Effect of Superplasticizer in Rich Mortar Mixes Containing Locally Available Sands

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The purpose of this study was to examine the effect of superplasticizer in the rich mortar mixes (1:1.5, 1:2, 1:25 and 1:3) containing locally avaible cheaper sands of different fineness modulii for the ferrocement work. Emphasis has been on the flow characteristics, compressive strength, water absorption, drying shrinkage properties which play an important role in the use for the ferrocement work.

The results obtained indicated that with the help of superplasticizer, mortars made from locally available cheaper sands have compressive strength, comparable with standard costlier sand.

INTRODUCTION

Superplasticizers are being employed increasingly for mortar, plaster and concrete [1,2] because of the benefits they provide in handling, placing, compaction and finishing along with other technical and economical advantages.

Superplasticizers find its special use in mixes where water cement ratio is strictly controlled to have impervious mortars and at the same time the desired workability. These impervious mortars are basically required to provide watertightness in ferrocement [3]. In ferrocement the matrix has 95% or more pronounced influence on the behavior of the final product. Therefore, the selection of constituent materials e.g. cement, aggregate, mixing and placing of the mortars should be carefully exercized [4]. Chemical composition of cement, the nature of the aggregate and water-cement ratio are the major influencing parameters in determining the property of the mortar.

The use of admixture in ferrocement has become indispensable for water reduction and increasing strength [5-7]. The use of water reducing agents permits the use of more sand for the same design strength which also results in lower creep strains and less surface cracking.

Pozzolanas such as fly ash [1] can also be added to superplasticized cement to increase the durability. Up to a maximum of 30% of cement can be replaced with pozzolanas in such a combination without reducing the ultimate strength.

In view of the advantages of the use of superplasticizers and with the availability of different types of locally available cheaper sand with varying fineness modulii in different parts of the country, it was decided to study the performance of mortars with such sands separately or after blending them.

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MATERIALS

1. Cement: Ordinary portland cement conforming to IS 269/1967.

2. Sand: Locally available river sands, Solani (FM = 0.8), Ranipur (FM = 1.9), Quarry sand (FM = 2.2) and Standard ennore sand (FM = 2.4) as per IS 650, 1966 and a blended sand (FM = 1.5) of Solani and Quarry by mixing equal weights.

3. Superplasticizer: Sulfonated napthalene formaldehyde condensate (SNF) was used for the present study. Different doses of superplasticizer had been used for determining the flow of mixes.

EXPERIMENTAL DETAILS

Four mortar mixes (1:1.5, 1:2, 1:2.5 and 1:. 3) were prepared using different sands. The water cement ratio was varied from 0.25 to 0.4. Cubes of 50 mm sides were prepared for the present study.

First the flow of mixes at different water cement ratios and varying dosage of superplasticizer (0.3%, 0.6%, 0.8%, 1.0%) by weight of cement were determined as per BIS 5512. The results are given in Table 1 and Fig.1.

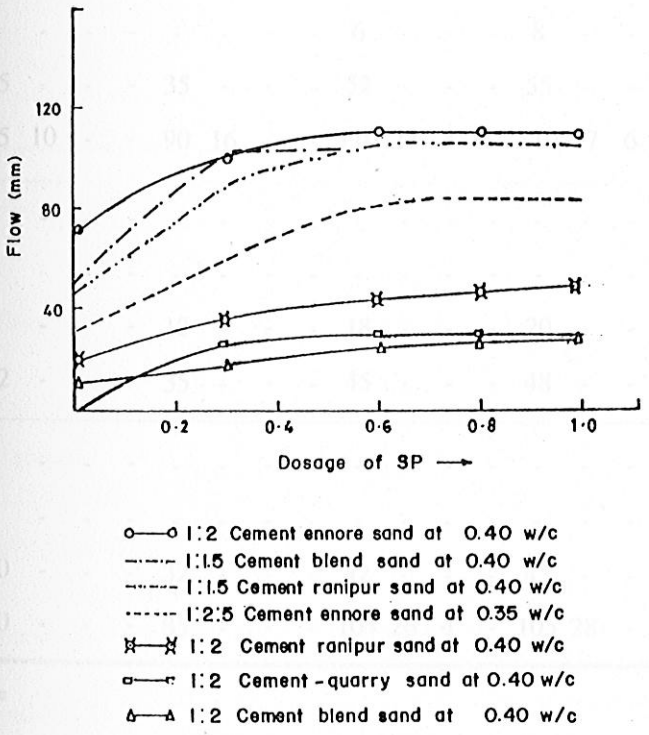

Fig.1. Variation of flow with dosage of superplasticizer for various mortar mixes.

Table 1 Flow Table Values (%)

Sand used	w/c ratio	Nil				0.3%				0.6%				0.8%				1.0%			
		1:1.5	1.2	1:2.5	1:3	1:1.5	1:2	1:2.5	1:3	1:1.5	1:2	1:2.5	1:3	1:1.5	1:2	1:2.5	1:3	1:1.5	1:2	1:2.5	1:3
Ennore	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.30	24	-	-	-	38	10	-	-	45	15	-	-	56	20	-	-	64	24	4	-
	0.35	85	35	-	-	115	55	11	-	125	80	17	-	Ex	95	19	-	Ex	105	21	-
	0.40	130	70	30	2	Ex	100	45	5	Ex	110	84	15	Ex	110	84	25	Ex	110	85	33
Ranipur	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.35	10	-	-	-	30	-	-	-	40	4	-	-	50	5	-	-	55	8	-	-
	0.40	46	17	-	-	90	35	-	-	115	42	-	-	115	44	-	-	115	53	-	-
Quarry (Q)	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.30	-	-	-	-	-	-	-	-	6	-	-	-	8	-	-	-	10	-	-	-
	0.35	15	-	-	-	35	-	-	-	52	-	-	-	55	-	-	-	58	-	-	-
	0.40	45	10	-	-	90	16	-	-	110	22	3	-	110	27	6	-	112	28	7	-
Solani (S)	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.35	-	-	-	-	12	-	-	-	18	-	-	-	20	-	-	-	22	-	-	-
	0.40	22	-	-	-	35	-	-	-	45	-	-	-	48	-	-	-	50	4	-	-
Blend (Q+S) 1:1	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.35	20	-	-	-	32	-	-	-	42	-	-	-	45	-	-	-	47	-	-	-
	0.40	50	-	-	-	85	-	-	-	104	26	4	-	105	28	-	-	108	30	4	-

Ex Exceeds flow table

The compressive strengths of 50 mm cubes for control and at 0.6% superplasticizer additions, cured at 27 ± 2° C for 28 days are shown in Table 2. The water absorption of the 25 mm x 25 mm x 250 mm bars using 1:1.5 and 1:2 mortar mixes are given in Table 3.

Shrinkage was observed with the help of length comparator as per IS 4031/1976. For cement sand bars of size 25 mm x 25 mm x 250 mm, the results are shown in Table 4.

DISCUSSION

It is evident from the results shown in Table 1 that with the addition of superplasticizer, there is an increase in flow. This is more predominant in case of no flow mix (1:1.5) found in locally available river Solani sand (FM=0.8). In this case 18% increase in flow at w/c ratio of 0.35 has been found. In cases where low initial flow was observed, addition of superplasticizer increases the flow by 100% or more. It is evident from Table 1 and Fig. 1, that the effect of superplasticizer on the flow after 0.6% addition is more or less constant. Therefore it can be considered as an optimum dosage level of superplasticizer in the present condition. Hence, in the present study, compressive strength, water absorption and shrinkage properties, for the mixes prepared with 0.6% superplasticizer addition have been reported.

The results of compressive strength shown in Table 2 indicate that in case of no-flow mix, the gain in strength can be attributed to the fact that after adding superplasticizer the no-flow mix becomes workable and the cohesiveness of the matrix is found to be increased. However, in case of mixes having certain flowability the gain in strength has been found to be less than 10%.

Table 2 Compressive Strength (kg/cm²)

Sand used	w/c ratio	No superplasticizer		0.6% superplasticizer	
		1:1.5	1:2	1:1.5	1:2
Ennore	0.25	400	324	440	400
	0.30	398	396	398	404
	0.35	385	428	460	408
	0.40	396	320	396	315
Ranipur	0.35	332	340	360	365
	0.40	310	296	340	316
Quarry (Q)	0.35	400	420	416	460
	0.40	382	400	384	390
Solani (S)	0.35	272	236	340	300
	0.40	264	220	290	280
Blend (Q+S) 1:1	0.35	380	356	392	370
	0.40	376	320	376	350

Table 3 Absorption (%)

Sand used	w/c ratio	No superplasticizer		0.6% superplasticizer	
		1:1.5	1:2	1:1.5	1:2
Ennore	0.25	8.8	10.1	6.4	9.0
	0.30	6.3	8.0	5.9	7.5
	0.35	7.9	9.0	6.7	8.1
	0.40	7.8	6.0	7.8	7.0
Ranipur	0.35	8.4	13.5	7.3	9.4
	0.40	9.6	11.9	10.1	10.6
Quarry (Q)	0.35	7.7	10.6	7.7	7.0
	0.40	8.4	7.8	8.4	8.0
Solani (S)	0.35	10.0	13.6	8.5	12.8
	0.40	8.8	12.8	8.8	12.0
Blend (Q+S) 1:1	0.35	8.3	11.7	8.3	10.6
	0.40	9.0	10.2	9.0	9.8

The observations on water absorption or the loss of weight with drying time (Table 3) show that the loss in weight in case of superplasticized mixes are less as compared to nonplasticized mixes. These results confirm that the superplasticized mixes are less porous.

The drying shrinkage, although a very important property particularly for the ferrocement work, has been found, in this study, to be nearly the same in superplasticized mortars as that in the case of control mix. The nature of sand used plays a great role in influencing the drying shrinkage. The higher amount of water used for mortar applications also results in higher shrinkage due to higher water loss on drying. However, in case of mortars studied, water was not in higher amounts, and the excessive flowability obtained by addition of superplasticizer may be of help in placing, compaction and finishing etc. but not in giving rise to higher shrinkage. In general the drying shrinkage has been found to be decreased by addition of superplasticizer with few exceptions.

CONCLUSIONS

In summary, the advantages of using superplasticizer with sands of varying fineness modulii are as follows:

1. It allows substitution with cheaper local sands for the more expensive quarry or standard sand.

2. The compressive strength of superplasticized mortars with Ranipur, Quarry, Solani and their blend for 1:1.5 and 1:2 mixes compares well with the strength obtained with nonplasticized mortars having standard Ennore sand.

Table 4 Test Results of Shrinkage

Sand used	w/c ratio	Control						0.6% superplasticizer					
		1:1.5		1:2		1:3		1:1.5		1:2		1;3	
		Flow	Sx10^{-5}	Flow	Sx10^{-5}	Flow	Sx10^{-5}	Flow	Sx10^{-5}	Flow	Sx10^{-5}	Flow	Sx10^{-5}
Ennore	0.25	-	72	-	74	-	-	45	64	-	71	-	-
	0.30	24	59	-	73	-	-	45	37	15	40	-	-
	0.35	85	69	35	81	-	33	125	75	80	75	-	32
	0.40	130	70	70	82	2	41	Ex	57	110	73	15	33
Quarry	0.35	15	74	-	67	-	43	52	75	-	70	-	32
	0.40	45	95	10	58	-	33	110	82	22	62	3	44
Ranipur	0.35	10	140	-	130	-	100	40	129	4	127	-	44
	0.40	46	127	17	110	-	89	115	121	42	105	-	93
Solani	0.35	-	89	-	131	-	75	18	108	-	99	-	64
	0.40	22	81	-	128	-	58	45	65	-	121	-	50
Blend	0.35	20	101	-	85	-	23	42	100	-	75	-	42
	0.40	50	103	-	46	-	50	104	101	26	40	-	13

3. In case of no-flow mortars, the addition of superplasticizer not only imparts workability but also increase the strength.

4. Water absorption is less in case of superplasticized mortars than the control mixes with the local sands and hence more dense and impervious as well as more corrosion resistant mortars are obtained which make them suitable for ferrocement work.

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