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Experimental Evaluation of Super plasticizers used in M20 & M25 Grades Concrete

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Abstract **- Chemical admixtures are one of the important ingredients in concrete other than Portland cement, water and aggregate added to the mix before or during mixing. Admixtures are primarily used to reduce the water-cement ratio to enhance workability and compressive strength of concrete along with other properties. Successful use of admixtures depends on the use of appropriate methods of batching and concreting. Most admixtures are supplied in ready-to-use liquid form and are added to the concrete at the plant or at the jobsite. Certain admixtures, such as pigments, expansive agents, and pumping aids are used only in extremely small amounts. The effectiveness of an admixture depends on several factors including: type and amount of cement, water content, mixing time, slump and temperature. The paper presents the experimental results for comparison of two super plasticizers (Naphthelene based and Poly-carboxi late based) used in M20 & M25 grade concrete mixes to achieve economical concrete mix.**

Keywords **– Super plasticizer, Slump, Compressive strength, Poly car boxilate based super plasticizer and Naphthalene based super plasticizer.**

I. INTRODUCTION

Admixtures are classed according to function. There are five distinct classes of chemical admixtures - air-entraining, water-reducing, retarding, accelerating, and plasticizers (super plasticizers). Super plasticizers can be supplied as pure product, Sulphonated Melamine Formaldehyde condensates (SMF), Sul phonated Naphthalene Formaldehyde condensates (SNF), Poly car bxylate Ether super plasticizers (PCE) or they can be blended with each other or with Ligno sul phonate as well as with other modifying chemicals.

Sulphonated Naphthalene Formaldehyde condensates (SNF) give 16-25%water reduction .It tends to reduce cohesion in the mix, increasing the tendency to bleed and segregate but can be very effective in improving mixes which are already over-cohesive and sticky. SNF gives little or no retardation makes them very effective at low temperature or where early strength is most critical, however, at higher temperatures it loses workability quickly, so are often added at the site rather than during batching at a ready mix plant. SNF generally give a good finish. Poly carboxi late ether based super plasticizer (PCE) typically gives 20-35% + water reduction. It is relatively expensive but very effective, so lower dose is normally used. The basic molecule can be manipulated to give targeted properties.

II. EXPERIMENTAL DATA

Two admixtures Naphthalene based and Poly carboxi late based have been used in design mix of M20 & M25 grade concrete for Jawaharpur Thermal Power project, Etah U.P.to achieve required slump & compressive strength. Properties of admixtures are as below:

1.Naphthalene based Super plasticizer

S.N.	Properties	Test Result
Chemical Analysis Test Results		
1	Color	Dark Brown Liquid
2	Physical State	Liquid
3	pH	6.16
4	Dry Material Content,%	42.58
5	Ash, Content,%	13.01
6	Chloride content,%	0.0016
Manufacture's Data		
7	Chemical Base	Modified Nap thalene Formaldehyde Sul-phonate
8	Relative density	~1.20 kg/l at 25°C
9	Consumption / Dosage	0.5% to 2.0% by weight of cement. Higher dosage may be used if agreed by engineer and consultant Actual dosage to be finalized on the basis of site trials. Stir well before use

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2. Poly Carboxilate based

S.N.	Properties	Test Result
Chemical Analysis Test Results		
1	Color	Light Amber Liquid
2	Physical State	Liquid
3	pH	6.46
4	Dry Material Content,%	47.58
5	Ash, Content,%	13.25
6	Chloride content,%	0.0013
Manufacture's Data		
7	Chemical Base	Poly carboxylic Ether
8	Relative density	1.12 ± 0.02
9	Consumption / Dosage	Dosage: Optimum dosage can only be established after trials, taking into account the rheological characteristics and the required mechanical performances. Rate of addition is generally in the range of 0.8-1.8% by wt of cementations material. For maximum dispersion throughout the mix.

III. RESULTS AND DISCUSSIONS

Table I: Design mix of M20 grade concrete using both admixtures.

Description of Mix	Mix Proportion for M20A20 (1 m^3) with Poly carboxilate based Admixture	Mix Proportion for M20A20 (1 m^3) with Naphthalene based Admixture
Make of Cement	Ordinary Portland Cement-43	Ordinary Portland Cement-43
Sand	Natural sand from Banas River	Natural sand from Banas River
Coarse aggregate	Crushed Coarse aggregate from Nangal, Rajasthan	Crushed Coarse aggregate from Nangal, Rajasthan
Admixture	Poly car boxilate based	Nephthelene based
Required Workability after 1.5 hour (Slump in mm)	100-120	100-120
FM of Sand	3.22	3.22
Exposure Condition	Severe	Severe
Water Cement Ratio Adopted	0.45	0.45
Cement, kg/m^3	350	350
Dosage of Admixture	0.45 % (1.58 kg)	1.6 % (5.60 kg)
Water, kg/m^3	158	158
CA:FA,(Ab.Vol)	54: 46	54: 46
Fine Aggregate (kg/m^3)	896	892
C.A particle (kg/m^3) Ind. Fractions 20- 10 mm 60% 10 - 4.75 mm 40 %	 631 421	 628 419
Slump after 1.5 hours in mm	110	110
Comp. Strength of 150 mm cube 7 days age, MPa 28 days age, MPa	 28.28 32.7	 35.94 46.70

Table II: Design mix of M25 grade Concrete.

Description of Mix	Mix Proportion for M25A20 (Pile) (1 m^3) with Poly carboxilate based Admixture	Mix Proportion for M25A20 (Pile) (1 m^3) with Naphthalene based Admixture
Make of Cement	Ordinary Portland Cement-43	Ordinary Portland Cement-43

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Sand	Natural sand from Banas River	Natural sand from Banas River
Coarse aggregate	Crushed Coarse aggregate from Nangal, Rajasthan	Crushed Coarse aggregate from Nangal, Rajasthan
Admixture	Poly carboxilate based	Naphthalene based
Required Workability after 1.5 hour (Slump in mm)	150-170	150-170
FM of Sand	3.22	3.22
Exposure Condition	Severe	Severe
Water Cement Ratio Adopted	0.43	0.43
Cement, kg/m^3	400	400
Dosage of Admixture	0.5 % (2.0 kg)	1.6 % (6.4 kg)
Water, kg/m^3	172	172
CA:FA(Ab.Vol)	54: 46	54: 46
Fine Aggregate (kg/m^3)	858	853
C.A particle (kg/m^3) Ind. Fractions 20- 10 mm 60% 10 - 4.75mm 40 %	604 403	601 401
Slump after 1.5 hours in mm	160	160
Compressive Strength of 150 mm cube 7 days age, MPa 28 days age, MPa	27.92 30.60	35.30 45.80

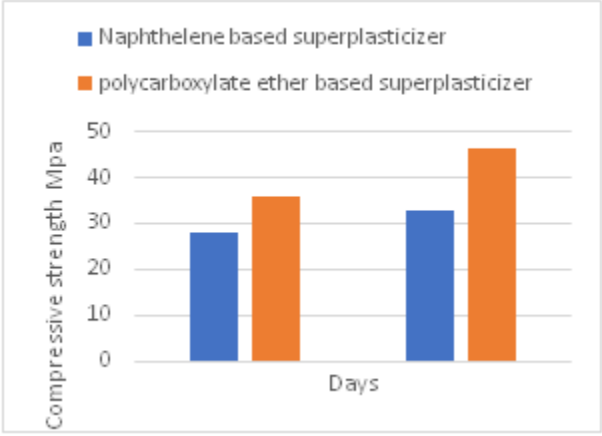

Fig.1. Compressive strength of M20 concrete with using both admixtures at 7 & 28 days.

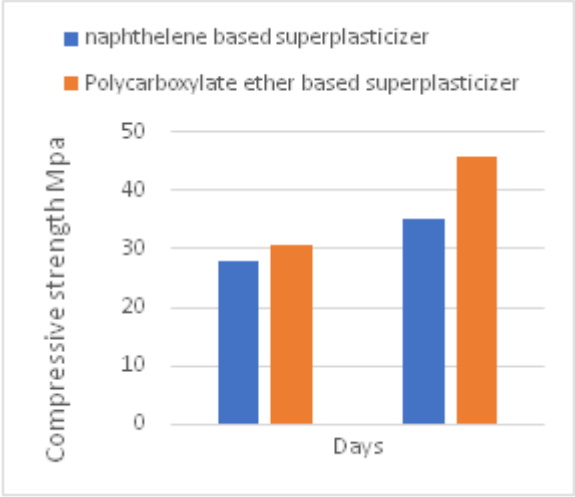

Fig.2. Compressive strength of M25 concrete with using both admixtures at 7 & 28 days.

Mechanism involved when both super plasticizers are used in concrete mix designs shown below:
Dispersion caused by electrostatic repulsion

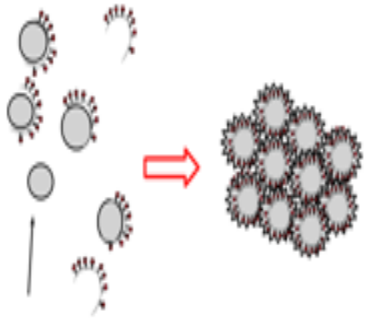

Fig.3. Mechanism of Action for Naphthalene based Super plasticizer

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Dispersion of particles caused by electrostatic repulsion when naphthalene based Super plasticizer is added in concrete mix. Distance between dispersed particles shown in Figure 5.

Dispersion caused by electrostatic Repulsion & Steric hindrance

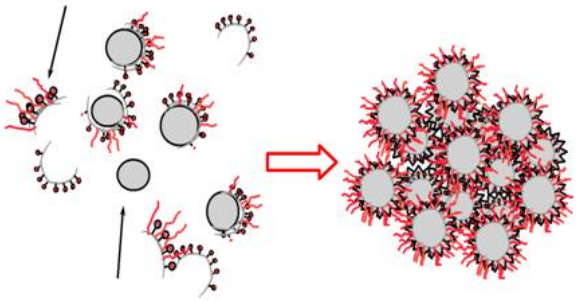

Fig.4.Mechanism of action for a Poly carboxylic Ether based super plasticizer.

Dispersion of particles caused by electrostatic repulsion & static hindrance. When Poly carboxylic Ether based Super plasticizer is added in concrete mix. Distance between dispersed particles shown in Figure 5.

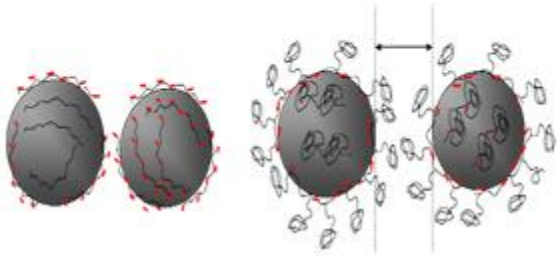

Fig.5. Distance between particles with using both super plasticizers.

It has been observed that to achieve required slump quantity of Naphthalene based super plasticizer used is much more than Poly car boxilate ether based super plasticizer in M20 & M25 grades concrete. The compressive strength achieved is also high in case of Naphthalene based super plasticizer due to high dosage, whereas, Poly-car boxylate ether based super plasticizer furnished required slump and compressive strength with less dosage.

IV. CONCLUSIONS

Poly-carboxy lateether based super plasticizer is more effective than Naphthalene based super plasticizer in the present study. However, Poly-carboxyl ate based super plasticizer is costlier than Naphthalene based super plasticizer. It may be concluded that overall cost of mix design is economical and effective with Poly-car boxy late ether based super plasticizer.

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