# INFLUENCE OF TYPE OF CHEMICAL ADMIXTURES ON SAND AND CEMENT CONTENT OF ORDINARY GRADE CONCRETE

M. K. Maroliya
Assistant professor, Applied Mechanics Dept, Faculty of Technology & Engineering,
M. S. University of Baroda, Vadodara, India

***ABSTRACT***

*Tests conducted on concrete addition of chemical admixtures to observe the change in ingredients contents of concrete like sand and cement under the influence of plasticizers and superplasticizers at various dosages level. The result of the treated mix was compared with the control mix. Observations were made on soft phases of concrete, to note the variation in workability 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 however increase in sand content is required to overcame bleeding and segregation, for the same strength it became possible to reduce the cement content is noted*

***KEYWORDS:*** *slump loss, density, compressive strength, workability, sand, cement content.*

## I. GENERAL INTRODUCTION

Many exciting innovations in material and construction procedures have appeared in last few decades. All round the globe effort are being made to make concrete a more exact material .and introduction to Admixtures has been one of the most notable contribution to concrete technology.

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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 of new construction. Admixtures are used to change the rheological properties of concrete or 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.

Out of 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

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.

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 proportion of concrete along with compressive strength 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. Due to its narrow range plasticizers were used at dosage level of 0.3, 0.45, and 0.6 percent by weight cement. But fir superplasticizers, 05, 0.75, 1.0 percent dosage levels were selected looking to their high range of dosage application slump and slump loss at different dosage levels were also observed at different interval of time

In first step the w/c ratio 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. During the course of investigation the effect of WRA s on higher requirement of sand content to overcome bleeding and segregation was noted.

# 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.

**Table 1.0** Properties of Plasticizers.

| properties | CLS | SMF | SNF |
|---|---|---|---|
| Specific Gravity | 1018 ± 0.01 | 1.22 ± 0.1 | 1.22 to 1.225 @ 25 ˚C |
| Chloride Content | Nil (i.e. less than 0.2%) | Nil | Nil (BS 5075 and IS : 456) |
| Air entertainment | Less than 2% | Less than 2% | Less than 1% |
| Self life | 12 Months | 12 Months | 12 Months |
| Standards | IS: 9103 – 1979 | ASTM:C 494 | IS: 9103 – 1979, BS: 5.75 -III |

# 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

## 5.1 EFFECTS DUE TO REDUCTION IN CEMENT CONTENT.

With reduction in water cement ratio the compressive strength improved. This benefit can be exploited by reducing cement content so that we have a concrete with same strength and workability at reduced water cement ratio and reduced cement content ( in presence of water reducing admixtures)
To arrive at the exact proportion to achieve the above mention conditions was difficult talking into consideration the availability of time, resources, and facilities available. But for the sake of academic interest cement content was reduced by 10 % and the proportion 1:1. 67:3.33 changed to 1 : 1.86 : 3.72 by mass. The compressive strength at 3, 7, and 28 days was recorded.
As observed the strength reduced compared to the mix of proportion 1 : 1.67 : 3.33 at reduced water cement ratio. But compared to control mix the strength a 3, 7, and 28 days was reported to be higher by 82.6%, 29.3% and 22.8%. The results are as under:

**Table 2.0** comp. Strength of concrete with age and cement content

| AGE (DAYS ) | COMP. STRENGTH Mpa CF = 400 kg/m$^3$ | COMP. STRENGTH Mpa after reducing cement factor by 10 % CF = 360 kg/m$^3$ |
|---|---|---|
| 3 | 15.24 | 15.3 |
| 7 | 26.83 | 23.8 |
| 28 | 30.23 | 30.2 |

The results indicate that the cement content can still be reduced to attain the ultimate strength equal to that of control mix. This is important point to note regarding the economic benefits of using a water reducing admixtures.

### 5.2 INFLUENCE OF SAND CONTENT:

While using water reducing admixtures at higher dosage level, at constant water cement ratio sighs of segregation and bleeding started to surface out, this prompted to increase sand content at the cost aggregates, Keeping the cement factor constant ( 400 kg/m3)
The signs of segregation started reducing when sand was increased to 40 % and almost disappeared at 45% of total aggregate content. This is a reason which advocates for higher sand content in flowing concrete. The mix then was very workable and plastic. The reason could be, the cement slurry which used to separate out under normal condition is mixed up with extra sand to give effectively higher paste volume which gives higher workability.
To understand its effect on compressive strength, cubes, were casted to record 7 days and 28 days only 9 for sake of academic knowledge only) the proportion then was 1:2.03:.03 by mass when sand content was 40% and 1:2. 7:2. 78 when the sand content was increased to 45 % of total aggregate.
With 40% sand, 0.75% of SNF, and water cement ratio of 0.42 giving slump equal to 60 mm, the 7 days strength was noted to be 33.7 N/ mm$^3$, where as 28 days strength was 40.73 N/mm$^3$, with 45% of sand and other thing in common, the water cement ratio required for 60 mm slump was 0.425 The 7 days and 28 days strength were recorded as 34.1 N/ mm$^2$ and 41N/ mm$^2$ respectively
The above results in comparison to those obtained from mix 1:1.67:3.33 at similar dosage of SMF are tabulated below:

**Table 3.0** Comp. Strength of concrete with age and water cement ratio.

| mix | %in comp. strength 7 days | %in comp. strength 28 days | Change in water cement ratio |
|---|---|---|---|
| 1 : 2.03 : 3.03 | 17.10 | 9.23 | -1.2% |
| 1 : 2.03 : 3.03 | 18.51 | 10.10 | -2.4% |

The water cement ratio required slightly increased as the surface area increased with the increase in volume of fine particles. The increase in the compressive strength might be because the mix got better graded.

## VI. ECONOMIC ASPECTS

The use of plasticizers and super plasticizers enable us to increase the strength of concrete at reduced water content. Certain amount of cement can thus be reduced, resulting in cost saving which at times can be higher than the additional cost admixture.

Considering a normal grade concrete ( 1:1.67:3.33 ) with cement factor 400 k/m3, the weight of sand and aggregates accompanying it would be 668 kg and 1336 kg respectively per cubic meter of concrete. Considering the bulk density of sand aggregates as 1.4 kg/m3 the volume of sand and aggregate required per cubic meter of concrete would be 0.477 cubic meters and 0.954 cubic meters respectively.

Dosage rate of plasticizers (CLS) was 0.3 to 0.6% by weight. With specific gravity of 1.18, requirement per cubic meter of concrete is 1 to 2 liters. Similarly for super plasticizers the range is 0.4 to 1.5 % with specific gravity of 1.22 requirements per cubic meter of concrete is 1.35 liters to 5 liters. It calculated as for 1N/mm2 of compressive strength the cost was reduced by 28.5% with CLS and 34%with SNF and SMF respectively thus chemical admixtures proves to be more economical in gain. The reduction in cost of concrete per N/mm2 of concrete was more with super plasticizers compared to plasticizers

## VII. CONCLUSIONS

Based on present investigation the results are summarized below:

- There is a marked improvement in the workability of fresh concrete. The normal slump of 63mm could be increased to 134 mm using plasticizers (CLS) and greater than 190 mm by super plasticizers (SNF or SNF) this apparent rise in workability is 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. Following relation was noted.

Slum loss with Super plasticizers › Slum loss with plasticizers › Slum loss with control concrete

- The slump loss also increased with increase in the dosage level.
- At higher dosage signs segregation and bleeding were noticed. Once the sand content was increased from 33% of total aggregates to 40 % and 45 % the sign of segregation almost disappeared even at 0.54 water cement ratio and 1.0% of super plasticizers.
- The most noticable advantage seemed to be increase in the compressive strength. Not only amount but the rate strength gain development also increased
- Using CLS, the 7 and 28 days strength of control concrete was gained in 3 and 7 days respectively. The ultimate strength was 33.4 N/mm2 which was 35.8% higher than control mix.
- Using super plasticizers the 3 and 7 days strength was greater than 3 and 7 day strength obtained by CLS, and much higher than 7 and 28 day strength of control mix SNF performed better than SMF. The ultimate strength at reduced water cement at 1.0% dosages level was 41.3 N/mm2 and 43.6 N/mm2 with SNF and SMF respectively. Thus per cent gain in ultimate strength by SMF was 67.9 % and SNF was 77.2 % respectively.
- In presence of water reducing agent, the variation in three days was greater than the variation in 7 day strength which was again greater than the variation in 28 days strength , whether water cement was reduced or not .At constant water cement ratio, with super plasticizers the strength was always higher compared to control mix. But with CLS certain reduction in strength was reduced at constant water cement ratio at maximum prescribed dosage level.
- Considerable amount of cement can be saved if the benefit of higher strength development is exploited.
- The cost of unit strength of concrete (cost per N/mm2) decreased by 28.5 % for lignosulphates, 38% for SMF and 34% for SNF.
- Considering all types of plasticizers and super plasticizers SNF. Both of them performed much better CLS.

Although the comparison is carried out talking into consideration the absolute numerical values, a point should be born in mind that molecular weight, monomer content (repeating unit) was unknown. These factors greatly influence the performance of any water reducing admixtures. Amongst the water reducing admixtures obtained, the SNF sample was highly condensed and can be applied for concrete of grade MN30 and above.

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**M K Maroliya**: Assistant professor, Applied Mechanics Dept, Faculty of Technology & Engineering, M.S. University of Baroda, Vadodara. He has over 15 years teaching experience. He has published about 14 papers in various journals/conferences. He is involved in research work in the field of concrete and fibre reinforced concrete.