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INFLUENCE OF MICRO SILICA AND STEEL SLAG ON PROPERTIES OF HIGH STRENGTH CONCRETE

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ABSTRACT:

In mix design of HSC many factor should be considering in selection of ingredient the mix design M60 is much critical than of normal strength concrete due to lower W/c ratio so, use of suitable quantity of plasticizer has been made here. An attempt has been made by partially replacing cement with micro silica (MS) and Fine aggregate with steel slag (SS) by incorporative different percentage. Compressive strength, spilt tensile strength, Flexural strength, and Durability test are investigated. Which conclude compressive, Flexure, tensile have been improved. Hence, the Viability of using micro silica and steel slag is found in concrete.

KEYWORDS: High strength concrete(HSC), Micro silica(MS), Steel slag(SS), Replacement, Strength.

1. INTRODUCTION:

Concrete is the material of choice where strength, performance, durability, impermeability, fire resistance and abrasion resistance are required. The hunger for the higher strength leads to other materials to achieve the desired results and thus emerged the contribution of cementitious material for the strength of concrete. Addition of pozzolonic admixture like the pulverised Fly ash (PFA) or condensed silica fume (CSF) which helps in the formation of secondary C-S-H gel contributes to the improvement of strength. By adding the nano materials, concrete composites with superior properties can be produced. Nano Technology applied to concrete includes the use of nano materials like Micro-silica, nanofibers etc. Due to the pozzolonic activity, additional Calcium Silicate Hydrates are formed to generate more strength and to reduce free calcium hydroxide. This also helps in reducing the cement requirement. Nano-silica improves the microstructure and reduces the water permeability of concrete thus making it more dense and durable. Certain problems like longer setting time, lower compressive strength at higher percentages can be overcome by adding micro- silica which improves these properties. The addition of pozzolonic admixture like the PFA will reduce the strength gain for the first 3 to 7 days of concrete but will show gain beyond 7 days and gives a higher strength over long term (anil kumar, IJERA 2014).

Aggregate, which makes up 70% of the concrete volume, is one of the main constituent materials in concrete production. Due to the high cost of natural sand used as a fine aggregate and the rising emphasis on sustainable construction, there is a need for the construction industry to search for alternative materials. Steel making slag (SS), one of the most common industrial wastes, is a byproduct of steel production. One ton of steel implies the production of 130 – 200 kg of slag, depending on the composition of the steel and on the steel production process. Slag often appears as granulated materials containing large clusters, coarse and very fine particles. Serious environmental problems formerly originated from unrestrained sand and gravel taken from rivers. Fortunately it has been considered for some decades the chance to use different recycled materials as concrete aggregates, even if just in partial replacement of natural counterparts. With the adverse effect of drying, concrete with slag showed a much more refined pore structure than ordinary Portland cement

concrete. The changes in pore structure were reflected in strength and shrinkage values (V. subathra Devi, procedia engineering 2014).

For the mix designed, specimens are cast and investigated experimentally. Preliminary attempt is made to study the effect of partial replacement of cement and fine aggregate by micro silica and steel slag respectively in the properties of concrete. The properties involve the compressive strength, tensile strength, flexural strength and durability. The main objective of this paper is to investigate the effect of partial replacement of cement and aggregates by micro silica and steel slag on the strength and durability properties of concrete and to determine the viability of Micro silica and steel slag usage in High strength concrete (HSC).

2. CONCRETE USING MICRO-SILICA AND STEEL-SLAG:

2.1. Fresh concrete properties: -

2.1.1. Slump test: -

Workability of fresh concrete can be determined through a slump test. Patil shreekedar et al, observe that There is a decrease in workability as the replacement level of Fly Ash and Micro Silica increases, and hence water consumption will be more for higher replacements. Yunsheng Xu and et al, found out The surface treatment of silica fume with a silane coupling agent prior to incorporation into mortar was found to greatly enhance the workability of the silica fume mortar mix. Sudarsana Rao.Hunchate and et al, also conclude that the percentage replacement of cement by silica fume increases, the workability decreases.

P. S. Kothai and et al, observed that Addition of steel slag both in the form of fine aggregate giving impact on workability slightly. mohammad nadeem and et al, found that The workability of concrete decreased with 100% replacements of normal crushed coarse aggregate with slag aggregate by about 30% in M20 grade and about 8 % in M30 and M40 grade of concrete compared to control mix of concrete. V Subathra Devi, and et al, conclude that Workability of concrete decreases as the percentage of replacement increases. Fine aggregate replacement shows better workability compared to coarse aggregate replacement.

2.2. Hardened Concrete Properties: -

2.2.1. Compressive strength: -

References [1]., Fig 1 shown it can be concluded that the compressive strength of concrete increases with increase in micro-silica content. Compressive strength of concrete gets substantially increased on increasing the amount of micro-silica in it (i.e. 0%, 5%, and 10%). This increase is of the order of at least 75%.

References [2]., Fig 2 shown Replacement of cement by Fly ash showed in M60 grade concrete compressive strength improvement up to the replacement of 10%. Fly ash level of 15% to 25 % showed reduction in compressive strength (28th days).

References [4]., The surface treatment of silica fume with a silane coupling agent prior to incorporation into mortar was found the compressive strength to increase by 27%, relative to the values obtained without treatment.

References [5]., conclude the silica fume content increases the compressive strength increases up to 15% and then decreases. Hence the optimum replacement is 15%.

References [6]., It has been observed that up to 36% replacement of fine aggregate with steel slag to be good in Compression.

References [7]., *Fig 5* shown that test results shows that the compressive strength of the concrete increases and the optimum value was found at a slag replacement proportion of 30% for fine aggregate and after that any further replacement of slag decreases the compressive strength.

References [8]., compressive strength of steel slag aggregate concrete was marginally better than that of crushed limestone aggregate concrete.

References [9]., The study concluded that compressive strength of concrete improved by 4 to7 % at all the % replacements of normal crushed coarse aggregate with crystallized slag. In case of replacements of fine aggregate, the strength improvements were notably observed at 30 to 50 % replacement level by 4 to 6%.

References [10]., The maximum compressive strength value occurs at 25% slag ratio and declines beyond the 25% replacement ratio. The slight improvement in strength may be due to shape, size and surface textureof steel slag aggregates, which provide better adhesion between the particles and cement matrix.

References [11]., The optimum percentage of replacement for fine aggregate is 40% and for coarse aggregate is 30%, beyond which the compressive strength decreases on further replacement.

2.2.1. Splitting tensile strength: -

References [3]., *Fig 3 shown* The optimum silica fume replacement percentages for tensile strengths have been found to be a function of w/ cm ratio of the mix. The optimum 28-day split tensile strength has been obtained in the range of 5–10% silica fume replacement level, whereas the value for flexural strength ranged from 15% to 25%.

References [4]., The surface treatment of silica fume with a silane coupling agent prior to incorporation into mortar was found to the tensile strength to increase by 31% values obtained without treatment.

References [6]., Fig 4 shown that It has been observed that up to 36% replacement of fine aggregate with steel slag to be good in Tension, whereas the concrete properties with equal proportion of steel slag and conventional fine aggregate confirmed to be inefficient.

References [8]., *there is* no significant improvement in the flexural and split tensile strength was noted in the steel slag aggregate concrete compared to crushed limestone aggregate concrete.

References [9]., It could be said that full substitution of slag aggregate with normal crushed coarse aggregate improved split tensile strength at all replacements by 6 to 8% and in case of replacing fine aggregate with slag, the strength improvement was at 30 to 50 % replacement levels by 5 to 6%.

References [11]., It was observed that the partial replacement of fine aggregate by steel slag improves the compressive tensile of concrete. Improvement in strength property was slightly lower for CA replacement when compared with FA replacement.

2.2.1. Flexure strength: -

References [1]., Fig 6 shown that flexural strength is not much affected. But at 90 days, flexural strength increases by 50%. *References [3]., fig 7 shown that* Both the split and flexural tensile strengths at 28 days follow almost the same trend as the 28-day compressive strength does. Increase in split tensile strength beyond 15% silica fume replacement is almost insignificant, whereas sizeable gains in flexural tensile strength have occurred even up to 25% replacements.

References [6]., Table 1 shown the result of flexure strength which conclude that up to 36% replacement of fine aggregate with steel slag to be good in Compression, as well as in Tension, whereas the concrete properties with equal proportion of steel slag and conventional fine aggregate confirmed to be inefficient.

References [7]., fig 8 shown that flexural strength values follow the same for all the replacement proportions.

References [9]., It could be said that full substitution of slag aggregate with normal crushed coarse aggregate improved the flexure and split tensile strength at all replacements by 6 to 8% and in case of replacing fine aggregate with slag, the strength improvement was at 30 to 50 % replacement levels by 5 to 6%.

References [10]., In almost all replacement ratios the flexural strength increased by the increase in slag ratio; which support the notion that in the case of slag utilization, the compressive and flexural strength do not correspond to each other.

3. OBSERVATION AND REMARKS: -

- Micro-silica decreases the rate of strength gain (less initial strength) but strength keeps on increasing for larger time so ultimate strength is higher as compared to ordinary concrete.
- There is a decrease in workability as the replacement level of Micro Silica and Steel slag increases, and hence water consumption will be more for higher replacements.
- Chemical Admixtures is required for workability & gaining of required strength.
- Relative to replacement of (10%-20%) MS with cement and (20%-40) SS with fine aggregate, the maximum compressive strength is obtained at 28 days.
- Failure plane passes through the aggregates, which shows that bond strength was greater than strength of aggregates.
- With the partial replacement of cement by MS and fine aggregate by SS, the strength is increase by (10%-40%) then controlled specimens.
- Micro silica as filler material and steel slag as compare to fine aggregate proves to be suitable in high strength concrete.
- From the past research it has been observed that all studies for high performance concrete mainly focus on the partial replacement of cement by mineral materials which is insufficient for now days due to noticeable

increasing in requirement of FA/CA. highly requirement of natural aggregate which causes bad effects on environment so there should be required alternate source for natural aggregate.

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