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# An assessment of workability of ordinary concrete by using chemical admixtures

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**Abstract—***Today many types of water reducing admixtures are available in the market in the form of plasticizers and superplasticizers. The efforts were made to understand the possible differences between plasticizers and super plasticizers. The result of tests conducted on concrete in the presence of plasticizers and superplasticizers. The objective was to observe the modification in workability and compressive strength under the influence of plasticizers and superplasticizers at various dosages level. The result of the treated mix was compared with the control mix (mix without admixture). Observations were made on fresh and solid phases of concrete, to note the variation in properties at constant and reduce water cement ratio. From the experience and knowledge gained from this course of study both, plasticizers and super- plasticizers not only improved workability at constant water cement ratio but considerably enhanced the compressive strength at reduce water-cement ratio with slump remaining unchanged, At every stage superplasticizers were known to perform better than plasticizers.*

## I. GENERAL INTRODUCTION:

Concrete is one such material whose optimum use is to be justified not because large volume are to be consumed due to size of our population, but also because cement, one of its ingredients requires a large amount of energy for its production. This brings in the theme of investigation and development in concrete technology. Today efforts are made not only to improve concrete's compressive strength but also durability. Durability has gained worldwide concern because experts believe that the expenditure in rehabilitation and resurrection of concrete structure in near future going to be equal to the expenditure on new construction.

Admixtures are used to modify the properties of concrete on mortar to make them suitable for the work at hand, or for economy, or for such other purpose as saving energy. In many instances e.g very high strength, resistance to freezing and thawing, for retardation and acceleration of setting time, an admixture may be that only feasible means of achieving the desired result. In other instances, certain desired objectives may be best achieved by changes in composition of proportion of the concrete mix, if doing so result in greater economy than by using an admixture.

An admixture is defined as 'a material other than water' aggregate and hydraulic cement which might be added to concrete or mortar before or during its mixing to modify one or more properties in fresh and hardened state.

Amongst The different Types of admixtures used, plasticizers and superplasticizers topped the chart. Hence, some effort was made to understand the effect of both plasticizers and superplasticizers in concrete, in a comprehensive manner. Due to certain limitations more stress was laid on understanding the modifications in workability and compressive strength, because a better understanding of their two properties helps us to gauge their effect on other important properties also.

## II. EXPERIMENTAL STUDY:

Availability of funds, time, material, and other facilities limits are scope of any research work. However best efforts were made to understand the effects of different types of plasticizers and superplasticizers. A plasticizer – calcium lignosulphate (CLS) and superplasticizers – sulphonated melamine formaldehyde condensate (SMF) and sulphonated naphthalene formaldehyde condensate (SNF) were used to understand their effect on behavior of concrete and highlight the difference between them if possible.

Many times information given by manufactures might appear to be exaggerated. It is quite necessary for a structural engineer to study the quality effects claimed by investigators and manufactures and then quantify the benefits of plasticizers and superplasticizers to produce a novel and economical design of structural units. The main theme behind conducting the series of experiments was to study the modifications in workability and loss of slump due to the presence of plasticizers and superplasticizers.

The control mix of proportion 1:1.67:3:3.33 by mass, obtained by nominal mix design procedure was used which gives normal workability (55 to 60mm at 0.54 water cement ratio) and M20 grade concrete. Different types of water reducing admixtures at different dosage level were used at constant and reduced water cement ratio.

In first step the w/c ration was kept constant and CLS, SNF and SMF were applied at different dosage level to observe the change in workability with the help of slump test. In second step the plasticizers and superplasticizers were applied at the same dosage level as before, but the w/c ration was reduced so as to keep the slump constant.

Once the positive sign of strength gain started to appear, certain quantity of cement was reduced to understand the effect of reduction of cement content on workability and compressive strength. The sole idea behind reducing cement content was to understand the economic benefits of using WRAs. Concrete in its fresh state with high dosage of superplasticizers showed signs of segregation and bleeding. This prompted to increase sand first to 40% and then to 45% to understand the influence of higher sand content not only on segregation, bleeding and workability but also the compressive strength.

## III. MATERIALS SPECIFICATIONS:

- Ordinary Portland cement, 53 Grades conforming to I.S.269-1967.
- River sand ('Goma' sand) passing through is 4.75 mm sieve.
- Dried Basalt crushed stones (Kapchi) with maximum size of 20mm.

**Properties of Plasticizers**

Calcium Lignosulphate:

| | | |
|---|---|---|
| Specific Gravity | : | 1018 ± 0.01 |
| Chloride Content | : | Nil (i.e. less than 0.2%) |
| Air entertainment | : | Less than 2% at normal dosage rates |
| Compatibility | : | All types of cement except high clumina cement |
| Self life | : | 12 Months |
| Storage conditions | : | Free from frost and direct sunlight |
| Standards | : | Conforming to IS: 9103 – 1979, ASTM (C 494 Type A) |

Sulphonated Melamine Formaldehyde Condensate:

| | | |
|---|---|---|
| Specific Gravity | : | 1.22 ± 0.1 |
| Chloride Content | : | Nil |
| Self life | : | 12 Months |
| Storage conditions | : | Free from frost and protection from sunlight |
| Standards | : | Compiles with IS : 9103 – 1979, ASTM : C 494 86 Type F |

Sulphonated Naphthalene Formaldehyde Condensate:

| | | |
|---|---|---|
| Specific Gravity | : | 1.22 to 1.225 @ 25 ˚C |
| Chloride Content | : | Nil as per BS 5075 and IS : 456 |
| Air entertainment | : | Approx 1% additional air is entrained at maximum dosage |
| Compatibility | : | All types of cement except high alumina cement |
| Self life | : | 12 Months |
| Storage conditions | : | Protect from extreme temperatures and direct sunlight |
| Standards | : | Conforming to IS: 9103 – 1979, BS: 5.75 part 3 |

## IV. MIX PROPORTIONING

Using sand and gravel conforming to IS 383-1979 cubes were casted using mix proportion of 1:1.67:3.33 by weight, which yields M20 grade concrete on 28 days curing. When cement was reduced by 10% the proportion changed to 1:1.86.3.72. With the increase in sand content mix of proportion 1:2.03:303 (40% sand of total aggregate) and 1:2.28 : 2.78 (45% sand of total aggregate) was used. Sample were weighted to an accuracy of 50 grams (0.1% of total weight of batch)

## V. RESULTS AND DISCUSSION:

The marked improvement observed in the behavior of concrete in fresh state is one of the reasons which advocate the use of plasticizers and superplasticizers. It was observed that dosages the mix showed some signs of segregation with slurry separating out from the mix. This was reduced when the sand content was increased. During compaction sometimes bleeding was observed. This is undesired, but some researchers have reported that a bit of retempering after some time can enhance the strength, probably because the effective water cement ratio is reduced.

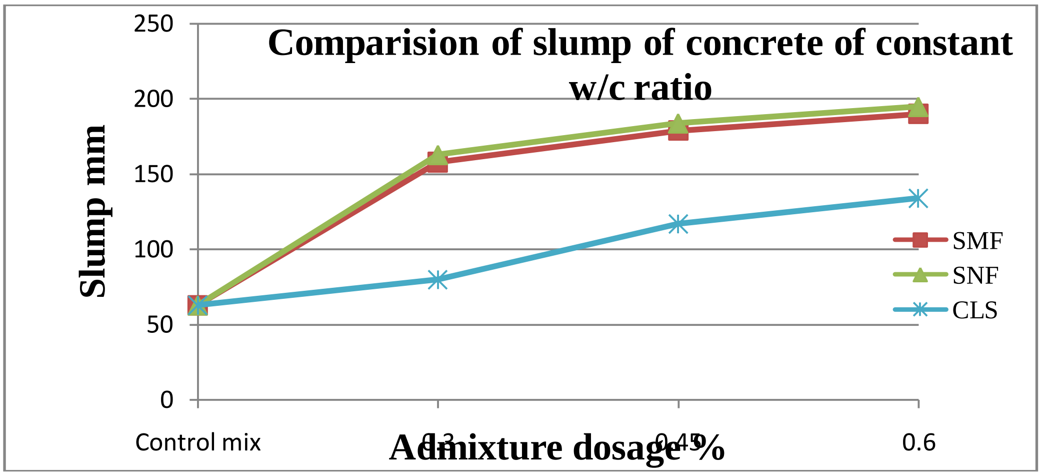


Fig.1.0 slump of concrete of constant w/c ratio

**5.1 Effect of calcium lignosulphate:**

At constant water cement ratio the slump increased from 63mm to 80,117 and 134mm respectively at 0.3, 0.45 and 0.6% dosage level. The slump increased with increase in dosage level, but at decreasing rate. At constant slump water cement ratio could be reduced to 0.51. 0.48 And 0.46 at 0.3, 0.45 and 0.06% dosage level respectively. The maximum reduction in water cement ratio was 14.8% which is within the range of 10-12% for most of the CLS available commercially. The mix was highly workable and could be easily mixed with efforts. At higher dosage some signs of segregation were noted and cement paste/slurry was characterized by presence of small amount air bubbles indicating air entrainment.

**5.2 Effect of Sulphonated Melamine Formaldehyde Condensate (SMF):**

Unlike CLS maximum prescribed dosage level was not applied. The slump of treated concrete at 0.5, 0.75 and 1.0% dosage level increased from 63mm (control) to 158,179 and 190mm respectively. At some consistency (slump of 60-65mm) the water cement ratio was reduced to 0.43, 0.41 and 0.39 at 0.5, 0.75 and 1.0% dosage level. The minimum possible reduction in water cement ratio was 27.7% whereas the slump at constant water cement ratio increased approximately by 201% dosage level.

The mix showed much enhanced workability, much higher than CLS. However, at 0.75% dosage level some signs of segregation were noticed which magnified at 1.0% dosage level. It is not for this reason that manufactures generally recommend to increase the sand content in the mix proportion. Like CLS, with SMF to the slump increased with the increase in the dosage level, but at the reducing rate.

**5.3 Effect of Sulphonated Naphthalene Formaldehyde Condensate (SNF):**

Like SMT, SNF was too applied at 0.5, 0.75, and 1.0% dosage level so that its performance can be compared with SMF. The result is tabulated in table 3. At 0.5, 0.75 and 1.0% dosage level, the slump at constant water cement ratio increase from 63mm to 163, 184 and 195mm respectively. Shows marginally better performance than SMF. Also at 0.5, 0.75 and 1.0% dosage level the w/c ratio could be reduced from 0.54 to 0.42, 0.4 and 0.375 respectively, which again is marginally lower than that obtained with SMF.

The maximum slump increase slump was 210% at constant w/c ratio and 30.5% reduction in w/c ratio at constant slump could be obtained at 1% dosage level which 106% greater than CLS and 10.1% greater than SMF. The performance of SNF in increasing the slump was best among the three water reducing admixtures used. However it showed higher signs of segregation at 0.75 and 1.0% dosage level compare to SMF and CLS. Also at higher dosage slurry which was separated was characterized with the presence of small air bubbles indicating some air entrainment, but it was less than reported with CLS.

In all three cases a common factors to be noted was that slump at constant water cement ratio increased in dosage level, but at decreasing rate. In increasing slump, both SMF and SNF performed better than CLS with SNF performing best. Another advantage of using plasticizers and superplasticizers is that at reduced water cement ratio not only compressive strength increases, but also the rate of gain strength increases.

The best results of series of experiments conducted with the different types of water reducing admixtures at different dosage levels of dealt separately in this section. The results are represented graphically. The results obtained with and without water reduction are compared with those obtained from control mix.

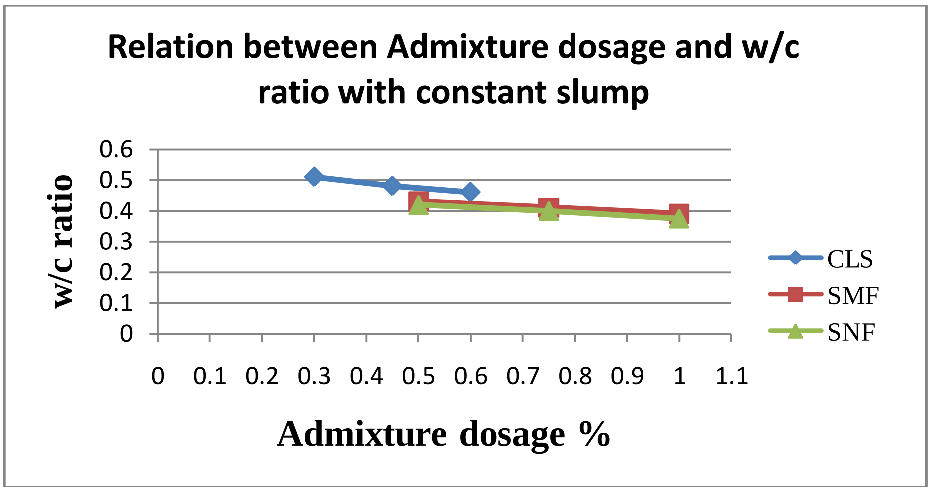

Fig.2.0 admixture dosages and w/c ratio with constant slump.

**5.4 EFFECT ON LOSS OF SLUMP.**

Maintaining the increased slump is as important as obtaining gain in zero hour slumps. Slump test at short interval were performed to understand the effect of water reducing agent on slump the most notable observation made was that the rate of slump loss in case of treated concrete was greater in the initial period and than the rate of reduction is reducing in the later period as compared to control concrete. However time required attaining zero slumps was also increased. These observations are same for all type of admixture results showing the increase in slump at different dosage of water reducing admixtures and after what time the slump equal to zero hour slump of control concrete was reported is tabulated below.

Table 1.0 Time required reaching to slump equal to slump of control concrete.

| Type of admixture | Dosage level % | Initial slump in mm | Time in min. |
|---|---|---|---|
| CLS | 0.45 | 117 | 20 |
| SMF | 0.50 | 163 | 40 |
| SMF | 0.75 | 175 | 45 |
| SNF | 0.50 | 179 | 45 |
| SNF | 0.75 | 190 | 50 |

## VI. CONCLUSIONS.

- There is a marked improvement in the workability of fresh concrete.
- The normal slump of 63 mm could be increased to 134 mm using plasticizers (**CLS**) and greater than 190 mm by super plasticizers (SNF and SMF) this apparent rise in workability is a short lived.
- Initially the slump loss was very high but the slump of treated concrete at all ages was greater than the control mix. The slump loss was found to be higher for a treated mix than control mix
- The slump loss also increases with the increase in the dosage level.
- At higher dosage signs of segregation and bleeding were noticed, composition needs to adjust the sand content to take care of this problem.

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