# EXPERIMENTAL STUDY ON BENDABLE CONCRETE

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**Abstract -** Bendable Concrete additionally called Engineered Cementitious Composites abbreviated as ECC is elegance of extremely ductile fiber strengthened cementitious composites, characterized via way of means of excessive ductility and tight crack width manipulate ability. This cloth is successful to show off extensively improved flexibility. An ECC has a pressure potential of extra than 3.zero percentage and for that reason acts extra like a ductile metallic as opposed to like a brittle glass. A bendable concrete is strengthened with micromechanically designed polymer fibers. The purpose of this observe is to research the hardened property (i.e. Flexural Test) of ECC via way of means of addition of AR Glass fibers in exclusive proportion.( The end result is a moderately low fiber volume fraction (<2%) composite which shows extensive strain-hardening.

***Keywords - : Bendable Concrete, ECC(Engineered Cementitious Composite)s, Deflection,***

## I. INTRODUCTION

Conventional concretes are almost un-bendable and have a strain capacity of only 0.1 percent making concrete highly brittle and rigid. This lack of bendability is a major reason of failure under strain and has been a pushing factor in the development of an elegant material namely Bendable Concrete also known as Engineered Cementitious Composites abbreviated as ECC. This material is capable to exhibit considerably enhanced flexibility. A bendable concrete is reinforced with micromechanically designed polymer fibres.

ECC is made from the same basic ingredients as conventional concrete but with the addition of high- range water reducing agent is required to impart good workability. However, coarse aggregates are not used in ECCs (So it is a mortar rather than concrete). The powder content of ECC is comparatively high. Cementitious materials, such as silica fume, fly ash, blast furnace slag, silica fume etc. may be used addition to cement to increase the paste content. Additionally, ECC uses low amounts, typically 2% by volume, of short, discontinuous fibers. ECC incorporates super fine silica sand and tiny PVA-fibers covered with a very thin slick coating. This surface coating allows the fiber to begin slipping when they are over loaded so they are not fracturing.

This material is capable to exhibit considerably enhanced flexibility. A bendable concrete is reinforced with micromechanically designed polymer fibres. ECC is made from the same ingredients as conventional concrete but with the addition of High Range Water Reducing agent is required to impart good workability. However, coarse aggregates are not used in ECC. The compressive strength of ECC is similar to normal concrete. Normal concrete is brittle in nature while ECC is ductile in nature due to this property it has wide applications & wide future scope. ECC elongates without fracturing, due to the interaction between fibers, cement, and sand working in a matrix that binds everything together within the material. In addition to reinforcing the concrete with fibers that act as ligaments to bond Department of Civil Engineering Project Report 2017-2018 I.C.E.T 2 MG University it more tightly. The design of the cement matrix with special ingredients to make ECC more compatible with the fibers and to increase flexibility. Where ordinary concrete and fiber reinforced concrete are designed to resist cracking, ECC is designed to crack only in a carefully controlled manner. The cracks that are formed in ECC are steady state cracks. The width of the cracks remains constant regardless of the length.

## II. LITERATURE REVIEW

**"Engineered Cementitious Composites (ECC)- Material, Structural and Durability Performance". By Victor c.li in the year 2007**

Summary

Beyond the peak load, ECC is no different than normal fiber reinforced concrete showing tension softening response the high tensile ductility is of great value in enhancing the ultimate limit state(ULS) in terms of structural load and deformation capacity as well as energy absorption.

**Experimental study on commercially available steel and synthetic fibers. By Soutsos et al. In the year 2012**

Summary

Flexural stress – deflection relationships have been used to determine: flexural strength, flexural toughness, equivalent flexural strength, equivalent flexural strength ratio. The flexural toughness of concrete was found to increase considerably when steel and fibers were used. However, equal dosages of different fibers did not result in specimens with the same flexural toughness.

**Experimental study to investigate the flexural behavior of self-compacting concrete By Pajak and Ponikiewski. In the year 2013**

Summary

The flexural behavior of SCC appeared to be comparable to NCV, where the increase of fibers volume ratio cause the increase in pre peak and post peak parameters of SCC. Nevertheless the type of steel fibers influences much this dependency. However the SCC achieves the maximum crack mouth displacement for lower deflections than NVC.

**Experimental study to examining the influence of the paste yield stress and compressive strength on the behaviour of Fibre Reinforced Concrete By Bensaid Boulekbache et al. In the year 2012**

Summary

The results show that the shear strength and ductility are affected and have been improved very significantly by the fibre contents, fibre aspect ratio and concrete strength. As the compressive strength and the volume fraction of fibers increase, the shear strength increases. The ductility was much higher for ordinary and self-compacting.

**Experimental study on the potential applications of the fiber reinforced engineered cementitious composite. By Jun Zhang et al. in the year 2013**

Summary

Composite slab containing both plain concrete and LSECC, with steel bars at the LSECC/concrete interface, and designed construction procedures, it is possible to localize the tensile cracks into the LSECC strip instead of cracking in adjacent concrete slab. The crucial problem that inter facial failure in composite slab was prevented by using reinforcing bars across the interfaces.

**Experimental study on Polyolefin fibre-reinforced concrete enhanced with steel-hooked fibres in low proportions. By Albert et. al in the year 2014.**

Summary

The result revealed that it is possible to produce a hybrid fibre reinforced self compacting concrete with a combination of hooked steel fibres and macro polyolefin fibres, preserving the high performance fresh properties within the most common self compacting requirements. It should also be noted that the addition of Fibres did not noticeably change the compressive strength, indirect tensile strength or modulus of elasticity of the reference SCC for any of the amounts types or combination of fibres used.

**Experiment on bendable concrete. A bendable concrete is reinforced with micro mechanically designed polymer fibers. By Sagar Gadhiya1, T N Patel and Dinesh Shah. in the year 2015**

Summary

Conventional concretes are almost un-bendable and have a strain capacity of only 0.1 percent making them highly brittle and rigid. This lack of bendability is a major cause of failure under strain and has been a pushing factor in the development of an elegant material namely, Bendable Concrete also known as Engineered Cementitious Composites abbreviated as ECC. This material is capable to exhibit considerably enhanced flexibility.

**Experiment on bendable concrete. By Kallepalli Bindu Madhavi, Mandala Venugopal, V Rajesh, Kuncheppu Suresh. In the year 2017**

Summary

Recron 3S fiber is introduced in the Engineered Cementitious Composite ECC with suitable mix designs. Fibers in the cementitious matrix tend to reinforce the composite under all modes of loading and the interaction between the fiber and matrix affects the performance of cement based fiber composite material. Fibers play an important role in bending of concrete. Recron fiber in bendable concrete shows an effective result when compared with conventional concrete. Bendable shows high flexural strength as water cement ratio decrease.

## III. OBJECTIVES

- To select the optimum mix design proportions for the bendable concrete
- To check the behavior of bendable concrete under compression and flexure strength test.
- To compare the test results of bendable concrete with conventional concrete.

## IV. METHODOLOGY AND MATERIALS

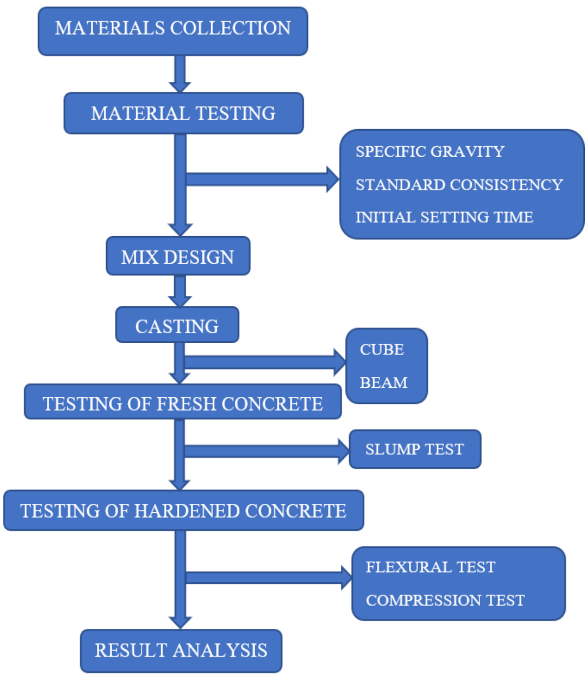


Figure 1: Flow diagram of Methodology

CEMENT: The cement used with inside the contemporary studies turned into Ordinary Portland cement. OPC is the overall sort of cement generally used across the world, being the primary key aspect for each concrete and mortar.

SAND: Sand is a certainly taking place granular fabric composed of finely divided rock and mineral particles. soil containing extra than 85% sand-sized particles. Sand is used elements of mortar and urban and for sharpening and sandblasting. The weight varies from 1,539 to 1,842 kg/m3, relying at the composition and length of grain. The great combination received from river mattress of Koel, clean from all varieties of natural impurities turned into used on this experimental program. The great combination turned into passing via 4.seventy five mm sieve and had a selected gravity of 2.68. The grading sector of great combination turned into sector III as according to Indian Standard.

WATER: Water used for ingesting is normally taken into consideration suit for making concrete. Water ought to be loose from oils, acids, alkalis, greens or natural Impurities. Soft waters produce weaker concrete. Water has features in a concrete mix. Firstly, it reacts chemically with the cement to shape a cement paste wherein the inert aggregates are held in suspension till the cement paste has hardened.

FLY ASH: In RCC production use of fly ash has been a hit in decreasing warmth technology without lack of power, growing last power past one hundred eighty days, and imparting extra fines for compaction. Replacement degrees of number one elegance fly ash have ranged from 30-seventy five% with the aid of using stable quantity of cementitious fabric. Class F fly ash is applied so the price is reduced. Only transportation price is estimated.

SUPER PLASTICIZER: Super plasticizers are progressed chemical admixtures over plasticizer with particularly powerful plasticizing results on moist concrete. Super plasticizer bring about massive enhancement in workability at a given water content material ratio. For a regular workability, discount of a water content material as much as 30%-35% can be done with the aid of using the usage of superplasticizers. Superplasticizers may be used on the better dosages than traditional plasticizers withinside the variety of 0.5% to 3% with the aid of using weight of cement. In this studies we're the usage of SP 430.

AR GLASS FIBER: A R Glass fibers additionally referred to as an alkali resistance glass fiber. Generally, glass consist of soda, quartz, sodium sulphate, potash, feldspar and some of refining and loss of life additive. Glass fibers are beneficial due to their excessive ratio of floor vicinity to weight. However, the improved floor vicinity lead them to a whole lot extra at risk of chemical attack. Humidity is an critical thing with inside the tensile power.

Figure 2: AR Glass Fiber

## V. MIX DESIGN

| Cement/Sand Ratio | Percentage Of Fly ash replace with cement | Fibres Percentage by weight of cement content |
|---|---|---|
| 1:0.7 | 30% | 1.5% |
| | | 2% |
| | | 2.5% |

## VI. RESULTS AND COMPARISSION

### 1. COMPRESSION STRENGTH TEST

| Sl. No | Name | Proportion (%) | Load (KN) | Compression Strength (N/mm²) | Average Strength (N/mm²) |
|---|---|---|---|---|---|
| 1 | FIBER CONRETE | 1.5 | 441 | 19.6 | 18.42 |
| | | 1.5 | 392 | 17.42 | |
| | | 1.5 | 411 | 18.26 | |
| 2 | FIBER CONRETE | 2 | 431 | 19.15 | 20.32 |
| | | 2 | 461 | 20.48 | |
| | | 2 | 480 | 21.33 | |
| 3 | FIBER CONRETE | 2.5 | 275 | 12.22 | 12.05 |
| | | 2.5 | 284 | 12.62 | |
| | | 2.5 | 255 | 11.33 | |
| 4 | NORMAL CONCRETE | 0 | 447 | 19.86 | 19.99 |
| | | 0 | 450 | 20 | |
| | | 0 | 453 | 20.13 | |

Figure1.1 7 Days test results

| Sl. No | Name | Proportion (%) | Load (KN) | Compression Strength (N/mm²) | Average Strength (N/mm²) |
|---|---|---|---|---|---|
| 1 | FIBER CONRETE | 1.5 | 490 | 21.77 | 24.69 |
| | | 1.5 | 608 | 27.02 | |
| | | 1.5 | 569 | 25.28 | |
| 2 | FIBER CONRETE | 2 | 608 | 27.02 | 29.06 |
| | | 2 | 667 | 29.64 | |
| | | 2 | 687 | 30.53 | |
| 3 | FIBER CONRETE | 2.5 | 334 | 14.84 | 17.16 |
| | | 2.5 | 432 | 19.2 | |
| | | 2.5 | 393 | 17.46 | |
| 4 | NORMAL CONCRETE | 0 | 580 | 25.77 | 25.98 |
| | | 0 | 589 | 26.19 | |
| | | 0 | 585 | 26 | |

Figure1.2 14 Days test results

| Sl. No | Name | Proportion (%) | Load (KN) | Compression Strength (N/mm²) | Average Strength (N/mm²) |
|---|---|---|---|---|---|
| 1 | FIBER CONRETE | 1.5 | 710 | 31.55 | 31.61 |
| | | 1.5 | 757 | 33.64 | |
| | | 1.5 | 667 | 29.64 | |
| 2 | FIBER CONRETE | 2 | 680 | 30.22 | 28.58 |
| | | 2 | 670 | 29.77 | |
| | | 2 | 580 | 25.77 | |
| 3 | FIBER CONRETE | 2.5 | 610 | 27.11 | 27.85 |
| | | 2.5 | 660 | 29.33 | |
| | | 2.5 | 610 | 27.11 | |
| 4 | NORMAL CONCRETE | 0 | 590 | 26.22 | 26.36 |
| | | 0 | 610 | 27.11 | |
| | | 0 | 580 | 25.77 | |

Figure1.3 28 Days test results

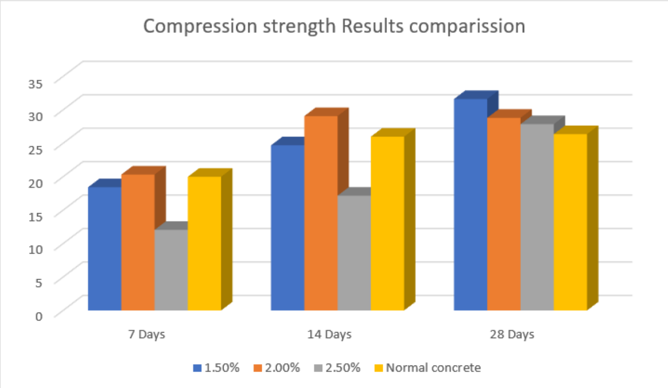


Figure1.4 Results comparison

2. FLEXURAL STRENGTH TEST

| Sl. No | Name | Proportion (%) | Load (KN) | Flexural Strength (N/mm²) | Average Strength (N/mm²) |
|---|---|---|---|---|---|
| 1 | FIBER CONRETE | 1.5 | 11 | 5.5 | 5.41 |
| | | 1.5 | 10 | 5 | |
| | | 1.5 | 11.5 | 5.75 | |
| 2 | FIBER CONRETE | 2 | 10 | 5 | 4.75 |
| | | 2 | 9.5 | 4.75 | |
| | | 2 | 8.5 | 4.25 | |
| 3 | FIBER CONRETE | 2.5 | 9 | 4.5 | 4.75 |
| | | 2.5 | 10 | 5 | |
| | | 2.5 | 9.5 | 4.75 | |
| 4 | NORMAL CONCRETE | 0 | 4.5 | 2.25 | 2.91 |
| | | 0 | 6 | 3 | |
| | | 0 | 7 | 3.5 | |

Figure2.1 7 Days test results

| Sl. No | Name | Proportion (%) | Load (KN) | Compression Strength (N/mm²) | Average Strength (N/mm²) |
|---|---|---|---|---|---|
| 1 | FIBER CONRETE | 1.5 | 13 | 6.5 | 6.75 |
| | | 1.5 | 14.5 | 7.25 | |
| | | 1.5 | 13 | 6.5 | |
| 2 | FIBER CONRETE | 2 | 15 | 7.5 | 6.58 |
| | | 2 | 12.5 | 6.25 | |
| | | 2 | 12 | 6 | |
| 3 | FIBER CONRETE | 2.5 | 13 | 6.5 | 5.91 |
| | | 2.5 | 11.5 | 5.75 | |
| | | 2.5 | 11 | 5.5 | |
| 4 | NORMAL CONCRETE | 0 | 9.5 | 4.75 | 5.08 |
| | | 0 | 10 | 5 | |
| | | 0 | 11 | 5.5 | |

Figure2.2 14 Days test results

| Sl. No | Name | Proportion (%) | Load(KN) | Flexural Strength (N/mm²) | Average Strength (N/mm²) |
|---|---|---|---|---|---|
| 1 | FIBER CONRETE | 1.5 | 14 | 7 | 7.25 |
| | | 1.5 | 15 | 7.5 | |
| | | 1.5 | 14.5 | 7.25 | |
| 2 | FIBER CONRETE | 2 | 13.5 | 6.75 | 6.5 |
| | | 2 | 12.5 | 6.25 | |
| | | 2 | 13 | 6.5 | |
| 3 | FIBER CONRETE | 2.5 | 13 | 6.5 | 6.25 |
| | | 2.5 | 12.5 | 6.25 | |
| | | 2.5 | 12 | 6 | |
| 4 | NORMAL CONCRETE | 0 | 11.5 | 5.75 | 5.83 |
| | | 0 | 12 | 6 | |
| | | 0 | 11.5 | 5.75 | |

Figure2.3 28 Days test results

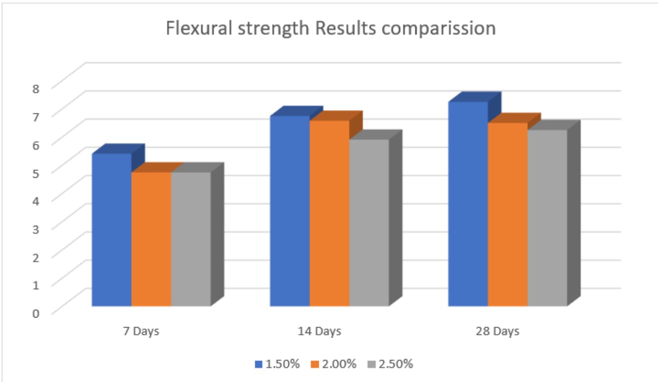


Figure2.4 Results comparison

**CONCLUSIONS**

1.From the investigations, it is concluded that Bendable Concrete with the mixes 1.5% of fiber mixes are having best results and stated as best mixes when compared to normal concrete.

2. Workability of A R Glass fiber reinforced ECC is appreciable issue as good workability is observed with use of SP 430 with dosage 2%.
3. The Compressive strength of Bendable concrete is 16% greater in compressive strength than compared to normal concrete
4. The maximum Compressive strength in bendable concrete
Having 30% replacement of cement with fly ash and having 1.5% of fibers as 31.61MPa.
5. The maximum Flexural strength in bendable concrete having 30% replacement of cement with flyash and having 1.5% of fibers as 5.41MPa.

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