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Environmentally Sustainable Concrete Curing with Coloured Polythene Sheets

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Abstract

Sustainability is imperative to the welfare and continual growth of society. Concrete is one of the most widely used sustainable construction material. It is persistently undergoing contemporary developments due to its versatility. Presently, sustainability in concrete is being achieved by several techniques including partial replacement of cement with supplementary cementitious materials like fly ash. These high-volume fly ash mixtures incite meticulous study of curing method followed. It would be also be of substantial significance to seek for an environmentally sustainable curing method that works equally well for conventional concrete mixtures and fly ash mixtures. The present study addresses curing of concrete with coloured polythene sheets. The coloured polythene sheets reflect/absorb/transmit solar radiation to concrete members in a definite fraction depending upon their thickness and optical properties. The vital objective of present study lies in identifying a curing method that supplies optimum amount of solar radiation to a concrete member for desired compressive strength development.

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Keywords: Concrete, Curing, Compressive strength, Sustainability.

1. Introduction

Concrete is one of the world's most widely used sustainable construction material. It is continually undergoing contemporary developments due to its versatility. Curing is the process of maintaining an

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optimum environment (temperature and relative humidity) around fresh concrete to promote proper cement hydration and strength gain. Hydration is a chemical reaction that occurs as soon as water and cement are mixed, but can continue for long periods. For this reaction to continue, concrete requires water. It is noteworthy that most freshly placed concrete contains considerably more water than required for complete hydration of the cement [1]. Curing has a strong influence on all important properties of hardened concrete such as durability, strength, water tightness, abrasion resistance, volume stability and resistance to freeze/thaw. Generally, concrete is mixed, cast and cured at a wide range of temperatures, and also remains in service at different temperatures. For the places like UAE, the actual range of temperatures has widened considerably due to extreme environmental conditions. This may affect the curing period required to achieve desired properties of concrete. On other side, it is highly advantageous to utilize the enormous amount of available solar radiations (or ambient energy) for the strength development process of concrete, which requires having knowledge of influence of temperature and other environmental factors on concrete.

In general, there is an increasing impetus on achieving sustainability in concrete construction. Several research works are underway to seek sustainable techniques for concrete construction. Naik [2] recommended that concrete industries must develop new techniques for creating concrete with minimal use of limestone. Jonkers *et al.* [3] investigated the potential of bacteria to act as self-healing agents for repair of cracks in concrete. Fonseca *et al.* [4] studied mechanical performance of concrete made with recycled concrete waste. A considerable amount of research has also been directed towards partial replacement of cement with supplementary cementitious materials like fly ash and ground granulated blast furnace slag. The process of curing as a sustainable approach would head to win–win situation.

All the operations of concrete manufacturing are energy intensive. Adoption of appropriate curing method can be sustainable approach as it advances towards the reduction of resource use. The duration and type of curing plays a big role in determining the required materials necessary to achieve the high level of quality. Curing is the process in which the concrete is protected from loss of moisture and kept within a reasonable temperature range. The result of this process is increased strength and decreased permeability. Curing is also a key parameter in mitigating cracks in the concrete, which severely impacts durability. When a smart, suitable, and practical curing method is used, the amount of cement required in achieving given strength and durability can be reduced by either omission or replacement with supplementary cementitious materials. Since the cement is the most energy intensive and commercially expensive portion of a concrete mixture, this leads to a reduction in the cost as well as the absolute carbon footprint of the concrete mixture. Additionally, being practical with curing methods can enhance sustainability by reducing the need for resource intensive conditioning treatments, should the curing method be incompatible with the intended service environment [5]. The present study proposes usage of colored polythene sheets as potential medium of curing. Curing of concrete structural members is carried out by covering them with different colored polythene sheets. These sheets have several advantages like they do not allow appreciable loss of water by evaporation and thus do not delay or prevent curing (or hydration process) besides providing optimal ambient energy (in terms of temperature, relative humidity, distance and orientation of surface receiving solar radiations, etc.,) for strength gain and sheets are readily available, reusable and can easily cover all surfaces of concrete structural members in building construction and infrastructure development.

The prime objective of present study lies in study of compressive strength and related parameters of M40 grade concrete. The concrete cubes cast were cured using five different colored polythene sheets (black, blue, red, white and yellow) to relate their response to compressive strength gain in comparison to conventional methods of curing (ponding and sprinkling). According to Kosmatka [6], in order to prevent damages in concrete due to volume changes, excessive rates of heating and cooling should be avoided. A higher curing temperature provides earlier strength gain in concrete than a lower temperature, but it may decrease characteristics compressive strength of concrete. Gardner [7] recommended that the period of time that