Continuously Reinforced Concrete Pavement

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CHAPTER 1. INTRODUCTION

PURPOSE

The purpose of this course is to provide the best practices information on rehabilitation strategies for extending the service life of continuously reinforced concrete pavements (CRCP). The procedures described in this course consist of defining the problem, identifying potential solutions, and selecting the preferred alternatives.[1,2]

Several guidelines for CRCP repair and rehabilitation strategies have been published, such as the *1993 AASHTO Guide for Design of Pavement Structures*; the FHWA series on the performance of CRCP that includes *Volume IV: Resurfacings for CRC Pavements* and *Volume V: Maintenance and Repair of CRC Pavements*; and *The Concrete Pavement Restoration Guide* from the American Concrete Pavement Association. (See references 3, 4, 5, and 6.) The most pertinent sections of these documents, and others, are highlighted in this course, yielding state-of-the-art rehabilitation procedures for CRCP. The intent is for users of this course to tailor the discussed rehabilitation strategies to meet their own project needs and priorities.

Potential rehabilitation strategies to extend the service life of existing CRCP are discussed in chapter 4. The decision tree presented in chapter 4 can be used to systematically determine which restoration methods are appropriate based on the pavement's structural and functional condition. The restoration treatments are presented as a function of pavement distresses, and general guidelines for selecting which resurfacing treatment to use are provided.

Rehabilitation treatments to extend the service life of existing CRCP s can be selected from the methods listed in chapters 5 and 6:

- Restoration techniques described in chapter 5 include full-depth repairs (FDRs), partial-depth repairs (PDRs), diamond grinding and grooving, joint resealing, slab stabilization and slab jacking, and cross stitching. Items to consider when selecting the restoration techniques are also presented.

- Resurfacing options, namely bonded concrete overlays (BCOs), unbonded concrete overlays (UBOLs), and hot-mix asphalt (HMA) overlays on intact CRCP are discussed in chapter 6, along with the prerequisites to their proper selection.

- Materials used for full-depth and partial-depth patching and for slab stabilization and jacking are presented in chapter 7.

- State specifications for the repair and rehabilitation of CRCP from Texas and Illinois, the States with the most constructed lengths of CRCP, are summarized in chapter 8. Also summarized in chapter 8 are State specifications from Iowa, Texas, and Illinois for overlays for CRCP.

- Standard details for FDR of CRCP from Texas, Illinois, and Georgia are presented in appendix A.

SCOPE AND TERMINOLOGY

This document is intended to provide guidance in selecting the optimal rehabilitation strategy for a CRCP based on observations of the pavement's structural and functional condition, along with an understanding of pavement engineering. It should be noted that the "engineering" solution for the optimum CRCP rehabilitation may not be the best final solution since other decisionmaking criteria such as traffic and constructability, agency policies, and funding can sometimes control the selection process.

Because rehabilitation terminology varies in the literature, the definitions used in this course are described here. It is assumed that the rehabilitation strategy is selected at the project level. Rehabilitation strategies describe the type and quantity of treatments that should be used, along with when they should be applied. They can be subdivided into two categories, restoration and resurfacing, as shown in table 1.

- *Restoration:* Restoration activities are designed to preserve the existing pavement by repairing isolated or localized areas of distress in the CRCP and then preventing their reoccurrence by stopping or delaying the deterioration process. Identifying the mechanisms leading to the distresses allows the optimal restoration treatment (or set of treatments) to be used. Preventive maintenance and repair methods fall into the restoration category. Pavement restoration activities can be utilized either before or in conjunction with pavement resurfacing methods.

- *Resurfacing:* Resurfacing activities, or overlays, are designed to significantly increase the structural or functional capacity of an existing pavement. These treatments are not localized, but are applied over the entire surface of the existing pavement. Overlays are used when restoration techniques are no longer sufficient or cost effective, but before reconstruction is required.

Table 1. Framework for rehabilitation activities.[3,7]

Classification	Function	Treatment Types
Restoration (see chapter 5)	Preventive maintenance, preservative or corrective	Retrofitted edge drains Joint or crack sealing Retrofitted concrete shoulders Cathodic protection
	Repair	Full-depth repair Partial-depth repair Diamond grinding and grooving Pressure relief or expansion joints Slab stabilization and jacking Cross stitching
Resurfacing (see chapter 6)	Overlay construction	Hot-mix asphalt overlay Bonded concrete overlay Unbonded concrete overlay

CHAPTER 2. EVALUATING CRCP

To develop the "best" rehabilitation strategy, the condition of the existing pavement must be thoroughly evaluated using visual condition surveys, deflection testing, and profile measurements. The data that should be collected can be divided into the following categories:

- Pavement condition: structural and functional.
- Pavement materials and soils properties: surface, subbase, and subgrade.
- Pavement design.
- Drainage conditions.
- Climatic conditions.
- Traffic volumes and loading.
- Geometric and safety factors.

The condition survey provides information on the pavement structural and functional condition via a visual distress evaluation. This survey also documents any previous maintenance activities performed, and the condition of the shoulders. A drainage survey (including local climatic conditions) should also be conducted at this time, along with the collection of field samples. Subsequent laboratory testing provides information on the properties of the pavement materials and soils. Special considerations to keep in mind when performing the condition survey include the traffic volumes and loads, pavement design, and geometric and safety factors. Deflection tests can be used to measure the load transfer efficiency (LTE) at cracks and joints, and to detect voids under the pavement. The results are also used to backcalculate the thickness and stiffness of the layers comprising the pavement structure. If collected, pavement profile measurements can be used to quantify the pavement smoothness. After all of the data are collected, the data should be analyzed to identify the mechanisms causing the deterioration. With this information, the proper rehabilitation strategy can be selected.

Pavement condition data can be used to assess the variability of pavement performance—assessing the rate of deterioration as it varies from point to point along the highway. A variability assessment can be used to determine whether the entire pavement should be resurfaced or whether only localized areas of restoration are needed. Periodic pavement evaluations are especially beneficial because they reveal the rate of deterioration of the pavement. They also assist in identifying deficiencies before they evolve into more significant structural distresses. Preventive, preservative, or corrective actions can be applied at the most opportune time if periodic surveys are conducted. Quite often, each agency has standard data collection and evaluation procedures that best suit its personnel and equipment resources. (Detailed information on how to perform systematic step-by-step condition surveys can be found in references 1, 3, 8, and 9.)

VISUAL CONDITION SURVEY

Before any rehabilitation project is initiated, a visual condition survey of the pavement should be conducted. The distresses visible on the surface of the pavement provide insight into the current structural and functional condition of the pavement. A visual condition survey is often described in terms of a distress survey, a drainage survey, field sampling and testing, and special considerations. Each of these is elaborated on herein.

Results from a visual condition survey may be presented graphically in the form of strip charts or historical performance charts that detail the condition of the pavement at various points along the project length. When used in conjunction with other field tests listed in this chapter, the pavement performance is more accurately characterized. Methods used to conduct visual condition surveys include windshield surveys, walking the pavement, and automated survey equipment. It may be useful to drive the pavement prior to the visual survey to obtain a sense of the distresses that are likely to exist based on the ride quality.

Distress Survey

A distress is defined as any visible defect or form of deterioration on the surface of a pavement. For CRCP, distresses include punchouts, wide transverse cracks, longitudinal cracks, and crack spalling. Other distresses that are more common to jointed concrete pavement (JCP) may also occur in CRCP, such as faulting, pumping, joint deterioration, blowups, and patch deterioration, Materials-related distresses (MRD) can occur in both pavement types and can include D-cracking, alkali–silica reactivity (ASR), freeze–thaw damage, popouts, scaling, corrosion, swelling, and depressions. The mechanisms behind each distress can be described in terms of traffic loads, climatic conditions, materials incompatibilities, or a combination of all three. The purpose of a distress survey is twofold:

- To document the condition of the pavement.
- To characterize the distresses by type, severity, and amount (relative area).

The *Distress Identification Manual for the Long-Term Pavement Performance Program* is one of the most widely cited distress identification manuals.[10] This manual has standardized definitions of the different distress types, allowing for uniformity in identifying their severity and extent. If the type, severity, and extent of the distress are not accurately noted in the survey, it may prove difficult to optimize the rehabilitation strategy. It is important that the survey team review all current and historical pavement records prior to performing a distress survey so they know what to look for while conducting the survey.

Drainage Survey

Distresses in rigid pavements like CRCP can be caused or accelerated by the presence of excess moisture in the pavement structure. A drainage assessment will reveal if drainage improvements are needed or if the current system is not functioning as designed. Recognizing this, drainage surveys are performed to:

- Identify signs of moisture or moisture-related distresses in the pavement.

- Document the pavement drainage conditions (topography, cross slopes ditches, and drainage inlets and outlets if present).[1]

Field Sampling and Testing

To properly characterize the existing pavement, the distress and drainage surveys should be supplemented with the results from laboratory tests on samples of the pavement structure. Destructive testing of core samples taken from the concrete, subbase, and subgrade allow for a more indepth and accurate analysis of the in-place materials and their engineering properties than the surveys provide. In addition, cores can confirm the layer thicknesses in the pavement structure, and can be used to identify MRDs.

Cores are commonly taken at locations observed to have structural deficiencies. They are also taken to validate or complement nondestructive test (NDT) results. Other guidelines for field sampling and testing include the following:

- For punchouts, wide cracks, and any other structural distresses, cores should be taken at the distress to determine the pavement thickness and concrete strength.

- For deteriorated longitudinal and construction joints, cores should be taken through the joints to determine whether or not they are working. If tie bar corrosion is suspected, the core should be taken through the bar to determine the extent of the corrosion and loss of bond.

- For MRDs, like D-cracking and reactive aggregate, petrographic examination and testing of field samples is recommended.

- For drainage deficiencies or foundation movement, subbase and subgrade samples should be tested to determine their permeability and gradation.[11]

The concrete is primarily sampled to measure its strength and thickness, and to identify any MRD problems. Tests on the subbase and subgrade layers focus on measuring their in-situ strength, resistance to load deformations, and resistance to moisture damage. For more field sampling techniques and an overview of in-situ field and laboratory tests, the reader is referred to reference 1.

Special Considerations

The amount of data to collect in a condition survey depends on the size of the project, its variability, the distresses observed, and the rehabilitation methods being considered. In addition, all constraints that will affect the rehabilitation choice should be identified, including geometric and safety factors, traffic control problems, available materials and equipment, and contractor expertise and manpower. Each of these should be assessed at the time of the condition survey. Larger projects on high-traffic-volume roads require a more comprehensive pavement evaluation because premature failures have a more serious effect on performance.[3] However, there are more safety issues with regard to obtaining field samples on high-traffic-volume roads.

Purchase this course to see the remainder of the technical materials.