A REVIEW ON STUDY OF PARTIAL REPLACEMENT OF CEMENT BY METAKAOLIN AND GLENIUM B233 IN SELF-COMPACTING CONCRETE

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Abstract -*Self-compacting concrete (SCC) refers to high strength concrete which will compact under its own weight and does not require external vibration. This seminar reviews the journals to study the effect of metakaoiln in SCC. The metakaolin is used as a replacement of cement and it is obtained from natural Kaolin clay. Metakaolin helps to increase the compressive strength, spilt tensile strength, flexural strength and also the fresh properties. The use super plasticizer greatly improves pump-ability and the slump value. GLENIUM B233 is a new generation based super plasticizer which is based on modified polycarboxylic ether. The fresh properties such as pump ability and workability and the durability properties of super plasticizer in SCC with metakaolin are discussed.*

Key Words: *Self-Compacting Concrete, Metakaolin, GLENIUM B233*, superplasticizer, *polycarboxylic ether*

1. INTRODUCTION

Self-compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement. The elimination of vibrating equipment improves the environment on and near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration. The improved construction practice and performance, combined with the health and safety benefits, make SCC a very attractive solution for both precast concrete and civil engineering construction. Since its first development in Japan during mid 1980's, SCC has gained wider acceptance in Japan, Europe and USA due to its inherently distinct advantages. Since the development of SCC in Japan, many organizations across the world have carried out research on properties of SCC.

Supplementary cementitous materials (SCMs), when used with portlandcement, contribute to the properties of concrete through hydraulic or pozzolanic activity or both. Hydraulic cement materials will set and harden when mixed with water, while pozzolanics require calcium hydroxide, usually supplied by hyrdrating the cement. 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 2 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.

1.1 Metakaolin

Metakaolin is a pozzolan, probably 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 800ºC. 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 is and it is off white in colour which in return influences the color of the final product.

1.2 Superplasticizer (GLENIUM B233)

GLENIUM B233 is a new generation based super plasticizer which is based on modified polycarboxylic ether. The product has been primarily developed for application in High performance concrete where highest durability and performance is required. It is free of 10 chlorine and low alkali content & compatible with all types of cements.

2. LITERATURE REVIEW

Madandoust R, et.al (2015) , in this paper 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 slump flow values for different concrete mixes were measured in the range of 660–715 mm. According to EFNARC all concrete mixtures under investigation can be categorized as slump flow class 2. The concrete mixture at this class of slump flow is suitable for many normal applications such as walls and columns. The flowability of the mixtures was reduced with the higher proportion of MK replacement. The MK inclusion made the concretes more viscous, it can be concluded that in the MK no viscosity modifying agent was needed. The higher compressive strength of MK mixes can be attributed to: (i) the filling effect of MK particles, (ii) acceleration of the cement hydration and (iii) the pozzolanic reaction of MK with calcium hydroxide. From the results of considered parameters, it is observed that 15% replacement of cement with metakaolin showed better performance in case of strength parameters such as compressive and split tensile strength. MK content increased early age strength of concrete as well as the long-term strength. The most remarkable strength development was found to attain for MK replacement at the levels of 15%.

Gill S.A, et.al (2018), in this paper the effect of metakaolin and rise husk ash in the M40 grade self – compacting concrete is being studied. The cement is replaced by metakaolin. Basic mechanical strength parameters such as compressive strength and split tensile strength 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 0% MK 5 % MK 10% MK 15% MK 20% MK Split tensile Strength (MPa) MIX 15 is being determined, Metakaolin is replaced in the orders of 5%,10% & 15% of weight of the cement. As per EFNARC guidelines, self-compacting concrete should carry passing ability, filling ability and segregation resistance. Various tests have been recommended by EFNARC to access these properties of SCC. In this study conducted the slump flow, V-funnel, L-box and U-box tests as per the procedure recommended by EFNARC committee. Here the values of slump flow was in the accepted limit of EFNARC. The compressive strength results for mixes prepared with MK of 24% increase in strength at 28 days. The reason for this significant improvement in compressive strength can be associated with the filling effect of MK particles, and the pozzolanic reaction of MK with calcium hydroxide. MK leads in the rise of compressive strength and tensile strength. The optimum results for compressive strength and split tensile strength were achieved at 15% MK. The best results for compressive strength and split tensile strength were achieved for 15% metakaolin replacement. The split tensile strength was decreased in below 15% replacement of metakaolin. When cement was replaced by 15% MK, there was 25% increase in compressive strength and 8% increase in split tensile strength at 28 days, when correlated to control mix.

Vejmelkova E, et.al (2011), in this paper the rheological, mechanical and durability properties of self-compacting concrete (SCC) mixes produced using blended binders containing metakaolin and blast furnace slag are studied. The compressive strength of self – compacting concrete with metakaolin grows very fast during the initial hardening period and remains significantly higher, as compared with the mix with blast furnace slag. Durability properties of the mix containing metakaolin are excellent. The freeze resistance of self - compacting concrete with metakaolin was excellent.

Badogiannis G.E, et.al (2015), in this paper studied the durability of Self-Compacting Concrete (SCC) incorporating with metakaolin (MK) (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 MK). The incorporation of metakaolin is improved durability. Lower porosities were measured for higher MK levels and lower MK 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), in this paper 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 MK and GGBS with two w/b ratios on the microstructural properties. The MK lead higher amount of C-S-H gel in presence of higher w/c 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), in this paper 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 highreplacement 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 19 amount of metakaolin was obtained as 15% in terms of compressive strength and split tensile strength.

Kannan V (2018) , in this paper, the effects of ternary system on corrosion behaviour of self - compacting concrete containing self - combusted rice husk ash (SCRHA) and metakaolin (MK) were studied. The OPC was replaced from 0% to 30% by MK. In order to assess the properties of blended self - compacting concrete (SCC), 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 MK blended concrete was increased 15% replacement of metakaolin.

Nova John (2013), in this paper studied the effect of Metakaolin as mineral admixture in the concrete and its performance. The metakaolin was replaced with 0, 5, 10, 15, and 20% of weight of the cement. M30 grade concrete mix was used for the experimental investigation. The cubes, cylinders and prisms were tested for compressive strength, split tensile strength and flexural strength respectively. The tests are performed after 7 days and 28 days curing of the specimens. The results indicate that the use of Metakaolin in concrete has improved the strength characteristics of concrete. From the results of considered parameters, it is observed that 15% replacement of cement with Metakaolin showed better performance in case of strength parameters such as compressive, flexural and split tensile strength.

Menhosh A.A, et.al (2018, in this paper studied the effect of Metakaolin in the concrete and its performance. The metakaolin was replacement with 0, 10, 15, 20, 30 and 40% of weight of the cement. M20 grade concrete mix was used for the experimental investigation. The mechanical properties like compressive strength, split tensile strength and flexural strength are conducted and durability properties of drying shrinkage, chloride penetration and chemical resistances are also studied. The compressive strength, split tensile strength and flexural strength are increased in the 15% replacement of metakaolin. Metakaolin was reduced the drying shrinkage and chloride penetration. The results confirm that replacing Portland cement with 15% metakaolin (by weight) provide the optimum improvement for Portland cement concrete on both mechanical properties and durability.

Ali Hussein Hameed (2012), discusses the results of an experimental investigation into the properties of self-compacting concrete mixes having varying dosage of high-performance superplasticizer (GLENIUM B233) (0.5%-3.0%) L per 100 kg of cement material. The properties investigated are workability on the fresh state of concrete by using one mix with five superplasticizer dosage (0.5%,1.0%,1.5%,2.5% and 3.0%) is used. The workability was assessed using three tests according to the specification of self compacted concrete (slump flow, L- box differential height and V-funnel tests. The three dosage (1.0%, 1.5% and 2.5%) comply with requirement for production of SCC while 0.5% and 3.0% don't comply with specification requirement. Dosage of superplasticizer need to produce self compacted concrete range between (1.0% - 2.5%) L/100 kg of cement according to the condition and material used in this paper.The slump flow increases with the increase of the superplasticizerdosage.For the slump flow range from 500 to 700 mm, the superplasticizer (Glenium B233) dosages were 0.39% and 0.54% for the self-compacting concrete.

3. CONCLUSION

It is desirable to use SCC because of its advantages like faster rate of construction and superior level of finish and also it can be used in congested reinforcement very well. The metakaolin in SCC improved the strength parameters. The metakaolin also improved the fresh properties of SCC. The higher compressive strength of MK mixes can be attributed to: (i) the filling effect of MK particles, (ii) acceleration the cement hydration and (iii) the pozzolanic reaction of MK with calcium hydroxide. The use superplasticizer Gelenium B233 improves the slump flow.In this type of SCC is used in situations where the castings are difficult due to congested reinforcement, difficult access etc.

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