An Experimental Investigation on the Behaviour of Polymer Modified Silica Fume Concrete Subjected to Sulphate Attack

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Abstract— **Concrete is most widely used construction material for sewer structures. The objective of this experimental study is to find out behaviour of the polymer modified silica fume concrete subjected to sulphate attack with varying percentages of polymer in it.The polymer modified silica fume concrete is subjected to magnesium sulphate media of 5%.Varying percentages of polymer studied are 0%,1%,1.5%,2%,2.5%,3%.The design mix for M_{20} is calculated and specimens casted. After curing specimens are immersed in sulphate media for duration of 60 days.The percentage of weight loss in specimens is calculated.The compressive,tensile and flexural tests are carried out. The percentage loss in strength due to sulphate attack on polymer modified silica fume concrete is analysed. It is observed that compressive strength, tensile strength and flexural strength of polymer modified silica fume concrete subjected to sulphate attack goes on increasing upto 1.5% polymer in it. Afterwards strength decreases. Hence it can be concluded that 1.5% addition of polymer into polymer modified silica fume concrete can resist sulphate attack in a better way. As polymer is added to the concrete the fluidity of concrete goes on increasing and hence concrete cannot achieve full strength beyond optimum percentage of polymer**

Keywords*— *Polymer modified silica fume concrete, SBR Latex polymer, silica fume, sulphate attack

1.INTRODUCTION

As demand for construction in harsh environments increases so does the concern for long service lives of these structures.concrete is most widely used construction material forsewer structures.The environment in somesewer structures can become very acidic due to formation of sulphuric acid converted from hydrogen sulphide by bacterial action. It is known that porosity of cement paste is important parameter that defines mechanical properties and durability of material in the hardened stage. The densest packing of complete mixture made of aggregates and binder can lead to high density. Acids will disintegrate concrete depending upon type and concentration of acid. At pH value below 4.5 the attack is very severe.As attack proceeds, all cement compounds are eventually broken down and leached away, together with any carbonate aggregate material. with sulphuric acid attack, calcium sulphate formed can proceed to react with calcium aluminate phase in cement to form calcium sulphoaluminate, which on crystallization can cause expansion and disruption of concrete. If acid solutions reach reinforcing steel through cracks, corrosion can occur which will cause cracking.Therefore research on evaluation of acid resistance of normal concretes is attractive.

2.MATERIALS

2.1 Cement: Ordinary Portland cement of 43-grade was tested as per IS-8112-1989.The specific gravity was found to be 2.84

2.2 Fine aggregate: Locally available river sand has been used having specific gravity 2.54, fineness modulus of 2.64 and water absorption 1.15 percentage.

2.3 Coarse aggregate: Crushed metal having specific gravity 2.71, fineness modulus 7.56 and water absorption 0.5 percentage was used.

2.4 Superplasticizer:To induce workability Conplast SP 430 Super plasticizer was used. It was used at rate of 1%(by weight of cement). It has specific gravity of 1.220 to 1.225 at 30^{0}C.

2.5 Silica fume: Silica fume was obtained from Corniche India Pvt Ltd, Navi Mumbai, India

Table 1: *Properties of silica fume*

Item	ASTM-C-1240	Actual Analysis
SiO_2	85%min	87.20%
LoI	6%max	2.50%
Moisture	3%max	0.70%
Pozz activity index	105%min	129%
Specific surface area	>15m^2/gm	22m^2/gm
Bulk density	550 to 700	600
+45microns	10% max	0.70%

2.6 Polymer: The polymer used in experimentation was Styrene Butadiene Rubber Latex.

Table 2:*Properties of Styrene Butadiene Rubber Latex*

Typical properties	
Physical state	Milky white liquid
Total solids(by weight of polymer)	40%
Specific gravity	1.01
pH	10.5
Mean particle size	0.17

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3. CASTING OF SPECIMENS AND TESTING PROCEDURE

Cement, sand and aggregate were taken in a mix proportion 1:1.3:3.09, which correspond to M20 grade of concrete.10% of cement is replaced by silica fume in all the mixes.All the ingredients were dry mixed homogeneously. To this dry mix, required quantity of water was added(w/c=0.47) and homogeneously mixed. Now superplasticizer was added at dosage of 1%. At this stage required quantity of SBR latex polymer was added and again a homogeneous mix was prepared. This wet concrete was poured into moulds which were kept on vibrating table.After compaction specimen were given smooth finishes. After 24hours specimens were demoulded and were allowed to cure for 28 days.

Some specimens remained in curing tank upto 60 days.Before immersion they were weighed accurately. The samples were then immersed in 5% magnesium sulphate solution for a period of 2 months. After 2 months of immersion specimens were washed and weighed. Then they were tested for their respective strengths

4. RESULTS AND DISCUSSIONS

Table 3: *Overall test results of compressive strength of cubes subjected to magnesium sulphate and without subjecting to sulphate attack*

% of polymer	Subjected to magnesium sulphate attack		Without subjecting to magnesium sulphate attack	
	Compressive strength (N/mm^2)	% variation in strength as compared to reference mix	Compressive strength(N/mm^2)	% variation in strength as compared to reference mix
0 Reference mix)	31		31.3	
0.5	32.33	4	32.56	4
1.0	33.59	8	34.53	10
1.5	35.67	15	36.85	18
2.0	34.78	12	35.5	13
2.5	33.1	8	34.08	9
3.0	32.18	4	33.01	5

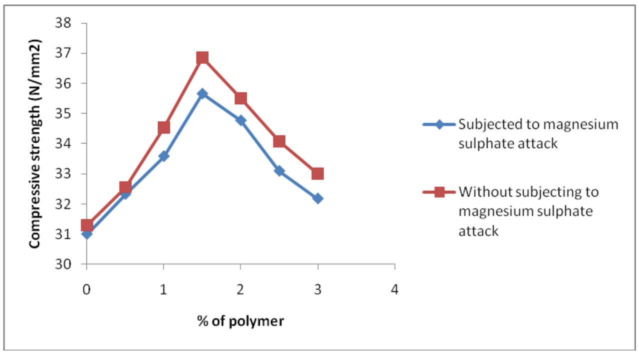

Fig 1: Variation of compressive strength when subjected to magnesium sulphate attack

Table 4: *Overall test results of tensile strength of cylinders when subjected to magnesium sulphate attack*

% of polymer	Subjected to magnesium sulphate attack		Without subjecting to magnesium sulphate attack	
	Tensile strength (N/mm^2)	% variation in strength as compared to reference mix	Tensile strength(N/m^2)	% variation in strength as compared to reference mix
0 (Reference mix)	2		2.07	
0.5	2.12	6	2.21	7
1.0	2.18	9	2.25	9
1.5	2.33	17	2.41	15
2.0	2.18	9	2.19	6
2.5	1.98	-1	2.01	-3
3.0	1.89	-6	1.91	-8

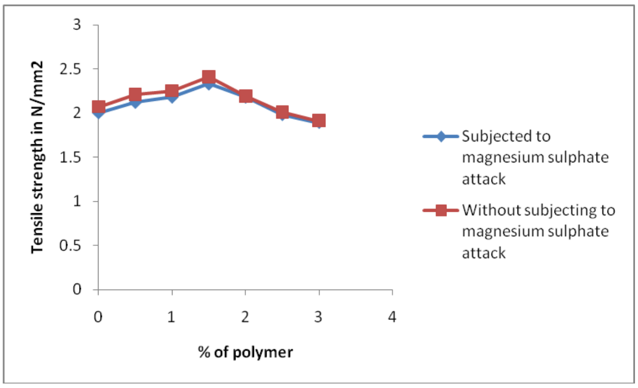

Fig 2: Variation of tensile strength when subjected to magnesium sulphate attack

Table 5: *Overall test results of flexural strength of beams when subjected to magnesium sulphate attack*

% of polymer	Subjected to magnesium sulphate attack		Without subjecting to magnesium sulphate attack	
	Flexuralstrength (N/mm^2)	% variation in strength as compared to reference mix	Flexural strength(N/mm^2)	% variation strengthas compar to reference mix
0 (Reference mix)	3.6		3.65	
0.5	3.72	3	3.8	4
1.0	3.76	4	3.85	5
1.5	3.9	8	4.1	12
2.0	3.81	6	3.9	7
2.5	3.53	-2	3.67	1
3.0	3.4	-6	3.52	-4

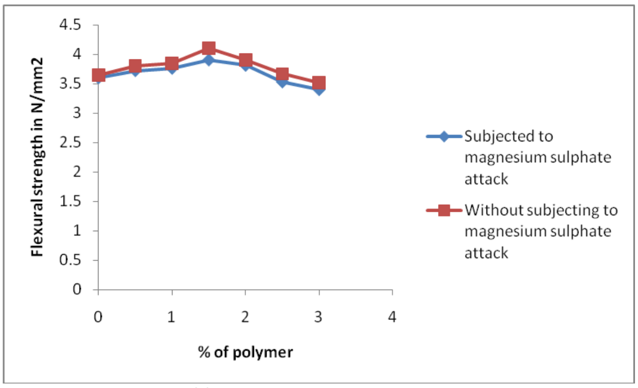

Fig 3: *Variation of flexural strength when subjected to magnesium sulphate attack*

Table 6: *Workability test results of polymer modified silica fume concrete.*

%of polymer	Compaction factor	Slump in (mm)	Vee Bee Degree (seconds)
0	0.915	28	16
0.5	0.915	29	16
1.0	0.919	29	15
1.5	0.924	29	15
2.0	0.920	28	14
2.5	0.912	28	13
3.0	0.904	27	12

It is observed that the compressive strength ,tensile strength and flexural strength of polymer modified silica fume concrete subjected to 5% magnesium sulphate attack goes on increasing upto 1.5% polymer in it, afterwards the strength decreases. It is observed that the density of concrete is maximum at 1.5% addition of polymer. At 1.5% addition of polymer the polymer modified silica fume concrete indicates an increase of 15%compressive strength with respect to reference mix(0% polymer). At 1.5% addition of polymer the polymer modified silica fume concrete indicates an increase of 17% in tensile strength with respect to reference mix (0%polymer). At 1.5% addition of polymer the polymer modified silica fume concrete indicates an increase of 8% in flexural strength with respect to reference mix(0% polymer).

This may be due to fact that addition of 1.5% polymer into polymer modified silica fume concrete may result in higher workability and may be able to fill up all the pores of concrete resulting in denser concrete which will not allow sulphate media to penetrate.

It is observed that polymer modified silica fume concrete subjected to magnesium sulphate attack show lesser compressive strength ,tensile strength and flexural strength when compared to polymer modified silica fume concrete without subjected to sulphate attack. This is true for all percentage addition of polymer into polymer modified silica fume concrete.

5. CONCLUSIONS

- 1.5% addition of polymer into polymer modified silica fume concrete can resist the sulphate attack in a better way.
- As polymer is added to the concrete the fluidity of concrete goes on increasing and hence the concrete cannot achieve full strength beyond the optimum percentage of polymer.
- By adding silica fume and styrene butadiene rubber latex polymer the resistance property to magnesium sulphate attack is enhanced in comparison to control concrete.

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