Report on the Physical Properties and Durability of Fiber-Reinforced Concrete

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This document addresses the physical properties and durability of fiber-reinforced concrete (FRC). The effects of fiber reinforcement are evaluated for various physical, short-term, and long-term benefits they impart to the concrete mixture. A variety of test methods, conditions, and properties are reported. Various properties listed, in addition to the wide variety of the choices available in formulating matrix systems, allow performance-based specification of concrete materials using fibers to become a viable option. This document provides a historical basis and an overview of the current knowledge of FRC materials for tailoring new, sustainable, and durable concrete mixtures.

This document is divided into three sections. The first section discusses the physical properties of FRC in terms of electrical, magnetic, and thermal properties. Rheological properties, which affect fiber dispersion and distribution, are discussed using both empirical and quantitative rheology. Mechanisms of creep and shrinkage and the role of various fiber types in affecting both plastic shrinkage cracking and restrained shrinkage cracking are also addressed. The durability of concrete as affected by the addition of fibers is documented under freezing and thawing, corrosion, and scaling. The durability of FRC systems is also affected as different fibers respond differently to the highly alkaline cementitious microstructure. The durability of alkali-resistant glass and cellulose fibers are studied by an in-depth evaluation of long-term accelerated aging results. Degradation and embrittlement due to alkali attack and bundle effect are discussed. Recent advances for modeling and design of materials with aging characteristics are presented. Literature on the use of FRC materials under aggressive environments, extreme temperatures, and fire is presented. The final sections list a series of applications where the use of FRC has resulted in beneficial durability considerations.

Keywords: aging; chloride permeability; corrosion; cracking; creep; diffusion; degradation; ductility; durability; electric properties; embrittlement; fiber-reinforced cement-based materials; fiber-reinforced products; fire resistance; flexural strength; freezing-and-thawing; glass; microracking; permeability; plastic shrinkage; polypropylene; polyvinyl alcohol; reinforcing materials; rheology; shrinkage cracking; steel; sulfate attack; thermal conductivity; toughness; water permeability; wood pulp.