

Experimental Study on Micro Environmental Concrete

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ABSTRACT: Use of the pozzolanic materials in concrete as a partial replacement of cement is increasing day by day. Economic gain is obtained by replacing a substantial part of the cement by low cost natural pozzolans or industrial by-products. Also durability of end product is increased. Another advantage is the reducing the blended cement environmental cost associated with the greenhouse gases which is emitted during Portland cement production. Pozzolans can be used to increase durability, decrease cost and reduce pollution without reducing the final compressive strength or other performance characteristics. Microconcrete which has high initial strength is mainly used for repair and rehabilitation works. In this paper we have discussed about the performance of microconcrete with addition of silica fume and Ground Granulated blast furnace slag which is very reactive pozzolanic material. Properties of material used for the experiment are find out then Specimens were casted, cured and tested to check the compressive, tensile and flexural performance of plain micro concrete and microconcrete with pozzolanic addition. Result obtained by replacing 15 % of cement by addition of same amount of silica fume and Ground Granulated blast furnace slag was show that compressive, tensile and flexural strength increases, thus improving the compactness of mixtures through pozzolanic effects.

KEYWORDS: Pozzolans; Durability; Rehabilitation

I. INTRODUCTION

Reduction in CO₂ associated with the manufacture and use of Portland cement, is an important issue for Sustainable Development in the construction industry. According to the World Business Council for Sustainable Development (WBCSD), emissions from Portland cement manufacturing vary in different regions of the world from 0.73 to 0.99 kg of CO₂ per kg of cement produced .To reduce CO₂ emissions from a concrete structure, clinker content should be reduced by replacing part of Portland cement by supplementary cementitious materials (SCM) such as fly ash. Utilization of industrial waste materials in concrete compensates the lack of natural resources, solving the disposal problem of waste and to find alternative technique to safeguard the nature. [6]

Micro-concrete (MC) is composition of suitably graded sand, cement and water to simulate concrete in small scale models. The sand and cement mixed in dry condition are available in pre-packed bags. It is ready to use dry powder but requires only the addition of water and mixing before application. The required quantity of water is to be added for ensuring the flowability. It is formulated for use in repair works of concrete where placing of conventional concrete is difficult. It should be non-shrink and free flow in nature. As it is prepacked, wastage is less. [4]

This paper describes the Microconcrete containing materials rich in silica (silica fume (SF) and Ground granulated Blast Furnace slag (GGBS) very finely ground) to replace 15% by weight of Portland cement. The main objective is to check the compressive, tensile and flexural performance of Micro concrete with and without additions of pozzolanic addition.

II.LITERATURE REVIEW

Dr. R. Vijayalakshmi; Dr. S. Ramangopal; Dr. R. Sathia; Arvinth Raj, In this paper, author discussed about performance of concretes used in repair and rehabilitation scenarios namely Self-Compacting Concrete (SCC) and micro concrete. Two brands of micro concrete available in the market were chosen and its mechanical and durable properties were tested. This study will help in understanding whether self compacting concrete can match the

performance of micro concrete in the repair and rehabilitation of RC structures. It may be inferred that usage of fly ash as mineral admixture in concrete mixes results in improved durability characteristics compared to the microconcrete. SCC has comparable mechanical strength when compared to micro concrete with aggregate and very high durability performance. [1]

Jonbi Jonbi¹, A. R. Indra Tjahjani¹, Nuryani Tinumbia¹, A. M. Pattinaja¹, and Bambang S. Haryono² This study modified micro concrete materials by adding Polycarboxylate Ether (PCE) and Polypropylene Fiber (PPF) at the time of mixing existing rapid setting materials. It then tested flow tests and setting time at 16, 20, 30, 40, and 60 minutes, as well as compressive strength; and flexural strength tests at the ageing times of 3 hours, 1 day, and 7 days. The concrete micro material was used directly in the field. The results obtained from the tests show that micro concrete material is definitely suitable for toll road repair. The addition of PCE and PPF can increase the modulus of elasticity and flexural strength, meaning that the material is not easily cracked under the repeated strains of heavy traffic loads. Therefore, the use of this micro concrete material has been proven to be feasible for future repairs of heavily trafficked toll roads. [2]

D. García^a, I. Vegas^a, I. Cacho^b The physical–mechanical properties of the concrete with rGFRP were characterized by compression and bending tests as well as shrinkage stability and alkali-aggregate reaction. Furthermore, the interaction between the rGFRP and the cementations matrix was observed and characterized by scanning electron microscopy. It was found that when the rGFRP material obtained from an optimized milling process was used to prepare the microconcrete specimens (40x40x160 mm³), the flexural and compressive strength at 28 days increased by 16% and 22%, respectively, in comparison to the control specimens. [3]

K. Naga Rajesh, Manoj Kumar Rath, P. Markandeya Raju Construction sector which uses cement in its activities causing a release of CO₂ into the atmosphere. Currently, all the sectors are viewing seriously in reducing environmental pollution and hazards. In this scenario, the research in industrial wastes such as fly ash, slag, used foundry sand, marble dust, etc., lead to use in construction industries as sustainable materials, thereby contributing to reduction in environmental pollution. This paper reviewed the utilization of these Sustainable material in the making of micro-concrete is very less when compared with new age conventional concrete, some of the effects of utilization of these sustainable material in micro-concrete are presented. [4]

Ahmed Hussain The objectives of this research are to understand the behavior of R.C square, square micro-concreted to circular (SMC) & R.C integral circular specimens subjected to axial compression & to differentiate the effect of CFRP confinement on the above three types of column specimens by means of an experimental investigation. Totally, 16 short reinforced concrete column specimens, 10 unconfined and 6 confined, subjected to axial compressive loading were considered for the experimental study. Here SMC represents specimens obtained using improved method of retrofitting the square columns by micro concreting. It is confirmed that confinement by CFRP is an effective method of retrofitting for enhancement of ultimate load carrying capacity & ductility of column and concluded that the degree of enhancement of ultimate axial load carrying capacity due to CFRP confinement of R.C square micro-concreted to circular specimens & integral circular specimens is more than that of similar confinement of reinforced concrete square column specimens. [5]

P. Lorca^a, R. Calabuig^b, J. Benlloch^b, L. Soriano^a, J. Payá^a The reduction in Portland cement consumption means lower CO₂ emissions. Replacement of Portland cement in appropriate amount by pozzolans such as fly ash has its limitations due to the quantity of calcium hydroxide generated in the mix. In this work auther studied the contribution of the addition of hydrated lime to Portland cement + fly ash systems. Auther also studied several levels of cement replacement, ranging from 15% to 75%. The good mechanical results were obtained replacing 50% of Portland cement by the same amount of fly ash + addition of hydrated lime (20% respect to the amount of fly ash). In these systems, an acidbase self-neutralization of the matrix has occurred through a pozzolanic reaction of fly ash with portlandite liberated in the hydration of Portland cement and the added hydrated lime. It has been identified for these mixtures a significant amount of hydrated gehlenite, typical reaction product from rich-alumina pozzolans.[6]

M Laneza*, M.N Oudjita, A Zenatia, K Arroudja, A Balib This paper describes a new generation of micro concrete, which has an initial as well as a final high physicomechanical performance. To obtained this, 15% by weight of the Portland cement have been replaced by materials rich in Silica (Slag and Dune Sand). The results obtained from the tests carried out on the Reactive powder concrete show that tensile and compressive strengths raised when incorporating the addition, thus improving the compactness of mixtures through filler and pozzolanic effects. With a reduction in the aggregate phase in the RPC and the abundance of the dune sand (southern of Algeria) and slag

(industrial by-product of the blast furnace), the use of the RPC will allow Algeria to fulfil economical as well as ecological requirements.[7]

III. PROPERTIES OF MATERIALS USED IN THE INVESTIGATION

3.1 Cement: Physical properties of 43 grade OPC cement used for casting of microconcrete specimen are given in Table 1.

Table 1. Physical Properties of Cement

Specific Gravity	3.15
Fineness	2.50%
Normal Consistency	32.16%
Initial setting time	30 minutes
Final Setting time	540 minutes

3.2 Fine Aggregate: Fine aggregate used in experimental programme is natural river sand collected from local source. The specific gravity of sand is 2.61. The fineness modulus of sand is 3.52 and its confirming to zone II.

3.3 Chemical Addition: Superplasticizer – Polycarbozylate Ether having specific gravity 1.110.It is deep brown coloured liquid.

3.4 Mineral Addition:

Silica Fume: It is a by-product of manufacturing silicon metal or ferrosilicon alloys. One of the most advantageous uses for silica fume is in concrete. Because of its physical and chemical properties, it is a very reactive pozzolan. Concrete carrying silica fume can have very high strength and can be very durable. Silica fume contains primarily of amorphous (non-crystalline) silicon dioxide (SiO₂). Each particles are extremely small, approximately 1/100th the size of an average cement particle. Due to its fine particles, large surface area, and the high SiO₂ content, silica fume is a very reactive pozzolan when used in concrete.



Fig.1. Silica Fume



Fig.2.GGBS

Ground Granulated Blast furnace Slag: It is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a granular and glassy product that is then dried and ground into a fine powder. Ground-granulated blast furnace slag is highly cementations and high in CSH (calcium silicate hydrates) which is a strength enhancing compound which improves the strength, durability and appearance of the concrete.

IV. MIX DESIGN

In order to improve the workability of microconcrete, super plasticizer was used. Addition of silica fume and Ground granulated blast furnace slag were incorporated at the rate of 15% by substitution of the cement’s weight to improve the compactness of cementing matrix of the microconcrete, aiming the high strength with low water / cement ratio (W/C). The combinations used are presented in Table 2. Microconcrete is designated as MC and microconcrete with Silica fume and Ground granulated blast furnace slag is designated as MC-SF and MC-GGBS.



Table 2: Composition of Microconcrete containing substitution of additions(Kg)

	Microconcrete with and without additions(SF, GGBS)					
	W/C Ratio	Water	Cement	Super-plasticizer	Sand	Mineral Addition
MC	0.20	177.4	887.2	17.74	935.31	0
MC- SF	0.20	177.4	754.12	17.74	935.31	133.08
MC-GGBS	0.20	177.4	754.12	17.74	935.31	133.08

In this experimental investigation total 27 Cubes (15 x 15 x 15cm), 9 Cylinders (15 x 30 Cm) and 9 Beams (15 x 15 x70 cm) were casted. The details of all specimens and its identification are listed in Table 3.

Table 3: Specification Details and its Identification

Type of concrete		Microconcrete	Microconcrete with	
			15 % replacement of cement by silica fume	15 % replacement of cement by Ground Granulated Blast Furnace Slag
Cube	Dimention	15 x 15 x 15 cm	15 x 15 x 15 cm	15 x 15 x 15 cm
	No. of cubes	9	9	9
Cylinder	Dimention	15 x 30 cm	15 x 30 cm	15 x 30 cm
	No. of cubes	3	3	3
Beam	Dimention	15 x 15 x 70 cm	15 x 15 x 70 cm	15 x 15 x 70 cm
	No. of cubes	3	3	3

V. RESULT AND DISCUSSION

The result of the mechanical test namely compressive strength, Split Tensile Strength and Flexural Strength are discussed below:

5.1 Compressive Strength

Compressive test was carried out by using compression testing machine of 1000KN capacity on all cube specimens as per IS 516: 1959 (R2004). Three cubes were tested for each mix combination at the ages of 7, 14 and 28 days. Total 27 cubes were casted for compression test on Microconcrete among them three are of plain Microconcrete and others are with additions of pozzolanic material. The results are tabulated in table 4. From the Fig 3, It is inferred that the compressive strength of mortar cubes of MC-SF is 110.10 Mpa and MC-GGBS is 76.80 MPa . Result shows that MC mix has crossed the target strength of 58.25 MPa and its average strength is 74.69 MPa at the age of 28 days.

Table 4: Compressive Strength of Microconcrete

Cube	Compressive Strength (MPa)		
	7 day	14 day	21 day
MC	41.51	60.10	74.69
MC-SF	85.02	99.50	110.10
MC-GGBS	50.39	68.85	76.80

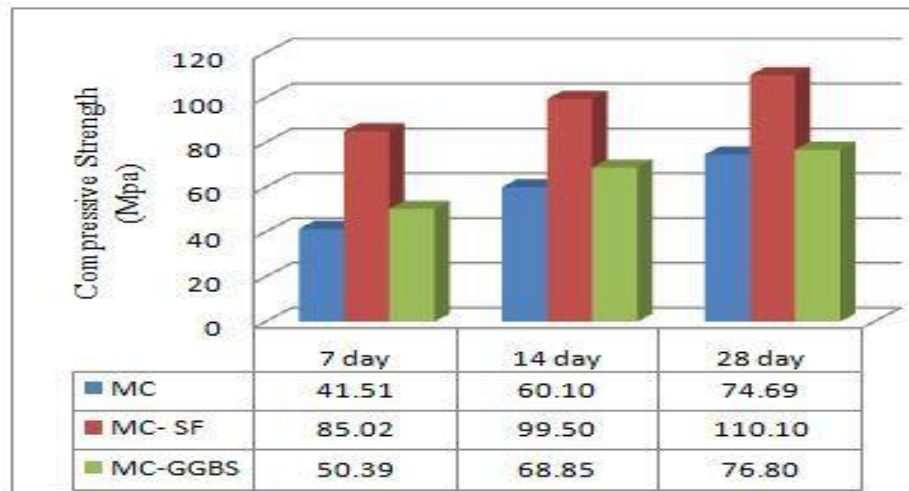


Fig.3. Compressive Strength of Microconcrete with and without additions

5.2 Split Tensile Strength

Tensile test were carried out on cylinders specimen with dimension of 150 mm x 300 mm as per IS 516:1959(R 2004). Three cylinders were tested for each mix and then mean value after 28 days of curing is reported in Table 5. The average Tensile strengths of MC, MC-SF and MC-GGBS are 8.58MPa, 10.0 MPa and 8.80 MPa respectively. MC-SF shows higher tensile strength of 10 MPa at the of 28 days.

Table 5: Tensile Strength of Cylinders

Cylinder	Tensile Strength (MPa)
MC	8.58
MC-SF	10.0
MC-GGBS	8.80

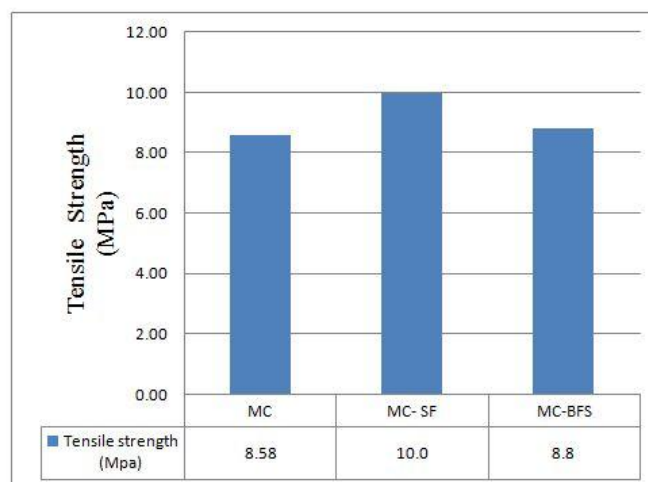


Fig 4. Graphical Presentation of Tensile Strength of Microconcrete Cylinders

5.3 Flexural Strength

According to Indian Standard 516:1959 (R 2004), the flexural strength was carried out at the age of 28 days on a beam specimen mentioned in table 6. The test was carried out on universal testing machine of 1000KN capacity. Two points loading was given to the specimens for each mix, three beams were tested after 28 days of curing and the mean value was reported. It is seen from the table 6 that the flexural strength of all the three types of beam specimen satisfies the required minimum strength $0.7 \sqrt{f_{ck}}$ at the age of 28 days. The average flexural strengths of MC, MC-SF and MC-GGBS are 8.32MPa, 8.95 MPa and 8.51MPa respectively.

Table 6: Flexural Strength of Beam

Beam	Flexural strength (MPa)	Required Value $0.7 \sqrt{f_{ck}}$
MC	8.32	4.95
MC- SF	8.95	
MC-GGBS	8.51	

Fck = Characteristics Strength of Concrete (50 MPa)

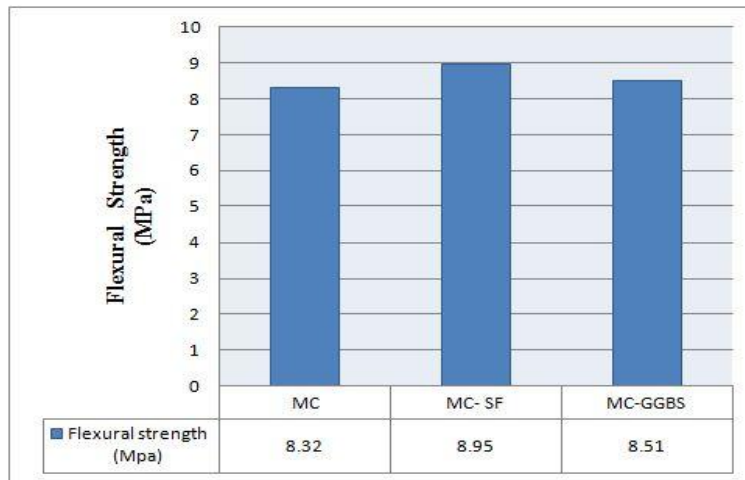


Fig 5. Graphical Presentation of Flexural Strength of Microconcrete Beam

VI. CONCLUSION

From the present study following conclusions are derived:

- The compressive, tensile and Flexural strength at the age of 28 days of the microconcrete containing additions (SF, GGBS) are greater than those of the conventional Microconcrete which means that with these additions have a pozzolanic role resulting in the formation of C-S-H of second generation. The Kinetics of formation of these C-S-H depends on smoothness of the material replacement of cement part and the silica content.
- High strength microconcrete with low water cement ratio can be achieved by addition of appropriate percentage of pozzolanic materials as replacement of cement.

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