A REVIEW ON EFFECT OF VARIOUS MINERAL ADMIXTURES ON SELF COMPACTING CONCRETE

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***Abstract*: Self- Compacting Concrete (SCC) is a special type of concrete that can flow and compact under its own weight and can occupy all the spaces in the without any vibration the effect, and at the same time cohesive enough to be handled without bleeding or segregation. The required compaction properties are achieved by adding super-plasticizers and mineral admixtures such as fly ash, rice husk ash, silica fume, etc. The utilization of these treated industrial by-products as cement replacement will not only help to achieve an economical SCC mix, but it is envisaged that it may improve the microstructure and consequently it durability of concrete. This provides solution to disposal problems and other environmental pollution issues created by these otherwise waste products. This paper presents the review of an experimental study done on SCC mixes of M30 grade by using the Modified Nan Su method, incorporating three mineral admixtures, viz., Fly Ash, Silica Fumes, Rice Husk Ash as supplementary cementing materials.**

***Keywords*: Self-Compacting Concrete, Fly Ash, Rice Husk Ash, Silica Fume.**

1. INTRODUCTION

SCC was first developed in Japan in the late 1980s as a concrete that can flow through congested reinforcing bars with elimination of additional compaction and without undergoing any significant segregation and bleeding under its own weight. SCC has gained wide use in many countries for different applications and structural configurations. The use of SCC has many advantages such as: faster construction, eliminating the need for vibration, reducing the noise pollution, improving durability, and the filling capacity of highly congested structural members, better surface finishes and also a safe working environment. SCC consists of the same components as the conventionally vibrated concrete, which are cement, aggregates and water, with the addition of chemical and mineral admixtures in different proportions. While designing SCC the volume of the coarse aggregate should be restricte to avoid the possibility of blockage on passing through spaces between steel bars. This reduction necessitates the use of a higher volume of cement which results in a greater temperature rise and the increase in the cost of construction. Thus incorporating high volumes of mineral admixtures such as fly ash, rice husk ash, silica fume, etc. can make it cost-effective. However, the durability of such SCC needs to be proved. For concrete to be self-compacting it should have the filling ability, pass inability, and resistance against segregation. These properties are obtained by limiting the coarse aggregate content and using lower water-powder ratio together with superplasticizer. Fly ash is a beneficial mineral admixture for concrete. Research shows that adding fly ash to normal concrete, as a partial replacement of cement (less than 35%), will benefit both the fresh and hardened states From the experimental investigation on SCC containing silica fume it is clear that cement can be replaced with 15% silica fume effectively, thereby reducing the consumption of cement, which in turn reduces the cost. Rice husk ash has been used as a highly reactive pozzolanic material to improve the microstructure of the interfacial transition zone between the cement paste and the aggregate in SCC. Research shows that the utilization of rice husk ash in SCC mix (less than 20%) produced desired results and also provided an environment friendly disposal of agro-industry waste product. So far a mixed design procedure to fix the ratio of all the ingredients in SCC is not standardized. No method specifies the grade of concrete in SCC except the Nan Su method. But the limitation of this method is that it does not provide required mix proportions for the grade which is less than M50.

3. LITERATURE REVIEW:-

Nan Su method (2001) proposed a new mix design method for self-compacting concrete. First, the amount of aggregates required was determined, and the paste of binders was then filled into the voids of aggregates to ensure that the concrete thus obtained has flowability, self-compacting ability, and other desired SCC properties. The amount of aggregates, binders and mixing water, as well as type and dosage of super plasticizer to be used are the major factors influencing the properties of SCC. Slump flow, V-funnel, L-flow, U-box and compressive strength tests were carried out to examine the performance of SCC, and the results indicated that the proposed method could be used to produce successfully SCC of high quality. Compared to the method developed by the Japanese Ready-Mixed Concrete Association (JRMCA).

Bouzoubaa and Lachemi (2001) carried out an experimental investigation to evaluate the performance of SCC made with high volumes of fly ash. Nine SCC mixtures and one control concrete was made during the study. The content of the cementitious materials was maintained constant (400 kg/m3), while the water/cementitious material ratios ranged from 0.35 to 0.45. The self-compacting mixtures had a cement replacement of 40%, 50%, and 60% by Class F fly ash. Tests were carried out on all mixtures to obtain the properties of fresh concrete in terms of viscosity and stability. The mechanical properties of hardened concrete such as compressive strength and drying shrinkage were also determined. The SCC mixes developed 28-day compressive strength ranging from 26 to 48 MPa. They report that economical SCC mixes could be successfully developed by incorporating high volumes of Class F fly ash.

Ahmadi(2007) reported the development of Mechanical properties up to 180 days of self-compacting concrete and ordinary concrete mixes with rice-husk ash (RHA), from a rice paddy milling industry. Two different replacement percentages of cement by RHA, 10%, and 20%, and two different water/cementitious material ratios (0.40 and 0.35) were used for the self-compacting and normal concrete specimens. The results were compared with those of the self-compacting concrete without RHA. SCC mixes show higher compressive and flexural strength and lower modulus of elasticity rather than the normal concrete. Upto 20% replacement of cement with rice husk ash in matrix caused reduction in use of cement and expenditures, and also improved the quality of concrete at the time period of more than 60 days. It was said that RHA provides a good effect on the Mechanical properties after 60 days.

Yaghuob mohammadi (2015) studied that the effect of silica fumes on properties of self-compacting lightweight concrete (SCLC) containing perlite and leca. For this purpose, silica fume has been replaced by different contents. In this study, all mixtures total cementitious materials (cement + silica fume) were kept at 450 kg/m3. Test was carried out such as Slum flow, L-box, U-box, V-funnel and J-ring. This research showed that mixtures without silica fume were not satisfactory.. For all tests added the silica fume demonstrated acceptable values. However, for the SCLC mixture containing 15% silica fume significant results were attained. Adding silica fume, compressive strength of samples increased.

B. H. Venkataram Pai [2014] presented the results of an experimental study aimed at producing SCC mixes of M25 grade by using the Modified Nan Su method, incorporating Silica Fumes, Ground Granulated Blast Furnace Slag (GGBS), Rice Husk Ash as instead of cementing materials. These SCC mixes in terms of their properties like compressive, split tensile and flexural strength were also discussed. The fresh concrete properties are also included in the study. The SCC mix containing GGBS achieved greater strength could be because of the high pozzolanic activity of GGBS. The better strength of SCC mix was possibly due to silica fume providing micro filler effect, and also the quantity of silica fume was less which makes the mix richer in cement content.

K. S. Jhansirani and A. Jagannathan (2015) Durability was studied on self compacting concrete by considering acid resistance, sulphate resistance, alkaline, sorptivity, chloride penetration. In this study fly ash and silica fume was used as cementitious material by replacing fly ash at 10%, 20%, 30% and silica fume at 5%, 10%, 15%, and 20%. Not only observed the results by using fly ash and silica fume separately but also by combining them at different levels. From the results it was identified that silica fume shows more resistance against the acid, alkaline, chlorine penetration then the fly ash and also when combine both. It also observed that by increasing of mineral admixtures in self compacting concrete both fresh and durability properties are increased.

V. Karthik, Dr. G. Baskar (2015) Mainly studied about durability of self compaction concrete with copper slag used as fine aggregate at levels of 20%, 40%, 60% and 80%. By conducting fresh concrete tests like T50, V-funnel, slump flow, L-box, J-ring to examined the fresh properties. Durability properties were studied by using weight loss technique. To conduct durability tests like acid resistance, sulphate resistance and corrosion tests, various chemicals like sulphuric acid, ferrous sulphate and sodium chloride solutions were used. From the results it was concluded that at 60% copper slag in concrete as fine aggregate gave the more durable concrete. Iman Afshoon and Yasser Sharifi(2014) Investigated about influence of Ground Copper Slag as a binding material on the fresh properties of self compacting concrete(SCC). In this investigation water – powder ratio was maintained at 0.51 and cement replaced at a levels of 0%, 5%, 10%, 15%, 20%, 25% and 30% with ground copper slag. Tests on wet concrete like slump flow, viscosity index, J – ring, V-funnel, L-box, air content and setting times were conducted. Due to usage of ground copper slag as cementing material slump flow increases, viscosity decreases, passing ability decreases, air content also decreased but setting increased.

4. MATERIALS

Cement: All through the experimental study, Ordinary Portland Cement conforming to IS: 8112 -1989, was used. The physical and mechanical properties of the cement.

Fly Ash

Fly ash is a by-product obtained during the process of combustion of pulverized coal in electric power generating plants. Fly Ash has particles of diameter about 10 – 25 μm. The particles are smooth and spherical. This improves the fluidity of the SCC mixture. Also, Fly Ash has pozzolanic properties where it reacts with calcium hydroxide, to produce calcium silicate hydrate, which is the product formed during hydration of cement. This helps in strength gain at later ages of curing and reduces heat of hydration which in turn reduces free shrinkage of concrete, resulting in a reduction of thermal shrinkage cracking. Fly ash also refines the pore structure of concrete and decreases its permeability, which has good implications on durability and long-term strength. The quality of slag is governed by IS: 3812-1-2003 .

Silica Fume

Silica fume is also called micro-silica or condensed silica fume. It is generally used as artificial pozzolanic admixture in concrete. It is a product obtained by reduction of high purity quartz with coal in an electric arc furnace in the manufacture of silicon or ferrosilicon alloy. Condensed silica fume is essentially silicon dioxide (more than 90%) which is present in non-crystalline form. It is extremely fine powder with particle size less than 1 micron and with an average diameter of about 0.1 micron, about 100 times smaller than average cement particles. The quality of silica fume is governed by IS 15388 -2003.

Rice Husk Ash (RHA)

Rice husk ash is a by- product obtained by burning rice husk by appropriate combustion technique. It is used in concrete as a supplementary cementitious material. The combustion period, chilling duration, and grinding process and duration are important factors that influence the property of RHA. It improves the microstructure of the interfacial transition zone between the cement paste and the aggregate.

Aggregates

Locally available river sand of specific gravity 2.64, fineness modulus 2.91, and conforming to Zone II was used as a fine aggregate. The crushed granite stone with a maximum size of 12 mm, and specific gravity 2.65 was used as coarse aggregate. Both fine aggregate and coarse aggregate used conform to IS:383-1970.

Super Plasticizer (SP)

Super plasticizer (SP) is a chemical admixture which is used in concrete to increase the workability, with minimal use of water. The superplasticizer used in the present work is the commercially available brand, Cera Hyper plasticizer

Water

Potable water was used for mixing and curing concrete.

5: EXPECTED OUTCOME

• In the Modified Nan Su method of mix proportioning of SCC, the quantity of the powder used in the concrete is mainly dependent on the consistency and the specific gravity of the powder itself. It can be observed from the both specific gravity and consistency of fly ash and rise husk ash powder.

• The SCC mix containing powders for curing days of 7 days and 28 days. It is evident from the compressive strength of SCC mix containing fly ash, silica fume, and RHA for a curing period of 28 days.

. • The split tensile strength of SCC mixes containing other powders. The split tensile strength of SCC mixes containing fly ash and silica fume, and RHA a curing period of 28 days.

The following conclusions can be made from the experimental study of achieving SCC using different mineral admixtures as filler:

• In the Modified Nan Su method of developing SCC, the quantity of the powder mainly depends on the specific gravity and consistency of the powder itself.

• The slow strength gain in SCC mix con Ash is because the fly a time for accelerating it pozzolanic nature.

• The strength of SCC mix containing silica fume is possibly due to silica fume providing micro filler effect, and also the quantity of silica fume is less which makes the mix richer in cement content, which imparts more strength.

• The silicates chain present in RHA helps the strength gain in SCC mix containing RHA as powder.

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