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A STUDY OF EFFECT OF MICRO SILICA AS A PARTIAL REPLACEMENT OF CEMENT IN CONCRETE

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ABSTRACT

Concrete is a compound material collected of fine and coarse aggregates bonded mutually with cement past that hardens over time. Concrete is most important construction material and the addition of some other materials may change the properties of concrete. Admixtures like Micro silica, Fly ash, Slag powder are used in concrete to improve the strength properties of concrete. Micro silica is a by-product of silicon and ferrosilicon alloys, it is a pozzolanic admixture. Micro silica is also called silica fume and its particle size is less than 1µm that is 100 times smaller than the average cement particles. In this experiment we will take various proportion of silica fume 5%, 10%, 15% and 20% replace by weight of cement in concrete to increase compressive strength after 7,14 and 28 days of M20 grade concrete.

Keyword – Cement, Micro silica, coarse aggregate, Fine aggregate, Compressive strength.

I. INTRODUCTION

Concrete is most widely used construction material which is a mixture of cement, sand, coarse aggregate and water. It can be used for construction of multistory buildings, dams, road pavement, bridge, canal lining. Admixture are used in concrete for various reasons especially for reducing the amount of cement required for making of concrete and also reduce construction cost. Micro silica is a pozzolanic admixture use in concrete as a filler material to fill up all voids and increase strength. The physical composition of silica fume diameter is about 0.1 micron to 0.2 microns, surface area is about 30,000 m^2/kg and density varies from 150 to 700 kg/m^3.

II. EXPERIMENTAL PROGRAM

Experimental were conducted on concrete prepare by partial replacement of cement from micro silica with various proportions of 5%, 10%, 15% and 20% to compare strength properties of cement and micro silica.

III. OBJECTIVES OF THE RESEARCH

The main objective of this project was to know the behavior of concrete with replacement of cement from silica fume at different proportions in M20 concrete.

- Reuse of waste material and reduction in environmental pollution.
- To obtain high strength concrete by replacing cement from waste products.
- Micro silica use as filler in concrete voids and increase in strength. To reduce the consumption of cement in concrete industry. To improve the strength of construction structure

IV. MATERIAL USED

4.1 Cement and water

Ordinary Portland cement of grade 43 is used to prepare the mix of M20 grade of concrete. The cement used was fresh and without any lumps water/cement ratio is 0.43 for this mix design IS 456:2007.

Table 1: Properties of cement:-

Properties		**Observed values**
Specific gravity		3.10
Fineness		4%
Initial setting time		42 min.
Final setting time		195 min.
Soundness		6mm
Compressive strength	7 days	22.4MPa
	14 days	30.6MPa
	28 days	42.4MPa

Fig. 1 Cement 43 grades

4.2 Fine aggregate

Aggregate of maximum size 4.75 mm are used as a fine aggregate.

Table 2 – Properties of fine aggregate:-

Properties	**Observed values**
Specific gravity	2.52
Fineness modulus	2.45
Water absorption	30%

4.3 Coarse aggregate

The size of coarse aggregate is 20mm used.

Table 3 – Properties of coarse aggregate:-

Properties	**Observed values**
Specific gravity	2.50
Fineness modulus	6.75
Aggregate crushing value	30.2
Aggregate impact value	34
Flakiness index	23.15%
Elongation index	30.40%
Water absorption	0.65%

4.4 Moulds

Cubical mould of size 150*150*150 mm was used to prepare the concrete specimens for determination of compressive strength of concrete.

4.5 Micro silica

Silica fume was produced from black cat industries, Nagpur. It is very fine non crystalline material, silica produced in electric arc furnaces as a byproduct of silicon and ferrosilicon alloys.

Table 4:- Physical and chemical properties of Micro silica:-

Properties	**Observed values**
Colour	Dark grey
Specific gravity	2.2
Particle size	< 1µm
Specific surface	15,000 to 30,000 m^2/kg

Ingredients	**Percentage**
Silica	99.86%
Alumina	0.043%
Ferric oxide	0.040%
Calcium oxide	0.001%
Titanium oxide	0.001%
Potassium oxide	0.001%
Sodium oxide	0.003%

Fig 2 Micro silica

V. EXPERIMENTAL PROCEDURE: -

The specimen of standard cube of size 150×150×150 mm was used to determine the compressive strength of concrete. Three samples were tested for 7, 14 and 28 days with each proportion of silica fume replacement. The water cement ratio was adopted 0.50. The concrete was filled in different layers and each layer was compacted. The samples was removed from mould after 24hours, cured in clean water for 7, 14 and 28 days and then tested for compressive strength as per Indian Standard. The temperature of the cured water and the test room was 27 ± 2° C. The materials mixed separately using definite proportion.

VI. RESULT AND DISCUSSION

Cubes were cast using M20 (1:1.5:3) mix proportion with water cement ratio of .50 samples with ordinary Portland cement 43 grade with various micro silica proportion 5%, 10%, 15%, and 20% were cast. During moulding the cubes were mechanically vibrated required less w/c ratio and increase strength. The concrete blocks were demoulded after 24 hours and subjected to curing for 7days, 14days and 28days.The cubical samples were tested for compressive strength using compressive testing machine of 200 KN capacities in unit N/m^2.

Table 5 – Compressive strength test in N/mm^2

Mix proportion	**5SF**	**10SF**	**15SF**	**20SF**
%of adding silica fume	**5%**	**10%**	**15%**	**20%**
7days	28.2	32	32.5	31
14days	30	33.3	35.4	35.3
28days	42.5	45	47.6	44.5

VII. CONCLUSIONS

From the result it is conclude that the silica fume is better replacement of cement and increases the strength of concrete more 25%. Micro silica is causes air pollution so it used as construction admixture in concrete decrease the air pollution. Micro silica also decreases the voids in concrete. The optimum value of compressive strength can be achieved in 10% replacement of micro silica. Compressive strength decreases when the cement replacement is above 15% of micro silica.

Fig. 3 Compressive strength testing Machine

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