activities in the construction industry, such as building materials, road development materials, aggregates, bricks, and tiles.

1.2 Metakaolin

Metakaolin is a pozzolan, probably one of the most effective pozzolanic material used in concrete. It is a product that is manufactured for use rather than a by-product and is formed when china clay, the mineral kaolin, is heated to a temperature between 600 and 800℃. Metakaolin is a valuable admixture for concrete/cement applications. Replacing portland cement with 8–20% (by weight) metakaolin produces a concrete mix that exhibits favourable 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. The average size of highly reactive metakaolin particle, which is smaller than cement particles, is ranging from 1 to 2 micron and it is off white in colour which in return influences the color of the final product. Specific gravity of highly reactive metakaolin is 2.6.The Fig 1 shows the metakaolin.

Fig 1 Metakaolin

2. LITERATURE REVIEW

In recent years, many studies were conducted by various researchers on environmental friendly concrete materials. Metakaolin and Quarry Dust are two such materials that can be used in the construction industry. The goal which is expected from the paper is to study the properties of self compacting concrete with Metakaolin and Quarry Dust to make a strong and durable low cost and ecofriendly self compacting concrete.

2.1 Self Compacting Concrete with Metakaolin

Madandoust R, et.al (2015), studied the effect of adding metakaolin in the self – compacting concrete and its performance. The replacement of metakaolin was done in a pattern of 0, 5, 10, 15 and 20% of weight of cement. Self – compacting concrete mix of M30 grade was used for the experimental investigation. The cubes and cylinders were tested for compressive strength, split tensile strength respectively. The tests are performed after 7 days and 28 days curing of the specimens. From the results of considered parameters, it is observed that 10% replacement of cement with metakaolin showed better performance in case of strength parameters such as compressive and split tensile strength.

Badogiannis G.E, et.al (2015), studied the durability of Self-Compacting Concrete incorporating with metakaolin (5%, 10%, 15% & 20% by weight of cement). The estimated properties (open porosity, sorptivity, water and gas permeability, chloride penetrability) were evaluated against a reference mixture (without metakaolin). The incorporation of metakaolin is improved durability. Lower porosities were measured for higher metakaolin levels and lower metakaolin levels. The sorptivity is inversely correlated to the replacement level and to the compressive strength. Higher replacement levels by metakaolin are not enhancing near surface water permeability. Metakaolin SCC generally exhibits lower gas permeability compared to the reference concrete mixture. The replacement of cement with metakaolin results in a significant decrease on chloride penetrability.

Bai J, et.al (2017), studied the feasibility of using metakaolin and GGBS as a replacement material in the self – compacting concrete production. In this paper the cement is replaced by metakaolin and it ranges between 0 - 20 % and GGBS in the ranges between 10% - 30%. SEM examinations were conducted to observe the effect of metakaolin and GGBS with two w/b ratios on the microstructural properties. The metakaolin lead higher amount of C-S-H gel in presence of higher w/b ratio without affecting the mechanical properties. Metakaolin has a greater effect on the microstructural strength of the transition zone than GGBS.

Joseph A, et.al (2017), studied the effect of Metakaolin as mineral admixture in the self – compacting concrete. The metakaolin was replaced with 0, 5, 10, 15, 20 and 25% of weight of the cement. M60 grade self - compacting concrete was used for the experimental investigation. The need for viscosity modifying admixture could be fully avoided at high replacement level of metakaolin because higher paste volume reduced the friction between the aggregates. Compressive strength of SCC 15% MK mix showed 11.5% increase than the control mixture. Split tensile strength is not much influenced by the metakaolin content. Maximum tensile strength is obtained at 15% replacement level. The optimum amount of metakaolin was obtained as 15% in terms of compressive strength and split tensile strength.

Gill S.A, et.al (2018), in this paper the effect of metakaolin and rise husk ash in the M50 grade self – compacting

concrete is being studied. The cement is replaced by metakaolin and rise husk ash and the comparison is being investigated. Basic mechanical strength parameters such as compressive strength, split tensile strength and flexural strength is being determined, Metakaolin in the ranges between 5%,10% & 15% of weight of the cement and RHA in the ranges between 10%,20% & 30% of weight of the cement. The metakaolin (MK) and RHA were used independently, the best results for compressive strength were achieved for 15% MK and 10% RHA replacement. When cement was replaced by 15% MK, there was 25% increase in compressive strength at 28 days when correlated to control mix.

Kannan V (2018), studied the effects of ternary system on corrosion behaviour of self - compacting concrete containing self - combusted rice husk ash (SCRHA) and metakaolin. The OPC was replaced from 0% to 30% by metakaolin. In order to assess the properties of blended self - compacting concrete, various tests were conducted for fresh state properties (Slump flow test, V-funnel test and L-box test), Strength properties (Compressive strength and splitting tensile strength) and durability properties (Rapid chloride penetration test and potential time study for steel corrosion). The compressive and splitting tensile strength of was increased 15% replacement of metakaolin.

2.2 Self Compacting Concrete with Quarry Dust

Johnsirani S.K, et.al (2013), studied an experimental investigation on M30 grade self-compacting concrete (SCC) with fine aggregate (sand) replacement of a Quarry Dust (QD) (0%, 25%, 50%, 75%, 100%) and addition of mineral admixtures like Fly Ash (FA) and Silica Fume (SF). The use of mineral admixtures improved the performance of SCC in fresh state. At the water/cement ratio of 0.4, slump flow test, V-funnel test and L-box test results were found to be satisfactory. The results of the hardened properties of SCC such as compressive strength and split tension strength had shown that the higher strength has been obtained for SCC_25% quarry dust of about 34.62 Mpa and 2.36 Mpa respectively. While fine aggregate replacement of quarry dust increases with the gradual decreases in the strength values after replacement of 25% of quarry dust.

Balamurugan G.D, et.al (2013), the present experiment is carried out to investigate the fresh and hardened properties of M30 grade Self Compacting Concrete with 50 percentage of quarry dust as a replacement for fine aggregate and fly ash as partial replacement of cement at 10%,20%,30% &40%. Steel fiber is also added in the concrete to improve the properties in certain ratio. The Compressive strength, Split tensile strength and Flexural strength increases with the replacement of fly ash for cement at 10% and 20% with the combination of 50% replacement of fine aggregates with quarry dust and the addition of steel fiber at 1%.The utilization of Fly ash as a partial replacement of cement increases the workability of concrete and also reduces the construction cost with efficient utilization of industrial waste. The usage Quarry dust reduces the usage of fine aggregate which helps in maintaining the ecological balance thus reducing the consumption of river sand.

Rai B, et.al (2016), studied the effect of quarry waste on self-compacting concrete containing binary cementitious blends of fly ash and cement. For this purpose nine trial mixes were prepared, where the percentage replacement of river sand by quarry waste was 0%, 10%, 20%, 30%, 40%, 50%, 70%, and 100% and to study the flowability characteristics of SCC. For all trial mixes the fly ash percentage replacement to cement was kept constant at 30%. The increase of water demand of concrete mixtures produced by the adverse effects of shape and texture of quarry sand can be minimized using a high range water reducing admixture. From the experimental results observed, river sand replacement of 30% with quarry waste is recommended. Examining the strength at 28 and 56 days of SCC mixes with quarry waste content from 0% to 20% has caused increase in compressive strength by 1% as compared to reference mix. But when the quarry waste replacement of 30% causes the compressive strength increase almost 2% at 56 days. The percentage replacement of quarry waste with river sand increased to 100% the loss in compressive strength. SCC mixes with quarry waste as fine aggregate at 30% the gain maximum strength.

3. CONCLUSIONS

This paper presents a review on the effect of Quarry Dust and Metakaolin on the properties of self compacting concrete. It was found that addition of Quarry Dust slightly increased the strength of self compacting concrete and the addition of Metakaolin as a partial replacement for cement, also increased the strength of self compacting concrete. Metakaolin is a pozzolanic material that can be used to replace cement to increase the strength of concrete. From the literature review, the optimum replacement of fine aggregate with Quarry Dust was 30% and cement with Metakaolin was 15%. The reduced voids and improved bonding between cement paste and aggregate due to fine particles of quarry dust resulted in improved elasticity modulus of concrete The higher compressive strength of metakaolin mixes can be attributed to: (i) the filling effect of metakaolin particles, (ii) acceleration the cement hydration and (iii) the pozzolanic reaction of metakaolin with calcium hydroxide.

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