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Review on Effect of Curing Methods on High Strength Concrete

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ABSTRACT: High-performance concrete (HPC) is a type of concrete that offers superior durability, strength, and workability compared to conventional concrete. Curing plays a crucial role in achieving the desired mechanical properties and long-term durability of HPC. This research article reviews the impact of different curing methods on the properties of HPC, including compressive strength, durability, and crack resistance. The study evaluates the traditional and modern curing techniques, such as water curing, membrane curing, steam curing, and curing with advanced materials. The results suggest that curing methods significantly influence the strength development and durability of HPC, with some techniques providing more consistent and enhanced results than others.

KEYWORDS: High Performance Concrete, Curing Methods, Compressive Strength, Durability, Membrane Curing, Water Curing, Steam Curing

I. INTRODUCTION

High-performance concrete (HPC) is designed to provide enhanced characteristics in terms of strength, durability, and workability. These properties make HPC particularly suitable for use in demanding structures such as bridges, high-rise buildings, and pavements (Mehta & Monteiro, 2014). Proper curing is a fundamental process in the production of high-performance concrete, ensuring that the hydration process is fully developed and that the concrete reaches its maximum potential in terms of mechanical properties (Kosmatka, Kerkhoff, & Panarese, 2002).

Curing involves maintaining adequate moisture, temperature, and time conditions for the concrete after mixing and placing to facilitate proper hydration. The curing method adopted directly affects the degree of hydration, which in turn influences the strength, durability, and surface quality of the concrete. Different curing techniques can be used depending on the availability of resources, environmental conditions, and project requirements. This paper aims to investigate the effects of various curing methods on the performance of HPC.

II.CURING METHODS FOR HIGH PERFORMANCE CONCRETE

Curing methods can be broadly classified into traditional and modern techniques. Each method has its own advantages and limitations, and the choice of method can significantly affect the outcome of the concrete's mechanical and durability properties.

Water Curing

Water curing is one of the most commonly used methods for curing concrete. It involves maintaining the surface of the concrete wet through methods such as ponding, spraying, or wet burlap. Water curing is highly effective in maintaining moisture content and temperature stability during the early stages of hydration (Bartz & Malhotra, 1995). This process helps to avoid premature drying, which could lead to shrinkage cracks and reduced strength development.

Research indicates that water curing provides excellent results in terms of compressive strength and durability, particularly in the first 28 days of curing (Neville, 2011). However, the long-term effects depend on the environmental conditions, as water curing can be challenging in hot or windy conditions.

Membrane Curing

Membrane curing involves the application of curing compounds that form a film over the surface of the concrete, thereby preventing the loss of moisture. This method is often preferred in situations where water curing is not feasible due to logistical issues or adverse weather conditions (Mindess& Young, 1981). Membrane curing is generally more efficient and requires less maintenance compared to water curing.

Studies have shown that membrane curing is particularly beneficial in preventing surface cracking and ensuring consistent moisture retention (Goetz & Tighe, 1997).However, the effectiveness of membrane curing depends on the quality of the curing compound and the uniformity of application. Additionally, this method may not be suitable for alltypes of HPC mixes, particularly those thatrequire higher levels of hydration for optimal performance.

Steam Curing

Steam curing is often employed in precast concrete production, where the concrete is subjected to controlled steam heat to accelerate the hydration process. This method significantly speeds up the curing process and helps to achieve high early strength development. Steam curing can also enhance the workability of HPC mixes by improving the rheological properties of the fresh mix (Mather, 1984).

Although steam curing leads to rapid strength development, it may cause thermal stresses that could lead to cracks if not controlled properly. The long-term durability of steam-cured concrete may also be affected by the increased temperature during curing, which could lead to microcracking (Bouzoubaa&Lachemi, 2001).

Advanced Curing Techniques

Modern curing techniques, such as the use of curing blankets or self-curing concrete, are gaining attention due to their effectiveness and ease of application. Self-curing concrete incorporates water-retaining agents into the mix, which provides internal curing by releasing moisture over time (Eldin et al., 2003). Curing blankets are designed to maintain a constant temperature and moisture content for an extended period, providing an alternative to traditional curing methods in harsh environmental conditions.

Research on self-curing concrete indicates that it can significantly reduce water evaporation and surface cracking, improving the long-term performance of HPC (Tazehkand& Yusoff, 2016). Additionally, curing blankets are useful in controlling temperature fluctuations, which can lead to better strength and durability development.

III.EFFECT OF CURING ON HPC PROPERTIES

The curing method directly influences several key properties of high-performance concrete. This section examines the impact of different curing techniques on compressive strength, durability, and crack resistance of HPC.

Compressive Strength

Compressive strength is a critical property of concrete, as it is often used to assess the overall performance of the material. Proper curing is essential to achieve the maximum compressive strength, as it allows the cementitious compounds to fully hydrate.

Studies indicate that water curing consistently provides the highest compressive strength for HPC, followed by membrane curing, which provides somewhat lower, yet still significant strength (Bouvard et al., 2018). Steam curing, while promoting early strength gain, may result in a slightly lower ultimate compressive strength due to the thermal effects on the microstructure of the concrete.

Durability

Durability is a vital consideration for structures subjected to aggressive environments, such as exposure to sulfate attacks, carbonation, or freeze-thaw cycles. Curing affects the porosity and permeability of concrete, which are important factors in its long-term durability.

Water curing has been shown to improve the durability of HPC, particularly in preventing chloride penetration and sulfate attack (Bouzoubaa&Lachemi, 2001). Membrane curing also results in improved durability, although it is slightly less effective compared to water curing in highly aggressive environments.

Advanced curing techniques, such as self-curing, have demonstrated enhanced resistance to cracking and better moisture retention, thereby improving the concrete's durability (Tazehkand& Yusoff, 2016).

Crack Resistance

Cracking is a significant issue in concrete due to shrinkage, thermal stresses, and inadequate curing. Water curing has been found to reduce the occurrence of surface cracks by maintaining adequate hydration and temperature control (Kosmatka et al., 2002). Similarly, membrane curing is effective in minimizing evaporation, which helps in reducing cracking. Steam curing, although beneficial for early strength, may induce thermal cracks if not carefully controlled.

IV. CONCLUSION

Curing is a crucial step in the production of high-performance concrete, with significant effects on its mechanical properties and long-term durability. The choice of curing method depends on the specific requirements of the project, such as environmental conditions, time constraints, and the desired concrete properties. Water curing remains the most effective method for achieving optimal strength and durability, but membrane curing and advanced techniques like self-curing and curing blankets offer valuable alternatives for certain applications.

Further research into innovative curing methods and their effects on HPC is necessary to optimize curing protocols for various conditions and ensure the best possible outcomes for the construction industry.

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