Chapter 22: Cement – Setting, Hardening & Types

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Abstract

Hydration, setting and hardening of cement is the chapter where it is bordered upon the chemical reactions and the processes that affect the formation of the cement strength. A series of hydration reactions occurring as a result of the mixing of cement and water produce cement products such as calcium silicate hydrate (C-S-H) and calcium hydroxide that confer strength and stability. The chapter explains the setting times during the initial phase and concluding phase, things which affect the setting times and the relevance of curing on the optimization of the compressive strength and the structural integrity. Cement is of the following types, Ordinary Portland Cement (OPC), Pozzolanic Portland Cement (PPC), rapid-hardening cement, and sulfate-resisting cement and their composition, properties, and industrial applications are explained. The emphasis is put on the use of pozzolanic materials, the minimization of heat of hydration, and sustainability. Its applicability in the industry is noted in construction works, infrastructure and high production of concrete when the consideration of setting and hardening in construction is a paramount aspect that determines quality assurance, material selection, and good durability. The principles of making materials design relying on cement, conditions of hydration optimization, and issues of long-term construction will be demonstrated to the students through the combination of both the concepts of chemistry and practical solutions that will prepare them to be useful in civil engineering, construction technology, materials science.

Keywords: Cement, Hydration, Setting time, Hardening, OPC, PPC, Pozzolanic cement.

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22.1.Introduction

The chemical reaction between cement minerals and water forms the basis of setting and hardening of cement which is one of the key processes in hydraulic processes. Such reactions convert cement to a fine powder into solid rigid and stone like cement with which aggregates can be held together to form it into a long life cycle concrete as one. The inability to remain plastic after a certain time of mixing with water is termed as setting process and further process is called hardening. These processes determine the most important performance properties of the concrete that include the early and long-term strengths, the durability, the workability, the impermeability and the resistance to the physical, chemical and environmental attacks. Cement creation history helps to provide an adequate knowledge of such processes knowledge. The Greek, the Roman and the Egyptian ancient societies built the permanent structures with the aid of the lime based binders and the natural pozzolans (volcanic ash). The use of romantic concrete in the Pantheon as well as aqueducts was exceptionally strong owing to the existence of pozzolanic reactions that complemented binding and resistance to water. No scientific knowledge of cement hydration however existed until the Industrial Revolution. One of the greatest inventions was the Portland cement which was produced in 1824 by Joseph Aspdin when he patented the cement which was developed by the use of limestone and clay to form a hard substance known as the clinker which was ground into fine powder. The Portland cement was so named because it had similarity to Portland stone. A later discovery involved the tricalcium silicate, dicalcium silicate, tricalcium aluminate and tetra calcium aluminoferrite phases of the main clinker and its contribution towards the formation of setting and strength, which were clarified in later research in the late 19th and early 20th centuries. The contemporary science of

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