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Go-Recron Fibre Reinforced Concrete with Foundry Sand as a Partial Replacement of Fine Aggregate

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ABSTRACT: This paper deals with the study of a new combination of GO-Recron fiber and foundry sand based on the parameters such as compressive strength, flexural strength, split tensile strength and durability of M25 grade concrete. Here the replacement of fine aggregate was done by foundry sand in percentage of 0%,50%,100%, recron fibre in 0.5,1,1.5 weight % of cement and GO had made constant through out the mix in 0.05% weight % of cement. The mix design was prepared with a water ratio of 0.5%,now a days the scarcity of natural or river sand, M-SAND are there the study on the use of foundry sand have a great opportunity. The results indicates that the increase of foundry sand in 50% can increase the strength in this new combination and future study can be done over this with new combination and new methods to find a optimum level.

KEYWORDS: Graphene oxide(GO),Foundry sand, Recron fibre

I. INTRODUCTION

In this research, a combination of three material Graphene oxide (GO), Recron fibre, Foundry sand are studied. Foundry sand is high quality silica sand that is a by product from the production of both ferrous and nonferrous metal casting Industries. From centuries foundry sand has been used as a moulding casting material because it's high thermal conductivity. Fibre reinforcement concrete is considered as a material of improved properties and not as reinforced cement concrete wherein reinforcement is provided for local strengthening of concrete in tension reason Since in fibre reinforcement concrete, fibres are uniformly dispersed which has better properties to resist internal stress due to shrinkage. Also reduces segregation and bleeding and also results in a more homogeneous mix. This leads to better strength and reduced permeability which improves durability. Cementitious materials (especially concrete) are the most common construction materials used worldwide. However, cementitious materials are generally brittle and have very low tensile strength and strain capacity, Graphene is one of the most popular nanomaterial's, and has attracted much attention for its many unusual properties. Despite its excellent properties, the incorporation of graphene in cement-based materials has been proven to be rather complex and very hard because it is hard to be dissolved with water.

II. LITERATURE REVIEW

There are lots of study going around the field to replace and strengthen the concrete and replacement of materials because the availability of materials are being limited. From the studies the addition of GO improves the degree of hydration of the cement paste and increases the density of the cement matrix, creating a more durable product,The

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shrinkage cracking is reduced by 83 to 85% by addition of fibers, Waste foundry sand addition had positive influence on sulphate resistance of concrete

III MATERIALS AND METHODS

III.1 MATERIAL PROPERTIES

Different tests were conducted for each material as specified by relevant IS codes.

III.1.1 Cement

Ordinary Portland cement of 53 grade was used for this study. Standard consistency, setting time, specific gravity, fineness etc. were checked by conducting various tests were given on the Table 1 and there is code limitations

Table 1. Physical properties of cement

properties	Test results	Is specification and test procedure
Specific gravity	3.12	3-3.15, IS 4031 part2-1988
Standard consistency	35%	33-35%, IS 4031 part4- 1988
Initial setting time	35 min	>30 min, IS 4031 part5-1988
Final setting time	360 min	<600 min, IS 4031 part5-1988
Fineness	8%	<10%, IS 4031 part1-1996

III.1.2 Coarse aggregate

the aggregates used in the works are commonly 20mm size and the the table shows the values for the coarse aggregate

Table 2. Properties of Coarse Aggregate

Properties	Test results	Is specification and test procedure
Specific gravity	2.7	2.5-2.9, IS 2386 part 3-1963
Fineness modulus	6.2	6-6.9, IS 2386 part 1-1963
Moisture content	0.23%	
Water absorption	0.5%	0.5-1%
Impact value	23.8%	For concrete not more than 30%, IS: 2386(Part IV)-1963
Crushing value	17.4%	Should not exceed 45%, IS: 2386(Part IV)-1963

III.1.3 Fine aggregate (M sand)

The sand used for the experimental program was locally procured and conformed to Indian standard specification. The sand was first sieved through 4.75mm sieve to remove any particles greater than 4.75mm

Table 3. Properties of Fine Aggregate

Properties	Test results	Is specification and test procedure
Specific gravity	2.65	2.6-2.8, IS 2386 part 3-1963
Fineness modulus	3.18	2.1-3.37, IS 2386 part 1-1963
Moisture content	2.4%	
Water absorption	3%	2-4%

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III.1.4 Fine aggregate (Foundry sand)

The sand sieved through the sieve machine so that the properties can be studied the testes were conducted and the results are given on the table 4

Table 4. Properties of Fine Aggregate

Properties	Test results
Specific gravity	2.45
Fineness modulus	3.18
Moisture content	2.4%
Water absorption	.5%

III.1.5 Graphene oxide (GO)

Appearance (Color) : Black, Brown ,Appearance (Form) : Powder or Flakes, Carbon : 42.0 - 52.0 %,Sulfur : < 3.0 %

III 1.6 Recron fibreCut length : 6 mm or 12 mm,Shape of fibre : comonomer special for improved holding of cement aggregates,Tensile strength :4000-6000 kg/cm², Melting point > 250o C



Fig1 Recron fibre 3s and GO respectively

III.2 TESTS PLANNED

Mechanical properties such as strength and durability of different cube, cylinder and beam specimens are to be evaluated. Following tests are planned

1. Workability tests -slump cone test.
2. Strength test - Compressive strength, Flexural strength and Split tensile strength.
3. Durability test – Water absorption, Acid resistance and Chloride resistance

III.2.1 Workability test

Though workability is a very important property of concrete, it is quite difficult to define and measure. A concrete is said to be workable if it can be easily mixed, handled transported, placed in position and compacted.

Slump Cone Test - Slump test is the most commonly used method of measuring consistency of concrete. It is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch.

III.2.2 Strength test

Compressive strength test - For evaluating the compressive strength, specimens of dimensions 150X150X150mm are prepared. They were tested on 1000kN capacity compression testing machine as per IS 516:1959.

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Split tensile strength - For evaluating the tensile strength, cylindrical specimens of diameter 150mm and length 300mm were prepared. Split tension test was carried out on 2000kN capacity compression testing machine as per IS 5816:1999.

Flexure tensile strength - A flexure tensile strength test according to EN-196-1-2005 was conducted on beam samples.

III.2.3 Durability test

Chemical resistance - The specimen immersed in different environment. Then the weight and strength of specimen is calculated 7 and 28 days.

Water absorption test - It was carried out on cubes of size 100mmX100mmX100mm after 7 and 28 days of water curing. Then the weight and strength of specimen are to be calculated.

IV.RESULTS AND DISCUSSIONS

Different experiments where done to determine properties of nano concrete. For the specimen were tested after 7 and 28 days of curing. The mechanical properties like compressive strength, split tensile strength and flexural strength and also durability properties like water absorption and resistance to different chemical environment was done.

IV.I MIXES

Table 5,mix proportion

Mix	Description
N	Control mix
F0R0.5	Replacement of fine aggregate by foundry sand 0%,recron fibre 0.5 weight %of cement
F50R0.5	Replacement of fine aggregate by foundry sand 50%,recron fibre 0.5 weight %of cement
F100R0.5	Replacement of fine aggregate by foundry sand 100%,recron fibre 0.5 weight %of cement
F0R1	Replacement of fine aggregate by foundry sand 0%,recron fibre 1 weight %of cement
F50R1	Replacement of fine aggregate by foundry sand 50%,recron fibre 1 weight %of cement
F100R1	Replacement of fine aggregate by foundry sand 100%,recron fibre 1 weight %of cement
F0R1.5	Replacement of fine aggregate by foundry sand 0%,recron fibre 1.5 weight %of cement
F50R1.5	Replacement of fine aggregate by foundry sand 50%,recron fibre 1.5 weight %of cement
F100R1.5	replacement of fine aggregate by foundry sand 100%,recron fibre 1.5 weight %of cement

IV.2 FRESH CONCRETE PROPERTIES

IV.2.1 Workability tests

Workability of concrete refers to the ease with which concrete can be made, transported, poured and compacted to a required shape and size without affecting its strength. Table5 below shows the slump value for the mix samples .the figure 1 shows the graphical representation of slump values representing the line with the colour green brown blue with percentage of foundry sand

Table 6. Slump test results

Mix	Slump
F0R0.5	71
F0R1	72
F0R1.5	74
F50R0.5	68
F50R1	66
F50R1.5	64
F100R0.5	65.5
F100R1	63
F100R1.5	60.7

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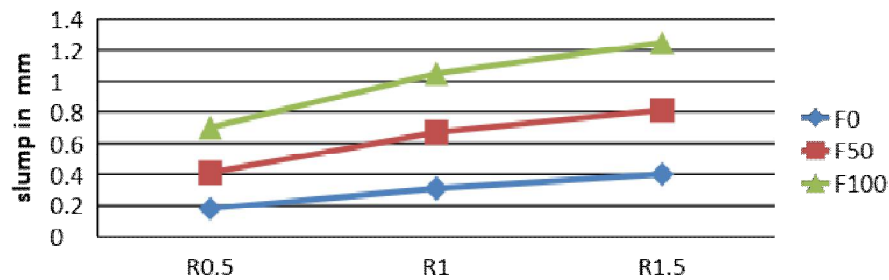


Fig 2 Variation of slump for different percentage of foundry sand and the recron fiber

IV.3 HARDENED CONCRETE PROPERTIES

IV.3.1 Compressive strength

The table 6 shows the results of compressive test done from the table the values indicate that as increase in the foundry sand beyond 50 percentage the strength decreases

Table 7. Compressive strength test results

Mix	Compressive strength N/mm ² 7 days	Compressive strength N/mm ² 28 days
F0R0.5	30	42
F0R1	31.7	44.3
F0R1.5	29.2	40
F50R0.5	32.1	44.9
F50R1	33	46.2
F50R1.5	30.6	42.8
F100R0.5	26	36
F100R1	27.3	37.8
F100R1.5	23.8	32.8

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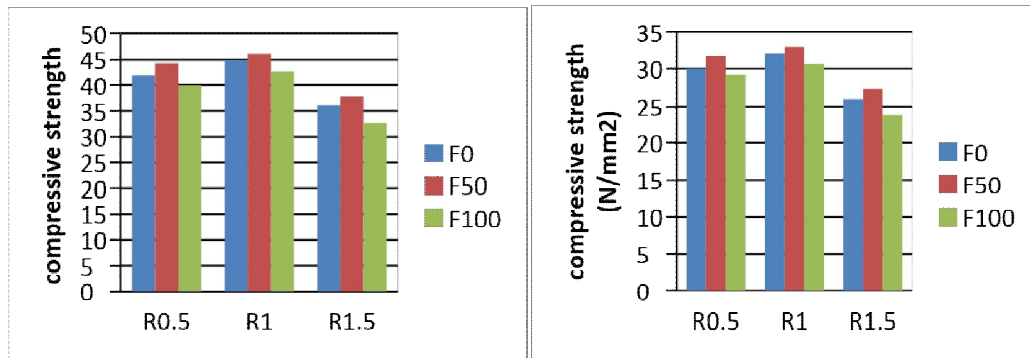


Fig 3. Bar chart showing variation of compressive strength of concrete at 7 and 28 day respectively for the respective specimens

The above figure shows the compressive strength results of specimens and its shown that for the percentage variation of fibre and foundry sand. From results its known that for 1% fibre in weight percentage of cement and 50% foundry sand strength increases

IV.3.2 Split tensile strength

Splitting tensile test is used to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle in nature. The concrete develop cracks subjected to tensile forces. Cylindrical specimen of 150mm diameter and 300mm height is used to find the tensile strength

Table 8. Split tensile strength result

Mix	Split tensile strength N/mm^2 7 day	Split tensile strength N/mm^2 28 day
F0R0.5	2.02	7.02
F0R1	2.1	7.1
F0R1.5	2.03	7.03
F50R0.5	2.21	7.21
F50R1	2.24	7.24
F50R1.5	2.2	7.2
F100R0.5	2.01	7.01
F100R1	2.02	7.02
F100R1.5	2	7

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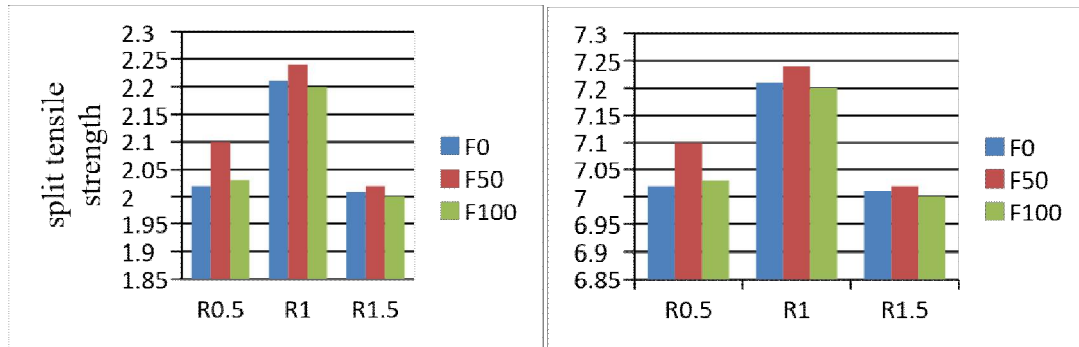


Fig.4 Bar chart showing variation of split tensile strength of concrete at 7 and 28 day respectively

Figure 4 shows the split tensile strength results of the specimens from the graph analysis the split tensile strength is achieved higher when 1% fibre and 50% foundry sand its shown when considering 100% foundry sand the strength loss is there considerably

IV.3.3 Flexural strength

The flexural strength test was conducted as per IS 516 -1959 on beams using a flexural testing machine. The testing machine shall be of sufficient capacity for the test and capable of applying a load at the rate of 1.8 KN per minute for 100 mm specimens and the rate of 4KN per minute for 150mm specimens. Beams of size 100mm x 100mm x 500mm are used for flexural strength

Table 9. Flexural strength result

Mix	Flexural strength N/mm ² 7 day	Flexural strength N/mm ² 28 day
F0R0.5	5	8.1
F0R1	5.3	8
F0R1.5	4.6	7
F50R0.5	6	8.7
F50R1	6.2	9
F50R1.5	5.1	8
F100R0.5	4.8	7.1
F100R1	4.42	7.15
F100R1.5	4.36	6.9

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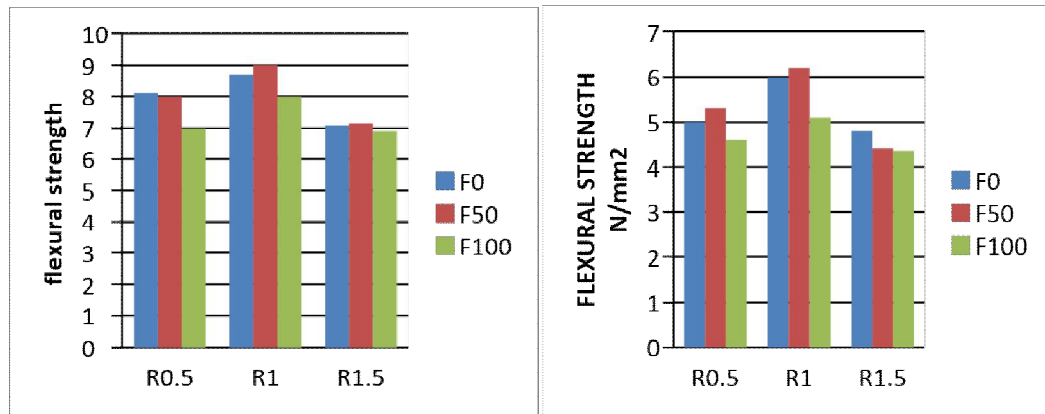


Fig 5 Bar chart showing variation of flexural strength of concrete at 7 and 28 day respectively

Figure 5 the values of flexural strength for different % of fibre and foundry sand based on the results the strength increases considerably than the normal concrete in addition of 1% fibre and 50% foundry sand when 1.5% fibre addition considerable decrease happens.

IV.3.4 Water absorption

This test inspect water absorption of concrete cubes size 100X100X100 mm. The weights of specimens were measured after casting (W1). After 28 and 56 days of curing in water, the specimen were surface dried and weight is measured (W2). Percentage of water absorption = $[(W2-W1)/W1] \times 100$

Table10. Water absorption test results

Mix	% of water absorbed (7 day)	% of water absorbed (28 day)
F0R0.5	.06	.18
F0R1	.07	.23
F0R1.5	.09	.29
F50R0.5	.1	.31
F50R1	.12	.36
F50R1.5	.12	.38
F100R0.5	.1	.4
F100R1	.13	.41
F100R1.5	.14	.44

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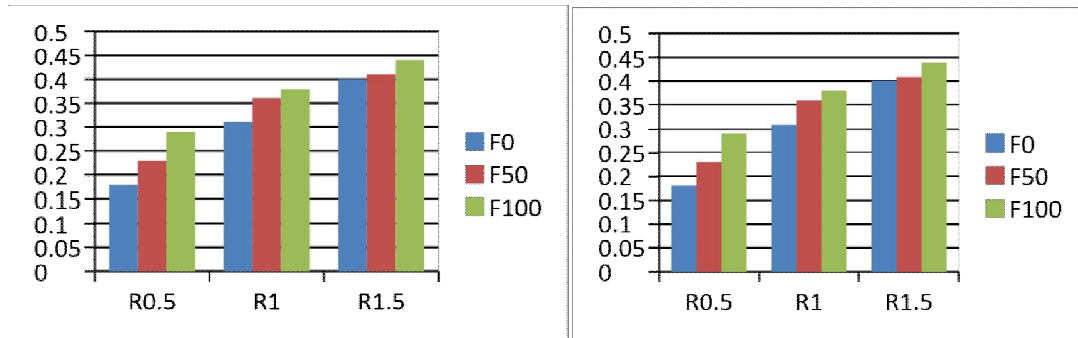


Fig 6. Water absorption of replacing concrete at 7 and 28 day curing

From the figure 6 the water absorption analysis can be done and from that the as increase in foundry sand increases the water absorption rate and maximum absorption is in 100% foundry sand

IV.3.5 Acid resistance

Cube size of 100x100x100 were cast and cured for 28 days. After 28 days curing cubes were taken out and allowed for drying for 24 hours and weights were taken. For acid attack 5% of diluted H₂SO₄ is used. The cubes were to be immersed in acid solution for a period of 28 days. The concentration is to be maintained throughout this period. After 28 days the specimens were taken from acid solution. The surface of specimen was cleaned and weights were measured. The mass loss and strength of specimen due to acid attack was determined. The degree of attack was evaluated by measuring the expansion of concrete cubes, compressive strength and weight losses of the specimens. The results are shown in table 9 and graph variations are shown in fig 7 and fig 8. The table 11 shows the loss of weight and loss of strength of specimens after testing and fig 6 and 7 shows the graphical representation of loss of weight and loss of strength in 7 and 28 days .

Table 11. Acid resistance test result

Mix	Loss of weight (%)		Loss of strength (%)	
	7 day	28day	7 day	28 day
F0R0.5	0.38	.98	1.32	5.1
F0R1	0.32	1.01	1.2	4.6
F0R1.5	0.31	.93	1.13	4.1
F50R0.5	0.25	.75	1.03	4.12
F50R1	0.2	0.7	1.01	4
F50R1.5	0.22	0.72	1.06	4.2
F100R0.5	0.24	0.74	1.13	4.2
F100R1	0.25	0.76	1.12	4.16
F100R1.5	0.23	0.71	1.21	4.9

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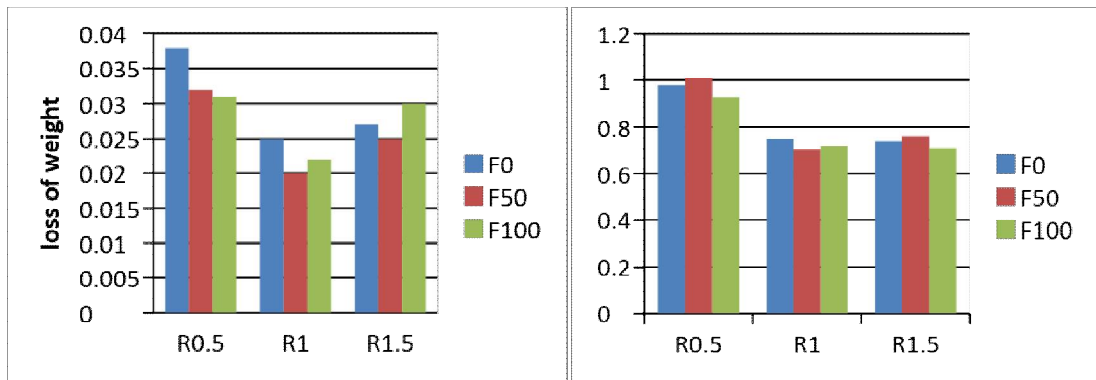


Fig 7. Weight loss of replacing concrete after 7 and 28 day (acid resistance)

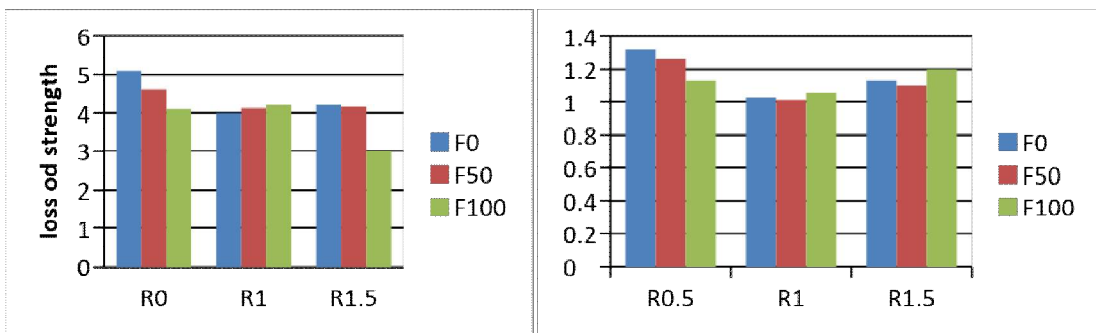


Fig 8. Strength loss of replacing concrete after 28 day (acid resistance)

The figure 7 shows the loss of weight of specimen in 7 day and 28 days and from analysis the loss of weight is low in the mix F50R1 ie,50% foundry sand and 1% fibre

The figure 8 shows the loss of strength of specimen for 7 and 28 days and from graph for the F50R1 specimen have comparably lower loss of strength

IV.3.6 Chloride resistance

The chloride resistance of concrete was studied through chemical attack by immersing concrete blocks in 5% of NaCl solution. The solution was replaced at regular intervals to maintain constant concentration throughout the test period. The mass of specimens were measured and the mass losses were determined. Also loss in strength is determined. The results are shown in table 9 and graph variations are shown in fig 9 and fig 10. The table 12, figure 8&9 shows the loss of weight and loss strength for 7 days and 28 days from the values we can see that different mix effect over the chloride

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Table 12. Chloride resistance test result

Mix	Loss of weight (%) 7 day	Loss of weight (%) 28 day	Loss of strength (%) 7 day	Loss of strength (%) 28 day
F0R0.5	.14	0.31	.66	2
F0R1	.16	0.36	.81	2.98
F0R1.5	.17	0.38	.72	2.6
F50R0.5	.15	0.34	.36	2.5
F50R1	.15	0.28	.3	1.7
F50R1.5	0.1	0.36	.38	2.1
F100R0.5	0.17	0.38	.5	1.9
F100R1	.14	0.31	.61	1.7
F100R1.5	.18	0.4	.68	2.23

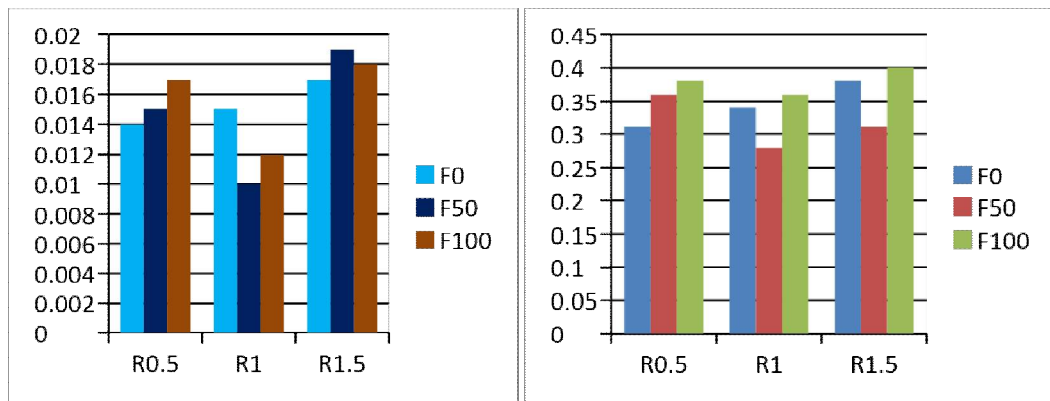


Fig 9. Weight loss of replacing concrete after 7 and 28 day (chloride resistance)

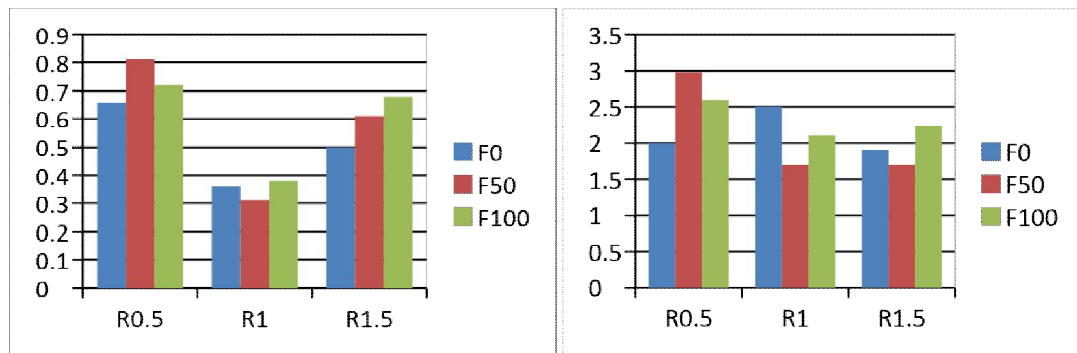


Fig 10. Strength loss of replacing concrete after 7 and 28 day (chloride resistance)

The figure 9 and 10 shows the analysis of weight loss due to chloride and strength loss and from analysis for the F50R1 have the less loss of strength and low loss of weight comparably

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V. CONCLUSION

- The value of compressive strength obtained maximum on the addition 50% replacement of foundry sand and Recron fiber in 1% the strength obtained on 7 day was 33mpa and for 28 days 46.2 mpa
- While in 100 % replacement the strength couldn't meet because of the finess of the foundry sand and excess water absorption properties
- In replacement of 50 % foundry sand and recron fiber in 1% the split tensile strength obtained 7.24N/mm² for 28 days and 2.24 N/mm² for 7 days
- In the replacement of 50% foundry sand and recron fiber in 1%the flexural strength obtained for 28 days 9 N/mm²and 6.2 for 7 days
- In the acid test the loss of weight 0.2% for 7 days and 0.7% for 28 days this shows the minimum loss of concrete than other mixes
- In the acid test the loss of strength 1.01% for 7 days and 4% for 28 days this shows the minimum loss on concrete than other mixes
- In the chloride test loss of weight for 7 days .15 % and for 28 days 0.34%
- In the chloride test loss of strength .3 for 7 days and 1.7for 28 days
- The result of water absorption test for the above mix is obtained by 0.12 for 7 days and .36 for 28 days
- In future research can be done on this project to find the optimum values of the combination and changing the the percentage of GO to find out more details

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