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SUPER PLASTICIZER : CONCRETE :
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The effect of a superplasticizer (from cashew nut shell liquid) on the properties of concrete and mortar

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The paper describes a new, cheaper water-reducing compound obtained from cashew nut shell liquid (CNSL). The properties of mortars, namely flow, setting time and compressive strength, were determined in the presence of 0.1 to 1.0% superplasticizer. The compressive strength of mortar containing the superplasticizer from CNSL was higher than that of the control

1. INTRODUCTION

Chemical admixtures for optimizing the properties of concrete have been very well established [1–3]. Since the early 1960s, a new group of chemical admixtures that improved concrete workability and water reduction beyond those achieved by normal water reducers have been used and have been classified as superplasticizers. The use of superplasticizers in concrete benefits the construction engineer in saving of time and in improved strength, workability and quality of the finished structure [4]. The main role played by these compounds is related to the surface-active constituents present in them. The long-chain sulphonated compounds, hydroxy carboxyl acid groups etc. promote the surface-active properties of the admixtures. These properties vary with the molecular size of the compound. This paper describes the use of a superplasticizer synthesized [5] from cashew nut shell liquid (CNSL) or the CNSL fractionated by sulphonating and condensing with formaldehyde in the presence of additives (labelled as CBRI SP). Some of the properties, like flow, compressive strength and setting time, obtained for cement sand mortars with CBRI SP are compared with those using material prepared from the commercially available sulphonated naphthalene formaldehyde condensate, Tamol.

2. EXPERIMENTAL PROCEDURE

Materials were as follows:

Cement: ordinary Portland cement conforming to IS:269-1967.

Sand: standard Ennore sand conforming to IS:656-1966.

Superplasticizer: Tamol, a sulphonated naphthalene formaldehyde condensate (SNF) supplied by BASF (India).

CBRI SP: a superplasticizer based on CNSL, synthesized at the Central Building Research Institute (CBRI).

Some of the properties determined during the study including pH, density, chloride content and shelf life are summarized in Table 1.

The flow percentage values of 1:3 cement:sand mortar at 0.45 w/c ratio and at different doses of superplasticizer on a solid contents basis in the liquid, measured according to IS:5512-1983, are given in Table 2.

The setting time of cement without and with CBRI-SP superplasticizer (0.6, 1.2 and 2.4% dose), determined according to IS:4031-1988, is given in Table 3. Table 4 gives a comparative evaluation of the compressive strength of concrete (M35) made from 50 kg cement + 50 kg sand (FM = 2.52) + 141 kg aggregate (20 mm) + 20.5 kg water and tested for 3, 7 and 28 days for 100 mm cubes. The average compressive strength of six cubes of control concrete is given in the first row. The second row shows the standard deviation and the third row the compressive strength of the cubes with 0.6% superplasticizer (CBRI-SP).

3. RESULTS AND DISCUSSION

The shelf life of the admixture (Table 1) is an important property, and samples of CBRI-SP stored for a reasonably long period (approximately 2 years) were tested to find the effect on flow of the mortar (1:3 cement:sand at w/c = 0.45). Normally the shelf life of the commercially available water-reducing agents varies over 6 to 18 months. However, it was found that the mortar flow using two-year-old samples of CBRI-SP resulted in the same flow as that with the fresh admixture. This proves that the samples possessed an adequate shelf life.

The flow values (Table 2) show that in 1:3 cement:sand the mortar flow increases with the dosage of superplasticizer. The increase in flow values using Orissa cement is higher than that with Satna cement. The fineness of the former was about 4200 $cm^2\ g^{-1}$ and that of the latter 3250 $cm^2\ g^{-1}$. Other physical and chemical characteristics may also determine the variation in the flow values.

The variation of flow of mortar with time is shown in Fig. 1. The flow value of plain mortar (1:3 cement:sand) just after mixing is 125–130 mm. With the addition of superplasticizer the flow value increases to 150–170 mm, varying distinctly with the kind of superplasticizer. It is clear from Fig. 1 that for plain mortar there is almost

Table 1 Physical properties of CBRI superplasticizer

Colour	Brown
State	Liquid
Density	1.18
pH	7.2
Chloride content	Nil
Shelf life	Samples prepared two years ago have the same properties and give the same flow in mortars
Flow table test	At 0.45 w/c ratio 1:3 cement (Satna): Ennore sand gives 65–70% flow against 27–30% for control
Dosage	6 ml for 100 g cement (6 ml of liquid contains ~0.6 g SP on drying)

Table 2 Flow values (%) of 1:3 cement:sand at 0.45 w/c ratio using superplasticizers

Type of cement	Dosage of superplasticizer (%)						
	0.0	0.1	0.2	0.4	0.6	0.8	1.0
Satna + CBRI-SP	110	115	120	140	150	165	170
Satna + TAMOL	110	114	120	130	138	155	163
Orissa + CBRI-SP	120	132	138	150	170	185	185

Table 3 Effect on setting time with the addition of superplasticizer

	Dose (%)	Initial time (min)	Final time (min)
Control (no superplasticizer)	–	168	239
CBRI-SP	0.6	185	265
	1.2	180	270
	2.4	181	275

Table 4 Compressive strength of M35 concrete (100 mm cubes)[a]

	Slump (mm)	Strength (kg cm^{-2})		
		3 days	7 days	28 days
Control	9	317.5	366.0	402.8
Standard deviation of control cubes		5.8	5.54	4.5
CBRI-SP	55 (at 0.6%)	375.0	406.7	475.0
Increase over control (%)		18	11.0	18.0
Standard deviation of cubes using CBRI-SP		0.90	1.53	0.0

[a] w/c ratio = 0.41.

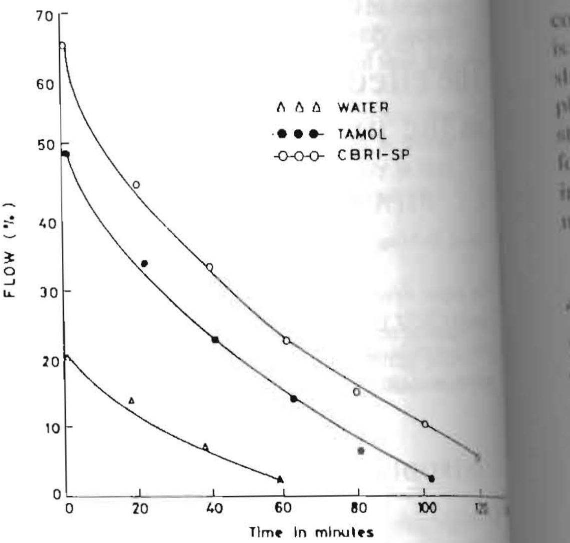

Fig. 1 Variation of flow of 1:3 cement:sand mortar (at w/c ratio) with time.

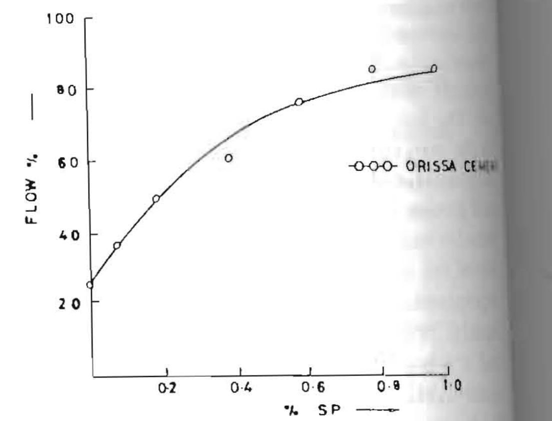

Fig. 2 Effect of superplasticizer dosage on flow properties of mortar at 0.45 w/c ratio (Orissa cement).

no flow after 60 min, whereas in mortar containing Ta and CBRI-SP the flow values are 15 and 25% hi than the reference, respectively. Fig. 1 demonstrates CBRI-SP provides better workability and workab retaining characteristics compared with Tamol.

Further, the effect of dosage on flow of (1:3 ce sand) mortar at 0.45 w/c is shown in Fig. 2 for O cement. At dosages higher than 0.8% CBRI-SP the no further increase in flow. This indicates that for cement 0.8% is the optimum dosage level.

The effect of admixture dosage on the setting of ce is given in Table 3. Setting times are not drastically al in the presence of CBRI-SP. The setting times (in and final) are within the limits of IS:4031-1988. Ev 2.4% CBRI-SP there is only slight retardation of setting of cement.

From Table 4 it is evident that up to 28 days, the of CBRI-SP in concrete results in an increase in stre over the control mix. The increase in strength over control (which has a slump of 9 mm at 0.41 w/c ratio) is particularly impressive because in spite of the higher slump of concrete (55 mm) containing the superplasticizer, the strength of the latter is higher. The higher strength in superplasticized concrete is attributed to the formation of a denser and more cohesive mix. The gain in compressive strength is comparable with the limit mentioned in BS-5075 Part 3, 1985.

4. CONCLUSION

It is evident from the studies carried out with the CNSL-based formulation that it is a good water-reducing agent. The CNSL-based superplasticizer, which is approximately 30% cheaper than the commercial superplasticizers available in India, has good potential in the concrete industry. This superplasticizer (CBRI-SP) promotes improved mortar strength.

Long-term studies on mortars, concrete and cements are under way. Simultaneously, a comparison of CNSL-based superplasticizers vis-à-vis other superplasticizers commercially available in India is also being carried out.

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RESUME

Influence d'un fluidifiant à base d'extrait de coquilles de noix de cajou sur les propriétés du béton et du mortier

On décrit un réducteur d'eau meilleur marché obtenu à partir d'extrait de coquilles de noix de cajou (CNSL). On examine les propriétés des mortiers: écoulement, temps de prise et résistance à la compression en présence de 0,1 à 1,0% de fluidifiant. La résistance à la compression du mortier contenant le fluidifiant est plus élevée que celle du mortier de contrôle.