OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

EXPERIMENTAL INVESTIGATION ON BENDABLE CONCRETE (ECC) FOR M-25 GRADE

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Abstract: Engineered Cementitious Composite (ECC), also called bendable concrete, is an easily molded mortar-based composite reinforced with specially selected short random fibers, usually polymer fibers. Unlike regular concrete, ECC has a strain capacity in the range of 3% – 7%, compared to 0.01% for Ordinary Portland Cement (OPC). ECC therefore acts more like a ductile metal than a brittle glass (as does OPC concrete), leading to a wide variety of applications. For this purpose there have been 1 standard concrete batch mix of total 36 samples (70% C + 30% FlyAsh + 100% FA + 100% CA) and 3 partially concrete batch mix of 108 sample were created (68.5% to 67.5% C + 30% FlyAsh + 1.5% to 2.5% ARGF + 100% FA + 0% CA). Every batch contains 27 samples of concrete cubes of 150x150x150mm size, 27 samples of beams of 100x100x500mm size and 27samples of cylinders of 150x300mm size. Additionally for the check of durability 9samples (cubes, beams and cylinders) were created. These samples were tested with different partially replaced samples for comparison purpose.

Keywords: *Cement, Bendable Concrete, Alkali Resistant Glass Fiber, Partial Replacement, Durability, Compressive Strength, Flexural Strength, Split Tensile Strength.*

I INTRODUCTION

The growth of fiber reinforced concrete material has experienced a number of stages. In the 1960's, there was a researchbyresearchernamed Romauldi and co-workers demonstrated the effectiveness of small steel fibers in decreasing thebrittleness of concrete. This progress has continued with scattering out to a multiplicity of other fibers, such as glass, carbon, synthetics, and natural fibers and in recent inordinate length of time, hybrids that associates one or the other different fiber types or fiber lengths. It ought to be noted that most participants of this class of material have a background that does not compriseof coarse aggregates,and must therefore be considered as fiber reinforced cement pastes or mortars. Yet it is termed as ECC or Engineered Cementitious Composite or BC Bendable Concrete due to its bendability under loads. Bendable concrete is not like common fiber reinforced concrete. It belongs to a family of micromechanically designed material. As cementitious material is developed on the basis of micromechanics and fracture mechanics theory to distinct massive tensile plasticity properties. Therefore, BC isn't a fixed material type, however a broad vary of topics under completely different stages of analysis, development, and implementations. The BC material family is quite expanding. The manufacturing and mix design of bendable concrete needs special efforts by systematic engineering of the material at nano-, micro-, macro- and composite scales.

II MATERIAL USED

2.1 Cement: Ordinary Portland cement (OPC) is used in this research work.

2.2 Sand: Sand is available near Narmada River. This sand is used for the above research work.

2.3 Natural aggregate: 20 mm natural coarse aggregate is used having a specific gravity of 2.72.

2.4 Alkali Resistant Glass Fibre (ARGF): AR stands for Alkali resistant Glass Fiber. Glass fiber (or glass fibre) is a material containing of abundant extremely fine fibers of glass.

Glassmakers in history have conduct experiments with glass fibers, but mass production of glass fiber was only made promising with the creation of finer machine tooling.

Table 1: Properties of ARGF:

Properties	Observed value
Softening Point	850º C
Chemical Resistance	High
Elasticity Modulus	70 GPa x 106 psi
Tensile Strength	1700 Mpa
Dry Density	2.65 gm/cm^3
Electrical Conductivity	Very Low
Fibre Diameter	10µm
Length of fibre	10mm

III METHODOLOGY

3.1 Mix Design for M-25 Grade: The proportion of M-25 grade concrete is calculated as per IS 10262-2009 & IS 456-2000 is 1:1:2. Water binder ratio is taken as 0.42.

3.2 Workability test: In the workability test the slump value vary from 75 mm to 45 mm.

3.3 Compressive Strength Test: The mould is prepared for cubes used in the compression test having a size of 0.15mX0.15mX0.15m. After preparing cubes rest on the compression testing machine and load is applied. After applying load the value noted from the dial gauge. Compressive strength determine at 7 & 28 days.

3.4 Flexural Strength Test: The mould is prepared for beams used in the bending test having a size of 0.10mX0.10mX0.50m. After preparing beams rest on the flexural testing machine and load is applied. After applying load the value noted from the dial gauge. Bending strength determine at 7& 28 days

3.5 Split Tensile Strength: The mould is prepared for cylinder used in the tensile test having a size of 0.15m diameter and 0.30m height. After preparing cylinder rest on the compression testing machine and load is applied. After applying load the value noted from the dial gauge. Tensile strength determine at 7& 28 days

IV TEST RESULTS

4.1 Workability As shown in below table 2 for different percentage of micro silica slump value were calculated.

Table 2: Workability Result

Batches	% ARGF	Slump (mm)
Mix-01	0	75
Mix-02	1.5	72
Mix-03	2.0	65
Mix-04	2.5	61

4.2 Compressive Strength: The below table shows the compressive strength for different percentage of ARGF which is vary from 0%-2.5%.

.**Table 3: Compressive Strength Result**

Mix Design	% ARGF	7 days Compressive Strength	28 days Compressive Strength
Mix-01	0	13.64	24.13
Mix-02	1.5	13.96	28.17
Mix-03	2.0	16.24	27.36
Mix-04	2.5	15.36	28.67

4.3 Flexural Strength The below table shows the Bending strength for different percentage of ARGF which is vary from 0%-2.5%.

Table 4: Flexural Strength Result

Mix Design	% ARGF	7 days Flexural Strength	28 days Flexural Strength
Mix-01	0	3.95	5.22
Mix-02	1.5	4.41	6.05
Mix-03	2.0	4.56	6.54
Mix-04	2.5	4.49	5.97

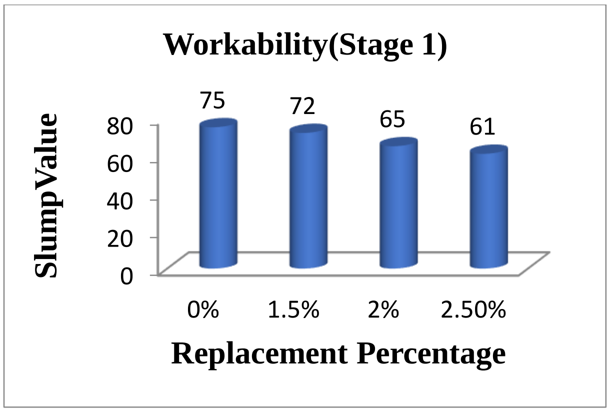
4.4 Split Tensile Strength The below table shows the tensile strength for different percentage of ARGF which is vary from 0%-2.5%.

Table 5: Tensile Strength Result

Mix Design	% ARGF	7 days Split Tensile Strength	28 days Split Tensile Strength
Mix-01	0	4.00	4.91
Mix-02	1.5	4.95	5.70
Mix-03	2.0	5.51	6.84
Mix-04	2.5	6.22	6.69

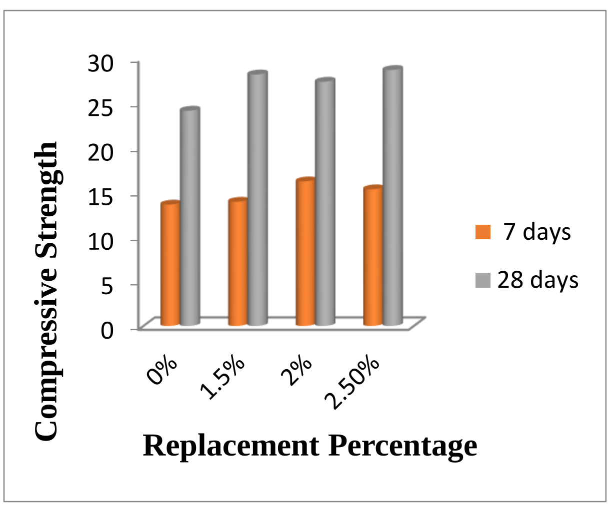
V DISCUSSION ON TEST RESULTS

5.1 Workability: From the graph 1 the workability decreases when percentage of micro silica increases.



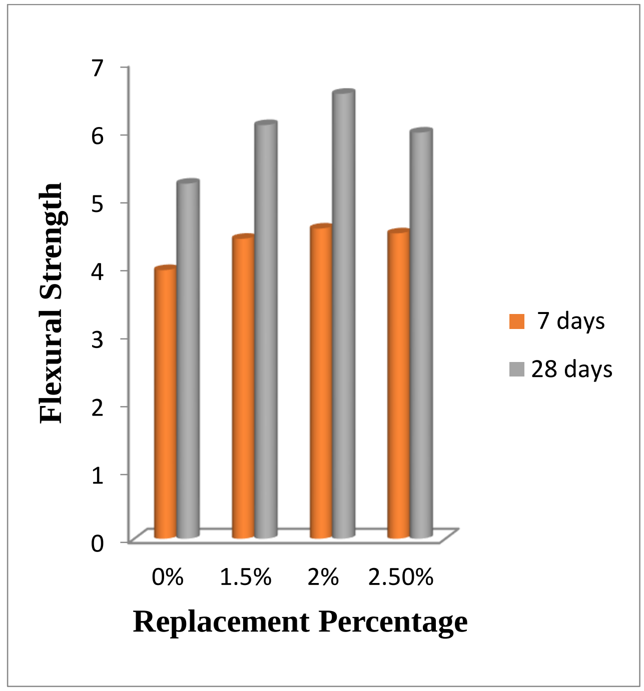
Graph 1: Slump Test for workability (mm)

5.2 Compressive Strength Test: From the graph 2 it is conclude that 7 & 28 days compressive strength 14.89% & 9.85% increases when percentage upto2.5%.



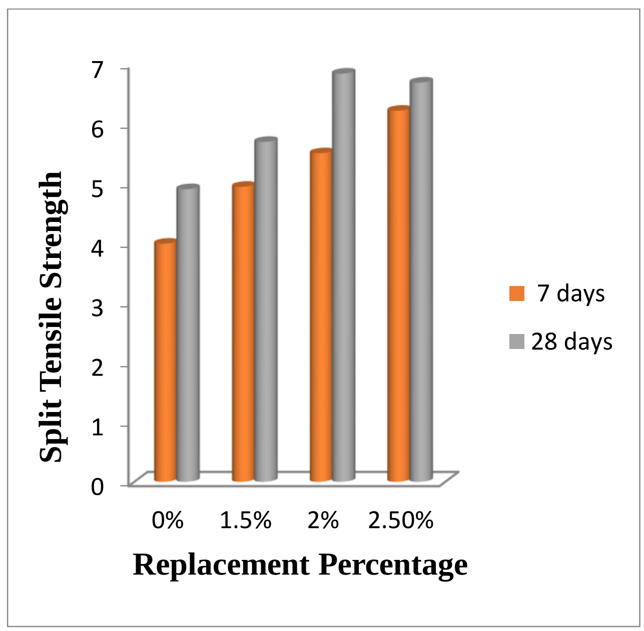
Graph: 2. Compressive Strength in N/mm²

5.3 Flexural Strength: It is conclude that 7 & 28 days bending strength 16.14% &13.77% increases when percentage upto 2.5%.



Graph: 3 Flexural Strength in N/mm²

5.4 Split Tensile Strength: It is conclude that 7 & 28 days tensile strength 31.12% &25.89% increases when percentage upto2.5%.



Graph 4: Split Tensile Strength in N/mm²

VI CONCLUSIONS

From the above research work the conclusion are as follows:

It is clear that there is drastic increment in Flexural strength and Compressive Strength of concrete at 2.0 % partial replacement of cement with ARGF. But durability and split tensile strength is little bit reduced at 2.0 % of partial

Replacement of cement with fiber. Hence, concrete made by partial replacement of cement with fiber at 2.0 % is more effective.

ACKNOWLEDGMENT

We do extremely thankful and respectful to our mentor **Mr. Siddharth Pastariya & Mr. Ashish Bhargava** Assistant Professor, Department of Civil Engineering, Sri Aurobindo Instiute of Technology, Indore (M. P.); that he always points to critical insights during the entire work,

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