

# SUMMARY AND RECOMMENDATIONS FOR THE IMPLEMENTATION OF RIGID PAVEMENT DESIGN, CONSTRUCTION AND REHABILITATION TECHNIQUES

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SUMMARY REPORT 177-22F(S)

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RESEARCH REPORT 177-22F

RESEARCH PROJECT 3-8-75-177

**CENTER FOR TRANSPORTATION RESEARCH**

**BUREAU OF ENGINEERING RESEARCH**

**THE UNIVERSITY OF TEXAS AT AUSTIN**

MARCH 1981

# SUMMARY REPORT 177-22F(S)

## Foreword

Research Report 177-22F is the final in the series of 22 reports describing the work done in the project entitled "Development and Implementation of the Design, Construction, and Rehabilitation of Rigid Pavements." The project has been conducted at the Center for Transportation Research, The University of Texas at Austin, as part of the Cooperative Highway Research Program sponsored by the State Department of Highways and Public Transportation and the Federal Highway Administration.

## Introduction

Since World War II, many miles of rigid pavements have been constructed in the State of Texas, and many of these pavements are now near the end of their projected design lives. Some of these pavements are still providing a satisfactory performance, while others are not. To explain the difference in the performance of these pavements, a quantitative evaluation is required to relate the mechanisms of distress to distress manifestation and to develop better predictors of performance. In theory, if all variables influencing the performance of a pavement structure could be correctly evaluated in all possible combinations of their magnitude, duration, and probability of occurrence, it would be possible to predict their effects upon the pavement and thus produce an ideal design. With this as an overall goal for the research project, specific objectives were defined accordingly as follows:

- (1) develop and implement rehabilitation design procedures and techniques for rigid pavements,
- (2) implement the research results accomplished to optimize the design and rehabilitation of rigid pavements, and
- (3) continue the performance study made of concrete pavements in Texas in order to establish design criteria and to confirm the reliability and significance of available models.

For the purposes of Research Report 177-22F, these objectives were divided into four general areas:

- (1) development of improved rigid pavement design procedures,
- (2) development of innovative rehabilitation techniques and incorporation into suitable maintenance programs,
- (3) development of an improved overlay design method, and
- (4) evaluation of rigid pavement performance by
  - (a) profile measurements and
  - (b) condition survey of CRC pavements in Texas.

## Summary of Approach

Methods previously used for the design and analysis of rigid pavements originated from concepts which were severely limited by the broad assumptions on which they were based. The CTR staff had previously derived underlying principles concerning the mechanistic behavior of composite materials. During the study, these principles were used in the development of improved concrete pavement and overlay design procedures by means of a more exact determination of relevant relationships. Maintenance and rehabili-

tation studies were performed concurrently using information collected from condition survey and surface profile measurements. This information was analyzed in depth in the development of distress prediction models and suitable criteria for use in rehabilitation decision making. The implementation of several innovative rehabilitation techniques was monitored and an evaluation of their applicability to Texas SDHPT needs was made. Specifically, the analysis included a reliable simulation of field conditions as part of the model development as well as the collection of current CRCP condition survey data. Also, information storage, analysis, and updating procedures were established.

Subsequently, reliable rigid pavement performance evaluation, design, maintenance, rehabilitation and overlay methods were recommended and implemented. Finally, procedures were recommended whereby these methods could eventually be incorporated into a comprehensive rigid pavement evaluation and design system. For any specific locality, this system can be used to select an optimum rigid pavement design, based on minimum overall cost considerations. Figure 1 illustrates a breakdown of all the research reports published during the project, according to research area as described in Research Report 177-22F.

(1) DESIGN	(2) MAINTENANCE
Reports: 177-1	Reports: 177-15
177-2	177-18
177-4	
177-7	
177-9	
177-16	
177-17	
(3) OVERLAY DESIGN	
Reports: 177-11	
177-12	
177-13	
177-14*	
(4) PERFORMANCE EVALUATION	
(a) PROFILE MEASUREMENTS	(b) CONDITION SURVEY
Reports: 177-3	Reports: 177-6
177-5*	177-8*
	177-10
	177-19
	177-20
	177-21
FINAL SUMMARY	
Report: 177-22F	

\*These reports were not published in final form.

Fig 1. List of Project 177 Reports, according to research area.

## Conclusions and Recommendations

The major conclusions and recommendations based on the results of all the investigations completed during the course of this research project are outlined below.

- (1) Detailed design of CRCP should be performed using the CRCP-2 computer program, which is now available on computers at the Center for Transportation Research and the Texas SDHPT in Austin. A copy of the input guide and an example output are included in Appendix A of Research Report 177-22F. Reference should also be made to CTR Reports 177-2 and 177-9.
- (2) Similar detailed design of JRCP can now be performed for temperature and shrinkage loads, using the JRCP-2 computer program, which is also available on the CTR and Texas SDHPT computers in Austin. Detailed procedures for the design against traffic loads will be established during the course of Project 249, which continues at least through 1983.
- (3) Design charts (nomographs) and design equations have been prepared, along with limiting criteria on relevant distress variables, for the complete design of CRCP (reinforcement and slab thickness) at a specific feasibility level. The entire procedure is discussed in CTR Reports 177-16 and 177-17. Associated preliminary studies are described in CTR Reports 177-1, 177-4, and 177-7. These design charts and equations are included in Appendix B of CTR Report 177-22F. It is strongly recommended that these design charts be included in the appropriate section of the Texas SDHPT Operations and Procedures Manual (Part IV, Design).
- (4) A CRCP overlay design procedure which was developed at the CTR should be incorporated into the Texas SDHPT Operations and Procedures Manual and implemented where appropriate as soon as possible. This procedure involves the use of the computer program RPOD-2, which is available on both the CTR and Texas SDHPT computers. The program is discussed in full in CTR Report 177-13. A copy of the user's manual has been included as Appendix C to CTR Report 177-22F. Following completion of preliminary investigations which were reported in CTR Reports 177-11 and 177-12, a procedure was developed which enables the designer to calculate the optimum time to overlay a given rigid pavement (CTR Report 177-14\*). Accordingly, optimum (with respect to minimum cost) overlay strategy selection is being incorporated into a comprehensive rigid pavement overlay design procedure still being developed at the CTR (under Project 249). Implementation of this procedure has already been initiated successfully using several projects in Texas, and its use is strongly recommended wherever overlays to rigid pavements are required.
- (5) Following the completion of the studies described in CTR Reports 177-2 and 177-5\*, procedures were developed for the reliable, yet economical, measurement of highway profiles. Also, information obtained with the Profilometer and the Mays Ride Meter concerning the profile of any rigid pavement can now be related to an evaluation of the distress condition of that pavement and hence to its maintenance needs at any time during its life. The continued use of these instruments to monitor the profile of all rigid pavements in Texas on a regular basis is

recommended here. This is being accomplished under Project 251.

- (6) Visual condition surveys of CRCP in Texas were completed in 1974, 1976 (photographic), and 1978, as described in CTR Reports 177-6, 177-10, and 177-20. The resulting distress measurements have since been used in the development of distress prediction models, as described in CTR Reports 177-8\* and 177-21. It is recommended that the condition surveys be implemented by the Texas SDHPT on a regular basis using the procedures established during this study, as outlined in CTR Report 177-19 (CRCP and JRCP) and CTR Technical Memorandum 177-72 (Overlay). Copies of these recommended rating forms are included in Appendix D of CTR Report 177-22F.
- (7) Finally, it is recommended that the distress prediction models, along with a data bank based upon the results of the regular condition survey, should be used in a comprehensive rigid pavement evaluation system for the calculation of pavement utility. This should be done for any rigid pavement in Texas, at any time, such that the resulting utility function could be used in the decision making process with regard to the distribution of funds for pavement maintenance and rehabilitation. Accordingly, it is recommended that the evaluation system and decision criteria (as discussed in CTR Reports 177-20 and 177-21) be incorporated into the appropriate section of the Texas SDHPT Operations and Procedures Manual and implemented as soon as possible.

In summary, the reader's attention is also directed to Research Project 249 at the Center for Transportation Research. Reports emanating from that project will supplement the work which has been completed and reported in Project 177.

**KEY WORDS:** rigid pavements, performance, distress, evaluation, design, overlay, maintenance, rehabilitation, condition survey, surface profile, prediction models, criteria.

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

There was no invention or discovery conceived or first actually reduced to practice in the course of or under this contract, including any art, method, process, machine, manufacture, design or composition of matter, or any new and useful improvement thereof, or any variety of plant which is or may be patentable under the patent laws of the United States of America or any foreign country.

The full text of Research Report 177-22F can be obtained from Mr. Phillip L. Wilson, State Planning Engineer, Transportation; Transportation Planning Division; File D-10R; State Department of Highways and Public Transportation; P.O. Box 5051; Austin, Texas 78763.

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\*Not published in final form.

