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Report on Glass Fiber-Reinforced Concrete Premix

Reported by ACI Committee 549

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Glass fiber-reinforced concrete premix technology is becoming increasingly popular worldwide for manufacture of precast concrete products used in industrial, architectural, civil engineering, and construction applications. Glass fiber-reinforced concrete premix products provide a useful balance of properties such as strength, toughness, durability, moisture resistance, dimensional stability, fire resistance, and aesthetics. This report summarizes the current knowledge of materials, manufacturing methods, engineering properties, and applications of glass fiber-reinforced concrete premix.

Keywords: cement-based composites; cement boards; cement panels; composite materials; concrete panels; ductility; durability; engineering properties; fiber-reinforced cement-based materials; ferrocement; fibers; flexural strength; glass fiber-reinforced concrete; glass fibers; manufacturing methods; mesh reinforcement; premix; toughness.

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CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

The use of glass fiber-reinforced concrete started in the late 1960s with the development and commercialization of alkali-resistant (AR) glass fiber. The technology spread rapidly throughout the world because of desirable physical properties and durability performance of products reinforced with AR glass fibers. Glass fiber-reinforced concrete premix, as known in the industry and presented in this report, is a material that incorporates AR glass fibers into the slurry during mixing and slurry preparation. In glass fiber-reinforced concrete premix, fibers of various lengths from 0.25 to 1.5 in. (6 to 38 mm) and in concentrations of 0.25 to 4.0% by weight of the mixture are typically used and mixed together with the cementitious mixture while preparing the slurry. This fiber-reinforced slurry is then used to produce glass fiber-reinforced concrete premix products by selecting an appropriate manufacturing process. Glass fiber-reinforced concrete premix products are now manufactured in more than 100 countries.

Specific property improvements obtained with glass fiber-reinforced concrete premix include superior crack resistance and enhanced mechanical performance that includes improved tensile, flexural, and impact strength behavior. Note that glass fiber-reinforced concrete premix differs from another class of material, herein called conventional GFRC, primarily in the method of delivering fibers into the slurry and the amount of fiber reinforcement in the composite. Conventional GFRC typically incorporates greater than 4% AR glass fibers by weight and, during production, keeps the glass fibers and slurry separate until delivering both simultaneously to the mold surface through a special spraying apparatus (ACI 544.1R and ACI 549.2R).

Glass fiber-reinforced concrete premix is a mixture of AR glass fiber, sand, cement, water, chemical and mineral admixtures, and aggregate, if required. Mixture proportions are determined by the physical property requirements of the end product. Physical properties of glass fiber-reinforced concrete premix, such as tensile and flexural strength, are influenced by the fiber content, geometry, length, orientation, and the water-cementitious material ratio (*w/cm*) of the mixture. The maximum amount of fiber successfully incorporated in the mixture is influenced by the fiber length, strand structure and integrity, and the ability of the mixer to efficiently disperse the fibers evenly throughout the matrix. Introducing over 4% of glass fibers by weight of the mixture does not significantly improve the mechanical strength of glass fiber-reinforced concrete premix composites. Conventional GFRC generally provides higher mechanical strength and ductility from its ability to incorporate higher fiber content, longer fiber lengths, superior two-dimensional fiber orientation, and lower water content. Both types of manufacturing methods are widely used commercially, and the choice between the two is primarily dictated by the required performance and aesthetical characteristics of the end product and application. The economics of manufacturing glass fiber-reinforced concrete premix are generally superior to that of conventional GFRC, mainly due to the lower labor costs per unit area of manufactured premix product.

Several manufacturing processes for producing glass fiber-reinforced concrete premix products have been developed, such as casting, spray premix, press molding, extrusion, and pultrusion. Many new products have been designed and produced to capitalize on the good performance of glass fiber-reinforced concrete premix. Glass fiber-reinforced concrete premix material and process technologies are commonly used for manufacturing precast concrete products for industrial, architectural, and ornamental applications. Examples include: trench lid covers for underground electrical distribution lines, modular building panels, decorative architectural products, terra cotta replacement products, and many other industrial products.

1.2—Scope

This report introduces glass fiber-reinforced concrete premix and reviews the state of knowledge regarding selection of materials, mixture proportions, and manufacturing methods for producing premix products. Also highlighted is a diverse range of glass fiber-reinforced concrete premix applications from around the world and dry-bagged premix materials that are used in surface bonding, stucco, and certain shotcrete applications. The terms "glass fiber-reinforced concrete premix" and "premix" are used interchangeably throughout this report.

CHAPTER 2—NOTATION, DEFINITIONS, AND ACRONYMS

2.1—Notation

V_f = volume fraction of fibers
w/cm = water-cementitious material ratio