

STUDY ON EFFECT OF MICRO SILICA AND NANO SILICA IN POLYESTER FIBRE REINFORCED CONCRETE

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Abstract - Nowadays the conventional concrete has lost its usage and it does not serve the present needs. Hence to improve the ultimate strength of the concrete, fibre reinforced concrete (FRC) and pozzolonas are used. Since early 1960's there has been an increased interest in fibre reinforced concrete (FRC), which means the addition of short discrete fibre in concrete. There are various studies and research that are emerging related to the FRC. This study is mainly concentrated on the mechanical characteristics of FRC with partial replacement of cement by micro silica (2%, 4%, 6%, 8 % and 10%) and nano silica (0.5%, 1.5%, 1%, 2 %, and 2.5%). From the experimental study, the concrete composites with superior properties can be produced using micro silica, nano silica, combination of micro silica and nano silica. This combination in the concrete causes shrinkage and decreases the tensile strength. To overcome this, varying percentages of polyester fibre (0.2, 0.4, 0.6 and 0.8) is added with the optimum 8% of micro and 2% of nano silica content. The usage of high volume of fibre affects the workability. To increase the workability superplasticizer are used. Water cement ratio is constant for all mixtures. The strength test such as compressive, split tensile, flexural strength were investigated.

Key Words: FRC, Micro silica, Nano silica, Polyester fibre, Superplasticizer.

1. INTRODUCTION

Cement is the most important material in the construction industry as it is used in different stages of construction in the form of mortar or concrete. The large scale production of cement adds pollution to the environment. Each ton of Portland cement production results in loading about one ton of carbon dioxide into the environment. Therefore it is necessary to find an alternative for cement. Such alternative are micro silica and nano silica, which is a by-product in the production of elemental silica or alloys containing silicon. The main objective of this work is to study the effects of incorporation of micro silica and nano silica in polyester fibre reinforced concrete mix as a partial replacement of cement respectively. Indrajit Patel, C D Modhera (2012) has shown that the use of polyester fibres has increased the compressive strength upto 15%. Fibre reinforced HVFA shows 16 to 23% increase in flexure strength compared to

plain HVFA concrete at 28 and 56 days. Dr. D. V. Prasada Rao, U. Anil Kumar (2014) made an experimental investigation on the influence of Nano-Silica (NS) on various strength characteristics of concrete containing Micro-Silica (MS). Based on the test results, concrete prepared with a combination of 10% Micro-Silica and 1.5% Nano-Silica possesses improved strength properties compared to the controlled concrete. K.Vamshi Krishna et.al (2014) has suggested that the use of polyester fibre increases the mechanical properties of concrete and also it results in 20% reduction of pavement thickness.

2. EXPERIMENTAL PROGRAMME

2.1 Materials used

Ordinary Portland Cement (OPC) of grade 53 conforming to IS: 12269 (1987) were used for the studies. Locally available angular shaped coarse aggregate with a maximum size of 20mm and river sand were used as fine aggregate. The triangular shaped polyester fibers of 12 mm length which was produced from Reliance industries Ltd., Coimbatore were used in the present study. Micro silica of diameter 150nm which was collected from Cidos agencies, Coimbatore and nano silica of diameter 40nm which was purchased from G.S Minerals, Coimbatore. A water reducing admixture, CONPLAST SP430 is used in concrete. Its density and pH are 1.2 and ~8 respectively. The properties of admixture micro silica and nano silica are shown in table 1.

Table- 1: Properties of material

Particular	Cement	Micro silica	Nano silica
Specific gravity	3.14	2.2	1.30
Bulk density(kg/m ³)	1258	540	94

2. 2 Mix design

M₃₅ grades of concrete were designed as per the Indian Standard code of practice 10262-2009. The mix proportion for M₃₅ grades concrete are 1: 1.29: 2.23 with W/C as 0.4.

2.3 Mechanical properties by partial replacement of micro and nano silica

The compressive strength of micro and nano silica is tested at 7& 28 days and the optimum value is chosen and it is found to be 8% and 2% respectively. The Compressive strength of micro and nano silica concrete at 7 &28 days are shown in Table 2.

Table- 2: Compressive strength of concrete at 7 &28 days

S.NO	% of Micro silica	% of Nano silica	Compressive strength in N/mm ²	
			7Days	28Days
1	0	0	25.70	39.31
2	2	0	26.76	40.12
3	4	0	24.66	40.94
4	6	0	28.38	42.03
5	8	0	30.32	42.47
6	10	0	27.67	40.82
7	0	0.5	26.04	40.22
8	0	1.0	27.22	40.89
9	0	1.5	28.59	41.42
10	0	2.0	28.79	42.67
11	0	2.5	27.55	41.31
12	8	2.0	30.92	43.32

Further the obtained value of micro and nano silica are taken and the specimens were cast to find the mechanical properties of polyester fibre reinforced concrete.

3. RESULTS AND DISCUSSION

3.1 Compressive strength test

Compressive strength testing was done on 150 x 150 x 150 mm cubes. The cubes were cast with 8% of micro silica and 2% of nano silica with varying percentages of Polyester fibre. The cubes were tested in compression testing machine. Total 3 cubes are cast for each trial. The cubes are cured and tested for 7,14 and 28 days The variation of the compressive strength is shown in chart 1

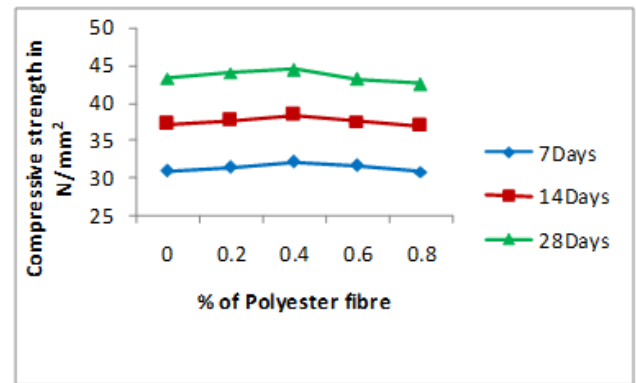


Chart-1: Compressive strength of polyester fibre reinforced concrete

3.2 Split tensile strength

The test is carried out with the cylinders of size 150mm x 300mm in height. The specimens are casted with the combination of 8% micro silica and 2% nano silica and adding the polyester fibre in the order (0.2%, 0.4%, 0.6% and 0.8%). Total 3 cylinders are cast for each trial. The cylinders are cured and tested for 7,14 and 28 days. The variation in the strength is shown in chart 2.

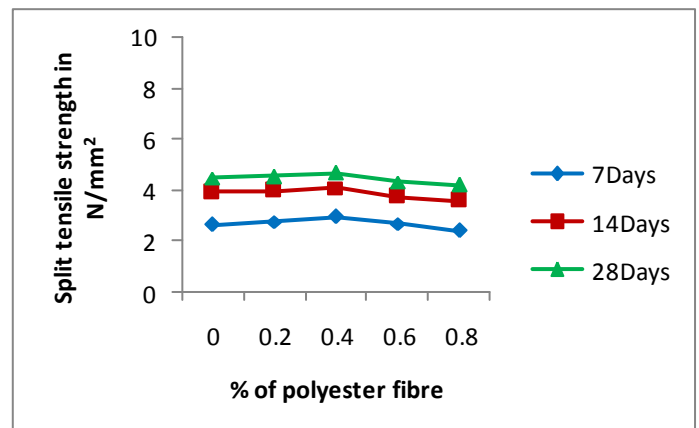


Chart-2: Split tensile strength of polyester fibre reinforced concrete

3.3 Flexural strength

The prisms of size 150mm x 150mm and 750mm in length are cast with the combination of micro silica of 8% and nano silica of 2% and also addition of polyester fibre at varying percentage of (0.2%, 0.4%, 0.6% and 0.8%). Total 3 prisms are casted for each trial. The prisms are cured and tested for 28 day strength. The specimen is subjected to 2 point loading and is tested by universal testing machine. The variation in strength is shown in chart 3.

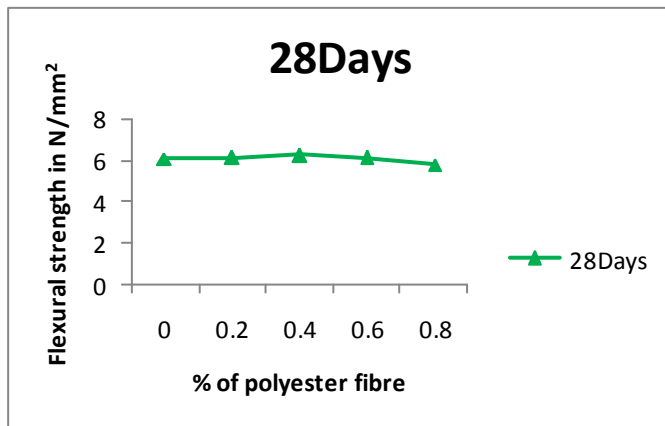


Chart-3: Flexural strength of polyester fibre reinforced concrete

4. CONCLUSIONS

Finally the test results revealed that the following conclusion,

- ✓ The concrete specimen incorporated with 8% micro silica was found to be good in compression which has compressive strength of 8% more than that of conventional concrete after 28-days curing period.
- ✓ The concrete specimen with 2% replacement of cement by nano silica showed higher compressive strength of 8.55% than the conventional concrete.
- ✓ The compressive strength get increased up to 10.2%, when combination of 8% micro and 2% nano silica were used in the concrete.
- ✓ Even though the compressive strength is higher in the above three cases, addition of polyester fibre to the combination increases the compressive, split tensile and flexural strength upto 13.05%, 19.74% and 17.85% respectively.

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