International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 06 | June -2017 www.irjet.net p-ISSN: 2395-0072

Effect of Mixed Fiber Reinforced Concrete Exposed to Different Exposure Condition

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Abstract - *Fibre reinforced concrete (FRC) is defined as composite mixture made with cement, aggregate and discontinues disintegrated fibres. FRC increased fatigue strength of concrete. The fibres are expensive as 1% addition of steel fibre will double the material costs of the concrete, and this has tended to limit the use of FRC to special applications like overlays of air-fields, road pavements, industrial flooring, bridge decks, canal lining, explosive resistant structure, refractory lining, etc. In this project study steel and glass fibres were used. Mix designs for M25 concrete having variation in steel and glass content was prepared by using trial and error method to cast cubic. The specimens were casted and after demoulding specimens were weighed and immersed in the made solutions of 5 % sulphuric acid and water. The weight loss recorded at 28-day concrete cube and at 7 and 28 days the specimens were tested for compressive strength, UPV test result also carried out.*

keywords: Fibre Reinforced Concrete, Compressive strength, Ultrasonic Pulse Velocity, steel and glass fibers, Acidic Condition.

1.INTRODUCTION

Fibre reinforced concrete (FRC) is defined as composite material made with cement, aggregate, and discontinues disintegrated fibres. Fiber reinforced concrete (FRC) is a concrete which improve structure's integrity reduced permeability and cracks. It contains short discrete fibers which are uniformly distributed and randomly oriented. Fibers of various type are steel fibers, glass fibers, Carbon fiber, synthetic fibers and natural fibers.

Plain concrete is a brittle material with a poor tensile strength & a poor strain capacity. The role of randomly distributes discontinuous fibers is to bridge across cracks that develop and provides ductility to concrete mixture. If fibers are strong which bonded together with concrete material that permit Fiber Reinforced Concrete to carry significant stresses over relatively large strain capacity in ductility or post cracking stage.

The study presents findings the durability criteria of mixed FRC to acids and salt resistance. The Research was carried out on different proportions of mixed fiber percentages of polypropylene glass fibers and steel fibers in total fiber content as 1 percentages of weight of standard concrete cube. Comparison of surface texture, denseness of the exposed and unexposed specimens is done by studying the properties like pH and weight loss at 28 days.

1.1 Objectives

Following are the objective of present study:

1. The objective of this research is to find that one of the main causes of deterioration in concrete when its exposure to harmful chemicals.
2. To evaluate the performance of steel and glass (polypropylene) fibers exposed to acidic condition.
3. Finding the behavior of compressive strength of concrete and UPV values, for those cured in water and acid.
4. To study surface effect of concrete specimens for those cured in water and for those cured in acid. The observations were recorded at exposed periods of the specimens in the solutions and water at 28-day of exposures and at 7 and 28 days the specimens were tested to compressive strength.
5. To find weight loss for the specimens at 28-day to study the effect of acid on concrete.

1.2 Problem Statement

Concrete is the most commonly used material in various types of construction, from the flooring to a multi storied high rise structure from pathway to an airport runway, from an underground tunnel and deep-sea platform to high-rise chimneys and Towers. The durability performance of concrete is important as it needs to have an ability to resist any weather attack and retain its original form, quality and serviceability when exposed to aggressive environment. It also needs to perform satisfactorily under anticipated exposure conditions during its service life span. No any concrete structure is durable as result of environmental effect due to which the properties of materials change with time. A material is assumed to reach the end of service life when its properties are changed or deterioration after exposure to aggressive condition. The OPC concrete always is a first material to choose when building is constructed. OPC concrete have low durability resistance and has poor ability to resist any chemical attack.

2. MATERIALS AND METHODOLOGY

2.1 Material

1. Cement: - Commercially available ordinary portland cement (OPC) of 53 grade Ultratech having specific gravity of 3.15 is used.
2. Coarse Aggregate and Fine Aggregate: - Machine crushed well graded angular granite aggregate of size 20 mm from local source are used. The specific gravity is 2.80 and fine aggregate of specific gravity 2.70 is used.
3. Fibers Properties: -

Table -1: Fiber Properties

Glass Fiber(Polypropylene)		Steel Fiber	
i.	Base: Virgin polypropylene	ii.	Length 35 mm
iii.	Specific gravity: 0.91	iv.	Diameter 0.6 mm
v.	Low absorption	vi.	Aspect ratio 60
vii.	High acid & salt resistance	viii.	Tensile strength > 1000Mpa
ix.	Electrical conductivity: Low	x.	Shape: Undulated along its length

4. Water and Acid Solution: - Locally available potable water is used and Sulphuric acid solution is made with 5 % acid in deionised water.
5. Mix proportional: - mix design was done according to IS 10262-2007 specification mix design for M20 grade concert is used.

2.2 Methodology

1. Casting: - Concrete cube of size 150mm X 150mm X 150mm are casted of standard size with total fiber content as 1% of weight of cube. This 1% contain combination of glass and steel fibers as given below.

Table -2: Type of Combination

Type of Combination	Total Fiber (1% of weight of cube)	
	Glass Fiber in Percentage	Steel Fiber in Percentage
Combination 1	0	0
Combination 2	25	75
Combination 3	50	50
Combination 4	75	25

Total 24 concrete cubes cast out of which 8 are tested at 7 and remaining cubes tested at 28-day.

2. Curing: - 12 cubes out of 24 cubes is immersed in made solution of 5% sulphuric acid and remaining 12 is immersed in water for curing period of 28 day.
3. Testing: - Concrete cubes are tested by using UPV (Ultrasonic Pulse Velocity) testing machine for 7 and 28-day also surface texture of concrete cube is also observed. Effect of weight and compressive strength of concrete due to different exposure condition is observed.

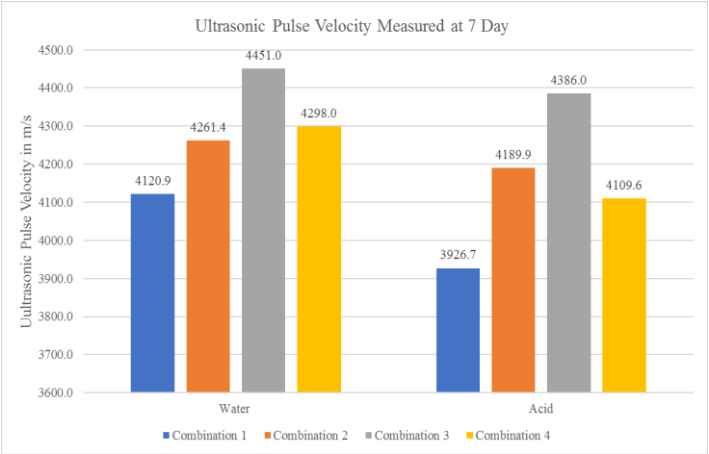
3. RESULT AND DISCUSSION

It is observed that significant effect of glass fiber and steel fiber added to mixture on the UPV values. From graph, it is clear that for combination-3 (i.e. 50% glass fiber and 50% steel fiber) shows UPV values result as characterizing the quality of concrete is found to be good as specified in UPV standard table for 7 and 28-day cube. The quality of concrete is determined in terms of absence of internal flows, uniformity and cracks by UPV standard table.it was observed that presence of steel fiber increase pulse velocity because pulse velocity in steel is 1.2 to 1.9 times the velocity in plain concrete.

Table -3: Ultrasonic Pulse Velocity Result

Combination Number	Ultrasonic Pulse Velocity Measured at 7 and 28 Day			
	Water		Acid	
	UPV in m/s at 7-day	UPV in m/s at 28-day	UPV in m/s at 7-day	UPV in m/s at 28-day
1	4120.9	4032.3	3926.7	3876.0
2	4261.4	4155.1	4189.9	4109.6
3	4451.0	4424.8	4386.0	4249.3
4	4298.0	4213.5	4109.6	3989.4

Chart -1: Relation between UPV values and mixed fiber reinforced concrete at 7-day.



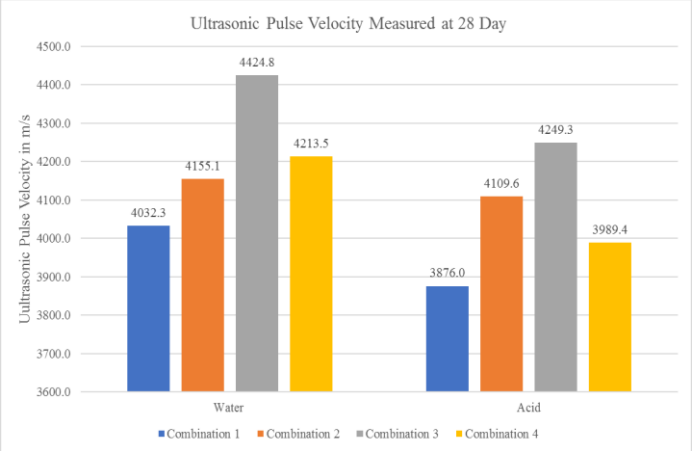


Chart -2: Relation between UPV values and mixed fiber reinforced concrete at 28-day.

Table -4: Weight Loss Result

Combination Number	Weight Measured at Exposed and Unexposed Condition in Kg					
	Water			Acid		
	Initial Wt. of Cube	Wt. At 28 Day	% Wt. Loss	Initial Wt. of Cube	Wt. At 28 Day	% Weight Loss
1	8.447	8.431	0.189	8.561	8.552	0.105
2	8.478	8.456	0.259	8.457	8.432	0.296
3	8.452	8.436	0.189	8.403	8.382	0.251
4	8.403	8.412	-0.107	8.207	8.193	0.171
	Average % Wt. loss		0.133	Average % Wt. loss		0.206

From table-4 weight loss for specimen for those cured in water is more than for those cured in acid.

It was determined that glass fiber added to concrete affect more than steel fiber. Effect of steel fiber on compressive strength of concrete shows alteration based on fiber volume.it can be said that increased of percentage of steel fiber to concrete mixture shows important increase in compressive strength of composite.

Table -5: Compressive Strength Result

Combination Number	Compressive Strength at 7and 28 Day for Exposed and Unexposed Condition in N/mm2			
	Water		Acid	
	At 7 Day	At 28 Day	At 7 Day	At 28 Day
1	18.311	27.178	15.884	25.760
2	21.533	30.000	16.498	27.787
3	26.018	32.244	18.022	29.889
4	21.200	29.324	15.111	26.778

From table-6, it is clear that for combination-3 (i.e. 50% glass fiber and 50% steel fiber) shows higher percentage increase of 42.087% in water and 13.458% in acid exposure at 7-day and similarly 18.643% in water and 16.028% in acid at 28-day.

Table -6: Percentage Increase in Comp. Strength

Combination Number	Percentage Increase of Compressive Strength at 7 and 28 Day for Both Condition as compare to control specimen (i.e. combination-1)			
	Water		Acid	
	At 7 Day	At 28 Day	At 7 Day	At 28 Day
2	17.597	10.384	3.861	7.867
3	42.087	18.643	13.458	16.028
4	15.777	7.899	-4.868	3.951

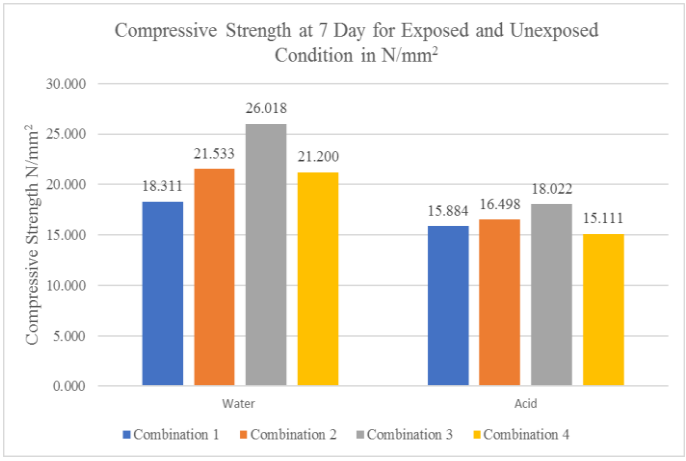


Chart -3: Compressive strength of concrete for both exposure condition at 7-day.

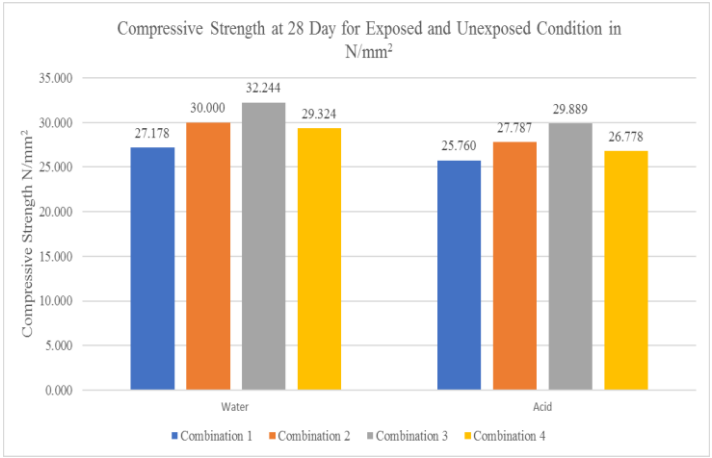


Chart -4: Compressive strength of concrete for both exposure condition at 28-day.

Surface of concrete specimen for those cured in acid is observed to be detorioted due to corrosion of concrete as compare to water. Surface corrosion of concrete is found to be more with increase in content of polypropylene fiber.

Fig -1: Surface effect of concrete for both exposure condition.

Due to exposure of 5% solution H_2SO_4 colour of concrete is changes to yellowish.

4. CONCLUSIONS

From above result it is found that main causes of deterioration in concrete is corrosion of concrete due to its exposure to harmful chemical. Strength of concrete can found to be increased for combination 3 (i.e. 50% glass fiber and 50% steel fiber) shows higher percentage increase of 42.087% in water and 13.458% in acid exposure at 7-day and similarly 18.643% in water and 16.028% in acid at 28-day. It was determined that glass fiber added to concrete affect more than steel fiber. it was observed that presence of steel fiber increase pulse velocity because pulse velocity in steel is 1.2 to 1.9 times the velocity in plain concrete.

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