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Effect of Different Chemical Admixtures on Fresh and Hardened Properties of M30 & M40 Grade Concrete

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ABSTRACT

In this study super plasticizers admixtures were used for the three grades of concrete 15, 25 and 40N/mm^2 to improve the properties of fresh and harden concrete in hot weather to achieve these properties in the summer season of Sudan: Increase the workability Increase the compressive strength by adoption super plasticizers admixtures which increase the workability and hence the strength is increased through the reduction of water content. Reduce the cement content and hence cost saving.

The experimental work was divided into two phases:

1. Tests on basic materials (cement, aggregate, sand, water) and the effect of recommended dose of admixture on the properties of fresh and hardened concrete.
   The results of tests for the basic materials were carried to ensure that their results conforming to their standards and can be used.
2. Concrete testing program for the three grades which contain four mixes for each grade.Ordinary reference mix Same mix with admixture to increase strength Same mix with admixture to reduce water content and hence increase strength. Same mix with admixture to reduce the cement content keeping same workability and strength.

INTRODUCTION

Concrete Constituents and Properties

General

Concrete, in the broadest sense, is any product or mass made by the use of cementing medium. Generally this medium is the product of reaction between hydraulic cement and water. Concrete is made with several types of cement and also containing pozzolana, fly ash, blastfurnace slag, etc,The main components of concrete are a mixture of cement, water, aggregate (fine and coarse) and sometimes admixtures.

The relation between the constituent of this mixture:

Firstly, one can view the cementing medium as the essential building material, with the aggregate fulfilling the role of cheap, Or cheaper diluting.

Secondly, one can view the coarse aggregate as assort of mini- Masonry which is joined together by mortar i.e. by a mixture of hydrated cement and fine aggregate.

Thirdly, is to recognize that, concrete consist of two phases hydrated cement paste and aggregate, and, as a result, the properties of concrete are governed by the properties of the two phases and also by the presence of interface between them.

Cement

The different cements used for making concrete are finely powder and all have the important property that when mixed with water a chemical reaction (hydration) takes place which In time produce a very hard and strong binding medium for the aggregate particles, in the early stage of hydration, while in its plastic stage, cement mortar gives to the fresh concrete its cohesive properties.

Types of Portland cements 1.Ordinary Portland cement

Ordinary Portland (Type 1) cement is admirably suitable for use in general concrete construction when there is no exposure to sulphates in the soil or groundwater.

Rapid-hardening Portland cement

This cement comprises Portland cement subclasses of 32.5 and 42.5 MPa as prescribed by BS 12:1991.rapid hardening Portland cement (Type 111), as its name implies, develops strength more rapidly, and should, therefore, be correctly describe as high early strength cement.

The use of it is indicated where a rapid strength development is desired,
e.g. when the formwork is to be removed early for re-use, or where sufficient strength for further construction is wanted quickly as practicable.

Low heat Portland cement

Cement having such a low rate of heat development was first produced for use in large gravity dams in the United States, and is known as low heat Portland cement (Type IV).

Sulphate resisting Portland cement

Except for its high resistance to sulphate attack, have principal properties similar to those of ordinary Portland cement.

Calcium chloride should not be used with this cement as it reduces its resistance to sulphate attack.

White and coloured Portland cements

Are similar in basic properties to ordinary Portland cement White cement required special manufacturing methods, using raw materials containing less than 1 per cent iron oxide.

Coloured cements are produced by intergrinding a chemically pigment with ordinary clinker.

Slag Cements

Different types of slag cements can be produced by intergrinding varying portions of granulated blastfurnace slag with activators such as ordinary Portland cement and gypsum.

Portland blastfurnace cement

It is produced by mixing up to 65 per cent granulated blastfurnace slag with ordinary Portland cement.

The basic characteristics are similar to those of ordinary Portland cement although the rate of hydration is lower.

High-alumina cement

This cement, which is manufactured by melting a mixture of limestone, chalk and bauxite (aluminium ore) at about 1450 C and then the cold mass, has different composition and properties from those of Portland cements.

Manufacture

Cement is prepared by first intimately grinding and mixing the raw constituents in certain proportions, burning this mixture at Avery high temperature to produce clinker, and then grinding it into powder form. Since the clinker is formed by diffusion between the solid particles, intimate mixing of the ingredients is essential if uniform cement is to produced. This mixing may be in dry or wet state depending on the hardness of the available rock.

The wet process is used in general, for the softer materials such as chalks or clay. Water is added to the proportioned mixture of crush chalk and clay to produce slurry which is eventually led off to a kiln. This is steel cylinder, with a refractory lining, which is slightly inclined to the horizontal and rotates continuously about its own axis. It is usually fired by pulverised coal, although or oil may also be used .it may be as large as 3.5 m in diameter and 150m long and handle up to 700 t of cement in a day.

The slurry is fed in at the upper end of the kiln and the clinker is discharge at the lower end where fuel is injected. With its temperature increasing progressively, the slurry undergoes a number of changes as it travels down the kiln. At 100 C the water is driven off, at about 850 C carbon dioxide is given off and at about 1400 c incipient fusion takes place in the firing zone where calcium silicate and calcium aluminates are formed in the resulting clinker. The clinker is allowed to cool and then ground, with 1 to 5 per cent gypsum, to the required fineness.

The dry or semi-dry process is used for the harder rocks such as limestone and shale and shale. The constituent materials are crushed into powder form, and with a minimum amount of water, passed into an inclined rotate nodulising pan where nodules are formed. These are known as raw meal. This is fed into a kiln and thereafter the manufacturing process is similar to the wet process although much shorter length of kiln is used. The grinding of the clinker produces a cement powder which is still hot and this hot cement is usually allowed to cool before it leaves the cement works.

Aggregate

Aggregate is much cheaper than cement and maximum economy is obtained by using much aggregate as possible in concrete. It's also considerably improves both the volume and the durability of the resulting concrete.

Natural aggregate are formed by the process of weathering and abrasion, or by artificially crushing a large parent mass.

Basic characteristics of aggregate

The criterion for a good aggregate is that it should produce the desired properties in both the fresh and hardened concrete.

Physical properties

The properties of the aggregate known to have a significant effect on concrete behaviour are:

Strength

The strength of an aggregate limits the attainable strength of concrete only when its compressive strength is less than or of the same order as the design strength of concrete. In practice the majority of rock aggregates used are usually considerably stronger than concrete.

Deformation

The deformation characteristic of an aggregate are seldom considered in assessing its suitability for concrete work although they can easily

Toughness

Is its resistance to failure by impact and this is normally determined from the aggregate impact test (BS 812).

Hardness

Is the resistance of an aggregate to wear and is normally determined by an abrasion test (BS 812). Toughness and hardness properties of an aggregate are particularly important for concrete used in road pavements.

Volume change

Is due to moisture movements in aggregate derived from sand stones, greywacke and some basalts may results in considerable shrinkage of the concrete.

Porosity

Is an important property since it affects the behaviour of both freshly mixed and hardened concrete through its effect on the strength, water absorption and permeability of the aggregate? An aggregate with high porosity will tend to produce a less durable concrete, particularly when subjected to freezing and thawing, than an aggregate with low porosity.

7.The specific gravity

Is the ratio of its unit weight to that of water? Since aggregates incorporated pores, the value of specific gravity varies depending on the extent to which the pores contain (absorbed) water when the value is determined.

The specific gravity of most natural aggregate falls within the range (2.5 to 3) .

Types of aggregate

The general classification of aggregate and the related British standards are shown in Fig (3).

Heavy weight aggregate

It provides an effective and economical use of concrete for radiation shielding by giving the necessary protection against X- rays, gamma- rays and neutron.

Normal weight aggregate

These aggregates are suitable for most purposes and produces concrete with density in the range 2300 to 2500 kg/m3.

Light weight aggregate.

Light weight aggregate find application in a wide variety of concrete products ranging from insulation screed to reinforce or priestesses concrete, although their greatest use has been in the manufacture of precast concrete blocks.

Their bulk density normally ranges from 350 to 850 kg/m3 for coarse aggregate and from 750 to 1100 kg/m3 for fine aggregate.

Water

Water is used in concrete making for three different purposes:

As mixing water.

For curing of concrete.

For washing aggregate.

The quality and requirements for the water depend on the type of the Summaries of the physical and physicochemical use.

Mixing water

The mixing water, that is, the free water encountered in freshly mixed concrete, has three main functions:

(1) it reacts with the cement powder thus producing hydration
(2) it acts as a lubricant, contributing to the workability of the fresh mixture
(3) it secures the necessary space in the paste for the development of hydration products

Water for curing of concrete

The requirements for curing water are less stringent than those discussed above, mainly because curing water is in contact with the concrete for only a relatively short time.

Water for washing aggregate

Water for washing aggregate should not contain materials in quantities large enough to produce harmful films or coatings on the surface of aggregate particles.

LITERATURE REVIEW

Introduction

Superplasticizers are a type of water-reducing additive used to manufacture high-strength and high-performance concrete. Plasticizers are chemical substances that allow concrete to be produced with a 15% reduced water content. Superplasticizers allow for a 30% reduction in water content while also improving the other properties of concrete. A well-dispersed particle suspension is required to improve rheological behavior such as workability, particularly concrete properties and superplasticizers. The application of admixture to concrete or mortar enables for a lowering in the water to cement ratio without compromising the mixture's workability, allowing self-consolidating and high-performance concrete to be produced.

Munday [1] studied the effects of admixture dosage and type on setting time and flow values. The time set and flow rates increased when the volume of mixtures was increased. Time and capacity played a role in the formation of the pore structure.

The excess quantity of cement mortar was utilised to determine the maximum pore surface area ratio. The pore area ratio decreases as compressive strength values rise. Mailvaganam [2] used small particles and a large surface area to create impermeable concrete with a high density and impermeability.

Topçu and Ateşin [4] studied the effects of a high-dose lignosulphonate-based water-reducing admixture and a naphthalene sulphonate-based high-range waterreducing admixture on mortar characteristics. As a result of these investigations, it was discovered that overdose on admixtures causes a loss of quality in concrete's physical and mechanical properties. As a result, it was decided that specific regulatory laws limiting the use of chemical admixtures with caution should be established. Mohammed et al.[5] tested for young's modulus, splitting tensile strength, and ultrasonic pulse velocity in both the fresh and hardened states, superplasticizers with sulfonated naphthalene polymer-based superplasticizers and second-generation polycarboxylic ether-based superplasticizers exhibit the best impact. When compared to lignosulfonate-based water-reducing agents, concrete compositions with superplasticizers perform well.

MATERIALS AND METHODS

Materials. The following is a list of the different ingredients used in the research investigation to produce concrete specimens of M30 and M40 grade concrete.

Cement. Ultratech Ordinary Pozzolana Cement (OPC) 43-grade cement was employed throughout the trial activity after reviewing the specifications. The laboratory tests the cement, and the results are shown in Table 1. The mean 28-days compressive strength of cement was 58.30 MPa, which is excellent; however, it is more than 53 MPa according to IS 8112-1989 [16].

Sand. This study employed a fine aggregate of natural sand (silica sand) from the Godavari river basin (Nanded, Maharashtra). According to BIS regulations, the sand sieve study confirmed Zone II. Tables 2 and 3 detail the properties and sieve analysis, respectively, following IS: 383-1983[17].

Aggregates. For this study, crushed stone coarse aggregate from a local crushing plant was used in the entire study. Two groups of coarse aggregates used by size, one group with a size of 20 mm (60%) and the other group with size 10 mm (40%) percentages, were used to obtain a weighted average size of 20 -10 mm mixed as per IS:383-1983[17]. Tables 4 and 5 show the sieve analysis and physical parameters of coarse aggregates with a size of 20 mm (60%) and 10 mm (40%), respectively.

Water. Concrete is produced with water which meets the requirements of IS: 456-2000[18]. Concrete is made from readily available tap water in this project.

Concrete mix design and proportioning. The quantities of the primary ingredients in concrete decided to employ a mixed design. Trials in the laboratory were used to evaluate the required alterations and readjustments to field conditions. From mix design calculations, it's necessary to understand the link between aggregate and cement paste, which are the most important constituent elements in concrete. The lubricating effect of cement paste is used to achieve workability, or the ability of the concrete mass, which is a mixture of coarse and fine particles, to flow. Cement paste's lubricating effectiveness is affected by its dilution. It is difficult to change the properties of aggregates since they are naturally compressed mineral compounds that are significantly stronger than the paste compound. As a result, it is critical to study the paste's structure in depth. The fresh paste is a cement and water suspension, not a cement solution in water.

Sample preparation. This study aims to see how varied admixture content affects concrete's fresh and hardened properties. Table 7 shows the work schedule, which includes changing percentages of admixture content for M30 and M40 concrete and a full investigation of the influence of different admixtures on the fresh and hardened properties of concrete.

METHODOLOGY

Testing of specimens.Using M30 and M40 grades of concrete, the admixture content of the concrete kept 0, 0.5, 1, and 1.5%. Accordingly, nine cube test specimens were cast from each sample, 150 x 150 x 150 mm in dimension. Three specimens are examined for compressive strength after three days, three after seven days, and three after 28 days. Each sample was made as three-cylinder specimens with a diameter of 150 mm and a length of 300 mm, which were subjected to a split tensile strength test at 28 days. Each sample yielded three beam specimens with a 100 x 100 mm and a length of 500 mm for flexural strength testing after 28 days. 180 cubes specimens, 60 cylindrical specimens, and 60 beams specimens were cast for the current study. All the samples and specimens of concrete were tested in a fresh and hardened state. In a new state slump value of the concrete is monitored regularly for each type of sample. Compressive strength, split tensile strength, and flexural strength was performed on each concrete sample in a hardened state.

Compressive Strength Test. Concrete was adequately mixed and compressed in three equal

layers into the appropriate moulds, then de-moulded after 24 hours, followed by curing in water for 7 and 28 days, and testing at room temperature of 27 ± 20C. The compressive strength tests were carried out on cube specimens of 150 mm x 150 mm x 150 mm. The maximum force at which the cube fails is noted, and the concrete cube's compressive strength is determined by dividing the force at failure by the specimen's area [22].

Weight Density. The weighted density of the concrete is an essential parameter in the concrete study point of view. Generally, all the other strength properties of concrete are directly proportional to weight density. Weigh each cube during testing, then divide the weight by the volume of the cube to get the weight density of concrete in Kg/m3, which is usually around 2400 Kg/m3.

Split Tensile Strength. Split tensile strength is often higher than concrete's direct tensile strength but lower than its flexural strength. It is a crucial parameter for determining the reinforcement's development length and calculating the concrete's shear resistance. The diametrical load applied about 2.35 kN/s along the length of a concrete cylinder of 150 mm in diameter and 300 mm in length after 28 days of curing [23]. Even though the cylinder is compressed over its length, it is subjected to tensile stresses along the loading plane. Under loading, the cylindrical area experiences tri-axial stresses, causing the cylinder to break, and a vertical crack appears along the loading plane. The cylinder's failure load is recorded, and the concrete's split tensile strength is estimated using a formula [23].

Flexural Strength Test.The flexural strength test is among the methods used to determine the concrete's tensile strength. It was performed using third point and second point loading arrangements. When the third point arrangement is used, the concrete specimen of dimensions 100 x 100 x 500 mm after 28 days of curing is placed on the supports and two-point loads are applied at a distance of 1/3 from the supports. Load is applied at the rate of 0.029 kN/s from the top, and the load at which the first crack of the beam appeared is noted as failure load [24]. The flexural strength of the concrete specimen can be calculated using a formula [24]. Testing of cylinder and beam sample for tensile and flexural strength measurement is presented in Figure

RESULTS AND DISCUSSION

Effect of different admixtures on slump cone test. Figures 3 and 4 illustrate the influence of several admixtures, such as Apple Chemie, Fosroc, Du-bond, and Sika, at various percentages on the slump value of the various samples investigated. Because the concrete mix was designed for a slump value of 75 mm, the concrete slump should indicate values above that. Above 75 mm, the Fosroc and Du-bond admixture with 1% and 1.5 % produces good slump results with good consistency. However, the result values for 0.5% are the poorest in M30 and M40 grade concrete.

Effect of different admixtures on weight density.The effect of the various admixtures like Apple Chemie, Fosroc, Du-bond, and Sika, with varying percentages on the weight density values of the different samples, was studied and presented in Figures 6 and 7. Apple Chemie and Du-bond work similarly considering weight density, but Du-bond performs well compared to Apple Chemie

Effect of different admixtures on split tensile strength. The effect of the various admixtures like Apple Chemie, Fosroc, Du-bond, and Sika, with varying percentages on the Split Tensile Strength of the various samples, studied and shown in Figures 10 and 11. All the admixture Apple Chemie, Auramix 350, Conplast SP430 increase split tensile strength consistently as admixture content increases. Conplast is declining its effect as a grade of concrete increases, but here we can see the Du-bond performing well for split tensile strength [32].

Effect of different admixtures on flexural Strength.The effect of the various admixtures with varying percentages on the split tensile strength of the various samples studied and shown in Figures 12 and 13. As far as the flexural strength is concerned, all admixtures show increasing strength values as grade increases. Kanagala et al. found that flexural strength is optimum at 0.7 & 0.9% of dosage of Conplast SP– 430 in M30 and M40 grade concrete in tune with findings[28]. But overall, Auramix 350 performs well with 1.5% content for M 30 Grade and consistently Sika with 1%.The results of the effect of different admixtures are in corelation with the findings of Price[33].

Effect of different admixtures on failure pattern of tested cube samples.Look at the usual failure patterns from different admixture samples following compressive strength testing in Figure 14 when evaluating the failure surfaces and patterns for matrix, aggregate, and aggregate matrix joints in concrete cubes. Apple Chemie is experiencing an increase in matrix and joint failures. The grout strength of Auramix 350 is appropriate since it has more joint failures and some aggregate failures. Conplast SP430 has matrix and joint failures, while Du-bond has higher aggregate and matrix failures but more minor joint failures. Overall, Auramix 350-its grout is doing effectively.

2-4-1Strength

The strength of concrete is defined as the maximum load (stress) it can carry. As the strength of concrete increases its other properties usually improve and since the test for strength, particularly in compression, are relatively simple to perform concrete compressive strength is commonly used in the construction industry for the purpose of specification and quality control. Concrete is comparatively brittle material which is relatively weak in tension. (N. Jackson 1981).

2-4-1-1compressive strength

The compressive strength of concrete is taken as the maximum compressive load it can carry per unit area. Concrete strength up to 80 N/mm^2 can be achieved by selective use of the type of cement, mix proportion, method of curing conditions.

2-4-1-2Tensile strength

The tensile strength of concrete is of importance in the design of concrete roads and runways. Concrete members are also required to withstand tensile stresses resulting from any restraint to contraction due to drying or temperature variation.

Flexure strength

The flexure strength of concrete is another indirect tensile value which is also commonly used (BS 1881:Part 4). In this test a simple supported plain concrete

The tensile strength of concrete is usually taken to be about one- tenth of its compressive strength. This may vary, however, depending on the methods used for measuring tensile strength and the type of concrete.

2-4-2Factors influencing strength
Several factors which affect the strength of concrete are listed below:

1. Influence of the constituent materials (cement, water, aggregate, admixtures).
2. Influence of the methods of preparation.
3. Influence of curing
4. Influence of test conditions.
(N. Jackson 1980)

EXPERMENTAL WORK

3-1Concrete Mix Design
Concrete mix design can be defined as the procedure by which, for any given set of conditions, the proportion of the constituent materials are chosen so as to produce a concrete with all the required properties for the minimum cost. The cost of the mix design includes

- The materials
- The cost of the mix design, of batching, mixing and placing the concrete and of side supervision
Two types of concrete mixes are available

a) Prescribe mix

It is given in least form included:
- Proportion of cement
- Fine and coarse aggregate
- Workability
Minimum compressive strength is very important to produce proper mix.

b)Designed mix
The basic requirements for concrete are conveniently considered at two stages in its life.
In its hardened state the concrete should have adequate durability, the required strength and also the desired surface finish.

3-1-1Factors governing the selection of mix proportion 1.Durability

Adequate durability of exposed concrete can frequently be obtained by ensuring full compaction, an adequate cement content and low water – cement ratio, all of which contribute to producing a dense, impermeable concrete.

The choice of aggregate is also important particularly for concrete wearing surfaces or where improved fire resistance is required.

Strength
The strength of the concrete is frequently an important design consideration particularly in structural application where the load –carrying capacity of a structural member may be closely related to the concrete strength

The strength requirement is generally specified in terms of a characteristic strength coupled with a requirement that the probability of the strength falling below this shall not exceed a certain value.

Typically this may be 5 per cent or 1 in 20 chances in strength falling below the specific characteristic strength, this generally be the 28 – day strength.

Design mean strength
The assumption of a normal distribution of concrete strengths forms the basis of mix design and statistical quality control procedures to satisfying the strength requirement.

Workability
Beside the requirements for the concrete to be satisfactory in the hardened state, properties when being transported, possibly pumped, and placed are equally important. One essential at this stage is a satisfactory workability. Selection of mix proportions which do not permit the achievement of appropriate workability totally defeats the purpose of rational mix proportioning.

The workability that is considered desirable depends on two factors:

- The minimum size of the section to be concrete and the amount and spacing of reinforcement.
- The method of compaction to be used.

The choice of suitable concrete mix proportions must take all these factors into account (A.M.Neville 2000).

Maximum size of aggregate
In reinforced concrete, the maximum size of aggregate which can be used is governed by the width of the section and the spacing of the reinforcement. It now seems that the improvement in the properties of concrete with an increase in the size of aggregate does not extend beyond about 40mm so that the use of larger size may not be advantageous. In particular, in high performance concrete, the use of aggregate larger than 10 to 15 mm is counter – productive. Furthermore, the use of a larger maximum size means that a great number of stockpiles have to be maintained and the batching operations become correspondingly more complicated.

Grading and type of aggregate
The grading influences the mix proportions for a desired workability and the water/cement ratio: the coarser the grading the leaner the mix which can be used, but this is true within certain limits only because a very lean mix will not be cohesive without a sufficient amount of fine material.

Cement content
The choice of cement is made either on the basis of experience or alternatively from charts and tables prepared from comprehensive laboratory tests. Such tables are no more than a guide to the mix proportion required because they apply fully only to the actual aggregates used in their derivation.

Moreover, recommended proportions are usually based on aggregate grading which have been found to be satisfactory(A.M.Neville 2000).

3-2Experimental Work
Where the main requirement is to:

1. improve workability
2. Increase strength.
3. reduce cement content, hence cost saving

A concrete mix design or trial mixes should be made with normal concrete mix design.

In this study three grades of concrete are to be used:

1. Grade 15
2. grade 25
3. grade 40

Beside the ordinary reference mixes, chemical admixtures should be used. These admixtures are:

High performance superplasticising admixture (conplast sp432ms)

The study will be divided to theses phases:

Materials test

Test of base materials, i.e. cement , aggregate , water and admixture

The effect of recommended doses of admixture on the properties of fresh and hardened concrete , i.e. (workability & strengths) 3.

TESTING PROGRAM

Grade 15
Ordinary reference mix (RM).

(12 cubes+3cylinder+3beams)

- 3 cubes will be crushed on 7 days
- 3 cubes will be crushed on 14 days
- 3 cubes will be crushed on 28 days
- 3 cubes will be crushed on 90 days
- 3 cylinder will be tested on 28 days
- 3 beams will be tested on 28 days

1. Reference mix admixture to increase workability (WrM).
(12 cubes+3cylinder+3beams)
2. Mix with admixture and same workability to increase strength (StM).
(12 cubes+3cylinder+3beams)
3. Mix with admixture to reduce cement content keeping same strength and workability (CrM).
(12 cubes+3cylinder+3beams)

B. Grade 25

Ordinary reference mix (RM)
(12 cubes+3cylinder+3beams)

- 3 cubes will be crushed on 7 days
- 3 cubes will be crushed on 14 days
- 3 cubes will be crushed on 28 days
- 3 cubes will be crushed on 90 days
- 3 cylinder will be tested on 28 days
- 3 beams will be tested on 28 days

2. Reference mix admixture to increase workability (WrM).
(12 cubes+3cylinder+3beams)
3. Mix with admixture and same workability to increase strength (StM).
(12 cubes+3cylinder+3beams)
4. Mix with admixture to reduce cement content keeping same strength and workability (CrM).
(12 cubes+3cylinder+3beams)

C.Grade 40

1. Ordinary reference mix (RM).
(12 cubes+3cylinder+3beams)

- 3 cubes will be crushed on 3 days
- 3 cubes will be crushed on 6 days
- 3 cubes will be crushed on 28 days
- 3 cubes will be crushed on 90 days
- 3 cylinder will be tested on 28 days
- 3 beams will be tested on 28 days

2. Reference mix admixture to increase workability (WrM).
(12 cubes+3cylinder+3beams)
3. Mix with admixture and same workability to increase strength (StM).
(12 cubes+3cylinder+3beams)
4. Mix with admixture to reduce cement content keeping same strength and workability (CrM).
(12 cubes+3cylinder+3beams)

CONCLUSIONS

The results from the various testes for the three grades (15, 25, and 40) conducted on the fresh and hardened state of concrete mixes lead to the following observations:

Super plasticizers admixtures improve the workability without increasing water demand, for the three grades of concrete no decreasing in compressive strength was observed.

Super plasticizers admixtures provide an increasing in ultimate strength gain by significantly reducing water demand in a concrete mix for the three grades, without affecting workability.

Super plasticizers admixtures reduce cement content up to 23%for the three grades without reducing the compressive strength and no effect on workability. Super plasticizers admixtures provide improved durability by increasing ultimate strength and reducing w/c ratio.

Super plasticizers admixtures save cost of the reduced cement of about (4.5 –
8.9)% per cubic meter for the three grades of concrete.

RECOMMENDATIONS

1. Further researches using admixtures should be conducted on concrete mixes with low and high workability.
2. Further researches should be conducted on grades above $40N/mm^2$.
3. More studies have to be carried on the effect of using super plasticizers admixtures on the percentage reduced of cement content on the concrete mixes .
4. More studies has to be carried on the effect of using admixtures in concrete mixes in the aggressive environment of Sudan to improve concrete properties such as strength, workability, durability, shrinkage, creep,…..etc.
5. Further researches has to carried here in Sudan to determine how concrete companies accept using concrete admixtures as a material to improves many properties of concrete especially those concern with the hot weather of Sudan.

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