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Water-reducing agent from coal tar waste

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This paper describes a cheap water-reducing agent obtained from coal tar waste. To study the efficacy of this water-reducing agent, properties of mortars, namely flow and compressive strength, were determined at various dosages (0–1.2%) of the water-reducing agent. The compressive strength of mortar containing the water-reducing agent from coal tar waste was similar to that of the control after 28 days. The increase in flow (%) as obtained by the addition of different dosages was 40% to 80% compared with 25% for the control.

Keywords: water-reducing agent; coal tar waste; mortars

Several distinct types of water-reducing agent[1–3] are available all over the world based on different chemicals. They have a similar function of reducing the water content in concrete without loss of workability. Normally, these agents are mostly organic compounds of high molecular weight, some are synthetic and others are derived from natural products. The main water-reducing agents are based on naphthalene, melamine, lignosulfonate and other natural compounds such as glucose, sucrose and hydroxylated polymers, and salts of organic hydroxycarboxylic acids, etc. Lignosulfonate, a waste liquor of the paper industry, is still the most widely used raw material in the production of water-reducing agents. Recently studies have been undertaken at the Central Building Research Institute, Roorkee, India, to obtain a water-reducing agent from other sources. Cashew nut shell liquid, a waste/by-product, has also been converted into a water-reducing agent[4–7].

The present paper describes the study of the use of a water-reducing agent developed from another source, a coal tar waste commonly known as coal tar creosote. These creosotes contain mixtures of naphthalene, anthracene, phenols, creosols and dimethyl naphthalene etc. The composition varies with the method of treatment for coal tar distillation. To obtain the water-reducing agent these creosotes are sulfonated and condensed with formaldehyde in the presence of additives. Owing to variations in the content of tar acids, the creosotes have been classified as heavy creosote oil and light creosote oil. In the present case the creosote oil with 8 to 10% tar acid was used for synthesizing a water-reducing agent. These creosotes consist principally of liquid and solid hydrocarbons and contain appreciable quantities of tar acids and tar bases.

Similar attempts to convert creosote into an admixture for concrete have been made[8]. Some of the physical properties of this product are given in *Table 1*. The properties such as flow and compressive strength obtained for cement sand mortars for a water-reducing agent based on coal tar waste (labelled as CR) are compared with those using material prepared from the commercially available sulfonated naphthalene formaldehyde condensate, Tamol.

Experimental materials

- Cement: ordinary Portland cement conforming to IS 269-1989[9].
- Sand: standard Ennore sand conforming to IS 650-1966 (Specification for standard sand for testing of cement).
- Superplasticizer: Tamol, a sulfonated naphthalene formaldehyde condensate (SNF), supplied by BASF, India.
- CR: A water-reducing agent based on coal tar waste, synthesized at the Central Building Research Institute.

Method

The efficacy of the water-reducing agent was evaluated by determining the flow percentage values of a 1:3 cement sand mortar at a w/c ratio of 0.45 and at various

Table 1 Physical properties of water-reducing agent synthesized from coal tar waste (CR)

Colour	Dark brown
State	Liquid
Density	1.2 mg ml^{-1}
Solid content	30–35% on drying
Shelf life	Two-year-old samples still give the same flow percentage values of 75–80% against 24% for the control of a 1:3 cement sand mortar determined at a w/c ratio of 0.45

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dosages (0–1.2%) of water-reducing agent. The flow values were measured with the help of a flow table according to IS 5512-1990[10] and are given in *Table 2*.

The compressive strength data for 50 mm cubes (hand compacted) of the 1:3 cement sand mortar at a w/c ratio of 0.45 and at different dosages of water-reducing agent are given in *Table 3*.

Results and discussion

The flow values (*Table 2*) show that in the 1:3 cement sand mortar, the flow increases with the dosage of both the water-reducing agents CR and SNF. The flow value increases from 24 to 80% in the case of CR and to 75% in the case of SNF, showing a three-fold increase compared with the control (*Figure 1*). Further, it is evident from *Table 1* that there is no increase in flow value beyond 0.8% of the dose in both cases, indicating that 0.8% is the optimum dose level.

The shelf life of CR was evaluated on the basis of its effect on the flow properties, which showed similar effects even after 2 years of storage.

It is evident from *Table 3* that the compressive strength (28 days) of the 50 mm cubes of 1:3 cement sand mortar at a w/c ratio of 0.45 and at various dosages of water-reducing agent is comparable with that obtained in the case of the control, i.e. 220 kg cm^{-2} (*Figure 2*). This indicates that there is no deleterious effect on the compressive strength even if the dose level is increased beyond the optimum level of 0.8%.

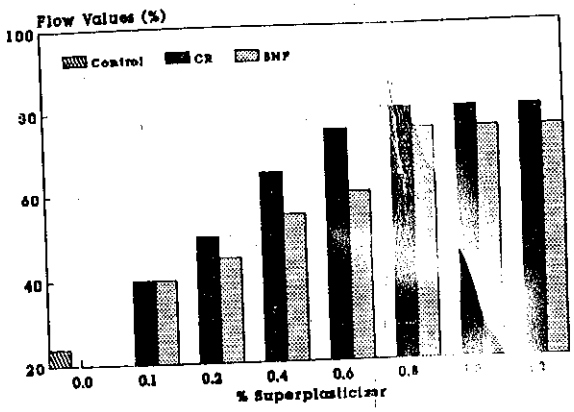

Figure 1 Flow values (%) of 1:3 cement sand mortar at a w/c r. 0.45 in the presence of superplasticizers

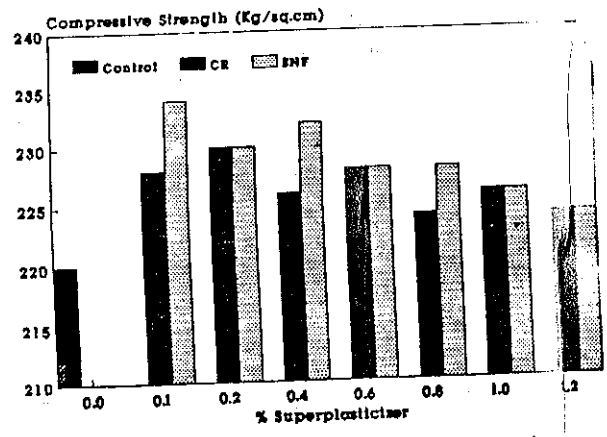

Figure 2 Compressive strength (kg cm^{-2}) of 1:3 cement sand mortar at a w/c ratio of 0.45 at various dosages of superplasticizer

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

Superplasticizer (%)	Flow values (%) Control	CR[a]	SNF[b]
0.0	24	–	–
0.1	–	40	40
0.2	–	50	45
0.4	–	65	55
0.6	–	75	60
0.8	–	80	75
1.0	–	80	75
1.2	–	80	75

[a] Water-reducing agent based on coal tar
[b] Sulfonated naphthalene formaldehyde condensate

Table 3 Compressive strength (kg cm^{-2}) of 50 mm cubes of 1:3 cement sand mortar at a w/c ratio of 0.45 and at various dosages of superplasticizers after 28 days

Superplasticizer (%)	Compressive strength (kg cm^{-2}) Control	CR[a]	SNF[b]
0.0	220	–	–
0.1	–	228	234
0.2	–	230	230
0.4	–	226	232
0.6	–	228	228
0.8	–	224	228
1.0	–	226	226
1.2	–	224	224

[a] Water-reducing agent based on coal tar
[b] Sulfonated naphthalene formaldehyde condensate

Conclusion

Studies carried out with a water-reducing agent (CR) based on coal tar waste show promising results. The effectiveness was comparable with that of commercial naphthalene sulfonate formaldehyde condensate (SNF). Because it is a product of coal tar distillation, this waste may be available in a plentiful supply, so the development of a commercial product might be undertaken. The cost of the new water-reducing agent may be 25 to 30% lower than commercially available water-reducing agents, which are costly materials, e.g. naphthalene, melamine, etc.

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