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Strength and Durability Properties on Fiber Reinforced Concrete by Replacing Fine Aggregate with Stone Powder

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Abstract:-The goal for taking p this exploration is because of the at that now a days the natural sand affirming to Indian standards is becoming scarcer and costlier because of non-accessibility in time for the reason that law of land, unlawful digging by sand mafia etc… For this reason a motivation has been done to identify a new source of aggregates. The objective of this study is to verify the appropriateness, feasibility &forthcoming utilization of Stone powder for future years. Stone powder is a loss from the quarry preparing units. It accounts 30% of the residue from the quarry industry. Use of stone powder as a replacement of Natural sand reduces cost of construction but also it helps to reduce the wastage of material so it can be give a good impact to the environment. Hence in the current study an attempt has been made on concrete mix of grade M40 by experimenting the strength properties & durability of concrete by replacing Stone powder by 25%, 50%, 75% & 100% to Natural sand and expand the project the addition of steel fibers of 0.5%,0.75% and 1% have done and also the effect of curing of 3% of H_2SO_4, HCI and Sea water on these concrete mixes are determined by immersing these cubes for 28 days, 90 days in above solutions and respective changes in compressive strength, tensile strength & weight reduction observed and it has been found that the compressive, split tensile strength of concrete made of stone powder increases nearly 17% and 60% with addition of steel fibers. The durability studies show a decrease of nearly 17% in compressive strength.

Key words: ***Stone powder (SP), Strength & Durability, Steel Fibers***

I. INTRODUCTION

Concrete is one of the daily utilized composite materials in our construction activities. It has a total production of some billion tones every year. Its key ingredients are cement, fine aggregate, coarse aggregate, water and admixtures etc… Generally Aggregates occupy 60 to 80% of the volume of concrete and also greatly influence on hardened concrete properties, mix proportions and economy. The main important property for good quality aggregate should satisfy the resistance to abrasion, resistance to freeze/thaw, wear & tear action etc… And also it must have to maintain to give good workable concrete as early as possible. For this purpose the best suitable material is SP.

It is the residue or waste material after the extraction and processing of rocks to form particles like coarse aggregates. The aggregates which are less than 6mm is termed as Stone Powder. It can be used for various different activities in construction like building materials, road development materials, bricks & tiles etc
As we know concrete is relatively high in compression and low in tensile due to its brittle nature. For this reason the concrete is reinforced with a material which is strong in tension. Compared to other building materials, fibers exhibit more tensile strength. Based on fracture toughness values steel is at least 100 times more resistant to crack growth than concrete. Steel fiber reinforced concrete(SFRC) can be a cost effective building material because it reduces the thickness of structural member for the same length of concrete thus inevitably results in lighter structure. SFRC is superior in resistance to cracking and crack propagation. As a result it has an increased extensibility and tensile strength to hold the matrix together. Durability is the ability of the material to withstand significant deterioration in concrete. The durable properties of concrete are to measure the lifespan and ability of concrete to withstand severe weatheringcondition. It is an important factor in identifying how sustainable the structure will ultimately be durable concrete in relatively impermeable as long as it remains un-cracked.

II. TESTING OF CONSTITUENT MATERIALS

Stone powderis obtained from the crushing units. It is the dust formed from rock particles at the time of grading of coarse aggregates. So, the properties of stone dust are same as that of coarse aggregate. But it is the best suitable for replacing fine aggregate, because the bulking capacity and fineness modulus are same as fine aggregate which is used in concrete. As a part of normal production processes in quarries, a certain portion of rock is reduced to such a size that it cannot be used as a part of coarse aggregates. The particle size of these aggregates is generally less than 6mm or depends upon the size of the lowest screening used. It consists of all sizes of sand particles as well as an appreciable amount of clay silt fraction i.e., finer than 75micronsize.

Material	Properties
Ordinary Portland Cement (53 grade , Ultratech)	Specific Gravity : 3.12 Normal consistency : 32% Fineness : 0.5% residue 90 µm sieve Initial setting time : 45 min Final setting time : 480 min

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Fine Aggregate (River Sand)	Locally Available Sand Specific gravity : 2.6 Fineness Modulus : 2.81 Percentage Bulking : 43.75%
Stone Powder	From G.Kondur – Particle size < 4.75mm Specific Gravity : 2.7 Fineness Modulus : 3.04
Coarse Aggregate	Locally Available Specific Gravity : 2.78 Fineness Modulus : 7.45
Super Plasticizer	Master Glenium sky B233 Specific Gravity : 1.08
Steel Fibers	Type : Hooked end Aspect ratio : 53.85 Length : 35mm Diameter : 0.6mm Density : 7900kg/cm^3

Table 1: Properties of the Materials

III. EXPERIMENTAL PROGRAM

The present work investigates the effect of using SP as a partial replacement for sand on the compressive strength and split tensile strength for M40 grade concrete. It identifies the trend in variation of these strengths with increasing replacement. The optimum replacement for which strength is maximized is found and the addition of Steel fibers had done with various percentages of 0.5, 0.75 & 1% by volume of concrete. Then the durability study (Acid resistant & Sulphate resistant) is done for the concrete.

IV. MIX DESIGN

Themix design is done in accordance with IS:10262-2009 for different trails and fixed this proportion i.e., 1:1.61:2.89

Materials	Quantity
Cement	430kg/m3
Water	163liters
Fine aggregate	692kg/m3
Coarse aggregate	1245.56kg/m3
w/c ratio	0.38
Super Plasticizer	0.62% of weight of cement

Table 2 Mix Proportion Details

The mix proportion is checked by replacing of 50% stone powder with aggregates to know the water/cement ratio and then the replacement of stone powder and addition of fibers to the optimum strength has been done.

V. MIXING PROCESS

As the Mixing process affects the properties of concrete, a uniform mix is adopted for preparing the mixes. Ordinary Portland cement and aggregate were first dry mixed for two minutes. 70% of total mixing water were added to the dry mix and mixing is done for 1 minute and then Chemical additives (Super plasticizer) was added to the remaining 30% of the water. The water is then poured into the mixed material& mixing is done for 2 minutes and cubes were casted. The cubes are of size 150 x 150 x 150mm were used.

VI. DIFFERENT MIXES OF CONCRETE WHICH HAD DONE

S.No	Mix Name	Mix Designation
1	Conventional Concrete	M0
2	Fine aggregate is replaced with SP by 25% in concrete	M1
3	Fine aggregate is replaced with SP by 50% in concrete	M2
4	Fine aggregate is replaced with SP by 75% in concrete	M3
5	Fine aggregate is replaced with SP by 100% in concrete	M4
6	Fine aggregate is replaced with SP 50% and addition of 0.5% steel fibers	M5
7	Fine aggregate is replaced with SP 50% and addition of 0.75% steel fibers	M6
8	Fine aggregate is replaced with 50% and addition of 1% steel fibers	M7

VII. RESULTS & DISCUSSIONS

A. STRENGTH RESULTS

1. Compressive Strength

i. Compressive Strength Results

S.No	Mix Designation	Compressive Strength (MPa)	
		28 Days	90 Days
1	M0	49.43	50.98
2	M1	53.51	55.23
3	M2	56.43	58.01
4	M3	49.06	50.36
5	M4	45.09	46.88
6	M5	57.29	58.73
7	M6	59.36	60.98
8	M7	58.02	59.86

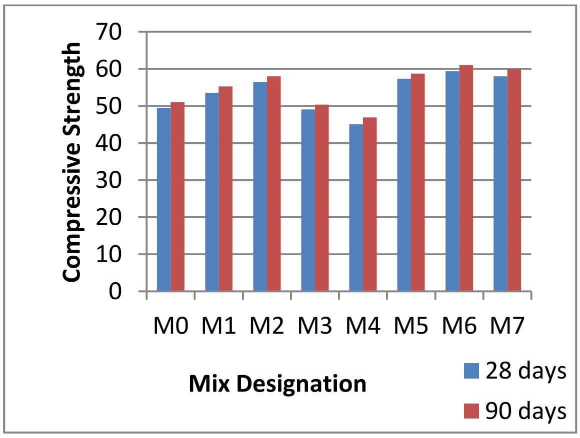

Fig 1 Graph for Compressive Strength Results

Compressive Strength was determined at different replacement levels of stone powder and also by adding of steel fibers at 28 days & 90 days. Table 4 represents the compressive strength values.

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It shows that on increment of SP in concrete the compressive strength increases from 49.43Mpa to 56.43Mpa at 28 days and 50.98Mpa to 58.01Mpa at 90 days for the replacement of 50% SP. The optimum replacement for which strength is maximized is found and the addition of steel fibers is done. Due to addition of fibers the strength is increased up to 56.43Mpa to 59.36Mpa at 28 days and 58.01Mpa to 60.98Mpa.

2. Split Tensile Strength

ii.Split Tensile Results

S.No	Mix Designation	Tensile Strength (MPa)	
		28 Days	90 Days
1	M0	4.30	4.93
2	M1	4.45	5.07
3	M2	5.56	6.23
4	M3	4.54	5.18
5	M4	3.55	4.35
6	M5	9.63	10.09
7	M6	11.42	11.89
8	M7	10.95	11.32

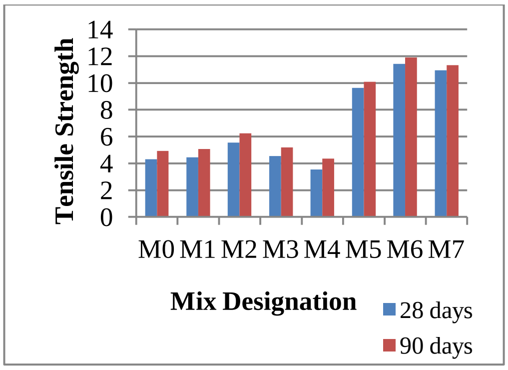

Fig2 Graph for Split Tensile Strength results

Split Tensile strength was determined at different replacement levels of SP and also by adding of steel fibers at 28 days & 90 days. Table 5 represents the compressive Strength values. It shows that on increment of SP in concrete the Tensile Strength increases from 4.30Mpa to 5.56Mpa at 28 days and 4.93Mpa to 6.23Mpa at 90 days for the replacement of 50% SP. The optimum replacement for which strength is maximized is found and the addition of steel fibers is done. Due to the addition of fibers the strength is increased p to 5.56Mpa to 11.42Mpa at 28 days and 6.23Mpa to 11.89Mpa.

Fig 3 Tensile Strength Setup

B. DURABILITY

The behavior of acids on the hardened concrete is the exchange of compounds into the salts of acid. Due to the exchange of ions there will be a loss in weight along with the compressive strength. Each and every concrete specimen gets affected by acid.

1. Chloride Attack

iii. Percentage weight loss & Compressive strength by chloride Attack

S. No	Mix Designation	Average weight before Immersion in Acid (Kg)	Average weight after immersion in Acid (Kg)	% weight loss (%)	Specimens cured under 3% HCL solution Compressive Strength (MPa)	
					28 Days	90 Days
1	M0	8.75	8.37	4.32	46.34	43.68
2	M5	9.11	8.98	1.48	52.91	50.69
3	M6	9.24	9.02	1.65	54.69	52.41
4	M7	9.30	9.16	1.5	53.34	50.94

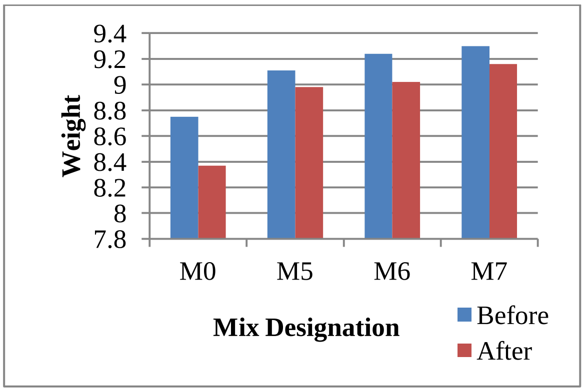

Fig 4 Graph for Percentage weight loss by Chloride Attack

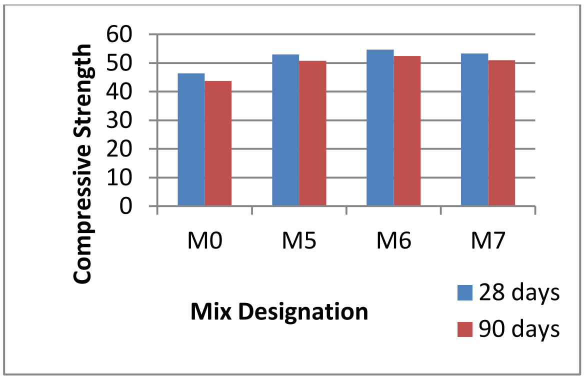

Fig 5 Graph for Compressive Strength by Chloride Attack

The table 6 represents the % weight loss & compressive strength to the specimens due to curing by hydrochloric acid. The effect of curing is done for 3% Hcl. The outer portion of the cubes gets consumed by the acid and there is a maximum reduction of 2mm at all sides for all the concrete specimens.

So, the weight of each cube gets decreased. The decreased weight is up to 4.32% for conventional concrete and 1.65% and strength decreased p to 8Mpa i.e., 60Mpa to 52.41Mpa to fiber reinforced stone powder concrete.

2. Sulphate Attack

iv. Percentage weight loss & Compressive strength by Sulphate Attack

S. No	Mix Designation	Average weight before immersion in Acid (Kg)	Average weight After Immersion in Acid (Kg)	% weight loss (%)	Specimens cured under 3% H_2So_4 Compressive Strength (MPa)	
					28 Days	90 Days
1	M0	8.54	8.01	6.21	46.13	43.23
2	M5	9.36	9.14	2.43	52.63	49.70
3	M6	9.2	8.98	2.39	54.39	51.28
4	M7	9.30	9.08	2.34	52.88	50.22

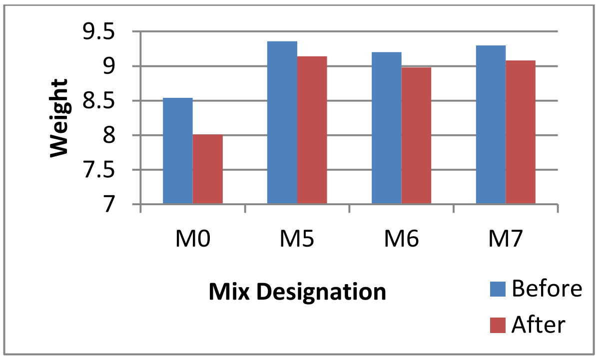

Fig 6 Graph for Percentage weight loss by Sulphate Attack

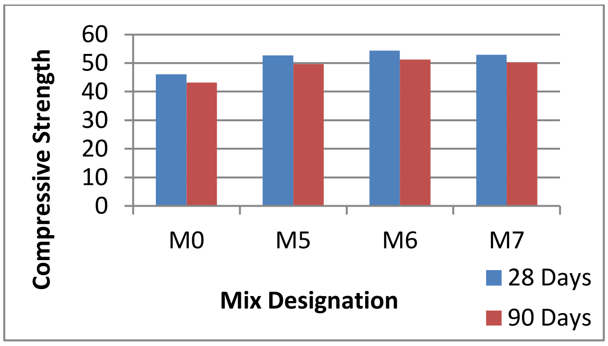

Fig 7 Graph for Compressive Strength by Sulphate Attack

The table 7 represents the % weight loss & compressive strength to the specimen due to sulphuric Acid. The effect of curing is done for 3% of H_2So_4. The outer portion of the cubes gets effected by the acid and it indicates a more attack than compared to curing by hydrochloric acid for all the concrete specimens. The weight of cube get decreased up to 6.21% for conventional concrete and 2.34% and strength decreased up to 9Mpa i.e., 60.98Mpa to 51.28Mpa to fiber reinforced concrete.

3. Sea water attack

v. Percentage weight loss & Compressive strength by sea water attack

S. No	Mix Designation	Average weight before Immer Sion In Acid (Kg)	Average weight After Immersion in Acid (Kg)	% weight loss (%)	Speccimen cured under Sea water Compressive Strength (MPa)	
					28 Days	90 Days
1	M0	8.25	7.99	3.04	48.16	46.32
2	M5	9.27	9.16	1.19	53.54	51.42
3	M6	9.27	9.17	1.11	55.26	53.36
4	M7	9.20	9.09	1.16	53.83	52.05

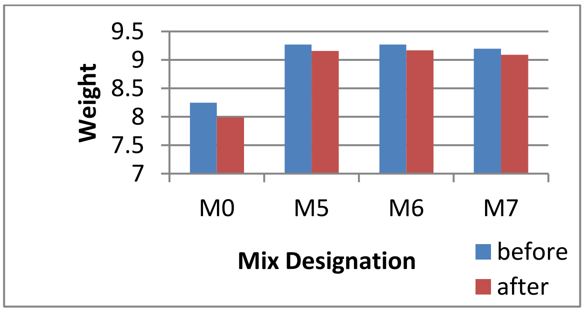

Fig 8 Graph for Percentage weight loss by Sea water Attack

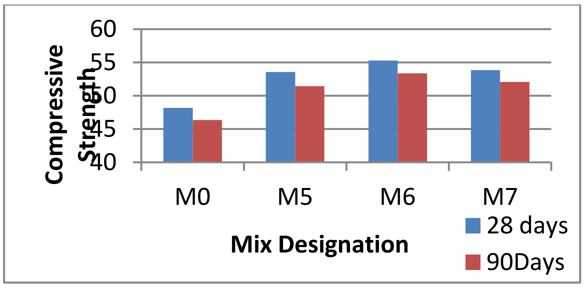

Fig 9 Graph for Compressive strength by Sea water Attack

The table 8 represents the % weight loss & compressive Strength to the specimen which is cured under sea water. The outer portion of the cubes gets effected by the salts present in the sea water and there is a formation of layer around the cubes of containing salts on all sides for all the concrete specimens so the weight of each cube gets decreased up to 3.04% for conventional concrete and 1.19% and strength decreased up to 7Mpa i.e., 60.98 to 53.36Mpa to fiber reinforced stone powdered concrete.

Fig 10 Cubes in Sea water

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VIII. CONCLUSIONS

Based on the experimental results in SFRC with partial replacement of fine aggregate with S, the following conclusions are observed:

- ❖At 50% replacement of fine aggregate by stone powder the optimum compressive & split tensile strength is obtained at 0.62% of super plasticizer.
- ❖There is an increase in compressive strength, for partial replacement of fine aggregate with SP& addition of steel fibers is up to 16.4% for 90 days.
- ❖There is an increase in split tensile strength, for partial replacement of fine aggregate with SP& addition of steel fibers is up to 58.53% for 90 days.
- ❖Durability test results shows reduction in compressive strength by 15.91%, tested against 3% H_2SO_4.
- ❖Durability test results shows reduction in compressive strength by 14.05%, tested against 3% HCl.
- ❖Durability test results shows reduction in compressive strength by 14.05%, tested against sea water.

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