Guide for the Use of Polymers in Concrete

Reported by ACI Committee 548

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This guide presents information on how to use polymers in concrete to improve some characteristics of the hardened concrete. Recommendations are included for polymer-impregnated concrete, polymer concrete, polymer-cement concrete, and safety considerations for the use of polymers in concrete. Information is provided on types of materials and their storage, handling, and use, as well as concrete formulations, equipment to be used, construction procedures, and applications. Glossaries of terms and abbreviations are also included.

Keywords: bridge deck; durability; latex; monomer; polymer; polymer concrete; polymerization; repair.

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CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

The mission of ACI Committee 548 is to report on the use of polymers in concrete. Since its organization in 1971, the committee has sponsored numerous symposia and technical sessions at ACI conventions, and has produced several documents on a variety of topics concerning the use of polymers in concrete (ACI 548.2R, 548.3R, 548.4, 548.5R, 548.6R).

Benefits derived from the use of polymers in concrete have worldwide appeal, as demonstrated by the extensive international attendance at the many symposia and congresses that have addressed this subject (ACI Committee 548 1973, 1978, 1981, 1985, 1987, 1989, 1993, 1996, 1997, 2003; Bartholomew et al. 1978; Fontana et al. 1978; Fowler et al. 1978; Fukuchi and Ohama 1978; Imamura et al. 1978; Kaeding 1978a,b; Koblischek 1978; Kukacka 1978; Locke and Hsu 1978; McClain 1978; Patty 1978; "Polymers in Concrete" 1976, 1978, 1981, 1984). The contributions made at these meetings, along with the practical experience gained within the growing industry that applies polymer technology to concrete, form the base of applied concrete technology that is limited only by the ingenuity of the concrete user.

1.2—Scope

This guide provides a fundamental background needed to apply the technology of polymers in concrete to a variety of engineering problems and applications.

The guide contains four basic sections that address polymer-impregnated concrete (PIC), polymer concrete (PC), polymer portland-cement concrete (now called polymer-cement concrete [PPCC]), and safety. Each of the three categories of concrete-containing polymers is usually applied to particular types of concrete elements or specific concrete property improvements, although there are significant overlapping areas. Safety, however, is a prerequisite for all polymer usage, and is discussed collectively. The guide does not contain extensive tabulated data from specific studies, as this type of information is available in other documents and does not contribute significantly to an understanding of how the polymers should actually be used in or applied to concrete.

CHAPTER 2—DEFINITIONS, ABBREVATIONS, AND ACRONYMS

ACI provides a comprehensive list of acceptable notation and definitions through an online resource. These were taken from the Cement and Concrete Terminology page of the ACI Web site (http://www.concrete.org/Technical/CCT/FlashHelp/ACI_Terminology.htm).

2.1—Definitions

accelerator—a material that increases the rate of a chemical reaction.

additive—a substance added to another in relatively small amounts to impart or improve desirable properties or suppress undesirable properties.

auto-ignition temperature—the temperature at which the vapor-air mixture above a liquid monomer spontaneously ignites at a normal atmosphere with no external ignition source.

bulk polymerization—the production of stable polymer or hardened epoxy by adding a polymerization catalyst and an initiator or heat to a monomer in open-top containers and allowing the monomer to polymerize. Hardeners are added to epoxies to accomplish this.

catalyst—a substance that accelerates a chemical reaction but is not permanently changed by the reaction.

cross-linking agent—a substance that increases the molecular weight of a polymer by chemically linking and bridging the polymer chains.

dry pack placement—method of producing polymer concrete by placing and tamping graded aggregate, completely wetting the aggregate with liquid monomer, and then polymerizing the composite.

emulsifier—a substance that modifies the surface tension of colloidal droplets, keeping them from coalescing and keeping them suspended.

emulsion—a two-phase liquid system in which small droplets of one liquid (the internal phase) are immiscible in, and dispersed uniformly throughout, a second continuous liquid phase (the external phase).

encapsulation—the production of fully impregnated concrete with minimal monomer evaporation and drainage losses during the polymerization process.

endothermic—pertaining to a reaction that occurs with the absorption of heat.

epoxy resins—a class of organic chemical bonding systems used in the preparation of special coatings or adhesives for concrete or as binders in epoxy-resin mortars, concretes, and fiber composites.

exothermic—pertaining to a reaction that occurs with the evolution of heat.

explosive limit—the upper or lower vapor concentration that supports combustion in air at room temperature and normal atmospheric pressure.

flash point—the lowest temperature at which the vapor of a combustible liquid can be made to ignite.

glass-transition temperature (T_g)—the midpoint of the temperature range over which an amorphous material (such as glass or a high polymer) changes from (or to) a brittle, vitreous state to (or from) a plastic state.

hardener—a chemical (including certain flurosilicates or sodium silicate) applied to concrete floors to reduce wear and dusting; or in a two-component adhesive or coating, the chemical component that causes the resin component to cure.