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Performance Assessment of Construction Chemical in Building Construction

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Abstract - - *Today there is practically no concrete without admixtures or construction chemicals. They are used in concrete at the time of construction or during maintenance & repairs to produce several desirable properties. Twenty years ago, construction chemicals were rarely adopted in India, but today there is a great awareness among practicing Engineers, Contractors and Public about the use of construction chemicals. To suit the demand, in India, a number of companies are emerging in the field of construction chemicals. Plenty of such products are available in the market. But there are no specifications and standards about their usage. In the absence of these norms, the companies advertising their products as Hi-tech and Super stuff. The only literature available is the manufacturer's brochures. Therefore the user finds it very difficult to choose a particular product. A comprehensive study about these chemicals was made in this work to evaluate their performance by conducting a series of laboratory tests.*

Several crores of rupees are being spent throughout the world on rehabilitation and restoration of structures. In traditional methods of repairs, the same problems may occur within a short span of time due to

i) Inadequate bonding of new concrete to old concrete or new plaster to old plaster

ii) Corrosion of reinforcement bars not being totally removed.

Today, construction chemicals play a vital role in repairs. They provide a long-term solution in the rehabilitation of the distressed members. They bring the damaged members to the original state within a short span.

For a particular admixture, there are plenty of market products available in the form of varied chemical bases.

But the field user does not have the knowledge to select a particular product among this plethora of chemicals. This work aims at guiding the user in choosing the correct product. A series of laboratory tests were conducted to assess their performance. Thus, this work is aimed to be of immense use to the CIVIL Engineering profession and the society.

Key Words: Waterproofers, Plasticisers, Superplasticisers, Lignosulphonate, phenolic, suiphonate

1. INTRODUCTION

Construction Chemicals are the materials added to concrete at some stage in its making to modify the properties of fresh concrete viz., increasing workability, retarding or accelerating initial setting time, reducing segregation, improving pump ability, reducing the rate of slump loss, etc., or to produce the desired properties in hardened concrete viz., increased strength, decreased permeability, early strength development, increased durability, etc., They are used in concrete to make it more suitable for the work on hand or for economy or for achieving desirable results.
Construction Chemicals play a vital role in making new constructions durable as well as in rehabilitating structures whose durability is in question. They are also used for repairs and maintenance. In traditional methods of repairs like re-plastering, jacketing, uniting, etc., the same problems may repeat in a short interval of time due to the inadequate bonding between old and new concrete/ plaster as well as due to incomplete removal of rust in steel. Today's scenario in the field of repairs encompasses the use of construction chemicals in the form of bonding agents, repair epoxy mortars, anti-corrosive coatings, etc., They provide an effective and long term repair solution to distressed R.C. members.
At present, a large number of construction chemicals are available in the market in different forms to serve special requirements in construction. The classes of chemicals considered in the work are Water reducers (Plasticisers and Superplasticisers) Bonding agents Waterproofers (Integral waterproofers and surface coatings) they are widely adopted in construction/ repairs.
The ICJ-RCH Bureau conducted a technical survey among practicing /charted Engineers, contractors and builders, architectural/engineering consultants, government departments, public sector undertaking. 87% of the respondents reported that they used water reducers to

increase the workability of concrete in the fresh state without increasing water content. Nearly 46% respondents used water proofers to decrease the permeability of concrete keeping in view of durability. Hence water proofers and water reducers were selected in this work to assess their performance.

In repairs, bonding agents play a vital role in achieving good bond between old and new concrete. Hence performance evaluation of bonding agents was also undertaken in the work.

2. DESCRIPTION OF CONSTRUCTION CHEMICALS

Water reducers are admixtures added to concrete during mixing to impart several desirable properties as listed under.

1) Achieving greater workability for a given w/c ratio without the addition of more water (thus avoiding strength losses). The workability so achieved provides a greater ease in compaction, reducing the risk of defects in the structures such as honey/ combing, etc. The increased workability is also useful when concrete pours are restricted due to either congested reinforcement or thin sections

2) In harsh mixes, (containing crushed aggregates or poorly graded aggregates) plastic properties of concrete can be improved using water reducers.
3) By maintaining workability at lower water content, concrete strengths can be increased without the need for addition of cement. Thus, it is possible to produce a denser and stronger concrete. Thus, it reduces the entry of deleterious ions that cause corrosion.
4) Whilst maintaining the w/c ratio and workability, concrete can be made to a given strength specification at lower cement contents than would otherwise be required. This leads to economy.
5) While pumping concrete without causing segregation in case of high rise structures.
6) In mass concrete where higher cement content leads to the evolution of enormous heat of hydration.

- Types of water reducers

Several distinct types of water reducers are available based on different chemicals although they purport to have a similar function in concrete. They are all organic compounds of high molecular weight, some being synthetic and others derived from natural products.

(i) Lignosuiphonates

The crude lignosuiphonates derived from wood-pulping are commonly used as plasticisers and in order to improve their effectiveness, they can be refined and modified.

The processing involves the removal of sugars and other unwanted impurities, selection of a higher molecular weight fraction and optionally, further sulphonation or partial ploymerisation. Calcium or other alkali metal salts are employed in the admixture, the latter having a superior water reducing capacity.

The basic repeating unit of the lignosulphonate molecule has a rather complex phenyl - propane skeleton. Substituent groups vary and include phenolic, carboxylic and methoxy in addition to suiphonate. In solution, the molecule coils into a spherical configuration, with ionized groups at or near the surface. Figure 2.1 shows the structure of a typical lignosulphonate molecule.

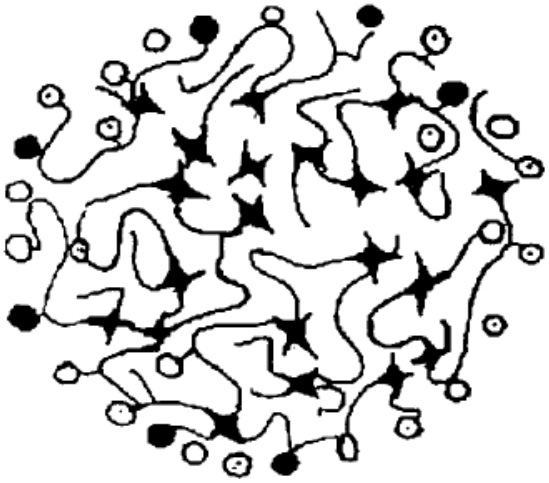

Fig 1 Lignosulphonate Molecule

ii) Carboxylic acids

They are formulated from wholly synthetic raw materials or chemically modified natural products, either as single component systems or blended formulations. Examples of such raw materials are polycarboxylic acid and their derivatives and certain polyhydroxy compounds such as starch hydrolysates.

(iii) Sulphonated melamine – formaldehyde condensates

These are polymers with the structural formula as below

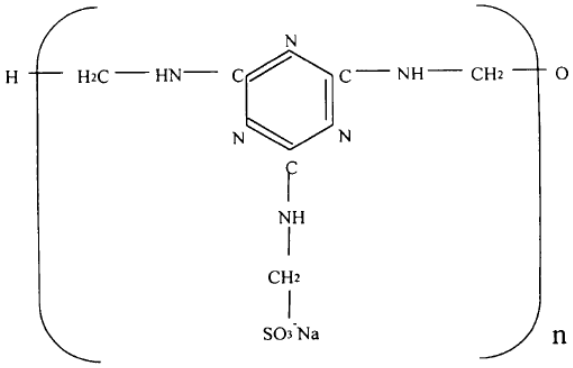

Fig 2 Sulphonated Melamine Formaldehyde

The value of n (the condensation number) is usually in the range 50-60 giving a molecular weight in the region of 20,000. These condensates are usually employed in the form of the sodium salt illustrated which is very soluble in water due mainly to the suiphonate groups on the side chains.

(Iv) Sulphonated Naphthalene–Formaldehyde Condensates

These are polymers similar in many ways to the previous category, with a simple repeating unit as shown below.

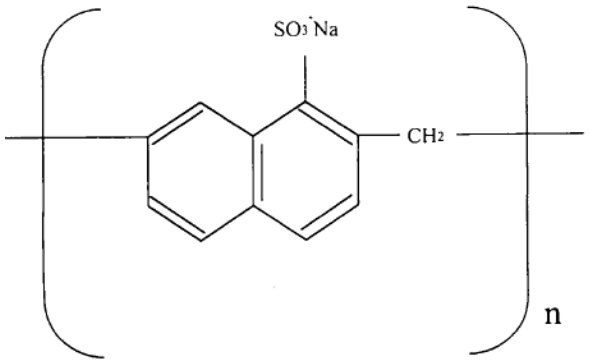

Fig 3 Sulphonated Naphthalene Formaldehyde

Again the sodium salt is usually employed, solubility being due to the suiphonate groups. The value of n is in the range of 5 - 10, giving a molecular weight of the order of 2000.

(v) Other materials

Acid amide/polysaccharide mixtures and other high molecular weight hydroxylated polymers and co-polymers are also used.

3. TYPES OF CONSTRUCTION MATERIALS

- **WATER REDUCERS**

S. No	Chemical type of water reducer	Availability	Specific gravity
1.	Specially selected organic polymer	dark brown	1.19
2.	Modified Napthalene suiphonate with th combination of resins	brown liquid	1.2
3.	Refined lingosuiphonates	liquid	1.19
4.	Processed lingosulphonates	brown liquid	1.19
5.	Melamine formaldehyde	Colourless liquid	1.06

Table 1 Type of Water Reducers Used

Application procedure

The exact quantity of water reducer was taken (either for a 0.5% dosage by weight of cement or 1% dosage). Then it was added to the gauging water and thoroughly mixed. It was then added with the dry mixture of cement, sand and gravels.

- **BONDING AGENTS**

Chemical Base	Nature of Product in the Market
Modified styrene butaiene emulsion	Single pack, milky white liquid
Acrylic emulsion	Single pack, milky white liquid
Epoxy bonding agents	Double pack, base & hardener, dark brown viscous fluid
Polymer latex (Poly vinyl acetate)	Single pack, white liquid

Table 2 Types of Bonding Agents Used

- **WATER PROOFERS**

Classification	Chemical base
Integral water proofer-	lignosuiphonates

liquid additive	Selected lignosuiphonates
Surface coatings	synthetic rubber bitumen emulsion
	methacrylate based coating
	bituminous coating
	Elastomeric cementitious coating (Two component system)
	silicone based water repellent

Table 3 Types of Water Proofers Used

4. .RESULTS

i) It is seen that the addition of water reducers increases workability. The slump values and compaction factor values of the mixes containing water reducers are more than that of the reference mix.

ii) From the test results, it is observed that the workability values in terms of slump and compaction factor, of the mixes with 1% dosage of water reducers are greater than with 0.5% dosage.

iii) Mixes with water reducers having chemical bases refined lignosulphonates, naphthalene base and m0elamine base performed well in producing very high workability. This was observed from the results of slump test and compaction factor test.

iv) One of the objectives of adding water reducers is to increase the workability with unchanged strength. On seeing and comparing the results of 28-day strengths of various mixes, it is concluded that melamine based superplasticiser performed best in achieving higher strength in addition to increased workability

5. CONCLUSION

These laboratory oriented investigations guide the practicing civil engineer, contractor, builder and the public to select a particular type of construction chemical from among the plethora of market products. The following products stand out clearly as the best among those tested for the four basic purposes stated under.

If the practicing civil engineer gets more specific knowledge about the efficacy and reliability of modern construction chemicals, he can open the doors of new profession the rehabilitation engineer. Dissemination of knowledge in this field will have a telling effect on the building industry and the building users as well.

The benefits gained in using admixtures are manifold. In U.S.A., Japan, Russia and European countries, there is no concrete without admixture. Admixtures become the fifth essential ingredient of concrete. In India, we are not reaching such stage. The scepticism in the minds of builders and engineers about the use of admixtures is because of their cost. The cost of admixtures used in a concrete job is nearly equal to 1% of the total cost of cement used. Today these rates are acceptable.

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BIOGRAPHIES

Anil Kumar Gupta is an M.Tech Scholar & currently researching on the Performance Assessment of Construction Chemical in Building Construction A part from this he is studious & have sound knowledge of the subject.