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INCREASING DURABILITY OF CONCRETE BY USING POLYVINYL ALCOHOL FIBRE

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Abstract:

The current study analyzes the behavior of polyvinyl alcohol fiber reinforced concrete (PVA-FRC) containing short-length (6 mm) Banana fibers & Sisal fibers with varying fiber content. The mix was dosed with Poly vinyl Alcohol solution at 0.5% volumetric fraction. Fly ash is also used as a partial replacement of Portland cement in all the mixes. The structural performance of PVA-FRC mixes have been compared to control concrete (devoid of fibers and PVA) at 2 storage intervals: early-age (0–7 days) and short-term (0–28 days) intervals. The results of Compressive Strength, Flexural Strength, Slump Test and Compaction Factor are compared to give an idea about the performance of PVA-FRC. PVA-FRC mixes exhibited higher performance characteristics than control concrete. In addition, the addition of fibers exhibited higher mass loss, thereby potentially contributing to higher shrinkage.

Keywords: FRC, Poly Vinyl Alcohol, Polymer Concrete, PVA-FRC, Concrete.

1. INTRODUCTION

Concrete is recognized as the most prevalent used construction material in the world. It is reputable that concrete provides notable mechanical performance, great versatility, and economic efficiency in comparison to other construction materials. However, it must be noted that concrete is discredited for its brittleness and strength-to- weight ratio. Also the tensile strength of concrete is only approximately one tenth of its compressive strength. As a result, concrete members are unable to support such loads and stresses that usually take place on concrete beams and slabs. In recent times the lower tensile strength of concrete is rectified by utilizing intrinsic fibers as a form of reinforcement in the concrete matrix. The use of natural fibers such as banana, sisal, jute or coconut fibers in fiber reinforced concrete (FRC) can affect the overall properties of hardened concrete. However, the exact influence of fiber length and volumetric content remains unknown. The use of fibers in concrete mixes (FRC) is generally seen as a prevention method for cracks formed in the surface layers of the hardened concrete. The fibers in concrete aims to produce a stronger and tougher concrete, particularly improving the ductility and durability and mitigating cracking due to shrinkage. The role of fibers is essential in arresting the advance of cracks by applying pinching forces at the crack tips, thereby delaying their propagation across the matrix and creating a slow stage of crack propagation. The ultimate cracking strain of the composite mix is thus increased by many times compared to that of unreinforced matrix. The introduction of small, closely spaced, randomly oriented fibers transfers an inherently brittle material with low tensile strength and impact resistance into a strong composite material with superior crack resistance and improved ductility.

2. RELATED WORK

Four sets of concrete mixes were prepared using the raw materials shown in Table 4. Ordinary Portland Cement (53 grade) and Fly ash were used. A maximum nominal size of 20 mm aggregate was used in all mixes. All aggregates used in mix design were sourced from Rasmara, Chhattisgarh (India), which include 50/50 blended fine/coarse manufactured sand and 10 mm and 20 mm crushed gravel. The aggregate was prepared to saturated surface dry condition prior to mixing. Drinkable grade tap water was used for the mixes after conditioning the water to room temperature (23 ± 2°C).

Fig.1.Fibre

Furthermore, in order to improve the workability, a polycarboxylic ether based high range water reducing admixture (HWR) was used. Banana fiber and Sisal fiber, with properties mentioned in Table 1 and the graphical illustration shown in Figure 3, was used in all FRC mixes. Slump and compacting factor were carried out to determine the consistency. In addition, air content and mass per unit volume were measured to study the effect of PVA fibers on the properties of concrete in its plastic state. The behavior of the concrete under compressive load has also been assessed by conducting compressive strength testing. Cubical specimens of 150mm x 150mm × 150 mm were tested under constant load rate. Compressive strength was determined at ages of 7 and 28 days. To assess the behavior of concrete subjected to flexural loadings, three-point loading was carried out. A beam of size 150mm x 150mm x 70mm was casted and loaded at a rate of 180 kg/min until fracture. Flexural strength was determined at the age of 28 days. The compressive strength of ECC concrete is considered to be higher in all cases when compared to that of conventional concrete. The Compressive strength of concrete using PVA fiber and Silica fume (0.4) is 45% higher than that of Conventional concrete and the Compressive strength of concrete using Coir fiber and Silica fume (0.4) is 49% higher than that of conventional concrete.

3. PROPOSED SYSTEM

Typical mix design of ECC (ECC-M45) with self- consolidating casting properties. All proportions are given with materials in the dry state. The ingredients and mix proportions have been optimized to satisfy the multiple cracking. The type, size and amount of fiber and matrix ingredients, along with interface characteristics are tailored for multiple cracking and controlled crack width. The binder system is defined as the total amount of cementitious material, i.e. cement and Rice husk ash (Type F) in ECC. Aggregated particle size of all matrix components should be properly graded to achieve self-consolidating fresh

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properties. ECC-M45 has water to binder (w/b) ratio of 0.26 to attain a good balance of fresh and hardened properties. Various fiber types have been used in the production of ECC. Here we have used PVA fiber and Coir fiber.

Properties	Range	
	Banana Fibers	Sisal Fibers
Diameter (mm)	0.20 – 0.25	0.15 – 0.25
Length	900 – 1100	1200 – 1599
Specific Gravity	0.9	0.69
Moisture content (%)	10 – 11.5	11 – 11.5
Density (g/cm^3)	1.35	1.41
Tensile strength (MPa)	53.7	297.8
Young's modulus (GPa)	3.48	11.37

Table.1. Properties

The fibers are surface-coated by a proprietary oiling agent to reduce the fiber/matrix interfacial bonding. To account for material heterogeneity, a fiber content of 2% by volume, which is greater than the calculated critical fiber content needed to achieve strain-hardening, is typically used in the mix design. A high range water reducing admixture Conplast 430 has been found to be most effective in maintaining the desired fresh property during mixing and placing. The mix design was experimentally demonstrated to produce good ECC fresh and hardened properties. After arriving at the material properties and mix design ratio, casting of specimens was done. Firstly the proper collection of raw materials was done as per the requirement. The mixing was followed and care should be given for achieving good mixing surface. Cement and fine aggregate was mixed thoroughly and 50% of total Rice husk ash was mixed.

4. ANALYSIS

Using this mix, the beams were casted of size 1200mm x 150mm x 150mm for both the fibers and their results are compared with that of conventional concrete. The ultimate load and deflections were calculated effectively. The beam casted with Coir fiber and Silica fume (0.4) is found to carry an ultimate load of 70 kN. Hence the ECC concrete is found to perform well in Ductility study. Regarding the Durability study, attack of acid, sulphate and sea water was found to be less in ECC concrete than that of conventional concrete. The compressive strength at the end of 90 days curing in acid, sodium sulphate and sodium hydroxide was done. It is found out that the compressive strength of ECC concrete using Coir fiber and silica fume (0.4) is 49.74% higher in case acid attack, 49.75% higher in case of sulphate attack and 49.76% higher in case of sea water resistance when compared to that of Conventional concrete. By examining the recorded results displayed in Table 3, it can be deduced that the PVA-FRC mixes tend to introduce air when compared to the control concrete. The introduction of natural fibers is known to create larger interstitial voids between the fibers, cement paste, and aggregates. It also shows that as the volume of fibre increases in the mix, the mass per unit volume of the concrete decreases. This is possibly due to the lower mass per unit volume of the fibers and higher entrapped air contents when the fibre volume increases.

Mix	Compressive Strength				Flexural Strength after 28 days (N/mm^2)	
	7 day Strength, $f_{ck,7}$		28 day Strength, $f_{ck,28}$			
	σ_{ck} (N/mm^2)	Strength Effectiveness	σ_{ck} (N/mm^2)	Strength Effectiveness	σ_f (N/mm^2)	Strength Effectiveness
M1	28.17	N/A	43.55	N/A	5.67	N/A
M2	27.58	- 2.1 %	47.16	+ 8.3 %	5.89	+ 3.9 %
M3	26.34	- 6.5 %	45.00	+ 3.3 %	6.43	+ 13.4 %
M4	29.38	+ 4.3 %	48.65	+ 11.7 %	6.78	+ 19.6 %

Table.2.Analysis

Results presented that, by increasing the amount of fibre in the mix, the density decreases from 2450 kg/m3 to 2300 kg/m3. it can be noted that with a fibre volume fraction of 0.5%, mixes evidently shown improved compressive strength. However the initial strength of 7 days was slightly reduced. Similar observations for other types of synthetic fibers (i.e. polypropylene fibers) have previously been reported by other researchers that increasing the length of plastic fibers leads to a lower compressive strength.

CONCLUSION

The compressive strength results show that almost all PVA incorporated mixes exhibited lower compressive strength than the conventional mix after 7 days of curing. On a positive note, this trend was found to reverse after 28 days of curing. All PVA incorporated mixes exhibited higher compressive strength than the conventional mix at 28 days. It is worth noting that, with the same fibre volume fraction, shorter fibers enhance compressive strength more than longer fibers. Test results show that PVA fibers in low volume fractions used in this study (<0.50%) greatly enhance the flexural strength of concrete. The overall flexural strength was increased by approximately 20% with the addition of hybrid fibers and poly vinyl alcohol.

REFERENCES

[1] M. Alhozaimy and M. J. Shannag, ―Performance of concretes reinforced with recycled plastic fibers,‖ Magazine of Concrete Research, vol. 61, no. 4, pp. 293–298, 2009.

[2] J. J. Park, D. Yoo, S. Kim, and Y. Yoon, ―Drying shrinkage cracking characteristics of ultra-high-performance fibre reinforced concrete with expansive and shrinkage reducing agents,‖ Magazine of Concrete Research, vol. 65, pp. 248–256, 2013.

[3] K. Sakata, ―A study on moisture diffusion in drying and drying shrinkage of concrete,‖ Cement and Concrete Research, vol. 13, no. 2, pp. 216–224, 1983.

[4] I. G. Barr and A. S. A. El-Baden, ―Shrinkage properties of normal and high strength fibre reinforced concrete,‖ Proceedings of the Institution of Civil Engineers: Structures and Buildings, vol. 156, no. 1, pp. 15–25, 2003.

[5] Cement Concrete & Aggregates Australia, Drying Shrinkage of Cement and Concrete, C.C.A.A., 2002.
[6] A. Neville, Properties of Concrete, 4th and Final Edition, John Wiley & Sons, 1991.

[7] A. M. Tam, V. W. Y. Tam, and K. M. Ng, ―Assessing drying shrinkage and water permeability of reactive powder concrete produced in Hong Kong,‖ Construction and Building Materials, vol. 26, no. 1, pp. 79–89, 2012.

[8] G. W. Wash, ―Volume changes of hardened concrete. Significance of tests and properties of concrete and concrete-making materials,‖ ASTM (STP 169-A), American Society for Testing and Materials, Philadelphia, Pa, USA, 1996. View at Google Scholar

[9] M. Grzybowski and S. P. Shah, ―Shrinkage cracking of fiber reinforced concrete,‖ ACI Materials Journal, vol. 87, no. 2, pp. 138–148, 1990.