FOREWORD

There are two options regarding use of concrete i.e. Site Mixed Concrete or Ready Mixed Concrete. Ready Mixed Concrete is quite popular in developed countries because of its assured good quality and readily availability. In India, use of Ready Mixed Concrete is in initial stage. Many Ready Mixed Concrete plants have come up in metro cities. Although, Ready Mixed Concrete is expected to be superior but it has certain limitations like its delayed availability for placement, loss of workability etc. Thus, while planning to use Ready Mixed Concrete, user is required to keep in view its limitation.

The subject of use of Ready Mixed Concrete was discussed as Informal Item No.1 during 70th Meeting of BSC held at Bangalore in Jan., 99. The Committee recommended that before adoption of Ready Mixed Concrete, guidelines for use of RMC need to be prepared. In order to frame guidelines, a sub-committee of JA/ SG officers was nominated consisting of the following officers:

1) Sh. R.K. Gupta, Dy. Chief Engineer (Bridge Design) / N. Railway.
2) Sh. B.M. Gupta, Director/ Bridges & Structures/ RDSO.
3) Sh. Sudheer Jain, Dy.Chief Engineer/ Planning/ Construction, W.Railway.
4) Sh. S.C. Gupta, Professor/Bridges, IRICEN.
5) Sh. D. Radhakrishna Reddy, Dy.Chief Engineer(Construction), S.Railway.

The Sub-committee submitted its draft report in the month of December, 1999. This draft report was discussed by BSC in its Extra ordinary meeting held in Feb. 2000. The Committee considered the report and recommended for adoption after certain additions/ modifications. Committee's recommendations were approved by Railway Board vide letter no. 98/CE-I/BR-I/13 (Policy) Pt. dt. 26.7.2000. Accordingly, this report has been prepared after incorporating necessary modifications/ additions.

This report contains all aspect relevant to production, transport, laying & testing of Ready Mixed Concrete. In addition, it also covers benefits & limitations of Ready Mixed Concrete. It is expected that this report will serve as guideline to field engineers associated with construction of concrete structures used Ready Mixed Concrete.

Recently, Use of Ready Mixed Concrete has been permitted on Indian Railways, vide Addendum & Corrigendum Slip no. 3 dated 1.8.2000 to IRS Concrete Bridge Code.

I would like to thank all Sub-committee members, who prepared the draft report and helped in finalising the report.

(A.K. Harit)
Executive Director/Bridges & Structures

Guidelines on use of Admixtures in Concrete

1 Introduction:

Concrete has become established superb building material over the years, the quality and consistency of which can be improved to meet the desired requirements by using appropriate chemical admixtures in the mix. Making quality concrete is a precise technology, and in many conditions when ordinary concrete would not be suitable, the technologist can ensure that the finished product meets this requirement by using the right admixtures in the right proportion. It is important that the operator has an intelligent appreciation of concrete admixtures and employs the correct admixture in the exact quantity specified in order to achieve the desired results. Broadly speaking, admixtures may be divided into various categories, namely, accelerators, retarders, water reducers, air-entraining agents, water proofers, pumping aids, plasticizers, superplasticizers etc.

While admixtures, unlike cement, aggregate and water, are not an essential component of the concrete mix, they are an important and increasingly wide spread component in many countries, a mix that contains no admixture is now a days an exception.

In this report, attempt has been made to compile detailed information from literature survey regarding mechanism of admixtures, and their utilities with specific reference to Indian Railways.

Analysis of individual material with reference to relative advantages and disadvantages has also been attempted in this report.

As per existing concrete bridge code, second revision 1997, the chief Engineer is empowered to permit the use of admixture for imparting special characteristics to concrete with certain limitations (also see para7).

The report no. RBF/BMC-22 dealing with concrete admixtures on the same subject, was also prepared in February 1993. As the technology has advanced and there are many new trends emerged in the field of concrete admixtures in the recent past, this report has been prepared. This report is more descriptive, incorporating certain other aspects and new trends in concrete admixtures and shall be considered in supersession of the previous report no. RBF/BMC-22 issued by RDSO.

Guidelines on use of Admixtures in Concrete

2 Definition:

A material other than water, aggregate, and hydraulic cement, used as an ingredient of concrete or mortar and added to the batch immediately before or during its mixing, to modify one or more of the properties of concrete in the plastic or hardened state, is termed as Admixture.[3]

Uses of Admixture:

Admixtures are used to modify the properties of concrete. This has been elaborated in the following paras:

Effect of Admixtures on the Properties of Fresh Concrete.

i) To increase workability without increasing the water cement ratio.

ii) To retard or accelerate time of initial or final setting.

iii) To modify the rate of bleeding.

iv) To retard segregation or increase cohesion.

v) To improve pumpability

vi) To reduce the rate of loss of workability

Effect of Admixtures on the Properties of Hardened Concrete

i) To accelerate the rate of strength development especially at early stage.

ii) To increase the strength

iii) To increase the durability

iv) To decrease the permeability

v) To control expansion by alkali – aggregate reaction.

vi) To improve bond with reinforcement.

vii) To improve bond with old /new concrete.

viii) To improve impact or abrasion resistance

ix) To inhibit corrosion of embedded reinforcement.

3 Types of Admixtures

IS: 9103 covers the following types of admixtures:

(a) Accelerating admixtures

(b) Retarding admixtures

(c) Water reducing admixtures , and

(d) Air entraining admixtures

Following paras describe above admixtures in brief.

Accelerating Admixtures:

These admixtures when added to concrete, mortar or grout increases the rate of hydration of hydraulic cement, shortens the time of set, accelerates the hardening or development of strength of concrete/ mortar.

These admixtures function by interaction with C_3S (Tri-calcium silicate) component of the cement thus increasing the reaction between cement and water.

Chemical Composition:

Many substances are known to act as accelerators for concrete. They include Alkali Hydroxides, Silicates, Fluoro-Silicates, Organic Compounds, Calcium Formates, Calcium Nitrates, Calcium Thio Sulphates, Aluminium Chlorides, Potassium Carbonates, Sodium Chlorides & Calcium Chlorides.

Of these calcium chlorides are most widely used because of its ready availability, low cost, predictable performance characteristics. Non-chloride Admixtures are preferred as chloride containing ones are believed to accelerate corrosion of reinforcement. For chloride free admixture also see para 8.1

Advantages :

i) Shortens the setting time of cement and therefore increases the rate of gain of strength.

ii) Enables earlier release from precast moulds thus speeding

production.

iii) Reduces segregation and increase density and compressive strength.

iv) Cures concrete faster and therefore uniform curing in winter and summer can be achieved.

v) Early use of concrete floors by accelerating the setting of concrete.

vi) Reduces water requirements, bleeding, shrinkage and time required for initial set.

Effect of use of Accelerator.

Table-1 below shows typical test results provided by M/S. Asian laboratories ,New Delhi.

Mix details: OPC 350 kg/cum., Zone 2 sand 26%, 5-20 mm crushed aggregates 74%, Dosage: 1% by weight of cement.

Table-1

	Cement Kg/m^3	Water Kg/m^3	Reduction in unit water content (%)	W/C Ratio	Slump in mm	Compressive Strength (Kg/cm^2)			
						1day	3days	7days	28days
Reference concrete	350	210	Nil	0.6	55	30.25	88.5	163.45	253
Concrete with CEMWET-ACC	350	178.5	15.0	0.51	60	51.0	135.0	216.0	304

From the results of above table it is seen that by the use of accelerator in concrete mix of same slump and cement content, the increased strength at early and final stage with better workability can be achieved even at reduced water cement ratio.

Dosage ranging from 0.06 to 3% by wt. of cement, for different products are recommended by different manufactures but it shall be fixed as per design requirement and site trials (see para 8.4)

Guidelines on use of Admixtures in Concrete

Retarding Admixtures:

This type of chemical admixtures decreases the initial rate of reaction between cement and water and thereby retards the setting of concrete. It functions by coating the surface of C_3S (Tri calcium silicate) components, thus, delaying this reaction with the water. Reaction products are slow to form as such the setting and hardening of concrete are delayed reducing early compressive strengths. Since the rate of stiffening of concrete can be too fast in our tropical climatic conditions, sufficient time for the concrete is required for transportation and placement before setting. In such conditions retarding admixtures can be very useful. Retardation in setting time up to 8-10 hours is possible by suitable use of retarders.

The delay in hardening caused by the retarders can be exploited to obtain an architectural finish of exposed aggregate: the retarder is applied to the interior surface of the formwork so that the hardening of the adjacent cement is delayed. This cement can be brushed off after the formwork has been struck so that an exposed aggregate surface is obtained.

Chemical Composition:

These admixtures can be divided in several categories based on their chemical composition. The main ingredients of retarders are as follows:

i) Lignosulphonic acids and their salts. e.g. Na, Ca or NH4,

ii) Hydro-carboxylic acids and their salts.

iii) Carbohydrates including sugar.

iv) Inorganic salts based on flourates, phosphates, oxides, borax and magnesium salts.

Advantages:

i) Improves workability, cohesion and extends setting time, provides protection against delays and stoppages and facilitates keeping workable concrete for extended period ..

ii) In the large construction, good workability of the concrete throughout the placing period and prevention of cold joints is ensured by adding retarders in the concrete.

iii) Extended setting time minimise risks of long distance delivery in hot weather, improves pumpability of concrete by extended setting period and improved workability of concrete.

iv) Reduces bleeding and segregation where poor sand grading are unavoidable.

v) Reduces adverse environmental effects of various nature on concrete and embedded steel by considerable reduction in permeability.

Effect of use of Retarder:

Retarding admixture forms a film around the cement grain that prevent or delays the reaction with water. After some times, this film breaks and normal hydration takes place. Table below shows typical test results provided by M/s FOSROC chemicals (I) Ltd., Bangalore.

Mix: Sand zone 2(IS:383)- 35%, Aggregate 20-5mm (IS:383) 65%

Cement OPC(IS:269)

Table-2

S. No.	Test	Dosage of conplast-RP 264 lit/50kg cement	W/C ratio	Slump in mm	Compressive Strength Kg/cm^2			Density Kg/m^3
					3days	7days	28days	
1.	Control	Nil	0.65	60	102	131	167	2368
2.	Workability increased	0.15	0.65	130	105	135	171	2384
3.	Strength increased	0.15	0.572	65	161	193	257	2390

From the results of above table it is found that by use of retarder in concrete as an admixture, due to increase in slump, the workability can be increased maintaining same water cement ratio and strength of concrete. With reduction of water cement ratio, the strength of concrete can be increased without loss of workability.

Dosage ranging from0.05 to 1% by wt. of cement, for different products are recommended by different manufactures. However, it shall be fixed as per design requirement and after site trials (see

para 8.4).

Plasticizer (Water Reducer) Admixtures

A material, which either increases workability of freshly mixed concrete without increasing water cement ratio or maintains workability with a reduced amount of water, is termed as water reducing admixture.

As their name implies, the function of water reducing admixture is to reduce the water content of the mix, usually by 5 to 10%, sometimes (in concrete of very high workability) upto 15%. Thus, the purpose of using a water reducing admixture in a concrete mix is to allow a reduction in the water cement ratio while retaining the desired workability or, alternatively, to improve its workability at a given water cement ratio. The actual reduction in water depends on dose of admixtures, cement content, type of aggregate used, ratio of cement, fine and coarse aggregate etc. Therefore, the trial mixes containing an actual material to be used on the job are essential to achieve optimum properties.

Chemical Composition:

The chemicals used as plasticizer (water reducing admixtures) are as follows:

i) Lignosulfonic acids, derivatives and their salts.

ii) Hydroxylated carboxylic acids, their salts and derivatives.

iii) Nepthalene sulphonic acid based

iv) Sulfonated melamine polycondensation products

v) Blends of above

vi) Inorganic material like borates, phosphates, amines and their derivatives, carbohydrates, sugar and certain polymeric compounds like cellulose, ethers etc.

Advantages:

i) They increase the workability of the concrete without reducing the compressive strength or without changing water-cement ratio. This is particularly useful when concrete pores are restricted either due to congested reinforcement or due to thin sections.

ii) High strength can be obtained with the same cement content by reducing water cement ratio.

iii) A saving in the quantity of cement (approx. upto 10%) can be achieved keeping the same water/ cement ratio and workability.

Effect of use of Plasticizers:

Typical test results provided by M/s. M.C.Bauchemie(I) Pvt. Ltd., Mumbai, showing increase in workability and increase in strength are given below in table-3.

Table-3

Description of mix	Dosage % cement wt.	Cement kg/m^3	W/C Ratio	Slump cm	Compressive strength N/mm^2			
					1 day	3 days	7 days	28 days
Reference	--	300	0.6	7	7	18	26	34
Plasticizes	0.2%	300	0.6	10	7	18	28	37
	0.3%	300	0.6	12	6	17	27	35
Strength increase	0.2%	300	0.56	7	7	21	32	41
	0.3%	300	0.54	7	8	23	33	44
Cement saving	0.2%	280	0.6	7	7	19	28	36
	0.3%	270	0.6	7	6	19	27	35

From the above table it is seen that one of the following advantages can be gained at a time:

i) Reduced cement content keeping same water-cement ratio and workability. This will lead to economy.

ii) Reduced water-cement ratio keeping same water content and same workability. This will lead to increase in strength.

iii) Increased workability keeping same water-cement ratio and cement content. This is specially required when workability retention for pumping etc. is needed.

Dosage ranging from 0.15 to 0.6% by weight of cement (different doses for different products) are recommended by manufacturers,

however, it shall be fixed as per design requirements and after site trials.(see para 8.4).

Superplasticizer Admixtures

Normal water reducers are well established admixtures called plasticizers in concrete technology. A normal water reducer is capable of reducing water requirements by 10 to 15%. Higher water reductions, by incorporating larger amounts of these admixtures, result in undesirable effects on concrete like bleeding, segregation and hardening . So, a new class of water reducers, chemically different from the normal water reducer and capable of reducing water content by about 30% has been developed. The admixtures belonging to this class are known as super plasticizers. Superplasticisers are infact the extended version of plasticisers.

At a given water /cement ratio and water content in the mix, the dispersing action of superplasticizer increases the workability of concrete, typically by raising the slump from 75mm to 200 mm, the mix remaining cohesive. The resulting concrete can be placed with little or no compaction and is not subject to excessive bleeding or segregation. Such concrete is termed as flowing concrete and is useful for placing in very heavily reinforced sections, in inaccessible areas, in floor or road slabs, and also where very rapid placing is desired. The principal mode of action of superplastcizers is their ability to disperse cement particles very efficiently. As they do not entrain air, they can be used at high dosage rates without affecting strength.

Chemical Composition:

There exist four main categories of superplasticizers based on their chemical composition:

(i) Sulfonated melamine formaldehyde condensates

(ii) Sulfonated naphthalene formaldehyde condensates

(iii) Modified lignosulfonates

(iv) Others such as sulfonic acid esters and carbohydrate esters

Advantages:

i) Cement content can be reduced to a greater extent keeping

the same water/cement ratio. This will lead to economy.

ii) Water-cement ratio can be reduced significantly keeping same cement content and workability. This will lead to increase in strength.

iii) Higher workability at very low water cement ratio like casting concrete with heavy reinforcement..

iv) Reduction in permeability

v) Where early strength development is required in prestressed concrete or casting of floor, where early access for finishing equipment is required.

Effect of use of Superplasticizers:

For increasing the workability of the mix, the normal dosages of superplasticizers is 1 to 3 litre per cum. of concrete of the liquid superplasticizer containing about 40% of active material. When superplasticizers are used for large water reduction and for high strength, their dosage is much higher: 5 to 20 litre per cubic metre of concrete. Generally, the dosage recommended by the manufacturer should be taken as guidelines and the correct dosage be decided based on site trials. The typical test results showing the increase in workability and increase in strength due to use of superplasticizer, given in tables 4-6 have been taken from the literature provided by CICO structural water proofing Pvt. Ltd., New Delhi.

Table-4

SN	Dosage in Lt/50 kg of cement	W/C ration	Cement content kg/m^3	Slump in mm
I	Control Mix	0.55	350	50
II	0.2	0.55	350	80
III	0.4	0.55	350	150
IV	0.6	0.55	350	200

The test results given in the above table-4 indicates that by use of different dosage of superplasticizer, the slump is increased resulting into better workability of concrete.

Table-5

SN	Dosage in Lt/50 kg of cement	W/C ration	Cement content kg/m^3	Compressive strength in kg/cm^2	
				7 days	28 days
I	Control Mix	0.55	350	175	270
II	0.2	0.50	350	255	343
III	0.6	0.46	350	325	410

From the above table-5, it is found that by use of different dosage of superplasticizer, the better strength can be achieved by reduced water cement ratio.

Table-6

S.N.	Dosage in Lt/50 kg of cement	% of cement saving	Cement content in kg/m^3	Compressive strength in kg/cm^2				
				3 Days	7 Days	28Days	1Yr	3Yrs
I	Control mix	-	400	125	175	285	310	325
II	0.2	8.5%	366	130	185	293	321	340
III	0.6	14%	344	130	195	310	325	340
IV	1.0	20%	320	45	203	315	326	345

Saving of cement up to 20% can be achieved by different dosage of superplasticizer in the concrete at constant water cement ratio (0.55) and workability (80-90) slump.

Air Entraining Admixture:

This is an admixture for concrete or mortar which causes air to be incorporated in the form of minute bubbles in the concrete or mortar during mixing, usually to increase workability and resistance to freezing and thawing. Air entrained also breaks the continuity of capillaries.

The dosages required are between 0.005 to 0.05% by mass of

concrete and it is advisable to mix it with batching water for uniform dispersion. As per department of Atomic Energy Practice, the air content is controlled between 3 to 6%. Method of measuring air content is given in IS 1190.

Chemical Composition

The major proportion of commercial products is based on the following chemical materials, set out in order of probable decreasing use;

i) Abietic and pimeric acid salts

ii) Fatty Acid salts

iii) Alkyl - aryl sulphonates

iv) Alkyl sulphonates

v) Phenol ethoxylates

Advantages:

i) Durability

ii) Reduced bleeding and segregation because of :

   a) Attachment of air bubbles with cement particle and linking them.

   b) Increase in inter particle attraction caused by adsorption of air entrainer.

   c) Bubble acting as extra fine filler and increased total surface area of constituents relative to water volume.

   d) Water flow between cement particles is restricted.

iii) Workability increased due to action of air bubbles as ball bearing which assist movement of particles each other.

4 New trends in Admixtures:

Silica-fume :

Silica-fume is a by product of industries manufacturing silicon metal and Silicon alloys. It can also be obtained by processing naturally occurring amorphous silica deposits in countries like New Zealand. Silica-fumes when added with standard cements, will increase the durability and strength of the concrete as well as reducing permeability and improving abrasion-erosion resistance.

Silica fume consists of very fine vitreous particles with silica content as high as 86-96 %. It is 100 times finer than cement and is highly pozzolanic. Silica fume concrete, on account of larger surface area of fine particles (silica fume), needs higher water content for same workability and so in order to limit the water content while producing high strength concrete, superplasticizer or high range water reducing admixtures (HRWRA) may be added. Further, the presence of such HRWRA improves dispersion of silica fume and cement to allow for better hydration, which leads to improved strength and durability.

Chemical Composition:

The typical chemical composition of silica fume used in USA is given as under.[15]

Constituent	USA %
SiO_2	90-93
Al_2O_3	0.5-0.6
Fe_2O_3	3.4-4.5
MgO	0.3-0.5
CaO	0.5-0.8
Na_2O	0.1-0.3
K_2O	1.0-1.2
C	1.3-3.6
S	0.1-0.2
SO_3	0.4-1.3
Free moisture	0-4.8

Dosage:

Dosage rates of silica fume will be dependent on the qualities of the cement and aggregates available as well as the requirements of the

application. Typical dosage rates are generally proposed by the manufacturers or designer. It is strongly recommended that trial mixes be made some time before construction starts. A number of trials of materials, mixing and placement practices may be warranted in order to achieve a specified high performance concrete.

Application Areas:

i) Improves strength durability and reduces permeability as addition of silica-fume improves the pore size and grain size reinforcement in the matrix in fresh concrete and pozzolanic reaction leads to the replacement of calcium hydroxide by strong CSH-Gel which influences strength at later stage.

ii) Improves resistance to chemical attack, since microsilica reduces the amount of soluble calcium hydroxide and reduces permeability as the main cause of chemical attack is leaching of calcium hydroxide or by ingress of harmful substances.

iii) Reduces reinforcement corrosion effect due to reduced permeability, and improved resistance to chemical attack.

Precautions:

Care should be taken in handling finely divided siliceous material and dust masks should be worn when dispensing and mixing the product. If a person is exposed to high concentration of dust over extended time periods, medical advice should be sought.

Water proofing and Damp-proofing Admixtures:

Water proofing is defined as “Treatment of surface or structure to prevent/ resist the passage of water” so the water proofing/ damp-proofing admixtures shall imply prevention of water penetration of dry concrete or stoppage of water transmission through unsaturated concrete. However, admixtures have not been found to produce such effects and the term has come to mean a reduction in rate of penetration of water into dry concrete or in rate of transmission of water through unsaturated concrete.

Damp proofing may reduce the rate of penetration of aggressive chemicals found in water, however, it will not stop them. Damp-proofing admixtures also may reduce the penetration of water into concrete, thus delaying the effects of damage caused by freezing and

thawing by reducing the amount or rate of moisture entering the concrete.

Water proofing admixtures may be classified into the following groups.

iv) Integral water proofer: Integral water proofer to be a material (powder, liquid or suspension)that when mixed with the fresh concrete ,results in reduction in hydraulic permeability of the cured concrete, water repelling or hydrophobic property being imparted to the said concrete.This type of admixtures are commonly used for all type of water proofing concrete.

v) Water repellent or hydrophober admixtures are used to render the concrete hydrophobic and therefore, capable of repelling water that is not under hydrostatic pressure. They include soaps, butyl stearate and certain petroleum products such as mineral oils, asphalt emulsions, and certain cut back asphalt . This type of admixture is used generally for damp proofing.

vi) Permeability-reducing admixtures: Mineral powders(essentially fly-ash, raw or calcined natural pozzolana, and silica fume),properly proportioned, reduce the permeability of mixes in which the cement content of the paste is relatively low. This is due to the production of additional cementitious material, primarily calcium silicate hydrates, and calcium aluminum silicate hydrates, which form by the combination of lime from the cement and silica and other components in the mineral powder.

Polymer-emulsion admixtures have been used to reduce permeability of concrete overlays for bridge decks and parking decks. The polymer particles forms into a continuous film, which reduces permeability by sealing air voids and blocking microcracks.

Application Areas :

To reduce permeability of concrete, thus reduces the seepage and infiltration of water . Its use is recommended in walls, roofs, verandahs and open terrace where ingress of water is likely. Damp proofers is useful in lining of walls to protect from direct contact with soil e.g. basement, retaining walls, kitchen garden terraces etc. and at plinth level as damp proof course.

Guidelines on use of Admixtures in Concrete

Corrosion Inhibiting Admixtures:

The major factor in reinforcing steel corrosion is the presence of chlorides in the concrete. The chlorides may come from circumstances such as exposure to saline or brackish waters, saline soils, or use of calcium chloride as an admixture constituent. Such corrosion is difficult to control once it has started. The corrosion of reinforcement is an electro-chemical reaction. The corrosive effects of chlorides can be observed by measuring natural electro-potential.

Corrosion inhibitors are used to prevent or delay corrosion of metals exposed to corrosive environments. Corrosion inhibitors are generally classified as anodic, cathodic or mixed inhibitors according to their function. Anodic inhibitors reduce the rate of reaction at the anode. They usually react with corrosion products to form a protective coating on the metal surface. Cathodic inhibitors act to prevent the reaction at the cathode. Mixed inhibitors influence both the anodic and cathodic sites.

Migrating corrosion inhibitor (MCI), as claimed by its manufacturing company 'Cortec Corporation, USA' has relatively high vapor pressures. They protect the steel at both the anode and cathode. This combination of properties gives unique protection at very low concentrations.

Material Used:

Numerous chemicals have been evaluated as potential corrosion inhibiting admixtures for concrete. These include chromates, phosphates, hypophosphorites, alkalies, nitrites, and fluorides. Recently, calcium nitrite has been proposed as an effective corrosion inhibitor.

Application Areas:

Acts by lining the pores of cement matrix, slowing the rate at which chlorides and moisture can enter the concrete, thus , slowing the rate of corrosion. Recommended for concrete exposed to corrosion attack from external media, in severe exposure conditions where very high level of chlorides are anticipated to be present.

Guidelines on use of Admixtures in Concrete

Grouting Admixtures:

Many of the admixtures used for specific purposes in concrete are used as grouting admixtures to impart special properties to the grout. Oil-well cementing grouts encounter high temperatures and pressures with considerable pumping distances involved. Grout for preplaced-aggregate concrete requires extreme fluidity and non-settling of the heavier particles. Nonshrink grout requires a material that will not exhibit a reduction from its volume at placement. Installation of tile subjects bonding and joint filling grout to very fast drying or loss of water through absorption by the substrate and the tile. A wide variety of special purpose admixtures are used to obtain the special properties required.

Material Used:

A wide variety of special purpose admixture are used to obtain the special properties required.

For oil well cementing grouts, retarders are useful in delaying setting time. Bentonite clays may be used to reduce slurry density, and materials such as barite and iron filings may be used to increase the density. Tile grouts and certain other grouts use material such as gels, clays, pregelatinized starch, and methylcellulose to prevent the rapid loss of water.

Grout fluidifiers for preplaced-aggregate concrete grouts usually contain water reducing admixtures along with admixtures to prevent settlement of heavy constituents of the grout. Non-shrink grouts may contain gas-forming or expansion-producing admixtures, or both

Application Areas:

These admixture are used in oil well as cementing grouts to encounter high temperatures and pressures

Expansion-producing admixtures

Admixtures that expand during the hydration period of the concrete or react with other constituents of the concrete to cause expansion are used to minimize the effects of drying shrinkage. They are used both in restrained and unrestrained concrete placement.

Guidelines on use of Admixtures in Concrete

Material Used:

The most common admixture for this purpose is a combination of finely divided or granulated iron and chemicals to promote oxidation of the iron. Expansion is greatest when the mix is exposed alternately to wetting and drying. Expansive cements are used on large projects where a predetermined uniform degree of expansion is required. Materials are also available (calcium sulfoaluminates) that can be added to portland cements to produce useful amounts of expansion.

The controlled expansion produced by these admixtures may be of about the same magnitude as the drying shrinkage expected at later ages or it may be slightly greater. For a given application, the extent of expansion and the time interval during which it takes place are very important and must be under control for the most satisfactory results.

Application Areas:

These are used to minimize the effects of drying shrinkage during the hydration period of concrete . These can be used both in restrained and unrestrained concrete placement.

Bonding Admixtures.

Admixtures specifically formulated for use in portland cement mixes to enhance bonding properties generally consist of an organic polymer emulsion commonly known as latex.

Upon drying or setting, the polymer particles forms a film, adhering to the cement particles and to the aggregate, thus, improving the bond between the various phases. The polymer also fills microvoids and bridges microcracks that develop during the shrinkage associated with curing. This secondary bonding action preserves some of the potential strength normally lost due to microcracking.

Greater strength and durability are associated with the lower water cement ratio of latex mixes. The polymer particles act as a water replacement, resulting in more fluidity than in mixes without latex, but having similar water cement ratio.

The compressive strength of moist cured grouts, mortars, and

concrete made with these materials may be greater or less than that of mixes of the same cement content without the admixture. However, the increase in bond, tensile, and flexural strengths far outweigh the possible disadvantage of slight compressive strength reduction. Latex -modified concrete has better abrasion resistance, better resistance to freezing and thawing, and reduced permeability.

Application area:

vii) Increases bonding properties of cement mixed with bonding admixtures thus useful to join old concrete to new one and for sealing cracks and joints.

viii) Bonding materials are particularly used in patching operations. A thin application of grout or mortar containing the bonding admixtures develops a higher bond strength than a thick application. When properly applied and cured , such a bond is often stronger than the materials that are being joined. .

Pumping Aids:

The sole function of pumping aids is to improve concrete pumpability. They normally will not be used in concrete that is not pumped or in concrete that can be pumped readily. The primary purpose of using admixtures to enhance pumpability of concrete is to overcome difficulties that can not be overcome by changes in the concrete mix proportions.

Material Used:

Many pumping aids are thickeners that increase the cohesiveness of concrete. The Standard Association of Australia identified five categories of thickening admixtures for concrete and mortar as follows:

ix) Water-soluble synthetic and natural organic polymers that increase the viscosity of water-cellulose derivatives (methyl, ethyl, hydroxyethyl and other cellulose gums): polyethylene oxides, acrylic polymers: polyacrylamides; carboxyvinyl polymers; natural water-soluble gums, starches, and polyvinyl alcohol.

x) Organic flocculants - carboxyl-containing styrene copolymers. Other synthetic polyelectrolytes, and natural water-soluble gums.

xi) Emulsions of various organic materials-paraffin, coaltar, asphalt, and acrylic and other polymers.

xii) High surface area inorganic materials - bentonites, organic modified bentonites and silica fume.

Application Areas:

i) Increase in the range of mixed designs which may be successfully pumped.

ii) Reduction in the risk of pipe line blocking.

iii) Improved flow of concrete through small bore pump lines e.g. upto minimum of 75mm diameter lines.

Coloring Admixtures

Pigments specifically prepared for use in concrete and mortar are available both as natural and synthetic materials. They are formulated to produce adequate colour without materially affecting the desirable physical properties of the mix.

Material used:

The pigments listed below may be used to obtain a variety of colours.

Shades of colour	**Pigment**
Grays to black	Black iron oxide, Mineral black, Carbon black
Blue	Ultramarine blue, Phthalocyanine blue
Bright red to deep red	Red iron oxide
Brown	Brown iron oxide, Raw and burnt umber
Ivory, Cream or Buff	Yellow iron oxide
Green	Chromium oxide, Phthalocyanine green
White	Titanium dioxide

Pigment content normally should not exceed 10 percent by weight of the cement. However, some pigments, such as carbon black, should

be used at lesser quantities. Except for carbon black, pigment contents of less than 6% generally have little or no effect on the physical properties of the concrete. Larger quantities may increase the water requirement of the mix to such an extent that the strength and other properties may be adversely affected

The addition of an unmodified carbon black will considerably increase the amount of air-entraining admixture needed to provide resistance of the concrete to freezing and thawing. However, most carbon-black available for coloring concrete do contain air-entraining materials in sufficient quantity to offset the inhibiting effect of the carbon black

Application Area:

Used in concrete and mortar to produce adequate colour without affecting the physical properties of concrete and mortar colouring effect in concrete is useful for aesthetic purpose in structures.

Fungicidal, germicidal, and insecticidal admixtures

Certain materials have been suggested as admixtures for concrete or mortar to impart fungicidal, germicidal, and insecticidal properties. The primary purpose of these materials is to inhibit and control the growth of bacteria and fungus on concrete floors and walls or joints.

Material Used:

The materials that have been found to be most effective are polyhalogenated phenols, dieldrin emulsion, and copper compounds.

Addition rates vary from 0.1 to 10 percent by weight of the cement, depending on the concentration and composition of the chemical. The higher rates, above 3 percent, may have an adverse effect on the strength of the concrete, The effectiveness of these materials, particularly the copper compounds, is temporary.

Application Area:

To inhibit and control the growth of bacteria and fungus on concrete floors and walls.

5 Additives to concrete

There are certain additives which are though not admixtures ,but added in cement to modify the properties of concrete and replace the cement partly. Commonly known addditives are fly ash and Ground Granulated Blast Furnace slag (GGBFS).

Fly Ash:

Fly Ash is a waste product obtained from coal fired thermal power plants. It is finely divided residue resulting from the combustion of pulverised coal, transported from the combustion firebox through the boiler by flue gases into precipitators. Fly ash is a siliceous or siliceous and aluminous material which itself possesses very little or no cementitious properties, but in finely divided form, in the presence of moisture, it chemically reacts with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties.

Fly ash has proven to be versatile material with many possible applications in the construction industry. Only about 20% of fly ash produced in the world are being utilised in variety of beneficial applications and the balance is dumped as the waste material.

Chemical Composition:

The major constituents of ash are, Silica (SiO_2), alumina (Al_2O_3) and iron oxide (Fe_20_3) with smaller amount of calcium (CaO), magnesium (MgO) and sulphur ($SO_{3)}$.

Chemical composition of fly ash samples of some of the Indian Thermal Power Plants[7] is given in table-7.

Table-7

Constituents	Delhi %	Singrauli %	Obra %	Panki %
SiO_2	59.00	56.80	64.40	58.00
$Al2O_3$	28.10	28.80	23.00	25.10
Fe_2O_3	4.30	7.80	6.50	10.00
CaO	2.50	2.70	0.70	1.10
MgO	0.30	0.60	0.20	0.40

SO_3	0.10	0.10	0.10	0.30

Indian coal contains high ash contents as much as 45-36%. The Indian fly ash can be divided into two classes depending on the combustion parameters of the boilers, and the behavioral effects of the resultant flyashes on the end product.

i) Low temperature (LT) Fly-ash produced at combustion temperature of 800-850^{0}C

ii) High temperature (HT), Fly-ash produced at combustion temperature of 1000-1400 ^{0}C.

In precast building material LT ashes are more reactive at early ages hence are preferred for precast building materials such as bricks/blocks.

Pozzolanic reaction is slow in HT ashes but it gets accelerated with age. This property together with a relatively ignition loss makes HT ashes more suitable for use in cement and concrete Industries due to there relatively low ignition loss, slow pozzolanic reaction in early stage which gets accelerated with age.

Fly Ash Mixed Cement / Concrete:

Fly ash is blended with other ingredients either during the manufacture of cement or proportioned with other aggregate when mixed. Mixing of fly ash in production of concrete serves two primary purposes;

i) It supplements or replaces fine aggregates and

ii) It provides effective pozzalanic action**.**

The blended cement with fly ash is ideally suited for the following constructions:

i) Hydraulic structures

ii) Mass concreting works

iii) Marine structures

iv) Masonry mortars and plastering

v) Under aggressive conditions

The provision of Code (IS:1489, pt.I) permits 10 to 25% of Fly ash in Portland pozzolana cement(PPC). Provision of IS:3812 contains specifications for fly ash for use as pozzolana and admixture.

Fly ash replacement in concrete improves workability. As the amount of fly ash increases, the water demand decreases. For the same workability the water cement ratio decreases significantly. Also fly ash mixed concrete greatly improves resistance of concrete to sulphate attack and reduces heat of hydration, which is important, when concrete is used for massive structure.

Compressive strength of concrete containing upto 50% cement replacement is found very acceptable for most of the structural applications. Fly ash concrete upto 30% cement replacement exhibits abrasion resistance similar to concrete without fly ash. High contents of fly ash can be used in aerated concrete. Uses of fly ash will not only reduce the cost of production due to reduction in power consumption for grinding but will also reduce quantity of binder. For experimental results, it is found that fly ash used to the extent of 25 to 35%, quantity by weight, does not affect 28 days strength, though early strength is somewhat lower than comparable portland cement concrete. Such concrete containing fly ash will be more compact, durable and better resistant to chemical frost attack.

Ground Granulated Blast Furnace slag – (GGBFS):

Blast furnace slag is produced as a by-product in the manufacture of pig iron from iron ore in the blast furnace. The molten slag is tapped from the blast furnace and quenched by pouring it over high pressure jets of water. During this process slag is fragmented into small granules and hence called ‘granulated blast furnace slag’. Granulated slag is a latent hydraulic material which is ground into a superfine state under controlled conditions. The end product is called “ground granulated blast furnace slag” which when blended with ordinary portland cement gives extraordinary properties to concrete as well as mortar.

Granulated slag reacts with water in the presence of an activator such as lime, alkali, alkali sulphates, to form a cementitious material. It is not considered a pozzolana because it needs only very small

amount of activators to make it hydraulic. The use of GGBGS started in India 1996 on Mumbai Municipal Corporation project of 3.5 Km long tunnel under sea to discharge sewerage, being constructed by M/S AFCONS. Now GGBFS is being used in many important projects.

When some of the portland cement has been replaced by slag, development of early strength is slower than that when only portland cement is used. For high strength concrete, it is necessary to use the slag in conjunction with silica fume.

When placing , concrete in large volume, it is vital to minimise the risk of early age thermal cracking by controlling rate of temperature, rise caused by hydration.

There is no IS: specification for GGBFS for use with OPC. BS: 6699 may be referred. Broad specification are given in following table-8.

Table-8

S.N	Property of GGBFS	Unit	Requirement
1.	Heat of Hydration (measured after 10 hours	J/gm	180 (max
2.	Glass content	%	70 (min
3.	Initial setting time	Minutes	180 (min
4.	Final setting time	Minutes	230 (min
5.	Fineness	M2/kg	400 (min
6.	Soundness (70% of GGBS+30% OPC	Mm	5 max
7.	Compressive strength – (70%GGBS+30% OPC) 7 days 28days	N/mm2 N/mm2	20 (min 40 (min
8.	Chlorides	%	0.05% (max)
9.	Cao/Sio_2	%	1.4% (max)
10.	Manganese	%	1% (max)
11.	Loss of ignition	%	2% (max)
12.	Sulphur trioxide	%	1.5% (max)
13.	Magnesia	%	14% (max)

14.	Sulphur sulphide	%	1.5% (max)
15.	Insoluble Residue	%	1.5% (max)
16.	Sulphate expansion	%	0.01(max
17.	Cl-diffusion Coefficient	$X10^{-12}$ m2/Sec.	4

Application Area:

GGBFS concrete are also recommended for use in water retaining structures, which reduces the risk of early age thermal cracking and improve the resistance to chemical attack and enhanced durability.

6 Relevant Codes and Manuals:

The relevant Codes and Manuals concerning to the use of admixtures are mainly as given below:

i) IS: 9103 – 1999: Specification for admixture for concrete(first revision)

ii) IS: 3812- 1981: Specification for fly ash for use as pozzolana and admixture.(first revision).

iii) IS:383:1976- Specification for coarse and fine aggregates from natural sources for concrete (second revision)

iv) IS:269-1989 Specification for 33 grade ordinary portland cement(4^{th} revision)

v) IS:456-1978 Code of Practice for Plain and Reinforced concrete(3^{rd} revision)

vi) IS:1199-1959: Methods of sampling and analysis of concrete

vii) IS:2386(pt.III)1963: Methods of tests for aggregate for concrete: Specific gravity ,density, voids, absorption and bulking.

viii) IS:516-1959: Method of tests for strength of concrete.

ix) IS:1489 (pt.I) 1991: Specification for portland pozzolana cement: Fly ash based(3rd revision)

x) IS:1343-1980:Code of Practice for prestressed concrete (Ist revision)

xi) BS:1881(Part 6) 1971: Methods of Testing Concrete: Analysis of hardened concrete

As the codes are revised from time to time, user may refer current codes.

Extracts of IS:9103

Some of the extracts of IS:9103 are given in the following para:

IS:9103 is the only Indian Standard Specification on admixtures for concrete covers the accelerating admixtures, retarding admixtures, water reducing admixtures, and air entraining admixtures. These admixtures have been defined in brief and their physical requirements have been tabulated to help judge their suitability. It explains the method of sampling of admixtures for test and

preparation of test samples of concrete with admixtures.

The following test methods of fresh concrete as well as of hardened concrete have been given in this code.

Test methods of fresh concrete:

xii) Test of workability

xiii) Test of air content

xiv) Test for time of setting

xv) Test for bleeding

xvi) Test for water content

Test methods of hardened concrete:

xvii) Test for compressive strength

xviii) Test for flexural strength

xix) Test for length change

IS:9103 was first adopted in 1979. It has been revised in 1999. Therefore, user may refer current code i.e. IS:9013: 1999.

7 Recommendation in IRS Concrete Bridge Code:

Earlier the use of admixtures in railway bridges was prohibited as per clause 4.5 of Concrete Bridge Code. The present Concrete Bridge Code for plain, reinforced and prestressed concrete for general bridge construction practices revised in 1997 (printed in 1999) has allowed the use of admixtures with the approval of Chief Engineer and the clause reads as follows:

"Clause 4.4 Admixtures: The Chief Engineer may permit the use of admixtures for imparting special characteristics to the concrete or mortar on satisfactory evidence that the use of such admixtures does not adversely affect the properties of concrete or mortar particularly with respect to strength, volume change, durability and has no deleterious effect on reinforcement.

Clause 4.4.1 The admixtures, when permitted, shall conform to IS:9103.

Clause 4.4.2 Calcium chloride or admixtures containing calcium chloride shall not be used in structural concrete containing reinforcement, prestressing tendons or other embedded metals.

Clause 4.4.3 The admixtures containing Cl. & SO_3 ions shall not be used. Admixtures containing nitrates shall also not be used. Admixtures based on thiocynate may promote corrosion and therefore shall be prohibited .

8 Acceptance Criteria:

Chloride free concrete:

Some of the properties influenced by the use of calcium chloride admixture are given as under:[9]

No	Property	General Effect
1.	Setting	Reduces both initial and final setting
2	Compressive strength	Increases significantly the compressive strength in the first 3 days of curing(gain may be about 30-100%)
3	Tensile strength	A slight decrease at 28 days.
4	Flexural strength	A decrease of about 10% at 7 days
5	Heat of hydration	An increase of about 30% in 24 hours
6	Resistance to sulphate attack	Reduced
7	Alkali-aggregate reaction.	Aggravated.

8	Corrosion	Causes no problems in normal reinforced concrete, if adequate precautions taken. Dosage should not exceed 1.5% $CaCl_2$ and adequate cover to be given. Should not be used in concrete containing a combination of dissimilar metals or where there is a possibility of stray currents.
9	Shrinkage and creep.	Increased
10	Volume change	Increase of 0-15% reported.
11.	Resistance to damage by freezing and thawing.	Early resistance improved.
12.	Water tightness.	Improved at early ages.
13	Modulus of elasticity	Increased at early ages.
14	Bleeding	Reduced

Cement contains such a small amount of chloride that it is practically undetected by ordinary methods of analysis and hence can be neglected as a source of chloride. The mix water, however, may contain chloride in the amount of about 0.005% at a water cement ratio of 0.5. This amounts to about 0.0025% chloride by weight of cement. There is also a possibility of the presence of chloride even in the so called chloride free admixtures. As concrete contains a large amount of aggregate, even small amounts of chloride inclusion would add upto a significant overall percentage of chloride.

It is recommended that concrete shall not contain chloride because of their adverse effects on properties.

Physical requirements:

Concrete made with admixtures when compared with identical concrete made without the admixture (control sample), should meet the applicable physical requirement as given in following table -9, as per IS:9103: 1979.[3]

Table-9

S.N.	Requirement	Accelerating Admixture	Retarding Admixture	Water Reducing Admixture	Air-Entraining Admixture

1.	Water content, percent of control sample, Mix.	-	-	95	-
2.	Time of setting, allowable deviation from control sample, hours Initial Max. Min. Final Max. Min.	 -3 -1 -2 -1	 +3 +1 +3	 $\pm$1 $\pm$1	 - -
3.	Compressive Strength, percent of control sample, Min 3 days 7 days 28 days 6 months 1 year	 125 100 100 90 90	 90 90 90 90 90	 110 110 110 100 100	 90 90 90 90 90
4.	Flexural strength, percent of control sample, Min. 3 days 7 days 28 days	 110 100 90	 90 90 90	 100 100 100	 90 90 90
5.	Length change, percent increase over control sample, Max. 28 days 6 months 1 year	 0.010 0.010 0.010	 0.010 0.010 0.010	 0.010 0.010 0.010	 0.010 0.010 0.010
6.	Bleeding, percent increase over control sample, Max.	5	5	5	2

Test on Concrete:

To ascertain the physical requirements so as to facilitate the field

engineer to decide the suitability of the admixture, the following tests on concrete with and without admixtures maybe done:

Test for Workability:

The workability of freshly mixed concrete in terms of slump or compaction factor shall determine according to method given in IS: 1199.

Test for Air Content:

Air content of freshly mixed concrete shall be determined by the pressure method given in IS: 1199

Test for Time Of Setting:

Time of setting, initial and final, shall be determined as given in IS:8142

Test for Bleeding:

Bleeding shall be computed as a percentage of net amounts of mixing water in the concrete. The net amount of mixing water is the water in excess of that present as absorbed water in the aggregate. Absorbed water in the aggregate shall be determined as given in IS:2386(Part III). The test shall be carried out in accordance with the details given in Appendix A ' of IS:9103.

Test for Water Contents:

The water cement ratio of the concrete shall be determined to the nearest 0.001, and shall be as follows;

Net water content of the batch shall be computed by determining the absorption water of aggregate as given in IS:2386(Part III)

Mass of cement per unit volume of concrete shall be computed as given in IS:1199.

Water cement ratio shall be determined by dividing the net mass of water content of the batch by the mass of cement in the batch.

Test for Compressive Strength:

Compressive strength shall be determined at each age of testing as

given in IS:516.

Test for Flexural Strength:

Flexural strength shall be computed as given in IS:516

Test for Length Change(Drying Shrinkage):

Changes in length on drying and wetting shall be determined as given in IS:1199. The moist- curing period, including the period in moulds shall be 14 days.

Test for chloride:

Chloride content may be determined as per the procedure given in BS1881:Part:6:1971(Para 9.1)

Site Trials for Estimation of Correct Dose:

Site trials are essential to decide dosages as well as efficacy of the proposed admixtures. The dosages recommended by manufacturer may be used as guide only. Site trials should be completed during formative stage of project and in any case prior to commencement of concreting activities.

Keeping in mind the purpose of using admixture and the dosages recommended by manufacturer, trial should start and the slump is observed for control mix as well as for mix with admixture and dosages are decided accordingly.

Trial should also be repeated with chosen dosages for loss of slump with the time. It may be noted that with the admixture rate of loss of slump is much higher than control mix. This is important in the context of time likely to be taken in placement of concrete after its mixing. Therefore, time required for transportation and placement should be estimated and target slump fixed at estimated time. Based on above target, trials should be repeated with varying dosages to get necessary slump.

Using revised dosages, trials should also be conducted to get 28 days strength with admixtures. Simultaneously, control mix cube is also made. If targeted strength is achieved, dosages are finally decided.

During progress of the projects the trials may have to be repeated if there is any change in type or source of cement etc.

Precautions:

i) Chloride content should be invariably checked for prestressed concrete and RCC to ensure that the admixture is chloride free.

ii) Self life should be monitored continuously.

iii) All containers should be correctly leveled. Reliable liquid dispenser for liquid admixtures should be used and calibrated.

iv) It is relatively easy to verify specific gravity as claimed by manufacturer. This will indicate defect at first hand.

v) Manufacturer should be asked to furnish adequate technical data such as :

   a. Additional influences whether detrimental or beneficial

   b. Potential occupational hazards for the user.

   c. Presence of detrimental substances like chloride, sulphates, sugar etc.

   d. Recommended dosages, preparation and procedure to be used.

   e. Any other data.

9 Recommendations and Conclusions:

Use of admixture may be encouraged in following situations:

i) In specialised job like prestressed concrete bridges, precast concrete elements requiring high early strength and retention of workability at elevated temperature. Early gain of strength enable earlier release from precast mould ,thus speeding up production.

ii) In the circumstances where increased workability of concrete is required without reducing the compressive strength or without changing of water cement ratio, especially when the concrete pores are restricted, due to congested reinforcement or due to complicated form work.

iii) In Ready Mix Concrete where retarding action with high workability is required for long distance transportation before placing.

iv) Where reduction in permeability in concrete is required e.g. in hydraulic structures, marine structures, damp proof courses, retaining walls, swimming pools, basements and kitchen garden terraces etc.

v) Where high performance concrete is required. Use of one or more admixtures can influence the strength at a later stage and improve resistance to chemical attack.

vi) In the circumstances where concrete is exposed to corrosion attack from external media in severe exposure conditions where very high level of chloride is anticipated.

vii) Admixtures enhancing bonding properties can be used to bond old concrete with new and also for patching operations.

In view of the increasing importance of the use of admixture in concrete, it is essential to ensure that persons engaged in the production/ handling of concrete have a sound understanding of the materials being utilised.

Before selection the admixture to be used in concrete, the purpose of use of admixture shall be clearly known.

10 Known suppliers in India:

For the help of user list of known suppliers, their addresses and their product details have been given in Table 10 & 11.

Table 10

Addresses of Known Manufacturers of Admixture

S.N.	Name of the manufacturers	Address
1.	Sika	Sika Qualcrete Ltd., 24-B, Park Street, Calcutta-700016 (India)
2.	Krishana Conchem	Krishna Conchem Products Pvt. Ltd., 5-B, Mohsin Building, R. K. Vaidya Road, Dadar, Mumbai-400028.
3.	MBT	MBT, 22,Old Rajendra Nagar, New Delhi
4.	FOSROC	FOSROC Chemicals (India), Ltd., Haffeeza Chamber, 2nd. Floor, P.B.No.2744, 111/74, K.H.Road, Bangalore-560027
5.	Asian Laboratories	Asian Laboratories, 88,DSIDC Shed Scheme-4 New Okhala Industrial Complex, Phase-II New Delhi-110020
6.	CICO	CICO Structural Water proofing Pvt. Ltd. 406,Deepali,92,Nehru place New Delhi-110019
7.	M.C.Bauchemie	M.C.Bauchemie(India) Pvt. Ltd. Perin Nariman Street, Sangli Bank Building , 5th floor ,Fort, Mumbai-400001
8.	ROFFE	ROFFE Construction Chemicals Pvt. Ltd. 12/C,Vikas Centre , S.V. Road, Santacruz(W)

		Mumbai-400054
9.	PIDILITE	PIDILITE Industries Ltd. Ramkrishana Mandir Road Off. M. Vasanji Road P.B. No.17411,Andheri(East) Mumbai-400059

Table-11

List of The Admixtures Manufactured / Available in India

1. Accelerators

SN	Product Name	Manufacturer	Standards Compliance	Approximate Cost
1.1	Conplast NC	FOSROC	BS:5075 (Pt.-I), ASTM:C494 Type C	Rs.56.00 per lit
1.2	Conplast W	FOSROC	BS:5075 (Pt.-I), ASTM:C494 Type C	Rs.22.50 per lit
1.3	Rapid Plast	CICO	ASTM:C494 Type E, IS:9103, IS:2645	Rs.24.00 per lit
1.4	Cemwet ACC	Asian Laboratories	IS:9103, BS:5075 (Pt-I) ASTM:C494 Type A	Rs.20.00 per kg.
1.5	ACL-15	Krishana Conchem	IS:9103	-
1.6	Sigunit Powder-1	Sika	-	Rs.37.50 per kg.

2. Retarders

S.N.	Product Name	Manufacturer	Standards compliance	Approx. cost
2.1	Conplast RP-264	FOSROC	IS:9103	Rs.26.50 per lit

2.2	Pozzolith CRP4	MBT	ASTMC-494 Type B&D, BS-5075 Pt-I	Rs.32.00 per kg
2.3	MC-Retard 060	MC-Bauchemie	-	-
2.4	Plasti-ment R, R1, R2	SIKA	IS:9103, ASTM C-494 Type B&D	Rs.34.65 per lit
2.5	Sikament –277	SIKA	ASTM C-494 Type B,D & G	Rs.41.40 per lit
2.6	Sikament –176 (M1)	SIKA	ASTM C- 494 Type G	Rs.44.10 per lit
2.7	Rugasol-2 Liquid	Sika	-	Rs.65.00 per lit
2.8	Retard-plast	CICO	ASTM C- 494 Type D, IS:9103	Rs.26.00 per lit
2.9	Cemwet SRA Super –1	ASIAN Lab	IS:9103, ASTM C-494 Type D	Rs.40.00 per kg
2.10	ROFF. Retard 310	ROFFE. Const. Chem. Pvt. Ltd.	ASTM C-494 Type B&D, BS:5075 Pt.-I	-
2.11	MC Erstarrungsbremse K-33	MC-Bauchemie	ASTM C-494	-
2.12	MC Erstarrungsbremse K-73	MC-Bauchemie	ASTM C-494	-

3.Plasticizer

S.N.	Product name	Manufacturer	Standards compliance	Approximate cost
3.1	Conplast P211	Fosroc	IS:9103-1979 ASTM:C494 type A	Rs.28.25 per lit.
3.2	Conplast 509	Fosroc	IS:9103-1979 BS:5075(Pt.1) and ASTM:C494 Type A&D	Rs.38.00 per lit.
3.3	Pozzolith standard	MBT	ASTM C494 Type A&D, BS 5075(Pt.1)	Rs.31.00 per kg.
3.4	Pozzolith LD 10	MBT	ASTM:C494 Type A,B &D, BS:5075(Pt.1)	-

3.5	Cemwet WRA I	Asian Labs.	IS:9103-79, ASTM C494 Type A&D, BS5075 (Pt.I)	Rs. 25/- per kg.
3.6	Cemwet WRA II	Asian Labs.	IS:9103-79, ASTM C494 Type A&D, BS5075 (Pt.I)	Rs.30/ per kg.
3.7	Zentrament-super (BV)	MC-Bauchemie	ASTM C494	-
3.8	Zentrament-F(BV)	MC-Bauchemie	ASTM C494	-
3.9	Emce Plast BV	MC-Bauchemie	ASTM C494	-
3.10	Pedicrete CF111-S	PIDILITE	IS:9103, ASTM C-494 Type G	-
3.11	Pedicrete CF111	PIDILITE	IS:9103, ASTM C-494 Type F	-
3.12	Pedicrete CF51	PIDILITE	IS:9103, ASTM C-494 Type E	-
3.13	CICO-CN-Plasat	CICO	IS:9103, IS:2645, ASTM C-494 Type A	-
3.14	Plastiment 240	SIKA	IS:9103, ASTM C-494 Type A	Rs.46.20 per kg
3.15	Plastiment 239	SIKA	IS:9103, ASTM C-494 Type A	-
3.16	Plastiment 205	SIKA	ASTM C-494 Type A, B and D	-

4.Superplasticizers

S.N.	Product name	Manufacturer	Standards compliance	Approximate cost
4.1	Conplast SP 337	FOSROC	IS:9103, BS:5075(Pt.-3), ASTM C-494 Type F	Rs.40.50 per lit
4.2	Conplast SP 430	FOSROC	IS:9103, BS:5075(Pt.-3), ASTM C-494 Type F	Rs.43.00 per lit
4.3	Rheobuild 1100	MBT	ASTM C494 Type A&F, BS 5075(Pt.-1 & 3))	Rs.43.00 per kg
4.4	Rheobuild SP1	MBT	ASTM C-494 Type F, BS 5075(Part 1)	Rs.41.00 per kg
4.5	Rheobuild Microflow	MBT	BS:5075(Pt.1), ASTM C494 Type D&G	Rs.43.00 per kg

4.6	Rheobuild 850	MBT	ASTM C 494 Type B, D & G	Rs.60.00 per kg
4.7	Rheobuild LD80	MBT	ASTM C494 Type D,F &G, BS:5075(Pt.1)	Rs.32.00 per kg
4.8	Rheobuild 561	MBT	ASTM C494 Type B, D &G.	-
4.9	Rheobuild 561M	MBT	ASTM C494 Type B, D &G	Rs.44.00 per kg
4.10	Rheobuild 2000M.	MBT	ASTM C494 Type A,C & E.	-
4.11	Rheobuild 5500	MBT	ASTM C494 Type G & UNI 8145	-
4.12	Glenium 51	MBT	ASTM C494 Type A & F	-
4.13	Cemwet SP1	Asian laborataries	IS:9103, BS 5075(Pt.3), ASTM C494 Type F	Rs.32.00 per lit
4.14	Cemwet SP300	Asian laboratories	IS:9103 ASTM C494 Type F	Rs.35.00 per lit
4.15	Cemwet SP 3000	Asian laboratories	IS:9103, ASTM C494 Type F&G	Rs.38.00 per lit
4.16	Supercon 100	Krishna Conchem	IS:9103, ASTM C494 Type F	-
4.17	Supercon 300	Krishna Conchem	IS:9103, ASTM C494	-
4.18	Supaplast	CICO	IS:9103, IS:2645, ASTM C494 Type F	Rs.31.68 per lit
4.19	CICO Supaplast MF	CICO	IS:9103, ASTM C494 Type F	-
4.20	Supaplast HS	CICO	ASTM C494 Type F	-
4.21	Sikament 259 (M3)	SIKA	IS:9103, ASTM C494 Type F	Rs.59.00 per kg
4.22	Sikament 259 (M2)	SIKA	IS:9103, ASTM C494 Type F	-
4.23	Sikament FF	SIKA	ASTM C494 Type F	Rs.56.50 per kg
4.24	Sikament 280 (M)	SIKA	IS:9103, BS:5075 (Pt.3), ASTM C494 Type F	Rs.52.30 per kg
4.25	Sikament 176(M1)	SIKA	ASTM C494 Type G	Rs.48.10 per kg

4.26	Sikament HE 200/220	SIKA	-	-
4.27	Sikament 277	SIKA	ASTM C494 Type B,D& G	Rs.45.00 per kg
4.28	Zentrament Super BV	MC Bauchemie	ASTM C494	-
4.29	Zentrament F BV	MC Bauchemie	ASTM C494	-
4.30	Centriplast FF90	MC Bauchemie	ASTM C494	-

5. Miscellaneous Admixtures

S.N.	Type of admixture	Product Name	Manufacturer	Standards Compliance	Approximate Cost
5.1	Corrosion Inhibiting admixture	MCI-2000	Krishna Conchem	-	-
5.2	Corrosion Inhibiting admixture	MCI-2001	Krishna Conchem	-	-
5.3	Corrosion Inhibiting admixture	MCI-2002	Krishna Conchem	-	-
5.4	Corrosion Inhibiting admixture	MCI-2003	Krishna Conchem	-	-
5.5	Corrosion Inhibiting admixture	MCI-2005	Krishna Conchem	-	-
5.6	Corrosion Inhibiting admixture	MC-Corrodur	MC Bauchemie	-	-
5.7	Corrosion Inhibiting admixture	Rheocrete 222+	MBT	-	Rs.130.00 per lit
5.8	Corrosion Inhibiting admixture	Proof Marine	MBT	BS:1881 Pt.-5(ISAT) Pt.-122 & Pt.124	Rs.70.00 per lit

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5.9	Corrosion Inhibiting admixture	Rheomac 707	MBT	ASTM: C494 Type A&D	Rs.35.00 per lit
5.10	Corrosion Inhibiting admixture	Sika-Ferrogard 903	Sika	-	Rs.110.00 per kg.
5.11	Micro silica Fumes	Sika Crete Powder 985/1	Sika	CAN/CSA-A 23.5 M86	RS. 21.50 per kg
5.12	Micro silica Fumes	Meyco MS-610	MBT	International Microsilica standard Norwegian Standard NS: 3045/rev. 92 Canadian Standard CAN/CSA-A 23.5 M86	Rs. 32-00 per kg
5.13	Micro silica Fumes	Micro Silica 600	Krishna Conchem	NZS 3122: 1995 AS 3582.3	-
5.14	Micro silica Fumes	Elkem Micro Silica Grade 920 D	Krishna Conchem	-	-
5.15	Bonding Agent	Nitobond –EP	FOSROC	BS: 6319 Pt.2,3,4 & 7.	Rs. 300-00 per sqm
5.16	Bonding Agent	Nitobond –PC	FOSROC	FIP Specifications in all respects	Rs, 745 per sqm.
5.17	Bonding Agent	Pidicrete-URP	PIDILITE	-	-
5.18	Bonding Agent	Nafufill SBR	MC-Bauchemie	-	-
5.19	Bonding Agent	MC-Bond Aid Plast	MC-Bauchemie	-	-
5.20	Bonding Agent	Nafufill BB2	MC-Bauchemie	-	-

5.21	Bonding Agent	Nafufill	MC-Bauchemie	-	-
5.22	Bonding Agent	Bond Aid	Asian Laboratories	-	-
5.23	Bonding Agent	Super Bond	Asian Laboratories	-	-
5.24	Bonding Agent	Tile-FEB	Asian Laboratories	-	-
5.25	Bonding Agent	Tile -SET	Asian Laboratories	-	-
5.26	Grout Additive	Conbex-100	FOSROC	BS:8110 Pt.1	Rs. 94.40 per lit.
5.27	Grout Additive	Pidigrout	PIDILITE	-	-
5.28	Grout Additive	MC Einpresshlfe EH. Powder	MC Bauchemie	-	-
5.29	Pumping AID	SIKA Pump	Sika	-	Rs. 30.00 per kg.
5.30	Damp Proofing admixture	Samafit VK	MC Bauchemie.	-	-

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