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USE OF MINERAL ADMIXTURE IN CONCRETE FOR SUSTAINABLE DEVELOPMENT

Mr.Vishvanath N.Kanthe[1], Dr. Shirish V.Deo[2] , Dr. Meena Murmu[3],

[1]Research Scholar, [2,3]Assistant Professor, Department of Civil Engineering, NIT Raipur (India)

ABSTRACT

The present paper is a literature review on the use of mineral admixture in concrete for the sustainable development of consumption of natural resources. The use of industrial and agricultural byproduct waste as a mineral admixture in concrete for partial replacement of cement shall reduce waste landfill sites and pollution as well as minimize the consumption of natural resources. The main focus of the resent literature review is to study the effect of partial replacement of cement with minerals on the properties of concrete and its durability. Review of literatures shows that the utilization of (FA) fly ash, (RHA) rice husk ash, (SF) Silica fume and (MK) metakaolin in concrete will enhance the strength and durability of concrete. Hence it is required to encourage its use in the local construction industry for sustainable development.

Keywords: RHA, Concrete, FA, SF, MK.

I. INTRODUCTION

In the developing country a huge quantity of natural resources are used in the form of concrete ingredient for construction of buildings roads and dams. The ingredients used for concrete comes from destroying natural form and hence the environmental imbalance occur and with this human activities also produces waste from industries and agriculture such as FA, RHA, ground granulated blast furnace slag (GGBS), SF, MK and materials from demolished structure.

The consumption of Portland cement in the world increased up to 2 million tons from 1.3 billion tons annually and it caused CO_2 emission [1]. This creates an interest to utilize the alternative for cement in construction field. The use of sustainable material would reduce the demand of cement and natural resources for concrete production. FA is highly pozolanic industrial byproduct was generated from electric generation power plant by burning of coal in huge amount and produced ash creates a disposal issue it can be used in concrete making shows the improvement in strength. RHA is one of the largest agricultural waste easily available in India the RHA and can be used in concrete by partial replacement of cement. The review of literatures on RHA shows improvement in mechanical properties of concrete. The RHA is also used in various industrial works as absorbent, building construction. SF is also a byproduct of an industrial waste in a huge quantity it can also be used in the construction industries for making concrete as partial replacement of cement and the result shows improvement in mechanical properties of concrete. The MK is produce from kaolin clay at control temperature and it can be used for concrete making as partial replacement of cement literature review shows the improvement in properties of concrete.

II. THE EFFECT OF FA ON PROPERTIES OF CONCRETE:

The FA is the major solid waste generated from power plant due to burning of coal. The concrete production is the most important areas of fly ash application.

2.1 Workability:

The fly ash replaces Portland cement in the paste, the rheological behavior is radically changed, due to the fineness and density of the ash [2]. The Fly ash played a important role in workability and reducing heat of hydration and it has shown insignificant effects on slump, early strength and initial setting time of concrete [3].

2.2 Strength:

The compressive strengths of all FA mixes with calcium hydroxide was shown higher than the control mix [4]. The compressive versus tensile creep comparisons found in the literature, shows similar creep behavior in compression and tension throughout the hardening stage [5]. The compressive strength and thermal conductivity of aerated Portland cement, FA, SF concrete increased when compared with aerated Portland cement, FA concrete after 28 days [6].

2.3 Durability:

The resistance to permeability of concrete was incresed by ultrafine FA because the pore structure was improved [7]. The carbonation resistance of concrete decreased with an increase in tensile stress level, whereas an increase in compressive stress level, first the carbonation resistance increased and then decreased [8]. The durability properties of concrete containing FA with high SO_3 and CaO contents are improved [9]. The high volumes of FA may reduce the shrinkage strain of concrete and inhibit the expansive strain of concrete [10]. The autogenously shrinkage of AAFA is not caused by the well known self-desiccation process that happened in cement paste in the concrete [11]. The mix with higher level of FA replacement level has got higher fracture energy [12].

III. THE EFFECT OF RHA ON PROPERTIES OF CONCRETE:

In the year 1978 P. K. Mehta obtained a patent for the production of RHA, which could be used as pozzolanic material. After that, a few studies have been carried out on the production of RHA [13]. Silica content in RHA combines with calcium hydroxide to produce additional cementations gel compound calcium-silicate-hydrate which holds the concrete ingredients and enhance the strength of concrete.

3.1 Workability:

The main property of fresh concrete is workability. The workability of concrete containing RHA decreases at the higher replacement levels compared to that of the control mixture due to the pore structure of RHA [14]. The increase in particle size or content of RHA predominantly increased plastic viscosity and yield stress [15].

3.2 Strength:

The water binder ratio with 0.30, 0.33, 0.36 and 0.44 the partial replacement of RHA the result shows that the mixtures attained strength comparable to that of respective reference mixtures and up to 30% of ordinary Portland concrete can be replaced with RHA without affecting strength and durability properties [13]. M30 grade of concrete mix partial replacement of cement by 3% RHA, 20% FA and only 20% FA the result shows that the compressive strength, split tensile strength and flexural strength test of rice husk ash concrete by 5.3%, 8.9% and 11.1% strength than the fly ash concrete [16]. The strength of the concrete increased 7.70% with the levels of percentage of replacement of 10% RHA at 90 days compared to normal concrete. In the case of M60 grade concrete the compressive strength increases with the addition of super plasticizer [17].

3.3 Durability:

The RHA up to 30% could be advantageously blended with cement without compromising the strength and permeability properties of concrete [18]. The Concrete mixed with RHA had good resistance to sulfate attack [19]. The self compacting concrete (SCC) mixes made with RHA reduced the chloride ion penetrability and increase in replacement decreased the charge passed. Very low permeability was achieved by the 15% RHA replacement to cement and moderate permeability was recorded for the control mix [20]. The best resistance to chloride ion penetration is obtained with 15% substitution of Portland cement by RHA and beneficial in reducing the alkali silica reaction (ASR) [21].

IV. THE EFFECT OF SF ON PROPERTIES OF CONCRETE:

The SF is one of the most popular pozzolans materials it consists mainly 90% of SiO_2, and is called a super-pozzolan. It also has pure silica in non-crystalline form.

4.1 Workability:

The partial replacement of cement by using of SF with 10 % shows a visible increment in the V-funnel flow times in the produced concretes [22].

4.2 Strength:

The X-ray diffraction and thermogravimetry results shows that increased pozzolanic reaction with increasing SF content increases the strength [23]. The incorporation of lime slug and SF with cement replacement up to 26 % increases the compressive strength [24]. The SCC specimens with SF 15% got the highest compressive strength [25]. The use of SF increased the compressive strengths, splitting tensile strengths, modulus of elasticity and Poisson's ratios for 130 days [26].

4.3 Durability:

The SF concrete generally showed higher carbonation resistance [27]. The SF significantly reduced expansion due to alkali silica reaction(ASR) [28].

V. THE EFFECT OF MK ON PROPERTIES OF CONCRETE:

The MK is a mineral admixture in dry dense form. It is white in color and ground to an average particle size of 1.5 to 2.5 μm. MK is an eco-friendly natural pozzolanic material obtained by heating kaolin to temperatures of 650°C to 900°C without CO_2 production, it contains typically 50 to 55% (SiO_2).

5.1 Workability:

The presence of MK shows increased viscosity response it is because the specific surface area and the layered structure of MK [29]. The use of MK as SCM in concrete design generally leads to an increase in the water quantity needed to achieve the desired fresh state flow properties of concrete [30].

5.2 Strength:

In the case of mortars with only MK, remarkable increase was observed in the strength gain, especially after 3 days [31]. The MK replacements by cement increase the compressive strength at early edge [32]. The increased in ultimate strength in compression for concrete specimens by utilization of MK [33]. The high strength can be obtained by the using MK at early age [34]. The high strength and high performance concretes can be developed by using MK at low water binder ratio of 0.3 [35].

5.3 Durability:

The MK was found to be the most significant factor affecting the chloride diffusion at later ages like 360 and 720 days [36]. The MK in concrete shows significant reduction in chloride ion penetration [37]. The improvement shows due to use of MK in strength, durability properties and chloride penetration resistance of concretes [38]. The use of 10 to 20% MK considerably increased the ASR resistance of the mortars [39]. The use of MK remarkably reduced the drying shrinkage strain [31].

VI. CONCLUSION

The developing country demands large quantity of natural resources. Hence for sustainable development it is most important to preserve available natural resources and consume waste materials from industrial and agricultural production such as FA, RHA, SF and MK. The literatures discussed in the present study shows that the industrial and agricultural byproduct has the potential to reduce the use of natural resources by partial replacement of cement in concrete construction. From the literature it is clearly shown that these mineral admixtures has improved the mechanical properties of concrete and its durability, however the performance of this should be taken up to encourage the use of these SCM in local construction industry for environmental friendly and low cost construction which makes the local constructs sustainable.

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