Guide for Polymer Concrete Overlays

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This guide provides an overview of thin (less than 1 in. [25 mm] thick) polymer concrete overlays for concrete and steel substrates. Emphasis is placed on their use in the transportation sector, specifically for bridge decks and parking garages. Surface preparation, application, quality control, and safety aspects are included.

Keywords: aggregate; bridge deck; epoxy; high friction surface; methyl methacrylate; mortar; overlay; parking garage decks; polyester; polymer concrete; premixed; resin; skid resistance; slurry.

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CHAPTER 1—INTRODUCTION

1.1—General

Reinforced concrete, steel grid, and steel orthotropic decks are constantly exposed to deicing salts and other environmental factors such as acid rain and pollution chemicals. Escalating costs of preservation and replacement of bridges and parking garage decks have promoted construction and maintenance options such as high-density concrete overlays, latex-modified concrete overlays, membrane/asphalt overlays, cathodic-protection systems, epoxy-coated reinforcing bars, and thin polymer concrete (PC) overlays (Mo et al. 2012).

Each option has advantages and disadvantages that should be analyzed before a choice is made. Costs vary by region with the availability of materials and experienced contractors. In addition, the life expectancies of these options are different.

Bridges and parking garage decks contain structural elements that are susceptible to premature failures due to moisture, chlorides, freezing and thawing, and wear from high traffic volumes.

1.1.1 *Advantages*—Compared with other overlay systems, PC overlays are cost effective on a life cycle cost basis (Kim and Lee 2013). Rapid-cure characteristics of PC overlays minimize disruptions, reduce traffic-control costs, and ease the inconvenience of scheduling repairs. With dead load of only 2 to 6 lb/ft^2 (9.8 to 29.3 kg/m^2), PC overlays result in greater live-load capacity than heavier conventional systems. This is a critical factor to be considered for aging structures. At application thicknesses of 3/8 to 1 in. (10 to 25 mm), PC overlays do not require modification of expansion joints or drainage structures. They are highly resistant to the penetration of water and exhibit better chloride-intrusion resistance than other types of concrete overlays. In addition, they offer a high skid resistance and wearing resistance for both concrete and steel deck protection (Lopez-Anido et al. 1998; Wang et al. 2013). PC overlays can be installed without specialized equipment; however, technical expertise is required. Maintaining quality control is important, and proper surface preparation requires close attention.

1.1.2 *Disadvantages*—A disadvantage associated with PC overlays is that they must be applied to dry surfaces. The workability and curing rate of PC overlays are dependent on the substrate, material, and ambient temperatures. Polymer overlays are not intended to provide resistance to reflective cracking.

1.2—History of polymer concrete overlays

Polymer concrete (PC) overlays date back to the 1950s, with original systems consisting of a single layer of coal-tar epoxy evenly spread over the substrate and broadcast with aggregate. These overlays were relatively porous and did not stand up well to heavy traffic. In the early 1960s, oil-extended epoxy came into use in an attempt to improve resistance to water penetration. By the mid-1970s, low- and medium-modulus 100 percent solids epoxy formulas were introduced, and many of these systems continue to be used successfully today.

By the mid-1960s, single- and double-layer polymer broadcast systems and polyester resins, and methyl methacrylate overlays were introduced. The first premixed and screeded polymer and aggregate systems also appeared at this time. Thicker PC overlays and brittle materials were used, frequently exhibiting cohesive failure in the concrete. Through trial and error, resin formulations were modified to provide better thermal compatibility and improved physical properties. Resistance to chemical and mechanical attack, corrosion resistance, and performance under adverse installation conditions have also been the subject of extensive development. For instance, Whiting (1991) showed, using field measurements, that corrosion current in reinforced concrete bridge deck substrates is decreased when a low-permeability overlay (for example, latex-modified concrete overlay) was installed. Virmani (1992) showed that electrically conductive PC overlays can be used as secondary anodes to distribute cathodic protection current across the concrete surface and provide a skid- and water-resistant surface. PC overlays have been shown to be successful, though some problems still exist. Many of these problems are the result of inadequate surface preparation, improper application techniques, or inappropriate selection of polymer materials.

There have been many improvements in PC materials and technology. PC overlays are now generally specified with flexible resins and high-friction wear-resistant aggregates. Workmanship and inspection techniques have also improved as designers, inspectors, and applicators have gained experience related to the causes and prevention of PC overlay defects continues to improve. Some of the best practices on PC overlays have been reported by Fowler and Whitney (2011).

1.3—Scope

This guide is intended to aid in the proper selection and application of PC overlays for structures in the transportation industry, focusing primarily on bridge and parking garage decks. Materials discussed are epoxies, polyesters, and methacrylates for application on either concrete or steel surfaces.

In general, these overlays are used for the protection of the substrate and are designed to be compatible without causing stress. The low permeability of PC overlays makes them resistant to the penetration of water and provides protection against chloride penetration. Overlays are designed to minimize deterioration from repeated thermal expansion and contraction (Fowler et al. 2001). In addition to describing the characteristics of PC overlays, this guide includes chap-