

Concrete additives

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1 Introduction

An introduction to the study of additives from the point of view of controlling the quality of concrete.

It is well established that concrete is a very complex material, especially reinforced, due to considerations related to the difference in the properties of the concrete components, as well as the difference in the properties of the concrete itself from steel reinforcement or fiber. Therefore, these differences should be taken into account in the design calculations, equations, and curves, whether the Ultimate state or the previous working state

The procedures and laws for controlling the quality of concrete in the design or implementation stages, whether before, during, or after pouring, hardening, and tests of materials and samples, are at the top of the responsibilities of external quality control consultants, quality control engineers, internal supervision, and the necessary processes to ensure the achievement of structural concrete sectors that conform to assumptions and requirements.

Internal supervision and operations are necessary to ensure the achievement of structural concrete sections that conform to design assumptions and requirements and withstand all internal and external stresses without any defects or defects in the short or long term. In all cases, the technical requirements of the project and the Egyptian code must be adhered to. Statistics of cases of defective concrete and structures have recently shown that many The reasons are due to the use of aggregates, water, or additives that do not conform to the technical specifications and requirements. Therefore, through this paper, we provide an overview of the characteristics of the three mentioned elements and the procedures for controlling their quality to take them into account in the design and manufacture of concrete and operating requirements.

2 Concrete design

It must be prepared using one of the approved design methods, and the specialized consultant must verify the validity of the design and the proportions of the mixture components resulting from it in order to achieve the targeted and distinctive resistance, and what this requires in terms of making experimental and confirmatory concrete mixes when necessary. Being satisfied with the results of the mixture without reviewing the design and proportions correctly is considered a defect in the design. The study requires treatment, especially for concrete with special specifications, such as high-resistance, self-compacting, cellular, or polymeric concrete.

3 Approval of mix station

The mixing station must essentially have the accreditation of the concerned authorities, such as the National Research Center. The consultant must prepare a table with the results of the required tests, conduct one or more field visits, and ensure that there are approved calibration certificates and that the distortions are carried out in a correct and informed manner.

4 Materials

4.4 Cement :

must be comply with related references as ASTM or EPC as initial/final setting times- fineness- compressive strength- physical/chemical properties ..etc

4.5 Aggregates

The ratios of (absorption - organic - chlorides) - flatness - Los Angeles coefficient - petrographic analyzes - x-ray diffraction must be verified to ensure that an alkaline-carbonate or siliceous reaction does not occur. The rest of the tests are according to - etc

4.6 Water

Concrete water must be drinkable water in principle and not exceed the prescribed percentages of salts and harmful substances according to the code, such as 0.5 g/liter as chloride salts in the form of cl.

5 Admixtures

Additives are among the most important and dangerous components of concrete, and of course there is a necessity for their use, which requires that the additives be subjected to tests according to their type and the function required of them. In this study, we will provide a more detailed report on the additives.

These are materials - other than aggregate, cement and water - that are added to the concrete mixture during the mixing process in very small quantities for the purpose of giving fresh concrete or hardened concrete additional properties.

5.4 RILEM definition about concrete admixtures is

Additives to concrete, mortar, or cement paste are inorganic or organic. It is added to the normal components of the concrete mixture but does not usually exceed 5% of the mass of cement or binder paste. These additives interact with cement through physical, chemical, or physicochemical processes, modifying one or more of the properties of concrete, mortar, or cement paste, either in the fresh or solid state. -These additives are usually very chemically complex compounds and with a few exceptions, they are unlikely to be pure compounds but are bound to some other secondary chemical compound or may be mixed formulations.

It is somewhat difficult for the civil engineer to understand due to its chemical nature, but its effect on cement concrete, mortar or paste can be evaluated by simple tests on the concrete or mortar. In most developed countries, additives have become an essential and essential component of concrete, just like cement, aggregates and water

5.5 Additives divided to

5.5.1 Chemical additives:

delaying the setting - accelerating the setting - water-reducing "plasticizing" additives - high-reducing "high-plastic" additives

5.5.2 Compound chemical additives:

such as water-reducing and water-reducing at the same time - high water-reducing, water-reducing - accelerating and water-reducing.

5.5.3 Mineral additives:

used to increase pressure resistance, endurance, reduce permeability, and reduce iron corrosion. They include furnace slag and fly ash. Most of these additives have pozzolanic properties, meaning they interact with the products of the reactions of cement compounds with water.

Its use requires ensuring the relative stability of its chemical composition - conducting tests for smoothness and weight loss after burning - using water-reducing additives with mineral additives - treating the concrete with water for a period of not less than two weeks to reduce the effect of shrinkage.

5.5.4 Various additives:

such as entrained air additives - resistance to water permeability - iron rust-inhibiting additives.

Functions.

- 5.5.5 Improving the workability of fresh concrete without increasing the mixing water.
- 5.5.6 Acceleration or delay in setting time
- 5.5.7 Reducing the rate of slump loss of concrete.
- 5.5.8 Improving the ability to pump concrete.
- 5.5.9 Segregation granulomatous detachment.
- 5.5.10 Increase the early resistance of concrete.
- 5.5.11 Obtaining high resistance concrete.
- 5.5.12 Improving the properties of hardened concrete, such as resistance to abrasion.
- 5.5.13 Obtaining impermeable concrete, cellular concrete, or concrete with special qualities.

5.6 Types of additives

5.6.1 Chemical additives:

There are many chemical additives that are used with concrete and they can be divided into the following groups

- 5.6.1.1 *Water-reducing and cloud-controlling additives (seven types).*
- 5.6.1.2 - *Entrained air additives.*
- 5.6.1.3 - *Additives to resist erosion of cement by water*
- 5.6.1.4 - *Various other additions.*

5.6.2 Additives to reduce water and control setting time

These additives are the most important and most common types of additives used in the field of concrete. They are specialized in reducing mixing water (to varying degrees) and controlling the hardening of concrete by delaying or accelerating. This group is divided into seven different types and is distinguished by the American specifications ASTM C 494 by the letters A to G as follows:

5.6.2.1.1 Concrete mixing water reducing additives ASTM C494 – Type A

5.6.2.1.2. Suspension Delay Additives ASTM C494 – Type B

5.6.2.1.3. Cast Acceleration Additives ASTM C494 – Type C

5.6.2.1.4 Additives to reduce mixing water and delay setting ASTM C494 - Type D

5.6.2.1.5 Additives to reduce mixing water and accelerate setting ASTM C494 – Type E

5.6.2.1.6 High grade concrete mixing water reducing additives ASTM C494 – Type F

5.6.2.1.7 Additives to reduce concrete mixing water to a high degree and delay setting ASTM C494 – Type G

5.6.2.2 *Admixtures Effects*

As we can see, the previous seven types in this group of additions are limited to one or more of the following three main effects:

5.6.2.2.1 Reducing mixing water (plasticizers and superplasticizers (ASTM Type A, F) Plasticizers and superplasticizers are generally found in liquid form and are added to the concrete mixture at a specified percentage of the weight of cement. They are the most widely used and most important types of additives. It has been found that 3% of superplasticizer gives the best results.

5.6.2.2.2 The difference between types A and F is that the degree of water reduction for type A (plasticizer) ranges from 6 to 12% when the consistency of the concrete mixture is stable. As for type F (superplasticizers), the degree of water reduction exceeds 12% and may reach 30% at the same consistency as the concrete mix.

5.6.2.3 *purposes*

- Improving the properties of fresh concrete by increasing workability and increasing fluidity with a constant m/h ratio
- Obtaining self-compacting concrete.
- Improving the properties of hardened concrete by reducing the ratio (m/h) in the mixture while maintaining stability
- Degree of workability and thus obtaining highly resistant concrete
- Obtaining concrete with high early strength
- Obtaining high-performance, low-permeability concrete
- Obtaining concrete without granular separation or leaching

5.6.2.4 Principles of selection of plasticizers and superplasticizers

5.6.2.4.1 Mixing water reduction rate

5.6.2.4.2 Rate of loss of operability

5.6.2.4.3 setting time Impact on the time of sett

5.6.2.4.4 Compatibility with the cement used

5.6.2.4.5 The resulting resistance of concrete

5.6.2.4.6- Price and costs.

5.6.3 Retarders

Retarders setting time

Delay Additions

ASTMC494 Type B

5.6.3.1 Function

.Its function is to delay the setting of cement, meaning it increases the time of setting and hardening of the concrete and reduces the hydration temperature of the cement. Delays may cause an increase in shrinkage rate of Strength Gain, so the rate of increase in plastic resistance in the concrete is reduced, but they have no significant effect on the natural and mechanical properties of the hardened concrete.

5.6.3.2 purpose

5.6.3.2.1 Its purpose is to make concrete in hot climates, where the initial setting of cement occurs very quickly.

5.6.3.2.2- If the conditions for pouring concrete are difficult and it is necessary to make the cement mortar plastic or liquid for a long time.

5.6.3.2.3 - If there is a cement message with a very small setting time.

5.6.3.2.4 - Obtaining concrete with prominent aggregate visible on its surface.

5.6.3.2.5 It delays the setting of cement, meaning it increases the time of setting and hardening of the concrete and reduces the hydration temperature of the cement. Delays may cause an increase in shrinkage rate of Strength Gain, thus reducing the rate of increase in plastic resistance in the concrete, but they have no significant effect on the natural and mechanical properties of the hardened concrete. The goal of these additions is: -

5.6.3.2.5.1 To make concrete in hot climates, where the initial setting of cement occurs very quickly.

5.6.3.2.5.2 If the conditions for pouring concrete are difficult and it is necessary to make the cement mortar plastic or liquid for a long time.

5.6.3.2.5.3 – If there is a cement message with a very small uncertainty time.

5.6.3.2.5.4 – Obtaining concrete with prominent aggregate visible on its surface.

5.6.4 Accelerators

Accelerators Accelerators of uncertainty

ASTMC494 Type C

5.6.4.1 Function

Its function is to accelerate or speed up the setting of cement, that is, it reduces the time of setting and hardening of the concrete, and thus the hardening rate increases, and the early heat released also increases.

5.6.4.2 purpose

5.6.4.2.1 Its goal - to eliminate the effect of lagging doubt resulting from low temperatures.

5.6.4.2.2 - Eliminate the effect of delayed uncertainty resulting from the use of another additive.

5.6.4.2.3 - Emergency works, such as stopping water leakage into tanks. - Remove the chop early.

5.6.4.2.4 - Accelerating the time of using the concrete structure.

5.6.4.2.5 - Reducing the time required for treatment.

Accelerates or speeds up the setting of cement, meaning it reduces the time of setting and hardening of concrete, especially in cold climates. Consequently, the rate of hardening increases, and the early heat released also increases. It should not be used if the central mixer is far from the site to ensure that early setting does not occur before pouring. In general, its goal is:

- Accelerating the formation
- Obtaining early
- resistant concrete

Obtaining frost-resistant concrete as a result of the early heat released

5.6.5 Air Entraining Admixtures

Air Entraining Admixtures Entrapped air

5.6.5.1 purpose

The goal is Frost Resistance, especially frost resistance - reducing the weight of concrete and increasing durability. This happens by forming regular air bubbles throughout the concrete mass, which remain so after the concrete hardens.

This can be done in two ways during mixing of concrete::

5.6.5.1.1 Adding materials that cause foaming, such as some foaming compounds.

5.6.5.1.2 Using solid materials that react with cement and produce hydrogen gas in the form of many fine bubbles, such as aluminum powder, zinc powder, and magnesium powder. These materials are used in proportions ranging from 0.01% to 0.03% by weight of cement and create trapped air ranging from 5% to 15% of the volume of concrete. These additions do not affect the setting time of concrete, while they lead to increased drying shrinkage and decreased resistance. It has been found that there is an inverse relationship between the percentage of air trapped in the mixture and the compressive resistance of concrete.

5.6.6 *_Ant washout _Admixtures*

Additives to prevent the scavenging of cement under water. When pouring concrete under water, the water causes the cement to be scavenged from the concrete, resulting in a decrease in its resistance and turbidity in the surrounding water. For this reason, this type of additive is used, which is considered one of the newest types of additives currently on the market. These additives work to form a gel in the water surrounding the cement grains, thus protecting them from being washed away by the water. They also work to increasing the viscosity and cohesion between concrete particles and improving its resistance to separation. This type of additives is also used in the production of highly fluid concrete or self-compacting concrete, as these additives resist granular separation and increase the cohesion of the concrete. These additives consist of acrylic polymers or cellulosic compounds in the form of a water-soluble powder and are added to the mixture at a rate of approximately 1% of the weight of the cement.

5.6.7 **Miscellaneous_ Admixtures**

There are many other additives that are used with concrete, including the following:

5.6.7.1 *Concrete injection additives.*

5.6.7.2 *Additives to help pump concrete.*

5.6.7.3 *Additives to prevent moisture formation in concrete.*

5.6.7.4 *Additives to prevent the formation of fungi and bacteria on the concrete surfaces of water facilities.*

5.6.7.5 *Additives to prevent corrosion and rust in reinforcing steel.*

5.6.7.6 *Additives to reduce the alkaline reaction between aggregate and cement.*

5.6.7.7 *Additives to form gases inside concrete.*

5.6.7.8 *Additives to improve the bond between rebar and concrete.*

5.6.8 Coloring additives

5.6.9 General requirements required when using concrete additives

5.6.9.1.1. It must not have a harmful effect on concrete or steel reinforcement.

5.6.9.1.2 The benefits resulting from the use of additives should be proportional to the increase in costs.

5.6.9.1.3 Calcium chloride or chloride-based additives should never be added to reinforced concrete, prestressed concrete, or concrete that contains buried metals.

5.6.9.1.4 The suitability and effectiveness of any additives must be confirmed through trial mixtures.

5.6.9.1.5 If two or more types of additives are used in the same concrete mix, sufficient information must be available to indicate the extent of their interaction and to confirm the extent of their compatibility.

5.6.9.1.6 It should be noted that the behavior of additives with mixed or highly sulfate-resistant cements differs from that in the case of Portland cement. Therefore, sufficient information must be available about the proper performance of additives with different types of cement.

5.6.9.1.7 Additives must be supplied packed in sealed barrels or containers with the trade name, production date, and shelf life printed on them, as well as a certificate of the properties of the supplied additive and its compliance with the relevant standard specifications. Additives must be stored in a way that protects them from moisture, sunlight, and heat.

5.6.9.1.8 Meeting the limits of Egyptian Standard Specifications No. 1899-1 by testing it in a specialized laboratory

5.6.9.1.9- It is prohibited to use additives that contain chlorides in reinforced or prestressed concrete, and they must not have a harmful effect on the reinforcing steel or the concrete.

5.6.9.1.10 Confirmatory mixes must be made on site with additives,

5.6.9.1.11 and experimental mixes must be made periodically without any additives.

5.6.9.1.12 If more than one compatible additive is used in concrete, each of them must be mixed separately.

5.6.9.1.13 Commitment to conducting tests in accordance with the Egyptian code

6 Statistical quality control of concrete

Controlling the quality of concrete statistically: It is not possible to separate concrete works on site from the evaluation processes and determining the quality level, especially in the event of failure of some test results, which must be

subjected to the rules of evaluation for a technician to make the correct decision. In the event of failure, the quality control consultant may be asked, before making the final decision, to carry out the statistical process in light of The results are to determine the lowest degree of concrete resistance, based on which the structural designer can recalculate to accept or reject it or not.

Therefore, the process of testing and recording the results comes at the top of the tasks of the supervisory body, for documentation on the one hand, and on the other hand, to determine standard deviations and ranges, elements of statistical rates for evaluation, and determine the degree of control of concrete quality according to the nature of the project. The analytical includes elements such as (central measures - dispersion - frequency distributions - characteristic and targeted resistance).) To determine the levels of control and judge the validity of the structure

7 Some admixtures under research studies :-

7.4 WATER-Reducing Admixture

The purpose to achieve 4000 psi after 12 hrs for this goals they used admixtures as follow as apart of mix design and methodology

- Water-reducing Admixture : there are many different types of water reducing admixtures- including conventional water reducers, mid-range water reducers and high range water reducers (HRWR) the purpose of water reducing admixture as stated by ACI Committee 212.3 r(2010) in their report on chemical admixture =s for concrete is to “ reduce the water requirements of the mixture for a given slump, produce concrete of higher strength ,obtain specified strength at lower cement content ,or increase the slump of a given mixture without an increasing in water content “ conventional water reducers will reduce the water added to concrete between approximately 5 and 12% and (HRWR) will reduce the water by more than 30% with mid range water reducers falling some where in between (ACI Committee E701 2003)

There are many potential benefits of using (HRWR) also known as super plasticizers rather than conventional or mid range water reducers as defined by (ACI Committee E701 2003) HRWRs act in similar manner to conventional water reducers, except the HRWRs have a greater dispersion effect on cementous materials, one of the primary differences between high range water reducers and conventional is that high range water reducers may minimize set retardation that may occur when using conventional way=ter reducer ,the use of HRWR has also shown to improve strength properties of hardened concrete ,the strength of concrete containing HRWR is normally higher than what is expected of the lower w/cm ratio ratio alone..Water reducing admixture have

also shown to increase the entrained air in concrete (ACI Committee E-701-2003) CONSEQUENTLY

7.5 Shrinkage Reducing Admixture

Shrinkage Reducing Admixture are organic base formulations that reduce surface tension of water in capillary pores of concrete .by reducing the surface tension of this water.the tensile forces within the overall concrete matrix are reduced causing a reduction in drying shrinkage potential .including the shrinkage rate and restrained shrinkage (ACI Committee E-701-2003) shrinkage reducing admixture have been proven to significantly reduce over all shrinkage potential .oncluding the shrinkage rate and restrained shrinkage cracking (Folliard and Berke 1997 ,see et al 2003)shrinkage reducing admixture have proven effective even with very short moist curing periods

7.6 Accelerating Admixture

Accelerating Admixture are used to accelerate the rate of hydration that Occurs in concrete /which accelerate the set time and the early strength development of concrete ,there are many chemicals used to accelerate The rate of hydration .but calcium chloride has been proven to shorten the set time and accelerate the early strength development .the increased rate of hydration will also result in other benefits including earlier finishing time ,reduced bleeding ,improved protection against early exposure to freeze thaw cycles and earlier use of structure

8 References

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Best Regards