An Experimental Study on Behavior of Concrete by Partially Replacement of Fine Aggregate with Granite Powder and Cement with Alccofine

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Abstract : **Self-healing concrete is a type of concrete that has the ability to repair cracks and damage on its own over time. This is achieved through the use of encapsulated healing agents such as bacteria or microcapsules that are integrated into the concrete mix. When cracks form, the healing agents are exposed and activated, leading to the formation of calcium carbonate and the closing of the crack. This technology has the potential to significantly extend the lifespan of concrete structures and reduce maintenance costs.**

Keywords: Compressive strength, Bio concrete, Bacillus Subtilis, Acid Attack, Chloride Attack, Sulphate Attack, Water Absorption.

1. INTRODUCTION

1.1 GENERAL

Concrete is the most widely used man made construction material in the world. It is obtained by mixing cement materials, water and aggregates, and sometimes admixtures in required proportions. The mixture when placed in forms and allowed to cure hardens into a rock – like mass known as concrete. The hardening is caused by chemical reaction between water and cement and continues for a long time, and consequently the concrete grows stronger with age. Concrete is generally classified as a normal strength concrete, high strength concrete and ultra-high strength concrete etc. As per Indian standard a recommended method of mix design denotes the boundary of 35Mpa between Normal strength concrete and high strength concrete. But as per international forum, the high strength concretelabel was applied to concrete having strength above 40MPa. Now it have been rose to 55MPa as per IS 456-2000.

2. MATERIAL PROPERTIES

2.1 MATERIALS USED

- Cement (OPC 53)
- Fine Aggregate
- Coarse Aggregate
- Water
- Granite Powder

3. LITERATURE REVIEW

T. Felixkala *et al.* [1] had obtained the test results that granite powder of marginal quantity as partial sand replacement has beneficial effect on the mechanical properties such as compressive strength, split tensile strength, modulus of elasticity. They also indicated that the values of both plastic and drying shrinkage of concrete in the granite powder concrete specimens were nominal than those of ordinary concrete specimens. They examine the possibility of using granite powder as replacement of sand and partial replacement of cement with fly ash, silica fume, slag and superplasticiser inconcrete. The percentage of granite powder added by weight was 0, 25, 50,75 and 100 as a replacement of sand used in concrete and cement was replaced with 7.5% silica fume, 10% fly ash, 10% slag and 1% superplasticiser. The effects of water ponding temperatures at 26℃ and 38℃ with 0.4 water- to-binder (w/b) ratios .

M. G. Shaikh *et al.* (2011) [3] has found that the mixes

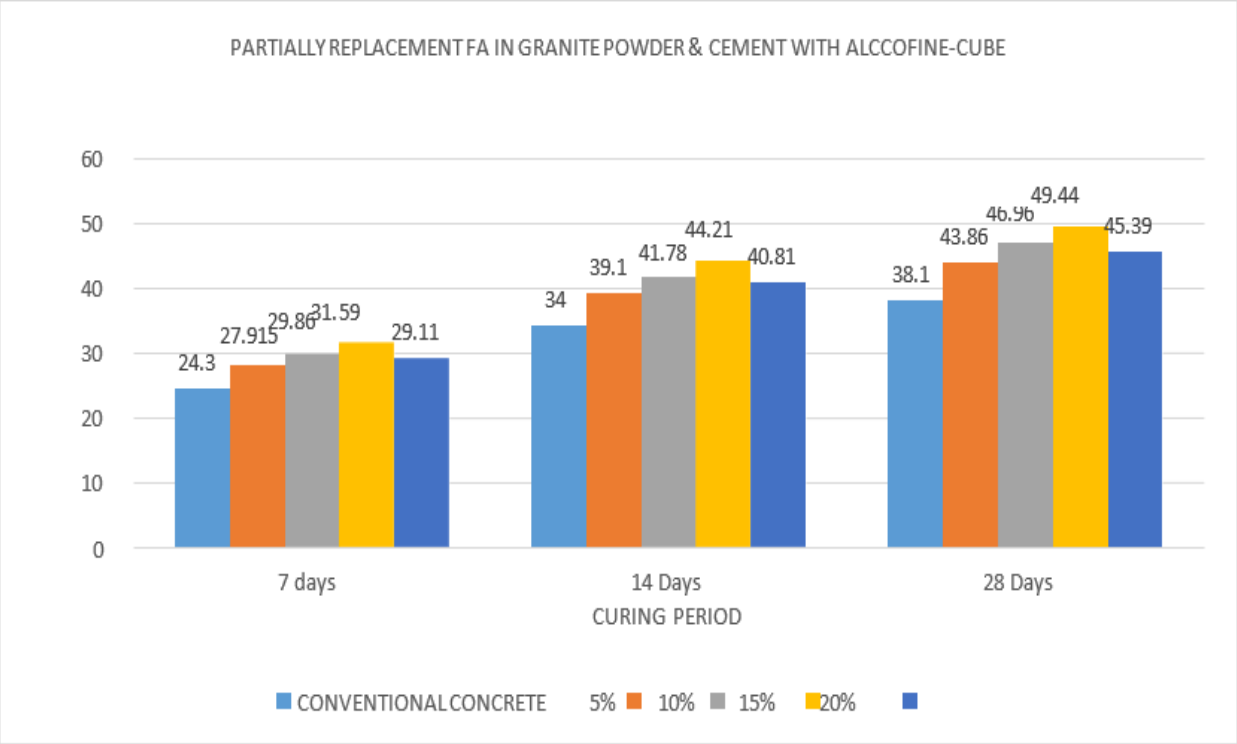
with the artificial sand with dust as fine aggregate gives consistently higher strength than themixes with natural sand. The sharp edges of the particles in artificial sand provide better bond with the cement than the rounded part of the natural sand. It was found that the weight loss of artificial sand block is considerably same with respect to natural sand blocks at 20, 40, and 60 and90 days, immersed in sulphuric acid solution during the experimental period and maintains pH 4 across it. Both concrete made using artificial sand and natural sand are moderate to chloride permeability. In water absorption test we observed after 24 hours curing, the increase in weight of both natural sand and artificial sand blocks are less than 3% that means both concrete are low absorber hence concretes are good quality. The test result obtainedfrom well planned and carefully performed experimental programencourage the full replacement of natural sand by artificial sand with dust considering the technical, environmental and commercial factor.

4. MIX RATIO

CEMENT	FINE AGGREGATE	COARSE AGGREGATE	WATER
1	1.33	2.75	0.45

5. EXPERIMENTAL INVESTIGATION

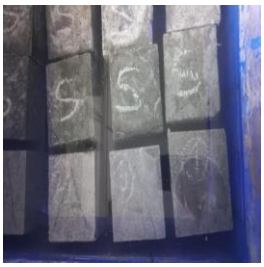
Compression strength test



6. DURABILITY PROPERTIES OF CONCRETE WITH REPLACMENT OF ALCCOFINE AND GRANITE POWDER

The durability properties are

- ✓ Acid resistance test
- ✓ Sulphate resistance test
- ✓ Chloride resistance test
- ✓ Water absorption test
- ✓ Sorpitivity test



6.1 ACID RESISTANCE TEST

WEIGHT GAIN RESULT IN ACID RESISTANCE TEST

Exposure Days	pecimenNo	0%				15%			
		Initial Weight (kg)	Final weight (kg)	Increase in weight (%)	Avg(%)	Initial Weight (kg)	Final weight (kg)	Increase in weight (%)	Avg(%)
15	1	2.420	2.475	2.272	2.123	2.385	2.415	1.257	1.402
	2	2.450	2.500	2.040		2.370	2.405	1.476	
	3	2.430	2.480	2.057		2.375	2.410	1.473	
30	1	2.415	2.480	2.691	2.550	2.375	2.410	1.473	1.604
	2	2.405	2.460	2.286		2.390	2.430	1.673	
	3	2.430	2.495	2.674		2.400	2.440	1.666	

COMPARISION OF COMPRESSIVE STRENGTH RESULT IN ACID RESISTANCE TEST

Exposure Days	pecimen No	15%					
		Compressive strength((N/mm^2)					
		Initial	Final	decreasein strength	Avg(%)	Residualstrength	Avg(%)
15	1	52.12	47.36	9.13	8.73	90.87	91.27
	2	52.12	47.60	8.67		91.33	
	3	52.12	47.75	8.38		91.62	
30	1	52.12	46.65	10.50	10.29	89.50	89.70
	2	52.12	46.88	10.53		89.47	
	3	52.12	46.98	9.86		90.14	

6.2 SULPHATE RESISTANCE TEST

WEIGHT GAIN RESULT IN ACID RESISTANCE TEST

xposureDays	pecimenNo	0%				15%			
		Initial Weight (kg)	Final Weight (kg)	Increase in weight (%)	Avg(%)	InitialWeight (kg)	Final Weight (kg)	Increase in Weight (%)	Avg(%)
15	1	2.610	2.665	2.107	2.107	2.600	2.625	0.961	0.955
	2	2.600	2.655	2.115		2.615	2.640	0.956	
	3	2.620	2.675	2.099		2.630	2.655	0.950	
30	1	2.565	2.625	2.339	2.274	2.610	2.640	1.149	1.158
	2	2.575	2.630	2.135		2.590	2.620	1.158	
	3	2.555	2.615	2.348		2.570	2.600	1.167	

COMPARISION OF COMPRESSIVE STRENGTH RESULT IN SULPHATE RESISTANCE TEST

Exposure Days	Specimen No	15%					
		Compressive strength((N/mm^2)					
		Initial	Final	Decreasein strength	Avg(%)	Residualstrength	Avg(%)
15	1	52.12	48.02	7.87	7.72	92.13	92.28
	2	52.12	47.98	7.94		92.06	
	3	52.12	48.28	7.36		92.64	
30	1	52.12	47.65	8.58	8.55	91.42	91.44
	2	52.12	47.88	8.13		91.87	
	3	52.12	47.46	8.95		91.05	

6.3 CHLORIDE RESISTANCE TEST

WEIGHT GAIN RESULT IN ACID RESISTANCE TEST

Exposure Days	Specimen No	0%				15%			
		Initial Weight(kg)	Final Weight (kg)	Increase in weight (%)	Avg(%)	Initial Weight (kg)	Final Weight (kg)	Increase in Weight (%)	Avg(%)
15	1	2.585	2.620	1.353	1.361	2.605	2.620	0.575	0.571
	2	2.570	2.605	1.361		2.625	2.640	0.571	
	3	2.555	2.590	1.369		2.645	2.660	0.567	
	1	2.505	2.545	1.596		2.655	2.680	0.941	

30	2	2.520	2.555	1.389	1.519	2.630	2.655	0.950	0.945
	3	2.540	2.580	1.574		2.645	2.670	0.945	

COMPARISION OF COMPRESSIVE STRENGTH RESULT IN SULPHATE RESISTANCE

Exposure Days	Specimen No	15% Compressive strength(N/mm^2) Initial	Final	Decreasein strength	Avg(%)	Residualstrength	Avg(%)
15	1	52.12	47.21	9.42	9.45	90.58	90.54
	2	52.12	47.30	9.25		90.75	
	3	52.12	47.06	9.70		90.30	
30	1	52.12	46.90	10.01	10.04	89.99	89.96
	2	52.12	46.80	10.20		89.80	
	3	52.12	46.95	9.92		90.08	
45	1	52.12	46.54	10.70	11.63	89.30	88.37
	2	52.12	45.65	12.41		87.59	
	3	52.12	45.98	11.78		88.22	
60	1	52.12	44.90	13.85	14.13	86.15	85.87
	2	52.12	44.86	13.92		86.08	
	3	52.12	44.50	14.62		85.38	

6.4 WATER ABSORPTION TEST RESULT

ExposureDays	SpecimenNo	0% Initial weight(kg)	Final weight(kg)	Water absorption (%)	Avg(%)
15	1	2.590	2.645	2.123	2.124
	2	2.580	2.635	2.131	
	3	2.595	2.650	2.119	
30	1	2.545	2.605	2.357	2.354
	2	2.580	2.640	2.325	
	3	2.520	2.580	2.380	

ExposureDays	SpecimenNo	15% Initial Weight(kg)	Final weight(kg)	Water absorption (%)	Avg(%)
15	1	2.616	2.641	0.955	0.965
	2	2.540	2.565	0.984	
	3	2.608	2.633	0.958	
30	1	2.702	2.737	1.296	1.292
	2	2.708	2.743	1.292	
	3	2.715	2.750	1.289	

6.5SORPTIVITY TEST RESULT

SORPTIVITY TEST ON CONVENTIONAL CONCRETE

TIME	√ TIME	INITIAL WEIGHT (g)	FINAL WEIGHT (g)	CHANGE INWEIGHT (g)	INTENSITY OF ABSORPTION (mm/sec)
0	0	1030	1030	0	0
60	7.745967	1030	1036	6	0.764
120	10.95445	1030	1040	10	1.273
180	13.41641	1030	1044	14	1.783
240	15.49193	1030	1044	14	1.783
300	17.32051	1030	1046	16	2.037
600	24.4949	1030	1050	20	2.547
900	30	1030	1052	22	2.801
1200	34.64102	1030	1056	26	3.31

SORPTIVITY TEST ON 15% REPLACEMENT OF ALCCOFINE AND GRANITEPOWDER

TIME	√ TIME	INITIAL WEIGHT (g)	FINAL WEIGHT (g)	CHANGE IN WEIGHT (g)	INTENSITY OFABSORPTION (mm/sec)

0	0	1025	1025	0	0
60	7.745967	1025	1028	3	0.382
120	10.95445	1025	1030	5	0.637
180	13.41641	1025	1034	9	1.146
240	15.49193	1025	1036	11	1.401
300	17.32051	1025	1038	13	1.655
600	24.4949	1025	1040	15	1.91
900	30	1025	1042	17	2.165
1200	34.64102	1025	1044	19	2.419

AVERAGE SORPTIVITY TEST RESULT

Mix	Specimen1	Specimen2	Average(mm/sec)
Conventional Concrete	0.0747	0.0626	0.0686
15% Replacement of Alccofine and Granite Powder	0.051	0.0528	0.0563

7.FLEXURAL STRENGTH TEST

Flexural strength is one measure of tensile strength of concrete.Concrete is relatively strong in compression and weak in tension. In reinforced concrete members little dependence is placed on the tensile strength of the concrete since steel reinforcing bars are provided to resist alltensile forces.

However tensile stresses are likely to develop in concrete due to drying shrinkage, rusting of steel, temperature gradient and many other reasons. Therefore the knowledge of tensile strength of concrete is ofimportance. A beam test is found dependable to measure

Before loading

After loading

FLEXURAL STRENGTH TEST OF CONVENTIONALSPECIMEN

S.NO	LOAD(kN)	AT L/2 (mm)	REMARKS
1	25	1	
2	30	1.3	
3	35	1.6	
4	40	1.9	
5	45	2.1	1st Crack
6	65	3	
7	70	3.2	
8	75	3.4	
9	80	3.7	Ultimate Load
10	75	3.9	

FLEURAL STRENGTH OF ALCCOFINE AND GRANITEPOWDER

S.NO	LOAD(kN)	AT L/2 (mm)	REMARKS
11	50	1.1	
12	55	1.4	
13	60	1.5	
14	65	1.7	
15	70	1.8	
16	75	1.9	1st Crack
20	95	2.6	
21	100	2.7	

22	105	2.8	
23	110	3	Ultimate Load
24	105	3.5	

8. CONCLUSIONS

1. From the various percentages of alccofine replacement to cement and granite powder replacement to fine aggregate concrete 15% replacement was found to be optimum value from the strength study.
2. Granite powder and alccofine can be used in a combination of supplementary cementitious material as partial replacement of fine aggregate and cement.
3. 15% alccofine and 15% Granite powder gives 49.44N/mm^2 in compressive strength, which is 29.76% increase in comparison with conventional concrete of M30 grade which is optimum amongst combinations in 28 Days.
4. 15% alccofine and 15% Granite powder gives 4.15N/mm^2 increase in splittensile strength which is 7.11% increase in comparison with conventional concrete of M30 grade which is optimum amongst other combinations within 28 Days.
5. In durability test such as acid resistance, sulphate resistance, chloride attacktest 15% of specimen is found to have 2-3.5 % higher compressive strength as compared to conventional specimen
6. In water absorption test, alccofine and granite powder 15% specimen shows rate of absorption of water 30% less than conventional specimen.
7. Sorptivity results shows that concrete in which granite powder and alccofine is replaced by cement.

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