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A STUDY ON ALCCOFINE AND TUNGSTEN CARBIDE AS A POTENTIAL CEMENTITIOUS ADDITIVE FOR THE FABRICATION OF HIGH PERFORMANCE CONCRETE

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Abstract:

Since past couple of decades, Supplementary Cementitious Materials (SCM) are witnessed as a remarkable breakthrough in the field of construction and Civil Engineering. These include Alccofine and Nano Modifiers such as Tungsten Carbide (WC). The following discourse presents a thorough study of Alccofine as a supplementary cementitious compound and its role in enhancing mechanical properties including strength, durability and workability of concrete structure. This paper also focusses on the fact that how Alccofine can be better replacement to cement owing to its technical and economic reasons. This study is followed by the properties of Nano Particles, specifically Tungsten carbide and its effective utilization in concrete composition to enhance its overall mechanical properties which can be employed in forging High Performance Concrete.

Keywords: ***Alccofine, Tungsten Carbide, Supplementary Cementitious Material, High Performance Concrete, Self-Compacting Concrete.***

Introduction:

Considering to the concurrent scenario, technological advancements in cementitious compound have gained the construction industries in significant ways. To elucidate, discoveries and inventions of new cementitious materials like synthetic and natural fibers, Alccofine and Tungsten Carbide (WC) have remarkably increased mechanical properties e.g. durability, workability, flexural strength, spalling resistance etc. These composites are now mandatory ingredients of the high performance concrete used in commercial cum industrial sector, like construction of bridges, dams, marine structures and Airports etc. In spite of the fact that high performance concrete possesses outstanding mechanical properties, due to very

low water to cement ratio it lags in achieving the workability for sufficient period of time. To troubleshoot this problem, it becomes indispensable to use adequate amount of water reducing elements. Most cementitious materials (e.g. silica fume) are suggested against high range water reducing agent, where characteristics like maximum strength and low permeability of concrete mix is required. Nonetheless, they are ineffective due to increased water content or admixture dosage for the workability of concrete composites. [1]. This study focusses on the properties of ultra-fine slag (Alccofine) as a replacement ingredient of cement for the fabrication of the "High Performance Concrete". It is evident from numerous studies that mixing Alccofine not only enhances the workability and fluidity of the mixture but also it greatly improves the compressive strength of concrete. Moreover, the researchers have concluded that it also exhibits segregation resistance, enhances reliability as well as durability of the reinforced concrete buildings. [2]. Fundamentally, Alccofine is a new generation micro fine substance, even finer than other traditional hydraulic elements such as fly ash, cement or silica fume.

Alccofine enhances the performance of concrete at the earlier stage (or fresh stage) and final stage (i.e. hardened stage) owing to its optimized distribution of particle size. It can be employed as a practical replacement of silica as it has moderate particle size distribution perfect for concrete composition. i.e. not too fine and not too coarse which is its one of the unique properties.

Literature Survey:

Alccofine Series:

Alccofine 1200 series is further classified into 1201,1202 and 1203. The numbers are assigned according to the particle sizes which represents fine, micro fine and Ultra fine particle sized respectively. Two of this series, 1201 and 1203 are prominent and used widely in construction field. The former is micro finer cementitious element used for grouting purposes whereas latter one (Alccofine 1203) is a slag based, ultra fine cementitious element with optimized particle size distribution. It can also be utilized as a high range water dehydrating element to improve compressive strength. With respect to performance, Alccofine is said to be superior amongst the other cementitious admixtures which are generally used in India. In addition, Alccofine can be used as a better alternative to cement to reduce the quantity of cement in the concrete mixture up to an extent or entirely.

Table: 1. Alccofine chemical composition and physical properties [2].

Chemical Composition	Mass in Percentage	Physical Analysis		Range
Al_2O_3	18-25	Surface Area		12000 cm^2/gm
CaO	30-34	Dense		600-700 kg/m^3
Fe_2O_3	0.8-3.0	Particle Shaped		Irregular
SO_3	0.1-0.4	**Particle Size Distribution**	D10	Less than 2mm
MgO	6-10		D50	Less than 2mm
SiO_2	30-36		D90	Less than 2mm

Role of Alccofine in SCC:

Self-Compacting Concrete (SCC) is a modified cementitious compound which, as the name suggests, compact itself under the influence of its own weight. Since SSC was introduced in the construction market, it rapidly gained popularity owing to its properties Improved Casting cycle, durability, enhanced quality and potential to diminish certain minor human errors.

Nevertheless, SCC is a sensitive compound which solemnly depends upon the characteristics of its forging ingredients. Its undesirable qualities like high flow ability with high segregation resistance can be resolved using high range water reducing mixtures (Alccofine) combined with a high concentration of fine particles as additional filler material. Major works are involved in designing and producing appropriate proportion of SCC to get final product with the desired properties. Practically, in fresh state SCC exhibits high fluidity, segregation resistance and self-contacting ability. All of the above characteristics greatly contribute in reducing the risk of honey combing of the concrete [3]. Which can perform outstandingly in improving the overall workability of the designed structure. SCC with Alccofine additives can also perform well in compression and can fulfil other constructional requirements. The conducted researched depicts the results that 10% Alccofine mix in the SCC mix yields superior results than that of the mix with 5% and 15% of Alccofine. [4]

To produce a highly durable concrete composition, employment of Alccofine 1203 gives a significant reduction in water demand for a certain level of workability. It can also be taken into account that it acts as a high range water dehydrating element to improve compressive strength. Alccofine series 1203 is known to produce high performance concrete (HPC) and can be used in two different ways. Firstly, as a complete cement alternative or to reduce cement quantity for cost effective utilization and secondly, improving concrete properties in either state, fresh and hardened. Alccofine with fly ash additives can appear as a potential alternative and can be termed as High strength and High performance concrete. The researches and experiments conclude that maximum compressive strength of the concrete mix is achieved at 10% of Alccofine with 30% of fly ash.

Moreover, the addition of Alccofine remarkably increases self-compatibility, passing ability, hardened properties [5] and resistance against segregation. As relative cost of Alccofine is less than cement, it is an economic approach in designing HPC. [6]

Tungsten Carbide:

Although Nano-modifiers have gained a prominent place in construction industries for improving construction quality and service life, their large scale employment in construction is still minimal. This is because the cost of Nano powders and their relatively small production volume that is failing to cover necessary requirements of the construction market. Recent studies have shown that the production of Nano Powders during carbide waste processes by micro-biological method can remarkably reduce the production cost and can be mass produced for utilization in construction industries. [7-9]

Tungsten Carbide, owing to its high hardness, is extensively used as reinforcement particle for concrete composites and wear resistant coatings for the surfaces subjected to extreme environmental conditions such as wood and metal machining, cutting ad shearing blades, drilling tools and other water resistant coatings [10-12]. And more importantly for the construction of concrete containers to encapsulate radioactive wastes for either containment of disposal. It specifically requires some promising properties dense structure, adequate strength and high ruggedness. [13]

In many countries researchers have shown that introduction of Nano structure into the concrete mix leads to the significant changes. [14-15]. The most commonly used Nano particles in construction industries are Tungsten carbide and carbon Nano tubes. However, the popularity of Nano particle son a commercial level depends upon the ability to mass produce these materials with cost effective methodologies. A number of scientists have also proposed the employment of refractory metal Nano powders and its compounds as an additive substance to concrete. It is also stated that introduction of Nano modificators increase the mechanical properties of the concrete. The referred discourse analyses the use of Tungsten Carbide (WC) and Titanium Carbide (TiC) and concludes that these modifiers reduces the level of leaching of calcium from concrete specimen by more than 44%, when using WC Nano modifier by more than 14% as compared with the control concrete without modifier by 80 Days. Thus WC Nano powders have a positive effect on the properties of concrete mixture and hence can be effectively used for industrial construction as well as marine structures.

Conclusion:

This paper presents a thorough analysis on the properties of Alccofine 1203 and Nano Modifier ‘Tungsten Carbide’ as a potential concrete ingredient. The above study concludes that Alccofine greatly enhances the workability and ruggedness of concrete structure while increasing the service life. In addition, WC can further enhance mechanical properties of the concrete mix which can further be used in radioactive waste management and for the construction of structures exposed to harsh and extreme environments.

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