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EXPERIMENTAL STUDY INVESTIGATING IMPACT OF SULPHATE AND ACID ATTACK ON GLASS FIBRE CONCRETE

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Abstract— ***In the era of urbanization & development more challenging and Critical structure are build all over the world. Now a day's word is witness of lots of critical and harsh environment conditions. demand of construction in harsh environment condition are increasing day by day so that the serviceability and durability of concrete structure take a serious concern. Previous researches show that the durability of concrete is decreased when it comes in influenced of sulfuric acid and sulphate due to its alkaline nature. To overcome this problem Glass fibre are added to the concrete. In this experiment concrete mixers are prepared by different percentage of glass fibre. GFRC were obtained by thoroughly mixing the glass fibre inside the dry mix before addition of water by varying percentage of 0.0%, 0.5 %, 1.0 %, 1.5%, 2.0 % and 2.5 % respectively with respect to the total weight of cement. Eighteen number of cubes are prepared from each mix. All cube is immersed in water for the period of 28 days. In the first phase compressive strength test is conduct at 7 and 28 days. In second phase remaining cube is immersed in magnesium sulphate and sulfuric acid solution of 5 % v/v. loos in weight and Durability test were conduct at 30 day and 60 day for both solutions. This result is compared with conventional concrete mix. It concludes that the workability of concrete not much affected by addition of glass fibre. While the durability of concrete increased with addition of glass fibre. Optimum result is found at 1 % of glass fibre***.

Keywords— GFRC, Durability, Magnesium sulphate, Sulfuric acid

I. INTRODUCTION

In recent years, the durability of the concrete takes real concern in the world of concrete technology. For long term serviceability of structure, it's important that factor affecting the life of structure should be in proper consideration. Chemical attack due to aggressive water is one of the sources that can damage the concrete. Exposure of concrete to solid sulfate does not affect concrete severally but when the chemical is in the solution form the entrance into the pores of the concrete and react with the hydrated cement product and from deleterious soluble alkali. Due to the use of fertilizers Ammonium Sulphate frequently present in the soil, also the industrial effluent content enough sulfate which potentially damages concrete. Water which used in the concrete cooling tower can also become a potential source of sulphate attack on concrete.

Concrete is suspectable to acid attack various minerals like sulphate, nitric, hydrochloric acid, Phosphorus acid affect the concrete. The most common form of sulphate attack in concrete takes place when ammonium bearing and Calcium Hydroxide react with sulphate ion. In natural groundwater only sulphuric acid likely to be found as a result of oxidation of sulphate mineral. When concrete is come in contact with such acidic water calcium hydroxide react with sulphuric acid to form gypsum which can be readily washed away these causes increase in porosity and permeability of the concrete surface. Acid rain is also one of the major forms of sulphuric acid attack on concrete. Unscheduled washing down, random spelling and dumping of chemical waste have a higher concentration of acid attack in the industrial environment.

Sanitary sewerage system is another common source which is affected by sulphuric acid corrosion, this corrosion generates in concrete due to bacterial action. Sewerage environmental condition has the capability of providing a suitable condition for the production of H2S gas which will consecutively oxidize into corrosive sulphuric acid. This resultant microbial Corrosion in concrete pipes, treatment plant, manholes, pumping station, junction chamber, etc. To reduce the effect of acid and sulphate attack on concrete and to make the concrete more durable to resist chemical attack glass fiber added in concrete glass fiber are one of the most source full material known today glass fiber obtained from a composition consisting by silica.

II. MATERIAL USED

Cement:

OPC 43 grade confirming as per IS 8112:1983 cement is used for the experiment. Various test has been conducted on cement as per IS 4031:1998. Consistency of cement observed at 31%. Fineness of cement observed 91%. Initial setting time and final setting time of cement found 30 minute and 600 minutes.

Coarse Aggregate:

Crushed stone locally available are used in concrete. Coarse aggregate as per IS 383:2016 were used. Specific gravity of 20 mm size aggregate found 2.872 and Specific gravity of 10mm size were found 2.826. Impact value of aggregate obtained 9.52.

Fine Aggregate

Locally available river sand used for mix design. Test were conduct as per IS specification. Fine aggregate found grading zone (ii) confirming as per IS 383:2016. Specific gravity of river sand was found 2.636 (gm/cc) & water absorption 1.254. Fineness modules of sand is 2.86.

Glass fibre

Glass fibre are now often used in concrete. Glass fibre are obtained from composition consisting of silica. Glass fibre of 12-15 mm size are used in this experiment. Specific gravity of glass fibre of these fibre is 2.68.

III. METHODOLOGY

The concrete mix is constructed as per the IS10262:2009 for M-40 grade of concrete The GFRC is obtained by thoroughly mixing the glass fibers inside the dry concrete mix before the addition of water by varying percentage of 0.5, 1.0, 1.5, 2.0 and 2.5% respectively with respect to the total weight of cement in the mix. The mixes are denoted as M-1 (0% glass fiber), M-2 (0.5% glass fiber), M-3 (1% glass fiber), M-4 (1.5% glass fiber), M-5 (2.0% glass fiber) and M-6 (2.5% glass fiber). Compressive Strength Test As per IS516:1956 is conducted in compressive strength test machine of capacity 2000 KN. Test is performed on 150mm X 150mm X 150 mm size cube. For Durability test 5% V/V solutions of H_2SO_4 and $MgSo_4$ is made. All types of concrete mixes are immersed in this solution for 30 and 60 days after the curing period of 28 days. Before the immersion of cubes, each cube is marked and weighed. After the end of the immersion period, the cubes are tested for their reduction in compressive strength and weight loss.

IV. RESULT

Following Result given in Table I show the compressive strength of concrete mixes i.e. M-1, M-2, M-3, M-4, M-5, M-6 at the end of curing period of 7 and 28 days.

TABLE 1
Compressive Strength test of concrete mix at 7 & 28 days

S. No	Concrete mix M-40 + Glass fibre	Compressive Strength in(N/mm2)	
		7 days	28 days
1	M-1(0.0 % GF)	33.67	47.36
2	M-2(0.5 % GF)	35.29	49.26
3	M-3(1.0 % GF)	38.47	54.52
4	M-4(1.5 % GF)	36.18	51.56
5	M-5(2.0 % GF)	34.93	48.81
6	M-6(2.5% GF)	31.48	46.39

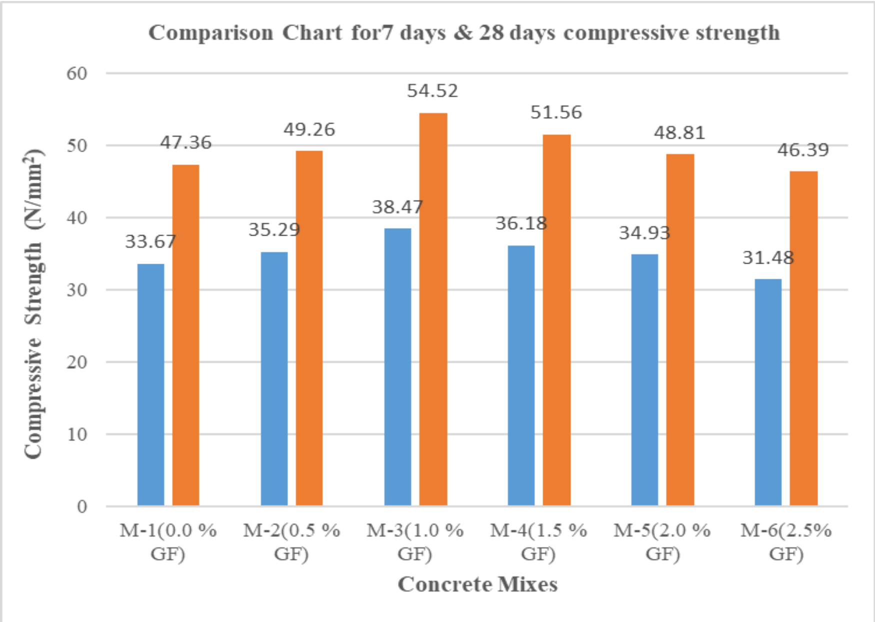

Fig. 1 Compressive strength of concrete mix at 7 and 28 days

Following Result given in Table II show the effect of magnesium sulphate on various concrete mixes. Concrete cube is immersed in $MgSo_4$ solution for curing period of 30 and 60 days.

TABLE II
Compressive Strength of cube against MgSO4 solution at 30 days and 60 days

S. No	Concrete mix M-40 + Glass fibre	Compressive Strength in(N/mm2)	
		30 days	60 days
1	M-1(0.0 % GF)	40.62	38.84
2	M-2(0.5 % GF)	44.37	42.73
3	M-3(1.0 % GF)	50.92	49.41
4	M-4(1.5 % GF)	47.45	45.45
5	M-5(2.0 % GF)	44.44	42.67
6	M-6(2.5% GF)	41.85	39.9

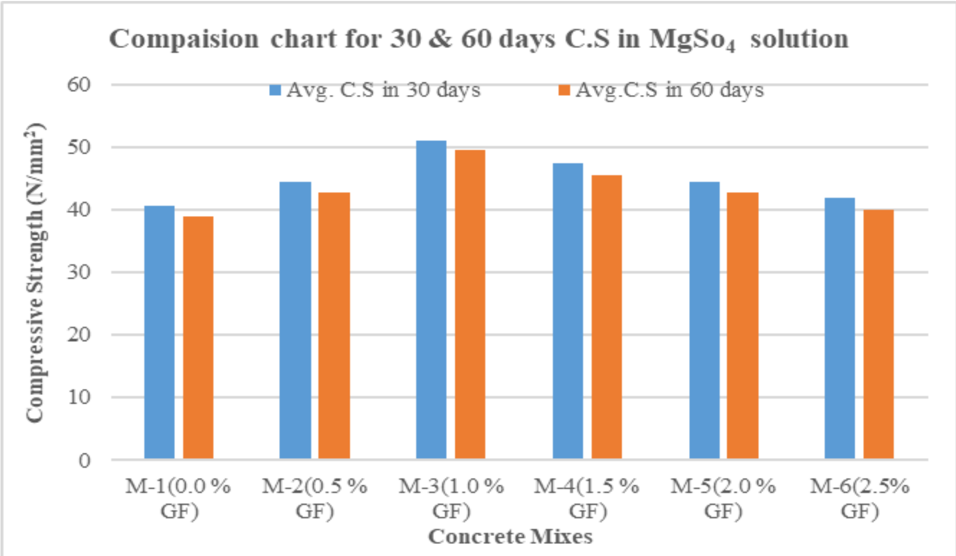

Fig 2 Strength of concrete in $MgSo_4$ Solution

Table III given below shows the impact of magnesium sulphate in concrete mixes. Compressive Strength Result obtained after 30- and 60-days curing period in $MgSo_4$ solution is compared with result obtained from 28 days curing in water. Reduction in Strength of concrete is showing in the form of percentage.

TABLE III
Percentage Reduction in concrete strength after 30 and 60 days in magnesium sulphate solution

Concrete Mixes	Compressive Strength (N/mm^2)	% Reduction in Strength (N/mm^2)	% Reduction in Strength (N/mm^2)
	28 days	30 Days	60 Days
M-1(0.0 % GF)	52.00	14.23	17.99
M-2(0.5 % GF)	49.26	9.92	13.26
M-3(1.0 % GF)	54.52	6.60	9.37
M-4(1.5 % GF)	51.56	7.96	11.84
M-5(2.0 % GF)	48.81	8.95	12.59
M-6(2.5% GF)	46.39	9.77	13.99

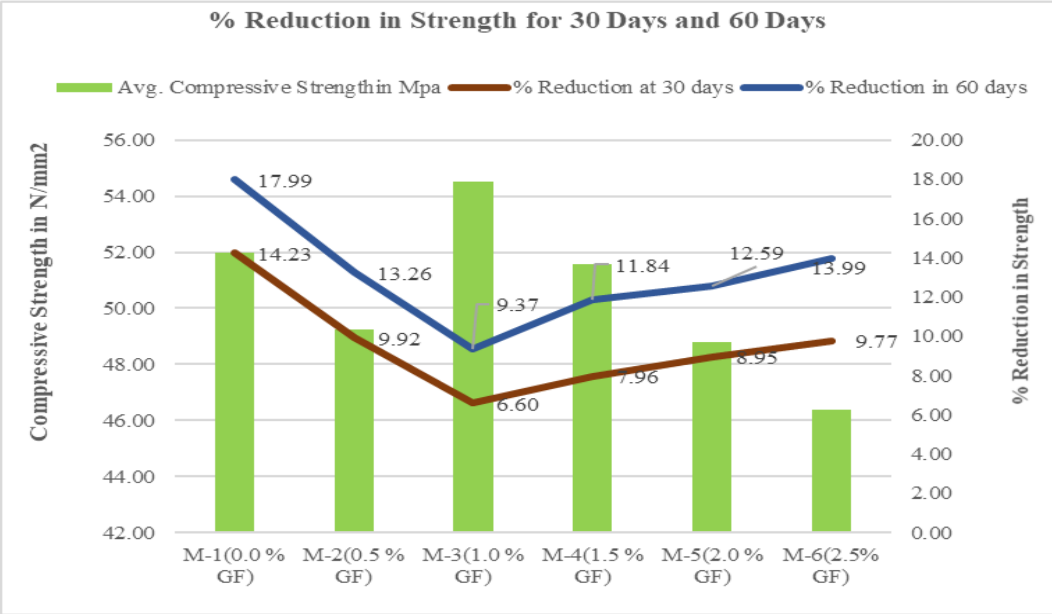

Fig 3 percentage reduction in Strength in H_2So_4 solution

Following Result obtained given in Table IV show the effect of Sulfuric Acid on various concrete mixes. Concrete cube is immersed in H_2So_4 solution for curing period of 30 and 60 days.

TABLE IV

Compressive Strength of cube against H_2SO_4 solution at 30 days and 60 days

S. No	Concrete mix M-40 + Glass fibre	Compressive Strength in(N/mm^2)	
		30 days	60 days
1	M-1(0.0 % GF)	39.46	38.12
2	M-2(0.5 % GF)	42.43	40.86
3	M-3(1.0 % GF)	49.3	47.27
4	M-4(1.5 % GF)	45.81	43.69
5	M-5(2.0 % GF)	42.8	40.68
6	M-6(2.5% GF)	39.76	39.74

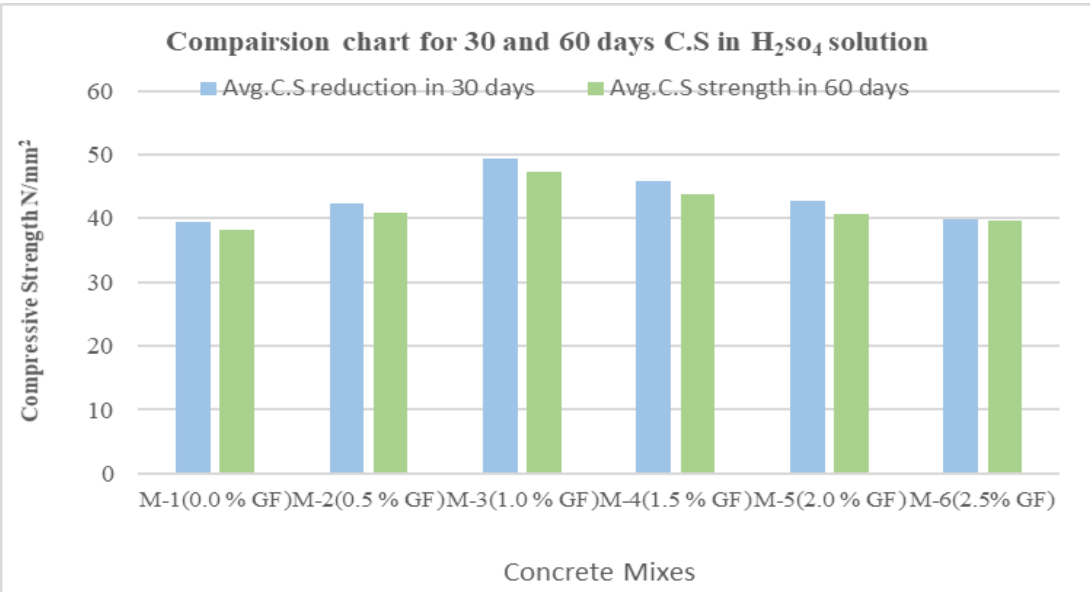

Fig 3 Compressive Strength in H_2SO_4 solution

Table V given below shows the impact of Acid attack in concrete mixes. Compressive Strength Result obtained after 30- and 60-days curing period in H_2SO_4 solution is compared with result obtained from 28 days curing in water. Reduction in Strength of concrete is showing in the form of percentage.

TABLE V
Percentage Reduction in concrete strength after 30 and 60 days in Acid solution

Concrete Mixes	Compressive Strength (N/mm^2)	% Reduction in Strength (N/mm^2)	% Reduction in Strength (N/mm^2)
	28 days	**30 Days**	**60 Days**
M-1(0.0 % GF)	47.36	15.64	19.52
M-2(0.5 % GF)	49.26	13.86	17.05
M-3(1.0 % GF)	54.52	9.57	13.29
M-4(1.5 % GF)	51.56	11.15	15.26
M-5(2.0 % GF)	48.81	12.32	16.66
M-6(2.5% GF)	46.39	14.28	18.21

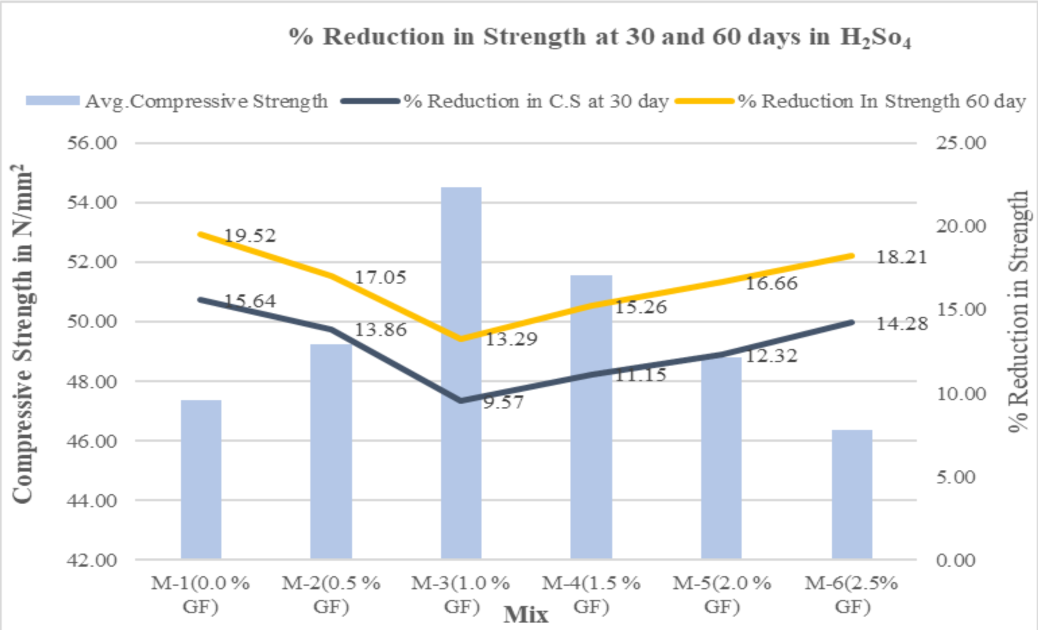

Fig 5 Percentage reduction in concrete against H_2SO_4 solution

Weight loss Study of concrete mixes

Following table VI show the effect of magnesium sulphate in weight of concrete mixes. Concrete cube is oil marked and weighted before immersing in solution. Reduction in weight of concrete cube shown in percentage.

TABLE VI

Concrete mix M-40 + Glass fibre	% Reduction in Weight in $MgSO_4$ solution	
	% Average Reduction in weight	% Average Reduction in weight
	30 days	**60 days**
M-1(0.0 % GF)	3.12	4.01
M-2(0.5 % GF)	2.42	3.33
M-3(1.0 % GF)	1.19	2.26
M-4(1.5 % GF)	2.3	3.16
M-5(2.0 % GF)	2.15	3.41
M-6(2.5% GF)	3.13	4.01

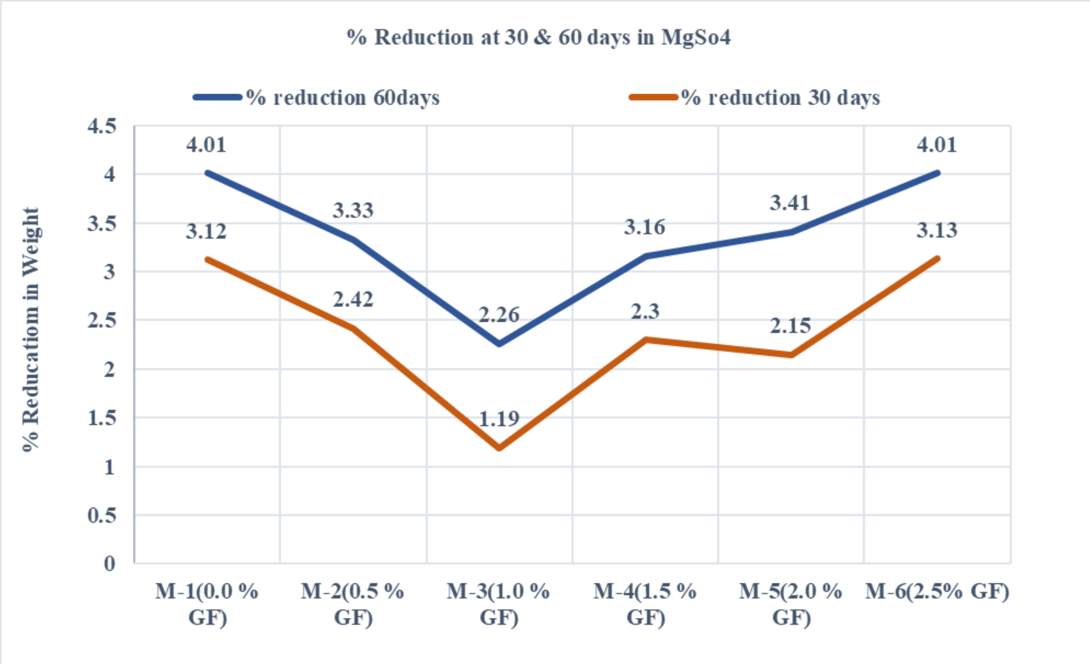

Fig 6 percentage reduction loss in weight of concrete in $MgSo_4$ solution

Following table VII show the effect of Sulfuric Acid in weight of concrete mixes. Concrete cube is oil marked and weighted before immersing in solution. Reduction in weight of concrete cube shown in percentage.

TABLE VII

Concrete mix M-40 + Glass fiber	**% Reduction in Weight in H_2SO_4** solution	
	% Average Reduction in weight	**% Average Reduction in weight**
	30 days	**60 days**
M-1(0.0 % GF)	6.04	8.07
M-2(0.5 % GF)	5.49	7.38
M-3(1.0 % GF)	4.22	6.31
M-4(1.5 % GF)	5.4	7.25
M-5(2.0 % GF)	5.21	7.36
M-6(2.5% GF)	5.67	7.75

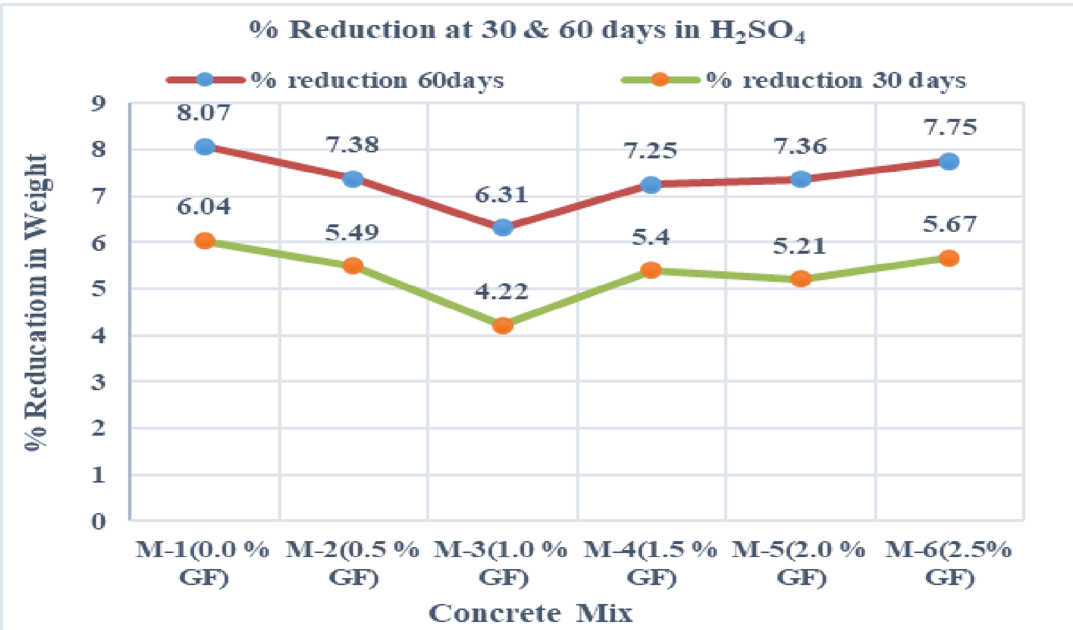

Fig 7 percentage loss in weight of concrete in H_2So_4 Solution

V. CONCLUSIONS

It concluded that workability of concrete mix is not affected by addition of glass fiber in initial stage. But after time repaid loss in water take please in those concrete mixes which having above 1.5 % glass fiber. It also concludes that deformation take please in concrete mix when it comes in influenced of sulphate and acid attack. It observed erosion and deformation on surface of concrete cubes. On the basis of results obtained from compressive strength test and durability tests against chemical attack the optimum percentage of glass fiber to be added can be concluded to be 1%.

VI. ANNEXURE

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