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Review on High Early Strength Concrete

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A B S T R A C T

This study reports and discusses a quick review of the literature on the influence of chemical and mineral admixtures on fresh concrete and their impact on the behavior of concrete in terms of strength and durability. Steam curing process is also discussed. The literature on mix proportioning for concrete with high early strength is also discussed.

Keywords: Alccofine, Calcium Chloride, Calcium Nitrate, Fly ash, Ground Granulated Blast Furnace Slag (GGBS), High Early Strength Concrete, Silica Fume, Steam Curing.

Introduction

High early strength concrete obtains its specified strength within a short period. For high-speed cast-in-place construction, fast track paving, quick form reuses in winter construction to reduce the amount of time temporary protection is needed for, among other purposes, high strength at an early age is desirable. The higher cost of high-early-strength concrete is frequently offset by quicker use of the structure, earlier reuse of the forms, removal of the shores, and cost savings from using temporary heating for a shorter period. When early opening of the pavement is required for maintenance and rehabilitation of road surfaces, strength at a young age is advantageous.

Previous Studies on High Early Strength Concrete

Abdul karim Yasin, Ridho Bayuaji and Trieddy Susanto (2017) have used local materials to reduce the production cost and they are using high early strength concrete with the compressive strength of high early concrete 27 MPa at age of 24hours with steam curing process and the application of this study not limited to a large building project but also small-scale building.

I.Papayianni and E. Anastasiou (2010) they have used high calcium fly ash (50% by mass), ladle furnace slag (30% by mass) as binders and electric arc furnace slag as aggregates. Combination of high calcium fly ash with electric arc furnace slag aggregates mixture gives concrete with higher strength, good abrasion resistance and fracture toughness and slag aggregates are used in replacement of coarse or fine aggregate.

P. Narasimha Reddy and Javed Ahmed Nagash (2020) they are focusing on the influence of mineral admixture (alccofine) and chemical admixture on fresh concrete and the effect on strength and durability behavior of concrete. The addition of mineral admixtures are pozzolanic in nature and helps in enhancing strength and durability of concrete and it also reduces the setting time issues that arise in the building and construction industries.

P. Narasimha Reddy and J. Ahmed Nagash (2019) they have analyzed the effects on the mechanical properties and durability of alccofine concrete of the addition of calcium nitrate as a non-chloride hardening accelerator. Usage of non-chloride accelerator with concentration of 0.65%,0.85% and 1.05% by cement was added to concrete and compared with conventional concrete and addition of non-chloride hardening accelerator in alccofine concrete enhanced compressive strength of concrete at an early age as well as durability due to increase in the rate of hydration of C_3A and C_3S.

Chandon Lee, Songhee Lee and Ngocchien Nguyen (2016) focuses on the effects of temperature, curing time and concrete strength on the accelerated development of compressive strength in high early strength concrete. Application of high early strength concrete to steam cured fabrication of precast prestressed units to reduce the fuel consumption and carbon dioxide and strength increased rapidly at higher temperature in early stage of curing, but it reduced rapidly in later age.

Wei-Chong Liao, B.J. Lee and C.W. Kang (2008) facts on the evolution of high-strength concrete are presented, with a focus on the growth of high early strength. Both goals were accomplished using either an ultrafine Portland cement or a Portland cement with a high early strength and a tricalcium silicate concentration of roughly 75%. The results indicate that utilizing an ultrafine cement, concrete can be produced with granite 10 aggregates and lightweight aggregates, respectively, with appropriate workability and one-day strengths of 60 to 80 N/mm² and 35 to 40 N/mm². It was possible to attain strengths of 10 to 25 N/mm² in 12 hours and 25 to 45 N/mm² in 1 day using high early strength cement and lightweight particles.

In Sung Cho, Tae-Beom Min et.al., (2014) have Studied on the development of compressive strength of early concrete age using calcium-based hardening accelerator and high early strength cement. This paper focuses on developing more than 10MPa as early strength after 6 hours of curing at room temperature for a precast concrete. Usage of calcium based hardening accelerator (calcium formate and amine type), superplasticizer (polycarboxilic ether) and high early strength cement (type III cement). Compressive strength is more than 10MPa after 9 hours as 3% of calcium hardening accelerator is added and here steam curing process is not used to save large amount of energy.

Methods for Obtaining High Early Strength

The following methods may be used singly or in combination to produce concrete with high early strength.

- High early strength cement
- High conventional cement content
- Chemical admixtures
- Mineral admixtures
- Steam or autoclave curing
- Low water – cement ratio (water to cement ratio of 0.35 – 0.45 by mass)

To produce the desired strength, the methods outlined above can be combined or utilised interchangeably. It is not necessary to employ specialised cements like Type III cement in order to achieve high early strength gains. With the use of locally accessible Portland cements, aggregates, and chosen admixtures, early strength is now attainable. To achieve early strength, this study combines a combination of Type III-High Early Strength Cement and chemical admixtures on the one hand, and a low water-cement ratio and/or a high conventional cement content on the other. It compares the two approaches as well as each approach alone.

Mineral and Chemical Admixtures in High Early Strength

Mineral admixtures boost strength, decrease permeability, and other qualities of concrete while also improving the economics of combinations. By hydraulic or pozzolanic activity, mineral admixtures modify the characteristics of the hardened concrete. Natural pozzolans, such as the volcanic ash used in Roman concrete, fly ash, and silica fume, are cementitious substances known as pozzolans. They can be combined or used separately with blended cement or Portland cement. The use of mineral admixtures or pozzolanic materials such as fly ash, GGBS, metakaolin and silica fume as partial replacement of cement in concrete results in the activation of binder reactions and mitigation of expansive reactions. This results in strength increase due to additional binder produced by the mineral admixtures when they react with lime and alkali present in concrete. The strength of the mix with mineral admixtures results in a higher strength when compared with conventional concrete.

Ingredients called admixtures are added to the batch of concrete either shortly before or during mixing. They give concrete some advantageous properties, such as resistance to frost, resistance to sulphates, controlled setting and hardening, improved workability, increased strength, etc. Colorant pigments, polymer latexes, expansion-producing admixtures, flocculating agents, antifreeze chemicals, formulations to prevent corrosion, etc. are used to create special concretes. Concrete's durability and its physical, chemical, surface-chemical, and mechanical qualities are affected by the mixtures. Accelerating admixtures shorten the setting period and quicken the development of strength. In cold weather concreting, they are employed. Accelerators include substances like calcium chloride, formates, carbonates, nitrites, and amines, among others. Water-reducing admixtures lessen the water content (8–10%) needed to mix concrete at a specific workability. These admixtures improve the strength and durability of concrete.

Conclusion

We can conclude from some of the explanations in this document.

- To address the challenges with setting time that arise in the building and construction industries, high early strength concrete was created. The typical time required to finish hardening concrete and reach the required minimum strength of 0.7 to 0.85 is 7 to 14 days. High early strength concrete suggests that structural concrete pouring (Compressive strength > 21MPa) might be accomplished by the concrete's compressive strength 24 hours after site pouring.
- There are four important factors to consider: cement type, cement quantity, admixture type, and W/C ratio.

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