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EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH MICRO SILICA

PANKAJ KUMAR[1], Dr. G.P. KHARE[2], Mr. PUKHRAJ SAHU[3]

[1]Student, M. Tech. (Structural Engg.), GEC Jagdalpur
[2] Principal, GEC Jagdalpur
[3]Assistant Professor, GEC Jagdalpur

ABSTRACT - *Concrete is a most important engineering material, It is mixture of cement, fine aggregate, coarse aggregate, water and admixtures. Admixtures are those material which change properties of concrete. Micro silica is mineral admixture, and it finds in the form of industrial waste material. It's disposal or dumping is costly and generate environment problems. In experimental study it observed that micro silica have some properties to improves mechanical properties of concrete such as compressive strength, split tensile strength, flexural strength etc. In this project micro silica is replaced with ordinary Portland cement (OPC) in certain percentage (0%, 5%, 10%, 15%, 20%) with water cement ratio 0.48. After 7 days curing compressive strength found as 22.62 N/mm², 24.22 N/mm², 23.61 N/mm², 23.0 N/mm², 22.18 N/mm² and after 28 days curing compressive strength found as 28.14 N/mm², 37.92 N/mm², 33.37 N/mm², 30.67 N/mm², 29.31 N/mm². Investigation shows that the maximum compressive strength found (for 150mm × 150mm × 150mm) cube specimen after 7 days & 28 days curing 24.22 N/mm² and 37.92 N/mm² respectively with micro silica content 5% replaced with cement. Similarly flexural strength observed after 28 days curing are 0.251 N/mm², 0.288 N/mm², 0.261 N/mm², 0.224 N/mm² with percentage of micro silica particles 0%, 5%, 10%, 15% and 20% respectively. Maximum flexural strength found as 0.288 N/mm² subjected to concrete beam contained 5% micro silica.*

Key Words: **Micro Silica, Compressive Strength, Split Tensile Strength, Flexural Strength, ordinary Portland cement (OPC), Admixture**.

1. INTRODUCTION

Cement is the most important material in concrete. It gives binding property to the concrete. Cement is more costly as compared to sand and coarse aggregate. So, by partial replacement of cement with micro silica particles, we are improving the strength of concrete and making it economical. Micro silica is an ultrafine powder and it is found as by product of silicon and ferrosilicon alloy and it has spherical shape particle with average particle size of diameter 150 nm.

Micro silica is mainly used in concrete as pozzolanic material. Experimental studies shows that Micro silica improves –'concrete compressive strength, split tensile strength, flexural strength, etc'. as compared to normal concrete. The fly ash and micro silica are industrial waste which are dumped in land due to which soil degradation and environment hazards happen. By the partial replacement of cement with micro silica particle, not only the concrete become eco-friendly, but it also brings sustainability in concrete production and makes it economical

2. MATERIALS –

Maha cement brand ordinary portland cement of 53 grade has been used for present work. Maha cement brand OPC of 53 grade available in the local market. Fine aggregate is a granular material composed to finely divided rock and mineral particles. Natural river sand has been collected from Indrawati river, Jagdalpur, Chhattisgarh. The angular crushed coarse aggregate obtained from quarry near Jagdalpur, Chhattisgarh of size 20mm and 10mm down size of limestone rock group. Silica fume is an ultrafine powder collected as a by-product of silicon metal and ferrosilicon alloy production. It is spherical in shape and the average particle size of silica fume 150 nm.

3. MIX DESIGN –

A. Data required for mix proportioning :–

Grade of concrete = M20
Grade of cement = OPC 53 grade
Maximum nominal size of aggregates = 20mm
Specific gravity of fine aggregate = 2.65
Specific gravity of coarse aggregate = 2.68
Specific gravity of cement = 3.15
Grading zone of fine aggregate = Zone II
Aggregate shape = Angular
Exposure conditions IS-456:2009 = moderate
Workability = 100mm
Free surface moisture = Nil

B. Target mean strength –
$F_t = f_{ck} + KS = 26.6$ N/mm²

C. Selection of w/c ratio - 0.48
D. Calculetion of water content - 186kg/m³
E. Calculetion of cement content - 411 kg/m³
F. Calculetion of mix proportion – Volume of cement = 0.130

Volume of water = 0.197m^3
Mass of coarse aggregate = 1125 kg/m^3
Mass of fine aggregate = 670 kg/m^3

F. Final Mix proportion by weight for trial mix:

Cement = 411kg/m^3

Fine aggregate = 670 kg/m

Coarse aggregate = 1125 kg/m^3

Water = 197 litre

W/C ratio = 0.48

4. METHODOLOGY

The specimen prepared according to testing of concrete. For compressive strength of concrete testing conducted by cube specimen and flexural strength of concrete conducted by beam specimen, the cube specimen size is 150mm x 150mm x 150 mm and beam specimen size 150 mm width, 150mm height, 700mm long used for testing compressive and flexural strength of concrete. For Micro Silica level 5%, 10%, 15%, 20% cast with normal concrete and made three samples of each percentage of micro silica for 7days and 28 days compressive strength, similarly beam specimen have been made for each percentage having three samples for 28 days flexural strength. Three samples have been made because average of the three samples will be more accurate than single cube or beam. Controlled concrete or normal concrete have also been casted for comparison of flexural and compressive strength with content of micro silica. A higher strength will show from any one of following percentage of micro silica.

5. RESULTS & DISCUSSION-

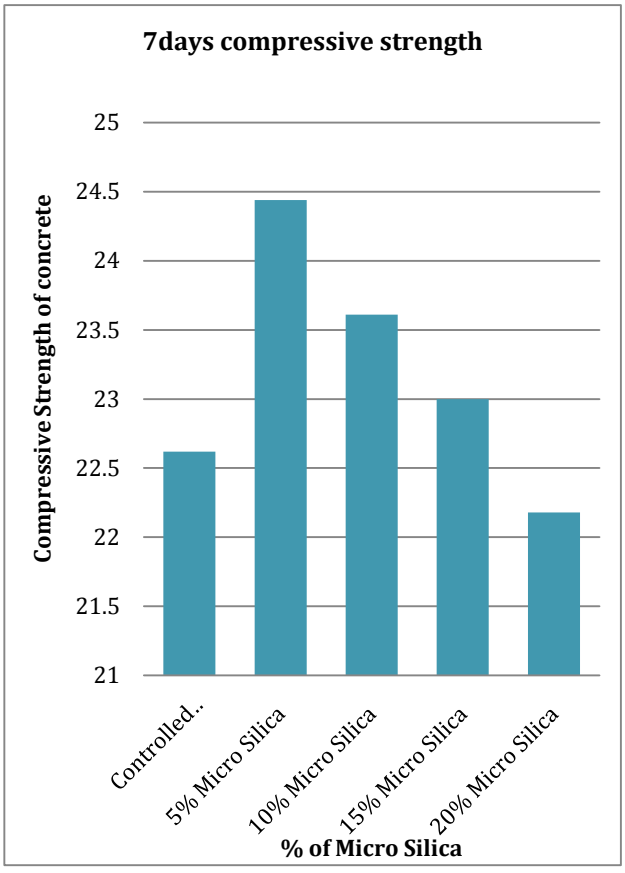
5.1 COMPRESSIVE STRENGTH –

The test result are obtained from 150mm x 150mm x 150mm cube which were casted using 1:1.63:2.74 with w/c ratio 0.48 Specimen with Ordinary Portland cement casted normal concrete and with Micro Silica percentages 5%, 10%, 15%, 20% concrete specimen casted. Compared all the avg. Samples after 7 days and 28 cured specimen tested and increment strength with silica content. The result are calculated in the form of N/mm^2 or MPa.

Table 5.1.1 –7 days Compressive Strength

S. No.	Mix	Micro Silica content (%)	Peak load (KN) For Individual Cube	Avg. Strength (N/mm^2)
1	M1	0.00%	548	22.63
			525	
			455	
2	M2	5.00%	580	24.44
			550	
			520	
3	M3	10.00%	549	23.61
			535	
			510	
4	M4	15.00%	540	23
			518	
			495	
5	M5	20.00%	475	21.18
			490	
			465	

The test report are shown for 150 mm x 150mm x 150mm cube specimens after 7days cured controlled concrete . Controlled concrete after 7 days Avg. Compressive Strength are 22.62 N/mm^2 and Concrete with Micro Silica 5%, 10%, 15%, 20% will be 24.22 N/mm^2, 23.61 N/mm^2, 23.0 N/mm^2, 22.18 N/mm^2 respectively. Thus the result are shown ,Silica fume with 5% gives the highest value of compressive strength and its 7days compressive strength is 24.22 N/mm^2.

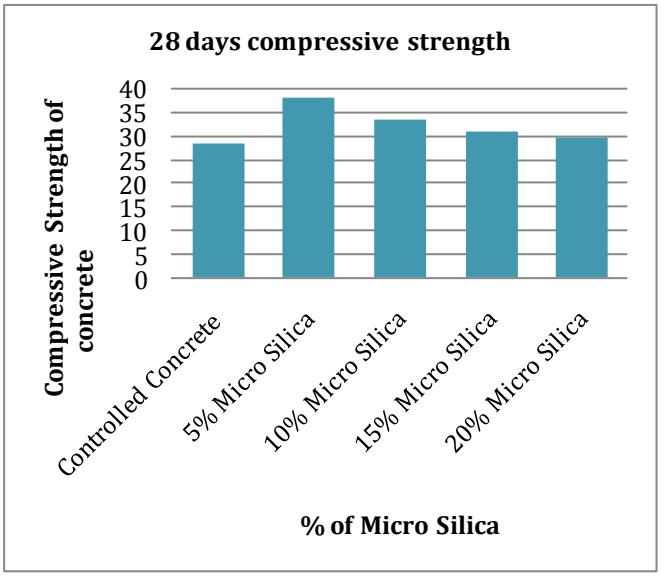


Graph 5.1.1 - 7 days Compressive Strength

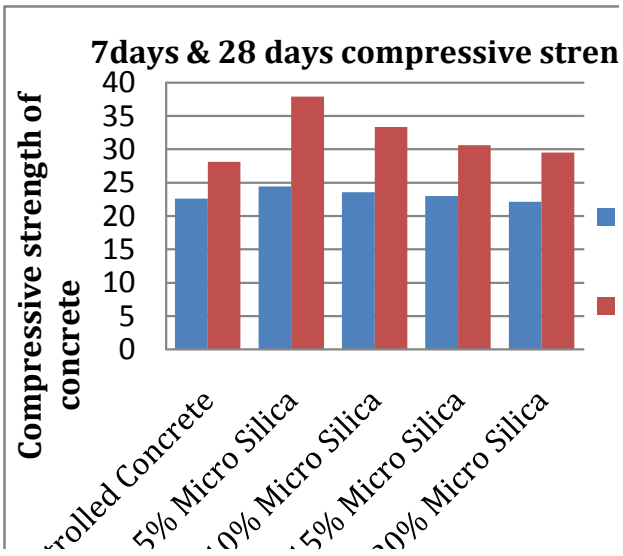
Table 5.1.2- 28 days Compressive Strength

S.No.	Mix	Micro Silica content (%)	Peak load (KN)	Avg. Strength (N/mm^2)
1	M1	0.00%	645	28.15
			690	
			565	
2	M2	5.00%	860	37.92
			835	
			865	
3	M3	10.00%	745	33.4
			785	
			725	
4	M4	15.00%	720	30.66
			685	
			665	
5	M5	20.00%	680	29.54
			669	
			645	

The test report are shown for 150 mm x 150mm x 150mm cube specimens. After 28days cured controlled concrete average compressive strength are 28.15 N/mm^2 and concrete with micro silica content 5%, 10%, 15%, 20% will be 37.92N/mm^2,33.4 N/mm^2, 30.66 N/mm^2, 29.54 N/mm^2 respectively. Thus the result are shown, silica fume with 5% gives the highest value of compressive strength and its 28days compressive strength is 37.92 N/mm^2.



Graph 5.1.2 – 28 days Compressive Strength



Graph5.1.3- 7days & 28 days Compressive Strength

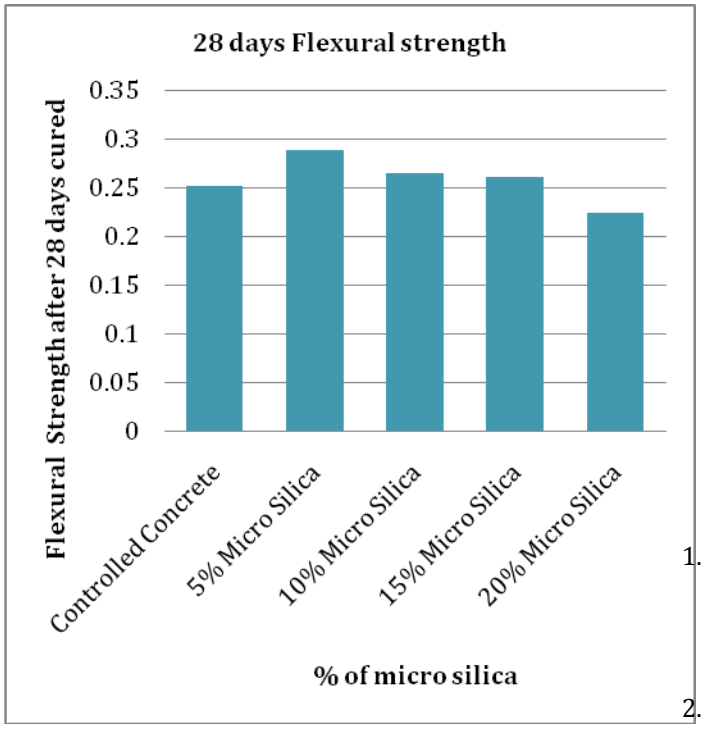
5.2 FLEXURAL STRENGTH –

Flexural Strength of concrete tested by cast beam samples of size 150 mm (width) x 150 mm (height) x 700 mm (length) with ordinary Portland cement and ordinary Portland cement with different percentage of micro silica 5%, 10%, 15%, 20% are casted. After casting it is cured for 28 days. After curing 28 days it is tested by UTM and result shows small variation as compared to controlled concrete.

S.No.	Mix	Micro Silica content (%)	Avg. Strength (N/mm^2)
1	M1	0.00%	0.25
2	M2	5.00%	0.28
3	M3	10.00%	0.25
4	M4	15.00%	0.26
5	M5	20.00%	0.22

Table 5.2 – 28 days Flexural Strength

The test report shown for 150 mm (width) x 150 mm (height) x 700 mm (length) beam specimens after 28 days cured flexural Strength in controlled concrete will be 0.25 N/mm^2 and concrete based on micro silica content 5%, 10%, 15%, 20% will be 0.288 N/mm^2, 0.25 N/mm^2, 0.261N/mm^2, 0.224 N/mm^2 respectively. Thus the result shown maximum flexural strength concrete with 5% micro silica are 0.288 N/mm^2 and increment as compared to Controlled Concrete 14.75%.



Graph 5.2 – 28 days Flexural Strength

5.3 DISCUSSION-

The test result obtained shows compressive strength between controlled concrete and concrete with micro silica has significant difference. And it is calculated by the graph or figure theoretically. Flexural strength test of concrete shows little variation in strength between concrete contained micro silica and controlled concrete. The cube specimen shows highest compressive strength with 5% micro silica. Similarly flexural strength tests yield higher strength with same percentage of micro silica

6. CONCLUSIONS

1. Increment in micro silica content required extra water for making paste.

2. Silica particles increases the strength upto a certain limit then decreases the strength (both compressive and flexural strength).

3. In flexural strength of concrete there is little increment of strength with silica fume.

4. Concrete with 5% micro silica gives peak average compressive strength as well as peak average flexural strength.

7. FUTURE SCOPE –

In this field super plasticizer can be used to increase workability of concrete. In this project only compressive and flexural strength analysis is done but with the help of SEM analysis microscopic study of concrete can also done. This will be helpful for internal cracking analysis. The particle size of micro Silica can be vary so that it may affect the mechanical properties of concrete. Micro silica has property to reduces the initial setting time of cement, this property may be beneficial for producing quick setting concrete. Use of micro silica looks promising and thus it offers a lot of scope for further research work.

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BIOGRAPHY

PANKAJ KUMAR