IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 7, June 2022
Impact Factor: 6.252

Bendable Concrete-A Concrete for Future

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Abstract: *We know that Concrete is one the major and largest materials used in construction industry. The performance of concrete depends upon the type and nature of ingredients used for making concrete. By many measures, concrete is an excellent construction material.Conventional concrete is prepared by using cement, sand, aggregates and water along with some admixtures. The concrete thus prepared can't take much of tensile load; it is almost unbendable and has limited strain capacity. Therefore, there is a need to address some of the deficiencies in conventional concrete structures like, Brittle failure under severe loading, Deterioration under normal service loading and Lack of sustainability of RC structures etc. The lack of bendability is one major causes of failure of concrete. However, the mechanical properties and functional characteristics of concrete will have to be improved, in many ways, and these improvements are already taking place in the industry up to certain extent. To overcome many drawbacks of conventional concrete, a Bendable concrete or engineered cementitious Composites (ECC) is the one of the best alternatives. In this concrete the ductility of concrete is increased by use of fibres and other cementitious materials. This paper deals with review of the various properties, applications and advantages of bendable concrete.*

Keywords: Cementitious, Composites, Bendability, Ductility, Ingredients, Fibres, Conventional, Flexural **S**trength, etc.

I. INTRODUCTION

Bendable concrete is a class of highly ductile fiber reinforced cementitious composites, which uses silica fume, fly ash, blast furnace slag etc. and works on the principle of micromechanics. It has numerous advantages as compared with the conventional concrete, these includes, improved durability, ductility, Flexural strength and workability. The cost of ECC is nearly three times that of normal concrete, however in the long run construction cost is saved in through use of smaller structural member size, reduced or absence of steel reinforcement, elimination of other structural protective systems, and speedy construction processby the unique fresh and hardened properties ofbendable concrete. This concrete can provide enhanced structural stability, safety, durability and sustainability. ECC makes use of low quantities of discontinuous, discrete fibres of about 2% by volume of cement, Bendable concrete contains little Polyvinyl Alcohol-fibres coated with a thin (nanometre thick), slick coating and fine silica sand.

This surface coating allows the fibres to start slithering as soon as it is dispersed in the mix, so they are not fracture. Coatingprevents the fibres from rupturing that can cause big cracking. Therefore, bendable concrete deforms greater than a conventional concrete. It is lighter in weight and flexible also therefor it is also called as flexible concrete.

II. LITERATURE REVIEW

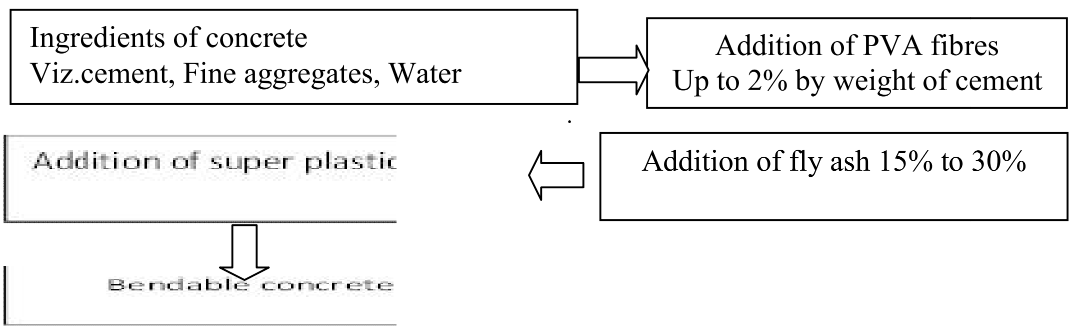
Agarwal (2020) carried the research workto assess the strength parameters of the concrete specimens made by inducing bacteria along with a suitable cement replacing substance.

Richard and P. Krithika (2019) carried out on growing the self-healing property of ECC with PP and PVA fibers with percentage of microorganism in water content. It indicated that PVA fibers provide higher overall performance as compared to PP fibers and self-healing takes place beneath distinct exposures of the ECC specimens**.**

Pan Z.(2015) Assessed un-oiled polyvinyl alcohol fibres and hybrid PVA fibres in ECC andhad been taken into consideration and additionally the combined proportion changed into redesigned via quantity analysis. In maintaining with the cost and overall performance of PVA-ECC, three normal mixes have been proposed: for M7 has low tensile strength and M17, M21 have excessive tensile strength.

Yadavalli Sandeep, Bandaru Ambika (2019) carried Experimental Investigation on Bendable Concreteconcluded that the significant properties of bendable concrete are ductility, durability, compressive strength and self-consolidation.Although the cost procured for designing of ECC is normally higher than that of the normal concrete but it has numerous potential applications. In this project the compression, split tensile and flexural strength measurements of bendable concrete are done. The values are compared with conventional cubes, cylinders and prisms. Therefore, it was proved that the bendable concrete has more strength than conventional concrete

III. METHODOLOGY



3.1 Components of ECC

It includes all the ingredients which are required to prepare the conventional concrete, except coarse aggregates
Ordinary Portland Cement-Specific gravity between 3.1 to 3.25
PVA Fibres -Polyvinyl alcohol develops a molecular and chemical bond with the cement during hydration and curing. Ca+ and OH- in the cement slurry gets attracted towards PVA fibres. Polymer fibres called PVA are used instead of steel bars which significantly improves the tensile properties of ECC. Percentage of fibers to be added is maximum up to 2% by weight of cement.

Table A

Sr.no	Description	Dimensions
1	Length	6-12 mm
2	Diameter	20-40 micrometer
3	Volume fraction	0.5 to2 % by weight of cement
4	Elastic modulus	40 Gpa
5	Fibre strength	1600Mpa
6	Internal bond strength	2.01 Mpa

Sand- Good quality river sand,free from organic silt and organic impurities shall be used. Angular shape, passing through 250 micron and retaining on 150micron sand shall be used.
Super plasticizers-Used to improve the rheological properties of concrete. It helps in dispersing the constituents uniformly in the mix. Improves slump properties from 5 cm to 50 cm without adding extra water.
Fly ash- A waste product having pozzolanic properties is used in making this concrete. Fly ash is added with sp.gravity 1.9 to 2.96 to increase paste. There are twotypes of fly ash 1) F Type -contains equal to more than 70

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% as constituents likeSiO2,AL2O3,FE203 andobtained from burning bituminous coals 2) C type-contains equal to more than 50 % as constituents likeSiO2,AL2O3,FE203 and obtained from burning sub bituminous coals or Lignite.

The conventional concrete has strain capacity of 0.1% only, which makes the concrete more brittle and rigid. In the ECC or bendable concrete ductility of the concrete is much improved by using natural and artificial fibres like PVA, jute,nylon,glass,silica,steel asbestosetc. The micro fibres give the flexibility.The fibres have slick coating which reduces the friction between the fibres particles and the cement. Partial replacement of cementby fly ash increases the paste content. No coarse aggregates are used therefore it is also called as a mortar concrete. e.ECC has strain Hardening property and can be applied with the conventional equipment's**.**

3.2 Behaviour of Concrete

Behaviour under Flexural Loading-

Figure a: Behaviour under Flexural Loading

Fig shows the behaviour of ECC under flexural loading. It shows deformation of the member without direct failure. It seems that the different ingredients of the ECC have worked together to take the load applied safely. ECC is 50 times flexible and 40 times lighter than convectional concrete

Self-consolidation-

Figure b: Self-Consolidation

Fig shows the self-consolidation characteristics of concrete. It follows principle of micromechanics ie interaction between fibres, mortar matrix and the interface between them.

Cracking Phenomenon in concrete-

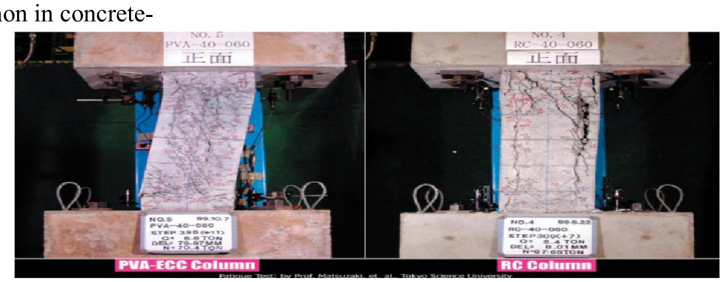

Figure c: Cracking Phenomenon in concrete

Strong molecular bond is formed between PVA fibres and concrete, when the load increases beyond its saturation value during hydration this bond helps to avoid the normal cracking phenomenon. By employing micromechanics-based material design, maximum ductility in excess of 3% under uniaxial tensile loading can be obtained with only 2% fibres content by volume ofcement.

3.3 Typical Stress Strain Curve

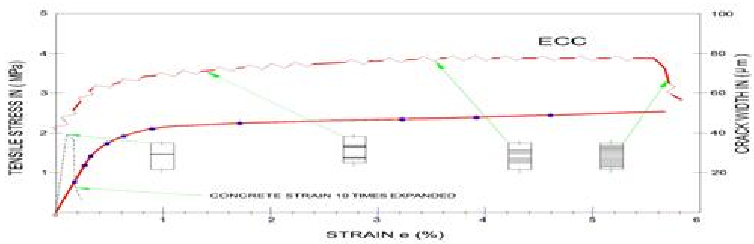

Figure d: Typical stress strain curve

Figure shows typical tensile stress-strain curve and crack width development of bendable concrete, it is seen thatstrain has much improved, which is an indication of enhanced ductility.

3.4 Self-Healing of Property

A significant percentage of the cement grains stay behind unused and dormant in the concrete mix because they are never getting hydrated and set and because of that crack are developed in the concrete.The Unhydrited grains chemically react with water and carbon dioxide in the air forming calcium carbonates,the thousands of micro cracks which are less than 5o micrometres whichgets developedafter concreting gets automatically filled with the calcium carbonate.This phenomenontakes place because of self-healing of concrete.

Table B: Comparison with Conventional Concrete

Point of Comparison	Convectional Concrete	Bendable Concrete /Bendable Concrete
Earthquake Resistance	The structures made with the original concrete are prone to earthquakes. They generally form cracks or may collapse during earthquakes	As the flexible concrete does not break easily by the earthquake motion. So, the structures made with flexible concrete are more earthquake resistant.
Self-healing property	The normal concrete has very low self-healing property as it has very low free cement concrete.	The flexible concrete has a very good self-healing property as it can heal the micro-cracks itself by the reaction of carbon dioxide and water.
Repair and Maintenance	The repair and maintenance cost of concrete structures is high as they developed cracks and other defects.	The repair and maintenance cost of flexible concrete is low as it does not develop that many cracks.
Self-weight	The self-weight of conventional concrete is more.	The flexible concrete is 30-40% lighter than conventional concrete.
Curing time	The concrete structure generally requiresmore curing time (around 28 days).	The flexible concrete generally requires less curing time (around 7 days)
Cost	The cost of construction is less as it consists of common material.	The initial cost of construction is more.
Reinforcement	Required to have tensile strength	Less or nil steel is required to have tensile strength
Durability	Lessdurable	More durable

3.5 Scope for Use

Conventional concrete is brittle and rigid material that might suffer catastrophic failure. While ECC acts as flexible concrete as compare to Conventional concrete.

It is used with specially-coated small discrete discontinuous reinforcing fibres that keep it together. Because of numerous properties and advantages, it can be used in the construction of

1. Roads and Bridges
2. Earthquake resistant buildings
3. Concrete canvas
4. Used in the coupling beams
5. Pavements.
6. Construction of joint less bridge

3.6 Advantages of Bendable Concrete

1. It is stronger, more durable, and lasts longer than the conventional concrete.
2. It has more resistance to cracking.
3. It does not emit that number of harmful gases as compared to conventional concrete
4. The use of steel reinforcement is reduced
5. The crack width can be reduced.
6. The flexural strength of the concrete can be increased.
7. ECC is green construction material
8. ECC incorporates elevated volumes of industrial wastes including fly-ash, sands and wastes from metal casting processes, wasted cement kiln dust from cement production
9. Reduced emission of Greenhouse gases

3.7 Disadvantages

1. Initialinvestment is high
2. Requires skilled manpower.
3. Material is not easily available
4. Compressive strength is lesser than standard concrete

IV. CONCLUSION

From the review,it is seen that there are numerous advantages of ECC over convectional concrete, these includesimproved ductility, compressive strength, Corrosion resistance, strain capacity, reduced cracks etc,thus overall durability gets increased than the conventional concrete. Waste materials like fly ash,slag is used there it saves environmental degradation. It has less CO2 emission therefore eco-friendly. It is lighter and flexible and therefore convenient to handle.It has high initial cost but considering life and durability of the structure it proves to economical.

REFERENCES

[1] C.Victor. Li. “Integrated Structures and Materials Design. "Materials and Structures.

[2] Yu Zhu, “Use of slag to improve mechanical properties of Engineered cementitious composites(ECCs) with high volumes of fly ash”, Journal of construction and building materials, vol. 36, pp.1076- 1081, 2012.

[3] Jun Zhang, Zhenbo Wang and Xiancunju, “application of ductile fibre reinforced Cementitious composite in joint less concrete pavements”, journal of composites, Part B, Vol.50, pp.224-23,2013. 4.

[4] Yu Zhu,Singh, M., Saini, B., &Chalak, H. D. 2018. Properties of engineered cementitious composites: areview. In International Conference on Sustainable Waste Management through Design ,473-483.

[5] Mustafa Sahmaran et.al., “Engineered Cementitious Composites. Can composites be accepted asCrack-free concrete?” Transportation Research Record: Journal of the Transportation ResearchBoard, No. 2164, TransportationResearch Board of the National Academics, Washington D.C., DOI: 10.3141/2164-01.

pp.1-8

[6] Jun Zhang, "Properties of Poly Vinyl Alcohol-steel hybrid fibre reinforced concrete composite withhigh strength cement matrix", ASCE, 2015.

[7] Tahir Kemal Erdem, "Specimen size effect on the residual properties of engineered cementitiouscomposites (ECCs) subjected to high temperatures", Journal of cement & concrete composites, Vol. 45, pp. 1-8, 2014.