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Influence of fines and microfines on Properties of Concrete

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Abstract :- **In the modern techniques of the concrete formation there is a lot of interest in increasing amount of microfine particles (<75µm) in aggregates and it is important to understand their effect, including clay and nonclay mineralogy. The present study concentrates on extenuating the influence of fines and microfines on properties of concrete. Generally the sand used in construction industry in major metro cities is of manufactured type, which is obtained by mechanically crushing aggregates in washed or unwashed condition. After washing too some silt impurities remain in the sand and this study is carried out to understand their influence in high performance concrete (HPC). The study is carried out by preparing trial mixes, by adding 1% to 10% silt in washed manufactured sand by weight of sand for M-60 grade of concrete mix. For each trial mix workability, compressive strength, water permeability, rapid chloride penetration test, modulus of Elasticity tests are carried out as per given IS specifications to understand optimum percentage of silt should be present in the concrete, and its effect as the impurities are increased. The study confirmed that the extent of silt content decreases the workability and compressive strength of concrete.**

Keywords: **- Concrete, fines, microfines, silt, HPC, effects.**

I. INTRODUCTION

Modern day concrete is a homogeneous mixture of cement, fine aggregates, coarse aggregates, water and admixtures. In today's concrete world the cement is replaced by various supplementary cemetatious materials like GGBS, fly ash, etc. GGBS is basically a useful by product obtained from blast furnaces used in the production of iron. And fly ash is the useful by product of the coal fired power plants and its use is environmentally beneficial. These materials enhance the concrete properties and it is verified by various authors in their studies, such as Chaudhri I. M. et.al, Suhasini Kulkarni et.al.

Now a day the newly designed structures and modern day engineers are demands for the high performance concrete (HPC) which must contain fairly high degree of cohesiveness, pumping ability, slump retention and also self-compacting characteristics. It's a known fact that aggregates constitute 60 - 80% of total concrete volume, and usually concrete failure is connected with the use of different aggregates. It is important that the aggregates used for concrete should be free from all sort of impurities. There are various factors which affects the properties of concrete, such as water cement ratio, type and size of fine and coarse aggregates, cement – aggregate ratio, type and quantity of admixture used, type of SCM's used, etc. Various new materials and techniques are developed to improve the properties of concrete and increase its durability, but special significance is given to the aggregates as it contribute between 60 – 80 % of total volume of concrete.

It is observed from the various studies that the presence of microfine materials in the concrete had a significant impact on ultimate quality of concrete (2003 Hanna A.H.). Microfines can be classified into three types: stone dust, calcium carbonate and clay minerals, the smallest particles those are smaller than 75µm, referred as microfine. Generally it is observed that the presence of microfine silt reduces the workability due to their high surface area, which requires the increased amount of water, which in turn reduces the strength and durability. It is important that sand used for making concrete should be free from impurities and clean. Nowadays in metro cities the natural sand and aggregates are very rarely used due to increase in their cost and other factors. The aggregates manufactured by mechanically crushing at quarries are used which typically have much higher percentage of microfine (< 75 µm) aggregates than ASTM limit and can have microfine levels up to 15 – 20 % of the sand (Hudson 2002). Currently, this excess material is stockpiled, at great financial and environmental expense. The manufactured fine aggregates are available in washed and unwashed conditions, it is stated that washed aggregates contains lesser impurities than unwashed but most silt particles are held tightly to the aggregates surface and cannot be removed by normal washing process. These silt particles during concrete mixing released into the water and become the component of the cement paste, which then affects the water cement ratio, because of their ability to absorb water and swell. This increased water demand causes the reduction in strength and increase in drying shrinkage. There for it is of interest to examine, whether the clay negatively impact the properties of concrete when the water content is held constant. The role of these materials is important because it is these particles that are so prevalent in manufactured fine aggregates.

The present study is undertaken to examine the effect of fine and microfine particles on properties of concrete. The study consists of finding the optimum quantity of these materials to achieve the desired properties of concrete. The effect of these materials in varying quantity on the water demand, water- reducing admixture demand, compressive strength, and workability of concrete is examined for M-60 grade of concrete. By performing the trials, what percentage of admixture is required to achieve the required workability with increasing microfines can be concluded. The fine particles were obtained by sieving the unwashed crushed sand from 75 µm sieve. The expected outcome of this study is to analyse the test results and compare it with the optimum mix.

II. MATERIALS AND METHODOLOGY

The entire work is carried out on M-60 grade of concrete. To start with the material selection, all the aggregates are procured from Maad minerals, Vasai. Manufactured VSI sand of both types, washed and unwashed is used. Washed sand is used for concrete trial mixes and unwashed sand is used to collect the microfine silt by sieving the sand through 75µm sieve. Microfine silt passing from 75µm sieve is used in order to maintain the homogeneity. The silt collected after sieving is mixed with the washed sand replacing the sand by its percentage weight. In the trial mixes the silt is added in the sand from 1% to 10% by weight of sand and subsequently reducing the sand, to maintain the required sand quantity in the mix design. 10 mm and 20 mm aggregates, OPC 53 Ambuja powercem, fly ash and alccofine 1203 are used in the design mix. To reduce the water demand and to maintain the initial flow Chryso Optima S936 admixture is used. Trial mixes prepared were tested for the compressive strength, workability, water permeability and modulus of elasticity. No of cubes prepared are 15 with standard size of (15 x15 x15) cm, and size of cylinder (15 x 30) cm.

III. CONCRETE MIXES

The concrete mixes are designed for M-60 grade of high performance concrete referring IS 10262:2009, the materials were same for all the batches except sand quantity which is replaced by silt in each trial mix varying from 1% to 10%. Admixture dosages are adjusted as per the requirement to obtain the targeted initial flow of 600 mm to 650 mm. The water cement ratio is same for all the trials. The casting, curing and testing of the specimens are done by referring the IS 456:2000 code. For curing normal water is used at room temperature.

IV. TESTING

To check the workability of each trial mix the flow vales of each trial mix is taken at initial, 30 min, 60 min and 90 min. the observes values are listed below in the table 1.

The compressive test of each trial batch is tested after 3 day, 7 days, and 28 days of wet curing following IS 516:1959. The results of these tests are reported in the table 2.

The water permeability is also checked for each trial mix after 28 days of wet curing following IS 3085-1965. The results of this test are reported in table 3.

Table 1: Workability results

Flow	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10	Trial 11
Initial	610	615	610	650	610	650	650	630	650	650	645
30 min	500	430	430	450	410	460	480	420	490	460	455
60 min	340	360	340	320	300	380	390	340	360	380	330
90 min	150	140	110	115	120	150	150	145	140	130	120

V. RESULTS AND DISCUSSION

Results on the influence of fines and microfines on the properties of concrete are presented and discussed in this section.

VI. EFFECT OF MICROFINE ON WORKABILITY

The influences of microfine on fresh concrete were investigated by measuring flow of concrete. To measure the flow the slump cone is used and after every 30 minutes of interval the flow is checked. It is observed that as the percentage of microfines are increased in the concrete the workability of the

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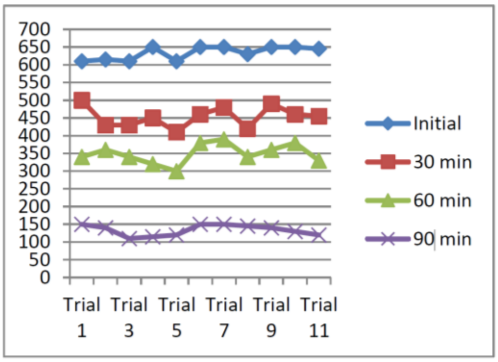
concrete reduces, and increasing percentage of these impurities also affects the water cement ratio, hence as the microfines increases the requirement of admixture also increases. It is observed that as the microfine percentage increases in the mix the mix becomes stickier and sets very early. For 0% of silt content the admixture required is 0.4% of cementatious material while it increase up to 0.57% for 7% of silt content and afterwards it is constant up to 10 % of silt content.



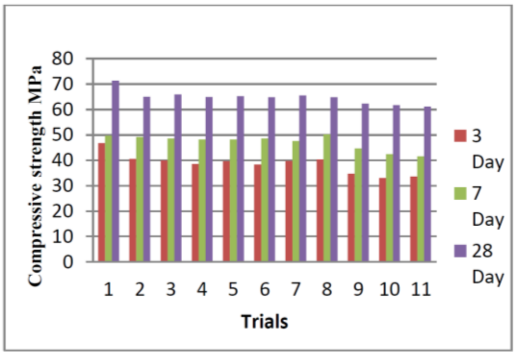
Graph 1: Workability results

Effect of microfine on compressive strength

The influence of microfines on compressive strength of concrete is determined by testing the casted specimen with compressive testing machine of 3000KN. To check the compressive strength for each trial mix, 3 cubes are tested at 3 days, 7 days and 28 days each. From the testing it is observed that as the microfine silt is increased in the concrete the compressive strength is decreases. Up to the 5 % silt content strength does not decrease considerably but as the silt content increases the strength reduction also increases up to 1 MPa.

Table 2: Compressive strength results

Compressive Strength in MPa			
Silt content %	3 Day	7 Day	28 Day
0	46.75	49.63	71.3
1	40.59	49.12	65.02
2	39.94	48.61	65.95
3	38.55	48.15	64.93
4	39.64	48.18	65.24
5	38.31	48.56	64.87
6	39.73	47.53	65.57
7	40.37	50.18	64.78
8	34.71	44.65	62.32
9	33.03	42.46	61.72
10	33.65	41.52	61.08



Graph 2: Compressive strength results

Effect of microfines on water permeability

The influence of microfines on water permeability of concrete is determined by testing the casted specimen. The casted specimens are still in testing phase. Standard size cubes are casted and tested for the test. According to the results obtained till date it is observed that as the microfine silt percentage increases the concrete allows more water to be permeable.

Table 3: Water permeability results

Silt content %	Water permeability (mm)
0	19
1	20
2	21
3	21
4	UT
5	UT
6	UT
7	UT
8	UT
9	UT
10	UT

UT – Under trial

VII. CONCLUSION

It is important to investigate the influence of microfine materials on properties of concrete and its durability, the present study examined the effect of increasing amount of microfine content in concrete, and it is observed that as the microfine percentage increases the workability of the concrete decreases it requires more amount of admixture to make flowable concrete if we keep water cement ratio constant. Also it is observed that, the compressive strength of concrete decreases with the increase in silt percentage in it. The decrease in compressive strength is not considerable up to 5% of silt content but after that it starts to decrease substantially up to 1 MPa, which is considerable if we check the percentage drop from 1% to 10%.

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