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EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF PVA FIBER REINFORCED CONCRETE USING M- SAND AND FLYASH

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Abstract - *Concrete is still now the most popular material in construction and one of the most environmentally harmful materials. Fly ash is an alternative material which can act as a replacing material of ordinary Portland cement. Fly ash used in various proportions (5%,10%,15%),which is cheap and will reduce environmental pollution to a large extent. Fly ash is one of major waste materials available from thermal power plants. To overcome this tribulation, M-sand is used as a replacement of River sand. The current study assesses the mechanical property of fiber reinforced concrete polyvinyl alcohol with various proportion (0.5%,1%,1.5%). An approach introduced to improve the post peak behaviour and ductile performance of concrete is using as intrinsic reinforcement. In this experimental work has an analysis the strength and durability properties of Fly ash and M-sand based fiber reinforced concrete by using polyvinyl alcohol fiber.*

Key Words*: *M-sand, Fly ash, polyvinyl alcohol fiber

1. INTRODUCTION

Concrete is known as a brittle-like material that has high compressive strength and low tensile strength and strain capacity, thus, shows no post peak behaviour. Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. In plain concrete and similar brittle materials, structural cracks developed even before loading particularly due to drying shrinkage or other causes of volume change.On the other hand, the abundant availability of fly ash worldwide creates opportunity to utilize this by-product of burning coal, as a substitute for OPC to manufacture concrete. When used as a partial replacement of OPC, fly ash reacts with the calcium hydroxide during the hydration process of OPC to form the calcium silicate hydrate (C-S-H) gel. Using of PVA fiber width of these initial cracks seldom exceeds a few microns, but their other two dimensions may be higher magnitude. It has been recognized that the addition of small, closely spaced and uniformly, dispersed fibers to concrete would act as a crack arrest and would substantially improve its static and dynamic properties.

1.1 *Fiber reinforced concrete*

Fibers have great role to control cracking due to plastic shrinkage and due to drying shrinkage. The fiber also improves the resistance it iron penetration which results in corrosion reduction of reinforcing bars. The PVA fiber increases the ductility and energy dissipating capacity. Further researches were done to study about the fracture properties and impact properties of fiber reinforced concrete.

1.2 *Polyvinyl Alcohol Fibers*

Polyvinyl alcohol fibers are an ideal environment –friendly cement reinforced material, which possesses alkali and weather resistance due to its unique molecular structure taking on good affinity to cement, effectively prevent and supports the cracks formation and development, improve bending strength, impact strength and crack strength, improve permeability, impact and seismic resistance of concrete

2. MATERIAL USED

2.1 FLY ASH

Fly ash is a by product collected in the de-dusting gases derived from the combustion of pulverized coal used in power plants. The fly ash is mainly classified into two types

i)class C ii)class F
Class C – Fly ash or high calcium fly ash, more than 20% of calcium oxide
Class F – Fly ash or low calcium fly ash consists of aluminium glass and has less than 10% of calcium oxide.

2.2 PVA FIBER

PVA consists of repeated structural units of -[-CH2-CH(OH)-] n-. Usage of PVA fibers as a reinforcement material leads to many benefits. Apart from being economical, the PVA fiber reinforcement improves the quality of concrete by making it fatigue and corrosion resistant.

Polyvinyl acetate is the starting material in the manufacturing of polyvinyl alcohol (PVA). PVA is hydrolyzed by treating it with an alcoholic solution in the presence of an aqueous acid or alkali. OH groups present in PVA are capable of forming hydrogen bonds between the fibers and the cement matrix. The resulting surface bonding helps in bridging the cracks. Fiber reinforced concrete can be defined as a“composite material consisting of mixtures of cement,

mortar or concrete and discontinuous,discrete, uniformly dispersed fibers".

Fig 1 PVA FIBER

3 TESTS

A. Test specimen

1. Strength test
   - Slump test
   - Compressive strength
2. Durability test
   - Sulphate resistance
   - Acid resistance
   - Chloride attack
   - Water absorption

B. Test result

1)Test on fresh concrete

The fresh properties of concrete mix are assessed by conducting slump and compaction factor test. Fibre reinforced concrete using M- sand slump value 75

2) Compressive strength

compression testing is a very common testing method that is used to establish the compressive force or crush resistance of a material and the ability of the material to recover after a specified compressive force is applied and even held over a defines period of time. compressive strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength resists compression. compressive strength is often measured on a universal testing machine. The maximum range of this machine is 2000 kN. the test was conducted on cube specimen of size 015x0.15x0.15 m .

Table 1
Compressive strength on partial replacement of fly ash by cement

S. no	Type	Cpmpressive strength MPa	
		7 d	28d
1	CC	17.2	31.2
2	5% FA	16.8	30.1
3	10% FA	16.2	29.5
4	15% FA	15	28

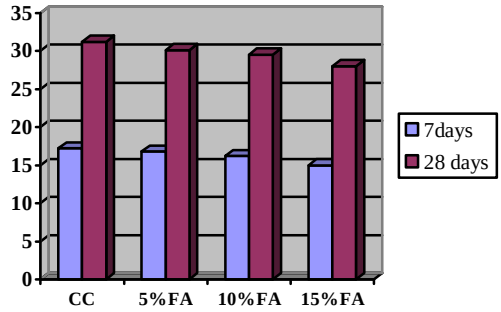

Fig 2 Compressive strength on partial replacement of fly ash by cement

Table 2
Compressive strength on fibre reinforced concrete

S. no	Type	Cpmpressive strength MPa	
		7 d	28d
1	CC	17.2	31.2
2	0.5% PVA	18.8	32.8
3	1.0% PVA	18.8	33.2
4	1.5% FA	19.8	34.5

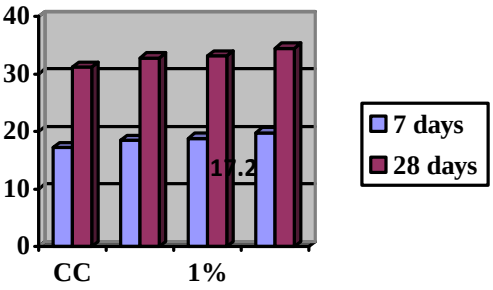

Fig 3 Compressive strength on PVA fibre reinforced concrete

Table 3
Compressive strength on fly ash and PVA fibre

S. no	Type	Cpmpressive strength MPa	
		7 d	28d
1	CC	17.2	31.2
2	PVA (0.5%) & FA(5%)	18.3	32.5
3	PVA (1.0%) & FA(10%)	18.5	33
4	PVA (1.5%) & FA(15%)	19.8	34.8

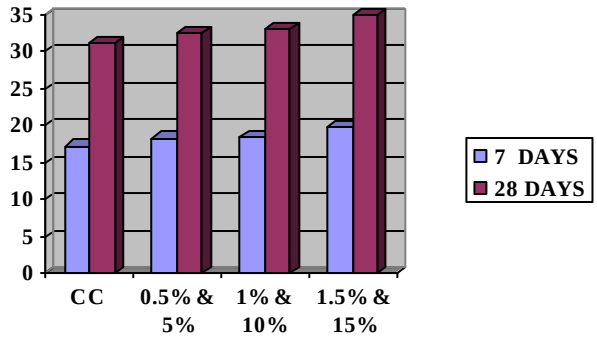

Fig 4 Compressive strength on fly ash and PVA fibre

A.Durability tests

1) Sulphate resistance test

A series of tests were performed to study the sulphate resistance of fly ash based fibre reinforced concrete. The test specimens were soaked in 5% sodium sulphate ($Na2SO4$) solution. The sulphate resistance was evaluated based on visual appearance, change in mass, and change in compressive strength after sulphate exposure up 7th day period. All specimens were heat-cured at 80^0C for 7 hours. PH value of the solution was checked at 7 days' interval and maintained throughout the test period. Size of cube 0.1x0.1x0.1m

Table 4
Sulphate resistance for fibre reinforced concrete

Type	Wt before exposure	Wt after exporsure	Compressive strength MPa
PVA (0.5%) & FA (5%)	2.232	2.395	18.2
PVA (1%) & FA (10%)	2.237	2.402	18.5
PVA (1.5%) & FA (5%)	2.235	2.386	18.9

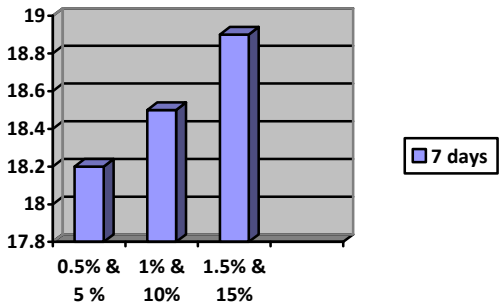

Fig 5 Sulphate resistance

2) Acid resistance

Acid resistance property of fibre reinforced concrete mixes has been studied by exposing the concrete specimens in hydrochloric acid for 7 days. pH value of the solution was checked at 7 days interval and maintained throughout the test period.(Hcl) Size of cube 0.1x0.1x0.1m

Table 5
Acid resistance for fibre reinforced concrete

Type	Wt before exposure	Wt after exporsure	Compressive strength MPa
PVA(0.5%) & FA (5%)	2.234	2.41	18
PVA (1%) & FA (10%)	2.33	2.43	18.1
PVA(1.5%) & FA (5%)	2.3	2.4	18.8

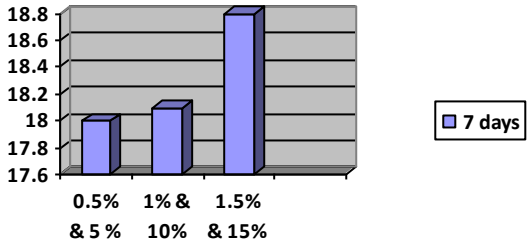

Fig 6 Acid resistance

3) Chloride attack

Chloride resistance property of fibre reinforced concrete mixes has been studied by exposing the concrete specimens in Sodium Chloride solution with 3% concentration for 7 days. With this short exposure period, no major change in compressive strength observed, only slight reduction in compressive strength. Size of cube 0.1x0.1x0.1m

Table 6
Chloride attack for fibre reinforced

Type	Wt before exposure	Wt after exporsure	Compressive strength MPa
PVA (0.5%) & FA (5%)	2.23	2.45	17.9
PVA (1%) & FA (10%)	2.236	2.47	18.2
PVA (0.5%) & FA (5%)	2.234	2.5	18.5

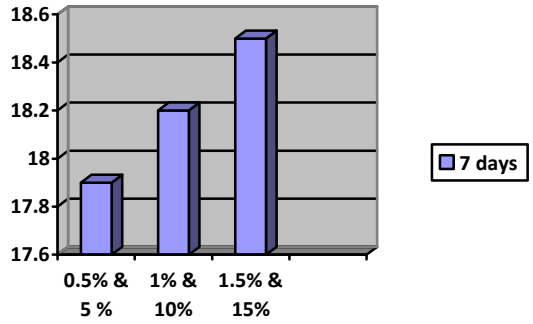

Fig 7 Chloride resistance

4)Water resistance

Water absorption characteristics of the concrete play an important role for the durability of the structure. Ingress of water defoliates concrete and in reinforced concrete structure, corrosion of the bars took place which results it no cracking and spalling of the concrete and ultimately reduces the life span of the strcture.

Table 7
Water absorption for fibre reinforced concrete

Type	Wt before exposure	Wt after exporsure	Compressive strength MPa
PVA (0.5%) & FA (5%)	2.202	2.42	24.8
PVA (1%) & FA (10%)	2.25	2.49	24.3
PVA (0.5%) & FA (5%)	2.243	2.5	23.7

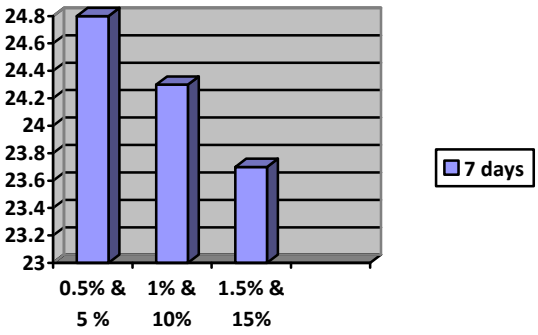

Fig8 Water absorption

IV. CONCLUSIONS

Concrete has been in use since ages because of its wide applications in the construction world. Fibres in concrete have been done for decades for treating the temperature and also the shrinkage cracks. Recently fibres are added for improving the additional properties of concrete. Concrete is partially a brittle material. In this research the fibres were added to the concrete mixture to improve its ability to deform like a wire under stress. The fibres added to the concrete are in contact with water. The effect of moisture on these fibres was studied. The fibre reinforced concrete increase the compressive strength of concrete. Fly ash is the replacement material for cement.

The casted cube, tested the mechanical properties were found out, such as compressive strength, on various fibre reinforced concrete mixes with PVA fibre (0.5%, 1% & 1.5%) and Fly ash (5%, 10% & 15%) at 7 and 28days. The test results were compared by using chart. When a crack is formed in concrete, these fibers act like bridges across the crack and prevent the further development of the crack. These fibers are under stress when they are pulled across the crack.The durability test for short time period (7 days) .Further addition in fibre content may result in improve the mechanical properties.

Polyvinyl alcohol fibres are mostly used in conventional concrete. These fibres are nowadays used in which is now proved to be enhancing the properties of fibre reinforced concrete.

REFERENCES

[1] H. Donza, O. Cabrera, E.F. Irassar, "*High-strength concrete with different fine aggregate, Cement and Concrete"* Research,

32 (11), 755–1761, **(2002)**

[2] Ara A. Jeknavorian,Eric Koehler," "*Use of Chemical Admixtures to Modify the Rheological Behavior of Cementitious Systems Containing Manufactured Aggregates",* NRMCA Concrete Sustainability Conference proceedings, **(2010)**

[3] Haitao Zhao, Qi Xiao, Donghui Huang, and Shiping Zhang *"Influence of Pore Structure on Compressive Strength of Cement Mortar"* The Scientific World Journal, **1**(12), **(2014).**

[4] M. Bederina, Z. Makhloufi, A. Bounoua, T. Bouziani, M. Queneudec, *"Effect of partial and total replacement of siliceous river sand with limestone crushed sand on the durability of mortars exposed to chemical solutions",* Journal of Construction and Building Materials, Vol. 47, 2013,146–158.

[5] Nimitha Vijayaraghavan, A S Wayal ,*"Effects of manufactured sand on compressive strength and workabilityof*

concrete", International. journal of structural & civil engineering research, **2**(4),2013.

[6] Mehta P K ,"*Concrete- Structure, Properties and Materials",* Prentice Hall-Inc.,Englewood Cliffs, New Jersey, **(1985)**.

[7] Neville A M, "*Properties of Concrete*", 3rd Edition,ELBS and Longman,Singapore, **(1989).**

[8] Nimitha. Vijayaraghavan, Dr.A S Vayal, "*Effect of manufactured sand on durability properties of concrete*",American journal of engineering Research(AJER), **2**(12),437-440, **(2013)**

[9] O. A. Cabrera , L. P. Traversa , N. F. Ortega ,*"Effect of crushed sand on mortar and concrete rheology",* Materiales de Construccion*,* **61**(303), 401 -416, **(2011).**

[10] SagarGadhiya, T N Patel and Dinesh Shah, Bendable Concrete : A Review, *International Journal of Structural and Civil Engineering Research,*Vol. 4, No.1, February 2015.

[11] M.M.Kamal, M.A.Safan, Z.A.Etman and R.A.Salama, "*Behaviour and strength of beams cast with ultra high strength concrete containing different types of fibres*", HBRC Journal, 2014.

[12] SagarGadhiya, Prof.T.N.Patel and Dr.Dinesh Shah, *"Parametric Study on Flexural Strength of ECC",* International Journal for Scientific Research and Development, Vol. 3, No.4, 2015.

[13] A.Sofi, B.R.Phanikumar, "*An experimental investigation on flexural behavior of fibre reinforced pond ash modified concrete*," Ain Shams Engineering Journal.

[14] Dhillon, Ramandeep, Sharma, Shruti and Kaur, Gurbir, "*Effect of Steel and Polypropylene Fibres on Strength Characteristics of Fly ash Concrete*," International Journal of Research in Advent Techbology,Vol.2, No.3, March 2014.
[15] Khadake S.N, Konapure C.G, "*An Experimental Study of Steel Fibre Reinforced Concrete with Fly ash for M35 Grade*, "International Journal of Engineering Research and Application, Vol.3, Issue1, 2013.

[16] Amar R Dongapure, Brijbhushan S, D K Kulkarni, "*A Study on Strength Properties of Hybrid Fibre Reinforced Concrete",* International Research Journal of Engineering and Technology, Vol. 2, Issue 6, 2015.