IN-LB	Inch-Pound Units
SI	International System of Units

Glass Fiber-Reinforced Concrete Premix—Report

Reported by ACI Committee 549

ACI PRC-549.3-22

American Concrete Institute
Always advancing

American Concrete Institute
Always advancing

First Printing
September 2022
ISBN: 978-1-64195-194-4

Glass Fiber-Reinforced Concrete Premix—Report

The technical committees responsible for ACI committee reports and standards strive to avoid ambiguities, omissions, and errors in these documents. In spite of these efforts, the users of ACI documents occasionally find information or requirements that may be subject to more than one interpretation or may be incomplete or incorrect. Users who have suggestions for the improvement of ACI documents are requested to contact ACI via the errata website at http://concrete.org/Publications/DocumentErrata.aspx. Proper use of this document includes periodically checking for errata for the most up-to-date revisions.

ACI committee documents are intended for the use of individuals who are competent to evaluate the significance and limitations of its content and recommendations and who will accept responsibility for the application of the material it contains. Individuals who use this publication in any way assume all risk and accept total responsibility for the application and use of this information.

All information in this publication is provided “as is” without warranty of any kind, either express or implied, including but not limited to, the implied warranties of merchantability, fitness for a particular purpose or non-infringement.

ACI and its members disclaim liability for damages of any kind, including any special, indirect, incidental, or consequential damages, including without limitation, lost revenues or lost profits, which may result from the use of this publication.

It is the responsibility of the user of this document to establish health and safety practices appropriate to the specific circumstances involved with its use. ACI does not make any representations with regard to health and safety issues and the use of this document. The user must determine the applicability of all regulatory limitations before applying the document and must comply with all applicable laws and regulations, including but not limited to, United States Occupational Safety and Health Administration (OSHA) health and safety standards.

Participation by governmental representatives in the work of the American Concrete Institute and in the development of Institute standards does not constitute governmental endorsement of ACI or the standards that it develops.

Order information: ACI documents are available in print, by download, through electronic subscription, or reprint and may be obtained by contacting ACI.

Most ACI standards and committee reports are gathered together in the annually revised the ACI Collection of Concrete Codes, Specifications, and Practices.

American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
Phone: +1.248.848.3700
Fax: +1.248.848.3701

www.concrete.org

ACI PRC-549.3-22

Glass Fiber-Reinforced Concrete Premix—Report

Reported by ACI Committee 549

Antonio Nanni, Chair

Corina-Maria Aldea, Secretary

Nemkumar Banthia
Christian Carloni
Paolo Casadei
Gianmarco de Felice
Michael E. Driver
Ashish Dubey
Usama A. Ebead
Mahmut Ekenel
Garth J. Fallis
Houman Akbari Hadad
Ardalan Hosseini
Barzin Mobasher
Hani H. Nassif
Bekir Yilmaz Pekmezci
Alva Peled
Marco Quaini
Larry Rowland
Surendra P. Shah
Yixin Shao
Flavio de Andrade Silva
Lesley H. Sneed
J. Gustavo Tumialan

Consulting Members

Gordon B. Batson
James I. Daniel
John Jones
Antoine E. Naaman
Paul Nedwell
P. Paramasivam
Parviz Soroushian

Special acknowledgments to N. Sparrow for his contributions to this report.

Alkali-resistant (AR) glass fiber-reinforced concrete premix technology has become increasingly popular worldwide for manufacture of precast concrete products used in industrial, architectural, civil engineering, and construction applications. AR 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 AR glass fiber-reinforced concrete premix.

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

CONTENTS

ACI PRC-549.3-22 supersedes ACI 549.3R-09(17) and was adopted and published in September 2022.

CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

The use of glass fiber-reinforced concrete (GFRC) started in the late 1960s with the development and commercialization of alkali-resistant (AR) glass fiber (GRCA Technical Working Group 2019). The technology spread rapidly throughout the world because of desirable physical properties and durability performance of products reinforced with AR glass fibers. GFRC 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 AR GFRC 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 with the cementitious mixture while preparing the slurry. This fiber-reinforced slurry is then used to produce GFRC premix products by selecting an appropriate manufacturing process. AR GFRC premix products are now manufactured in more than 100 countries.

Specific property improvements obtained with GFRC premix include superior crack resistance and enhanced mechanical performance that includes improved tensile, flexural, and impact strength behavior. Note that GFRC premix differs from another class of material, herein called spray-up GFRC, primarily in the method of delivering fibers into the slurry and the amount of fiber reinforcement in the composite. Spray-up 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; ACI 549.2R).

GFRC 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 AR GFRC premix, such as tensile and flexural strength, are influenced by the fiber content, geometry, length, orientation, and the water-cementitious materials 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 GFRC premix composites. Spray-up GFRC generally provides higher mechanical strength and ductility from its ability to incorporate higher fiber content, longer fiber lengths, superior two-dimensional (2-D) 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 GFRC premix are generally superior to that of spray-up GFRC, mainly due to the lower labor costs per unit area of manufactured premix product.

Several manufacturing processes for producing GFRC premix products have been developed, such as casting, spray premix, press molding, extrusion, calender extrusion, and pultrusion. Many new products have been designed and produced to capitalize on the good performance of GFRC premix. AR GFRC 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 considers AR GFRC 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 AR GFRC premix applications from around the world and dry-bagged premix materials that are used in surface bonding, stucco, and certain shotcrete applications. The terms “AR glass fiber-reinforced concrete premix,” “glass fiber-reinforced concrete premix,” and “premix” are used interchangeably throughout this report.