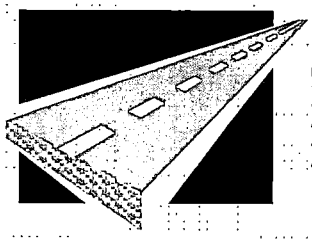

CENTER FOR
PORTLAND CEMENT CONCRETE
PAVEMENT TECHNOLOGY

Evaluation of Unbonded Ultrathin Whitetopping of Brick Streets

Construction Report
August 2002

Iowa Department of Transportation

Department of Civil and Construction Engineering
IOWA STATE UNIVERSITY

Sponsored by
the Iowa Department of Transportation, the Iowa Highway Research Board
(Project TR-466), the Iowa Concrete Paving Association, and the City of Oskaloosa

Technical Report Documentation Page

1. Report No. Iowa DOT Project TR-466	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Evaluation of Unbonded Ultrathin Whitetopping of Brick Streets		5. Report Date August 2002 6. Performing Organization Code	
7. Author(s) J.K. Cable, S. Somsky, N. Streit, and J. Williams		8. Performing Organization Report No. CTRE Project 01-91	
9. Performing Organization Name and Address Center for Portland Cement Concrete Pavement Technology Iowa State University 2901 South Loop Drive, Suite 3100 Ames, IA 50010		10. Work Unit No. (TRAIS) 11. Contract or Grant No.	
12. Sponsoring Organization Name and Address Iowa Highway Research Board 800 Lincoln Way Ames, IA 50010		13. Type of Report and Period Covered Construction Report 14. Sponsoring Agency Code	
15. Supplementary Notes This is not a final report; evaluation continues.			

16. Abstract

Many cities in Iowa have retained the original brick street surfaces in downtown areas and in older residential areas as the base for modern driving surfaces. The original brick surfaces were not built to handle current and future traffic loadings. In recent years these surfaces have tended to shift and become uneven, creating problems with safety. Asphaltic concrete overlays have been the typical rehabilitation technique in these situations. This has proven to be a successful rehabilitation technique in some cases; in other cases the combination of the movement of the brick and the flexibility of the asphalt has proven to accentuate the original problems. Most of the existing literature on rehabilitation of brick streets shows the use of asphaltic concrete. Other rehabilitation methods include reconstruction of the brick surface and strengthening of the surface by placing asphaltic concrete or portland cement concrete, along with sand, underneath the brick layers. To date, little if anything has been done in the area of using portland cement concrete as an overlay of the brick surface. This construction report documents the planning and construction of an unbonded ultrathin whitetopping rehabilitation of a brick street in Oskaloosa, Iowa. A future report will contain an evaluation of the performance of the portland cement concrete overlay over time.

17. Key Words brick street rehabilitation, portland cement concrete overlay, unbonded ultrathin whitetopping		18. Distribution Statement No restrictions.	
19. Security Classification (of this report) Unclassified.	20. Security Classification (of this page) Unclassified.	21. No. of Pages 8	22. Price NA

EVALUATION OF UNBONDED ULTRATHIN WHITETOPPING OF BRICK STREETS

Iowa DOT Project TR-466
CTRE Project 01-91

Principal Investigator
J.K. Cable
Associate Professor of Civil and Construction Engineering, Iowa State University

Research Assistants
S. Somsky, N. Streit, and J. Williams
Department of Civil and Construction Engineering, Iowa State University

Preparation of this report was financed in part
through funds provided by the Iowa Department of Transportation
through its research management agreement with the
Center for Transportation Research and Education.

Center for Portland Cement Concrete Pavement Technology
Iowa State University
2901 South Loop Drive, Suite 3100
Ames, IA 50010
Phone: 515-294-8103
Fax: 515-294-0467
www.ctre.iastate.edu

Construction Report • August 2002

TABLE OF CONTENTS

LIST OF FIGURES

ACKNOWLEDGMENTS

The authors would like to thank the Iowa Department of Transportation, Iowa Highway Research Board, City of Oskaloosa, Iowa Concrete Paving Association, and the Center for Portland Cement Concrete Pavement Technology at Iowa State University for sponsoring this research.

The work was completed with the cooperation of the City of Oskaloosa Public Works Director Larry Stevens and the contractor, Stevens Concrete, Ltd. This report would not have been possible without the assistance of the City of Oskaloosa engineering staff, Stevens Concrete, Ideal Ready Mix, and Iowa Concrete Paving Association. The cooperation and professionalism of all involved in this project are appreciated. It is this type of research that makes Iowa a leader and opens new doors for portland cement concrete applications.

INTRODUCTION

Background

Many cities in Iowa have retained the original brick street surfaces in downtown areas and in older residential areas as the base for modern driving surfaces. The original brick surfaces were not built to handle current and future traffic loadings. In recent years these surfaces have tended to shift and become uneven, creating problems with safety. Asphaltic concrete overlays have been the typical rehabilitation technique in these situations. This has proven to be a successful rehabilitation technique in some cases; in other cases the combination of the movement of the brick and the flexibility of the asphalt has proven to accentuate the original problems. Figures 1 and 2 show exposed brick under the asphalt and the asphalt cracked in several places.

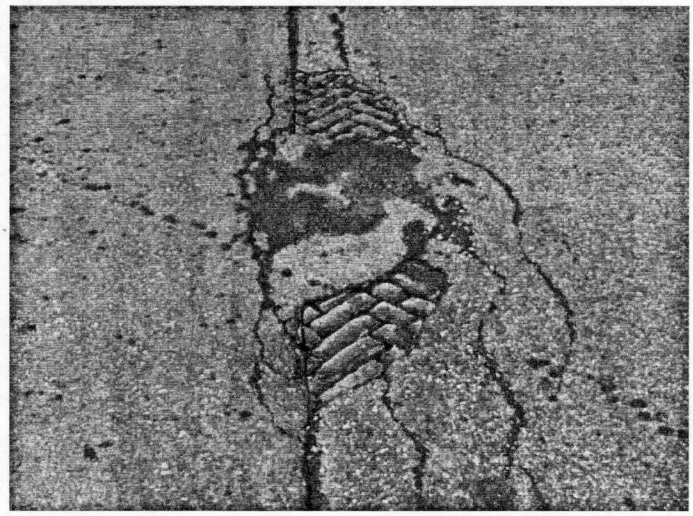

Figure 1. Asphalt Surface with Exposed Brick

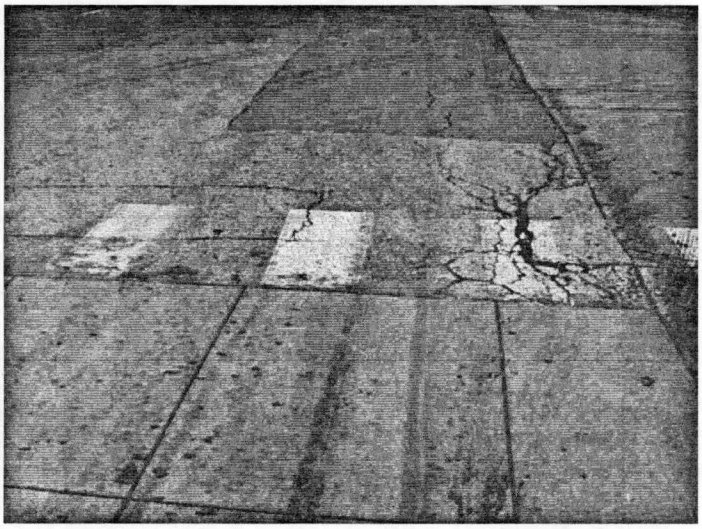

Figure 2. Deteriorated Asphaltic Concrete Surface

Research Objectives

The first objective of this project is to demonstrate the ability to design and place an ultrathin portland cement concrete (PCC) overlay on an existing base of existing asphaltic cement concrete and brick. The second objective is to evaluate the short-term (one year) and long-term (five years) performance of a portland cement concrete overlay of approximately three inches in depth, compared to that of a three-inch asphaltic cement concrete overlay.

Project Overview

This report documents the planning and construction of an unbonded ultrathin whitetopping rehabilitation of a brick street in Oskaloosa, Iowa.

In order to accomplish the above objectives of the research, falling weight deflectometer (FWD) tests and visual distress surveys will be conducted to determine the performance of the PCC overlay over time. A final report will contain an evaluation of the overlay's performance at the end of one year, three years, and five years.

PROJECT SITE DESCRIPTION

The project was constructed in the city of Oskaloosa, located in the southeastern part of central Iowa. The project itself consists of the portland cement concrete overlay of two city blocks. The curb and gutter was rebuilt to a higher elevation to allow the concrete to be placed over the brick. The project begins at Station 0 + 32, located at 8th Avenue on South D Street, and ends at Station 6 + 10, located at 6th Avenue on South D Street. See Figure 3.

In 1899, the original street was built by placing a concrete curb and gutter unit, then placing two layers of brick. The bottom layer of brick was placed in a north to south direction on its back, and the top layer was placed on edge, in an east to west direction. Sand was used as a filler between the bricks in both layers.

In 1960, the bricks had become deteriorated, and a three-inch lift of hot mix asphalt was placed over the bricks. Before the current construction began, near the center of the existing project, there was a utility cut that had been filled with concrete. The site also includes a 50-foot section of concrete that was a former railroad crossing. In this area, the brick had been previously removed and replaced with concrete.

The original pavement construction cross section and the overlay cross section are shown in Figure 4. This figure, from the construction plans, illustrates the various layers of sand, brick, and portland cement concrete overlay.

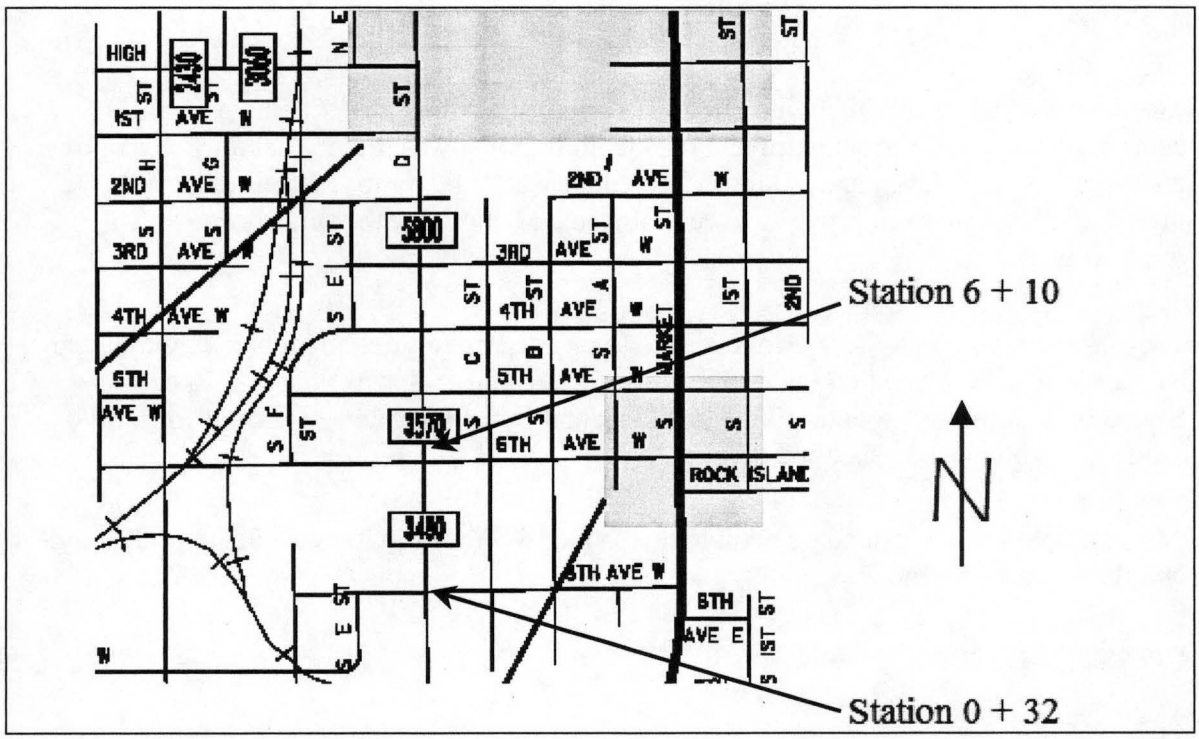

Figure 3. Project Site

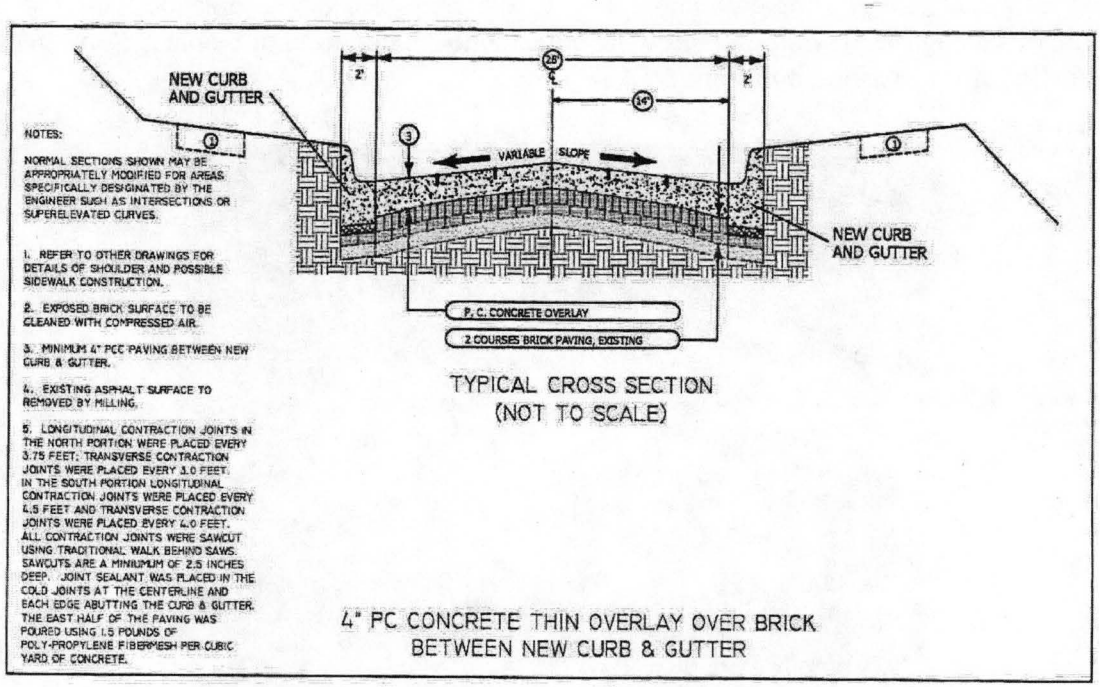

Figure 4. Design Cross Section

EXPERIMENTAL DESIGN

The design of this experiment included the partial removal of the existing asphaltic concrete overlay. At the same time, a full-depth removal was required at a former railroad crossing to achieve drainage. All curb and gutter was to be removed and replaced at an increased elevation to improve surface drainage and allow for the three to four inch overlay depth.

The surface area was to be subdivided into three preparation treatment areas. In one, the overlay was to be placed on the asphalt surface; in another, the asphalt was to be pre-coated with curing compound (bond breaker); and in the third area, a film of form oil or sand was to be placed as a bond breaker.

The concrete surface was to be cut into 3.5 foot or 4.0 foot squares to a depth of T/3 and cured by normal methods.

CONSTRUCTION

The contractor first removed the existing asphalt overlay by milling and air blasting. The goal was to allow an inch of asphalt to remain on top of the brick surface, but with the weight and vibration of the milling machine all the asphalt came loose and was removed from the bricks. The existing curb and gutter were then removed and replaced, with the contractor raising the elevation to allow for four inches of concrete to be placed on top of the existing brick, as shown in Figure 5.

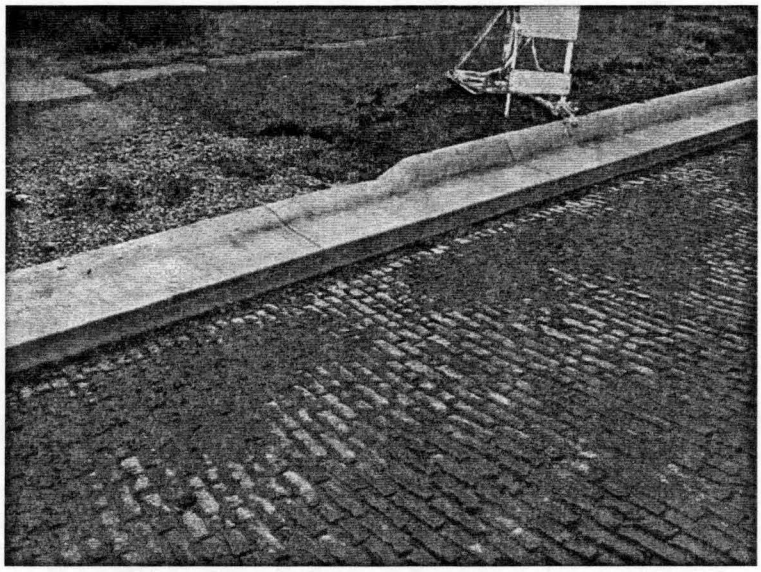

Figure 5. Finished Curb and Gutter Unit

While the contractors removed the curb and gutter, they also removed approximately an eight-inch width of brick along each edge of the street to allow a thickened edge concrete section to be placed. This area was then filled with concrete to the depth of the top layer

of brick. The surface of the brick was prepared by air blasting the entire area to remove all loose materials and allow the concrete to penetrate up to one half inch down between the top layer of bricks.

The concrete slab, located in the previous railroad crossing area (Station 3 + 82 to 4 + 42) was removed and replaced at full depth in order to provide proper gutter grades on the final product.

In the area south of the railroad crossing (Station 0 + 32 to 3 + 32) and in the area north of the railroad crossing (Station 4 + 42 to 6 + 10), the concrete was applied directly to the brick. The city chose to apply no debonding agents at any place in the project.

Construction of the overlay was accomplished by using a power screed. A wooden form was placed along the centerline of the roadway, and the gutter was used as a form along the outside edge. Paving was done by Steven's Concrete, Ltd., and concrete was provided by Ideal Ready Mix, from a nearby plant. On October 8, 2001, pavement began by placing concrete in the southbound lane, going from the north and paving south through the railroad crossing. Three days later, the northbound lane was paved in the same area. On October 16, 2001, the rest of the southbound lane was paved; then two days later, the northbound lane was completed. Figure 6 shows the paving of the first lane. Figure 7 shows the first lane of paving completed.

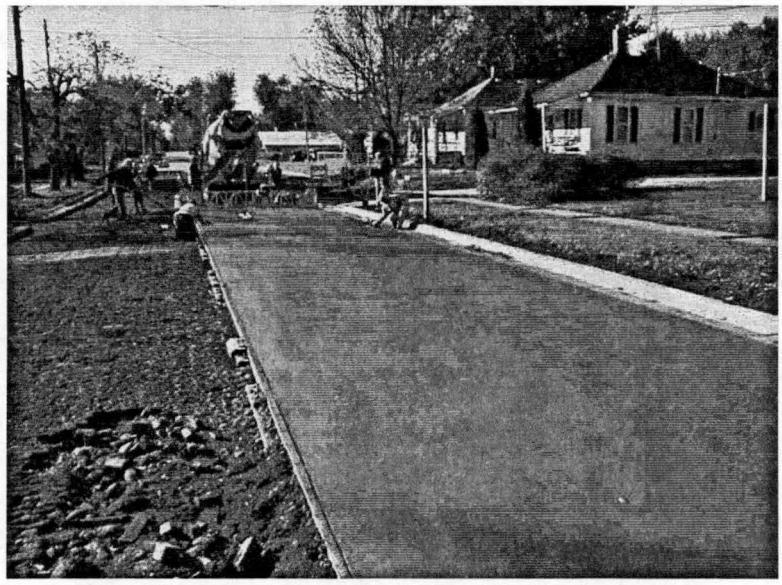

Figure 6. Southbound Lane Overlay Paving

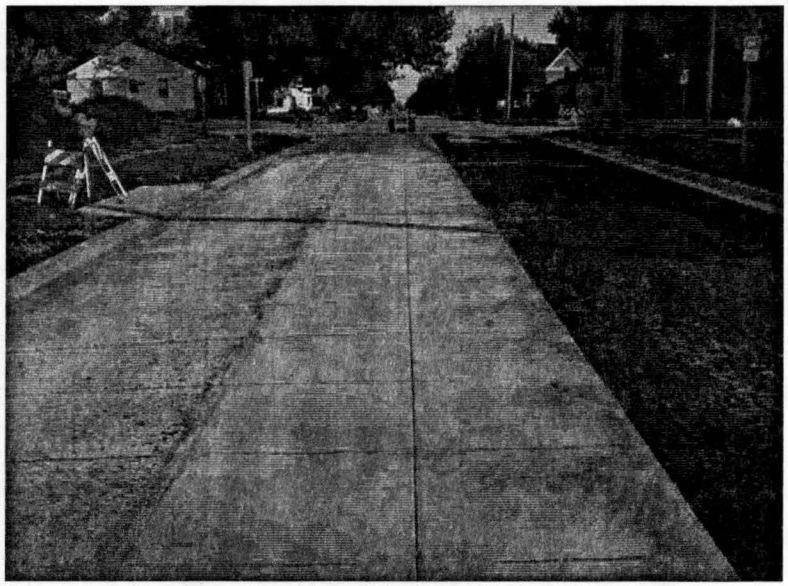

Figure 7. Southbound Lane Paving Completed

The overlay of the concrete was placed in half roadway widths, with one or two days to be allowed between pours. A two by four inch wood form was used along the centerline to establish a depth of approximately four inches. A parabolic crown was placed with the vibrating screed on each side to match the two by four and gutter section top elevation. No tie bars were used at centerline due to the shallow depth of the concrete overlay. The concrete used was Iowa DOT C-4WR, using a Class 3 aggregate and having a target slump of one inch. In the northbound lane one and a half pounds of polypropylene fibers per cubic yard were added, while no fibers were added in the southbound lane.

Joints were cut with a dry saw 3/8 inches wide, cut to a depth of T/3 or T/4. The spacing of the joints from Station 0 + 32 to 3 + 82 was as follows: longitudinal joints were cut 59 inches apart and transverse joints were cut 48 inches apart. Curb and gutter sections were cut transversely at 72-inch intervals, which resulted in the curb and pavement joints matching at every third transverse pavement joint. The section from Station 3 + 82 to 4 + 42, is 10 inches in depth, with longitudinal joints every 84 inches and transverse joints occurring every 144 inches. From Station 4 + 42 to 5 + 94, longitudinal joints occur every 43 inches and transverse joints are spaced at 36-inch intervals. Station 5 + 94 to 6 + 10 has longitudinal joints spaced every 43 inches, and a transverse joint cut at 69 inches, then 59 inches, then another at 69 inches. In this area, brick was removed to allow for a thickened end. Figure 8 shows joints after saw cutting.

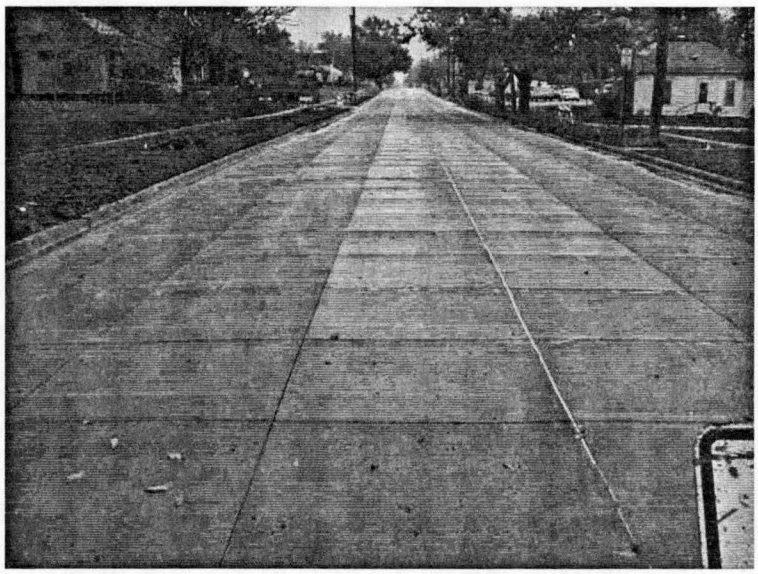

Figure 8. Completed Jointing Pattern

The removal of approximately one foot of brick along each edge was to allow for a thickened edge of concrete along the curb and gutter section. This posed a problem as heavy trucks drove on the brick, causing the bricks to shift and expose the sand and dirt below. A few areas were four feet square, which were filled with concrete to a full depth. Figure 9 shows the completed project.

Figure 9. Completed Project

TESTING PROCEDURES AND EQUIPMENT

Testing is being conducted using the Iowa DOT FWD to accomplish deflection testing and determine the support value of the existing surface. The FWD will collect information on load transfer and maximum deflection of the concrete at the joints. The existing surface will be photographed in order to document the preoverlay condition. The testing of the FWD will be conducted before the street is opened to traffic, then again at the end of one, three, and five years. The goal was to get FWD data on the brick without any concrete placed on top. However, the data were not useful so they were discarded. Testing locations were determined before the first test was performed, and will be used for each testing period over the project life.

Visual distress surveys are also being conducted at the same times as the FWD testing. The tests will be conducted in April or May of each noted year. Additional testing will be done if the city notes any rapid deterioration in the condition of the PCC overlay, and also prior to any maintenance rehabilitation.

Evaluation of the project will include the analysis of the tests in order to determine the performance of each overlay type over time. The evaluation will relate the visual distresses to the modulus of the various layers and the traffic carrying capacity of the pavement structure over time.

CONCLUSIONS

The construction of this project was completed in an efficient manner. It has been proven that a local contractor was able to complete the work with few setbacks. During the construction process, it was brought to the attention of everyone involved with the project that when the curb and gutter unit is not in place, construction traffic on the brick shall be kept to a minimum because of shifting bricks.

Field modifications by the city during construction did change the expected performance outcome. The changes included deletion of the bond breaker material applications, increase of the overlay depth, addition of a thickened edge concept and special areas of single brick layers, and replacement with reinforced concrete. Each change has an impact on the performance of individual areas of the project. Another report will be prepared when the research period is expired in late 2006.