Guide for Maintenance of Concrete Bridge Members

Reported by ACI Committee 345

Richard E. Weyers
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Alan B. Matejowsky
Harold R. Sandberg
Johan Silfwerbrand
Michael M. Sprinkel
Paul St. John
Jerzy Zemajtis

Bridges represent a substantial investment of public funds, and are expected to provide satisfactory performance and remain in service for many years. Design specifications typically require 75- or 100-year design life for new bridges. Neglecting or delaying bridge maintenance can result in reduced service life and increased costs due to repair, rehabilitation, or replacement at an early age. Another consequence of neglecting maintenance is that the condition of the bridge can become life-threatening to the public. It is believed that continuous and systematic maintenance of a bridge will extend its service life and reduce its overall operating cost.

This document addresses typical problems and presents potentially cost-effective maintenance techniques for concrete bridge elements. It provides guidance for engineers and maintenance staff. It does not cover repair, rehabilitation, reconstruction, or bridge inspection, and therefore, it does not include topics such as cathodic protection, repair with shotcrete, and deck overlays. Detailed methods of repairing and inspecting bridges may be found in the references.

Concrete bridge maintenance is defined as those activities that are relatively inexpensive and repeatable, performed when the concrete element is still in good to fair condition, intended to prevent or minimize deterioration of the concrete. These activities may include sealing, washing, caulking, crack repair, and other minor repairs intended to prolong the functionality of the bridge element.

Keywords: bridge decks; cementitious; coating; maintenance; placement; polymer; sealant.

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ACI 345.1R-06 supersedes ACI 345.1R-92 and became effective March 14, 2006.

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CHAPTER 1—BRIDGE MAINTENANCE

1.1—Introduction

Bridges represent a substantial investment of public funds and are expected to function for many years. United States design specifications typically require a 75- or 100-year design life, and European specifications require a 120-year design life. Neglecting or delaying bridge maintenance can result in reduced service life and increased life-cycle costs due to repair, rehabilitation, or replacement at an early age. Another consequence of neglecting maintenance is that the condition of the bridge can become life-threatening to the public.

When exposed to sufficiently aggressive environmental conditions, structural concrete members will eventually deteriorate and lose strength. Aggressive environmental conditions for bridges involve cycles of freezing and thawing, and cycles of wetting and drying, with or without the presence of chloride. Corrosion of reinforcing steel spalls the cover concrete, reduces the cross-sectional area of the reinforcing steel, and therefore, its strength. The time required for deterioration to occur varies considerably, depending on the severity of the exposure conditions and the characteristics of the structural concrete. It is believed that continuous and systematic maintenance of a bridge will extend its service life and reduce its overall operating cost.

1.2—Concrete bridge maintenance

Bridge deterioration usually occurs slowly at first and is often overlooked. In later stages of deterioration, however, sudden catastrophic events can occur, demanding immediate action. Progressive deterioration can be retarded and sometimes avoided if proper systematic preventive maintenance is practiced (Carter and Kaufman 1990). Concrete bridge maintenance involves relatively inexpensive, repeatable activities that either prevent or minimize concrete life of bridge elements or are minor repairs that extend the service of the structural concrete members.

Concrete bridge maintenance is performed when the structural concrete member is still in good to fair condition, and can be subdivided into preventive and responsive maintenance.

1.2.1 *Preventive maintenance*—Preventive maintenance procedures are done before deterioration is visible and the structural concrete member is still in good condition, and are usually planned at the design stage and started accordingly. Procedures include sealing, washing, caulking, and crack repair. A procedure not planned is installing retrofit drains.

1.2.2 *Responsive maintenance*—Responsive maintenance procedures are usually more extensive, and are done in the early stages of the visible deterioration cycle. Procedures include small repairs, establishment of positive deck drainage systems, maintaining the functionality of deck joints, and similar activities to extend the service life of structural concrete members in bridges.

1.3—Purpose of maintenance

Maintenance activities are often more cost effective when the concrete is still in relatively good condition and is focused on those parts of a structure that face the most severe exposure conditions. Preventive maintenance addresses causes of the potential deterioration, as opposed to treatment, of the effects of deterioration. For example, sealing the deck surface reduces the infiltration of chloride. Proper preventive maintenance activities can reduce the rate of deterioration, extend service life, and reduce future repair costs (Carter 1989a). Responsive maintenance activities help to keep bridges operating safely and efficiently.

1.4—Limitations

Maintenance is no substitute for proper design and construction. Even proper maintenance will not produce desirable results when applied to improperly designed and constructed concrete bridge elements. Examples of improper design include insufficient reinforcing steel cover depths, excessive surface cracking, and poor drainage characteristics, such as ponding of chloride-contaminated water on a concrete bridge deck.

1.5—Timing of maintenance

Maintenance activities performed at the proper time are extremely cost effective. Similarly, maintenance activities conducted at the wrong time can be a poor investment. The wrong time for maintenance is after significant damage has occurred. Maintenance can prevent damage, but it cannot restore deteriorated concrete. Damage such as scaling,