A RIGID PAVEMENT REHABILITATION DESIGN SYSTEM

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This paper summarizes the development, use, and applicability of the new Texas Rigid Pavement Rehabilitation Design System, RPRDS. Like other pavement design systems, RPRDS makes use of the systems concept and incorporates a number of pavement design and analytical models into a computer program, RPRDS-1, for the generation, analysis, and comparison of numerous pavement design strategies. Unlike other design systems, RPRDS only considers structural rehabilitation, i.e. overlay construction, where the design model used is an improved and extended version of the ARE Inc/FHWA and Texas SDHPT rigid pavement overlay design procedures, RPOD1 and RPOD2. In addition, provision is made in RPRDS for the consideration of other factors which affect pavement performance and accompany overlay construction. These include ACP, CRCP, and JCP type overlays; concrete shoulder construction; variable concrete flexural strength; as well as variable overlay thickness.

Basically, RPRDS generates a number of feasible overlay design strategies based on user inputs, performs a present value cost analysis on each, and then presents those which are optimal.

The other design and analytical models used to complete this task include 1) a distress/maintenance prediction model, 2) a traffic delay cost (during overlay construction) model, and 3) a model for the prediction of overlay construction cost.

The original study which is summarized in this paper was conducted at the Center for Transportation Research at The University of Texas at Austin as part of a cooperative research program with the Texas SDHPT. Hopefully, this paper will not only provide a summary of RPRDS but also some basis for its use nationwide.

Background

There are many factors which affect the design and performance of a roadway. Some of these include: traffic, load, material properties, temperature, moisture, availability of raw materials, construction methods and controls, costs, and the variation of many of these, both in time and space. Due to the large number of these factors and the fact that many of them interact with each other, any rational pavement design method which attempts to consider them will necessarily be somewhat complex.

Unfortunately, because of a lack of precise analytical techniques for predicting pavement response and performance, early pavement design methods were simple and depended mainly on experience and empiricism. This was especially true in rehabilitation methods. These simple methods provided designs which were adequate for many conditions, but there was no real way of evaluating the economics of the design or the use of the alternative methods. This simplicity set a precedent which has become very hard to change, even with the development of modern computers. Also, it must be pointed out that these early methods did not necessarily provide optimal designs as far as performance and economics are concerned.

Roadway design began hundreds of years ago during the Roman era. The last major milestone in the development of roadway design methods, however, was the AASHO Road Test (2) conducted in the late 1950's and early 1960's. This experiment provided the basis for numerous design methods (most notably, the AASHTO Interim Guide for the Design of Pavement Structures), and the data obtained from the Road Test is still being analyzed today.

The 1960's also marked the beginning of high-speed computers and advanced mathematical techniques for analyzing pavement behavior. Such analytical techniques included layer theory, slab theory, and finite-element theory.

With the development of these new analytical techniques and a multitude of other pavement design oriented models, it was recognized that each could be incorporated into a comprehensive pavement design program capable of analyzing a large number of design strategies on an economic basis. The process of developing, implementing, and reviewing the feedback from such programs came to be known as the systems methodology. An example of a systems program for rigid pavements is the Rigid Pavement System, RPS (3, 4), and it is capable of considering many of the pavement design factors pointed out earlier. The use of such a program allows the highway designer to select from a large number, the pavement design strategy which best suits his design criteria.

The background up to now has basically described the development of design methods for new pavements. Obviously, the next logical step was the development

of a design method to rehabilitate old pavements. The Federal Highway Administration (FHWA), recognizing the need to, at some point, rehabilitate the interstate highway network, sponsored research in the middle 1970's to develop just such a design method. The result, for portland cement concrete pavements, was the rigid pavement overlay design (RPOD) procedure (5) which was later improved in Texas (6, 7). RPOD, however, could basically only analyze a small number of strategies and could not perform any type of cost analysis.

The next logical step, then, is the incorporation of RPOD into a systems program for the performance and cost analyses of multiple rigid pavement rehabilitation strategies, which is the subject of this paper.

Objective

The objective of this paper is to describe a systems design method for rigid pavement rehabilitation. The related computer program is the first version of the rigid pavement rehabilitation design system, RPRDS-1 (1) and was developed at the Center for Transportation Research at The University of Texas at Austin under a cooperative research program with the Texas State Department of Highways and Public Transportation.

Scope

The scope of this paper basically covers the description of RPRDS-1 and its various components. Some attempt is made to describe the development of the program which is covered in detail in (1).

RPRDS-1

The rigid pavement rehabilitation design system, RPRDS, which is discussed here is a manifestation of the systems methodology in the design of pavement rehabilitation. The systems method is a highly recognized procedure used in many fields to analyze a complex problem at the different levels with which it interfaces with the environment. Haas and Hudson (8) provide a good description of the method and an illustration (Fig 1) of its major phases and components. The backbone of RPRDS, then, is a computer program, RPRDS-1, which includes many of these components. Fig 2, which is a flow diagram of RPRDS-1, shows which of these components are considered. Fig 2 also represents an outline for the description of RPRDS-1 in the rest of this paper.

Before continuing on the discussion of RPRDS-1 input variables, it is useful to point out that RPRDS-1 considers only conventional overlay rehabilitation methods. Though it is capable of considering many of the factors which affect the life and performance of an overlay (i.e., thickness, strength, concrete shoulder construction, etc.), it cannot at this time consider other methods of rehabilitation (i.e., sulfur asphalt overlays, all-sulfur overlays, undersealing, pressure grouting, polymer impregnation, etc.) due to the lack of design criteria and design methodologies. Such other rehabilitation methods will be included into later versions of RPRDS as design-performance criteria become more readily available.

Figure 1. Major phases and components of the systems method.

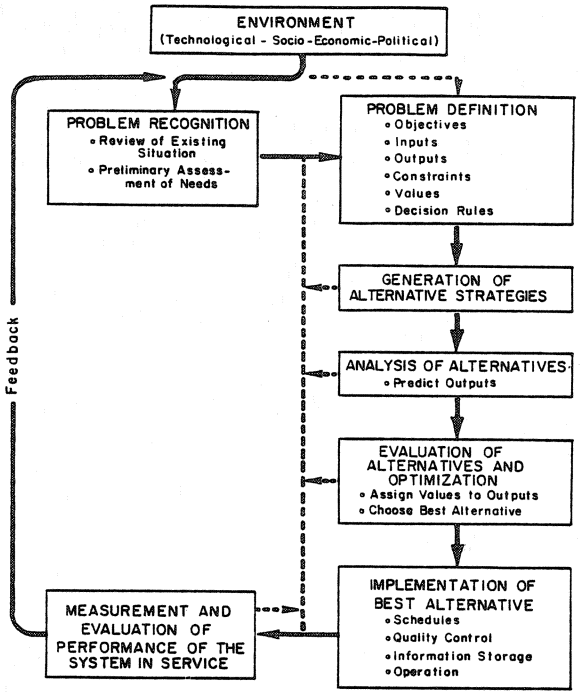
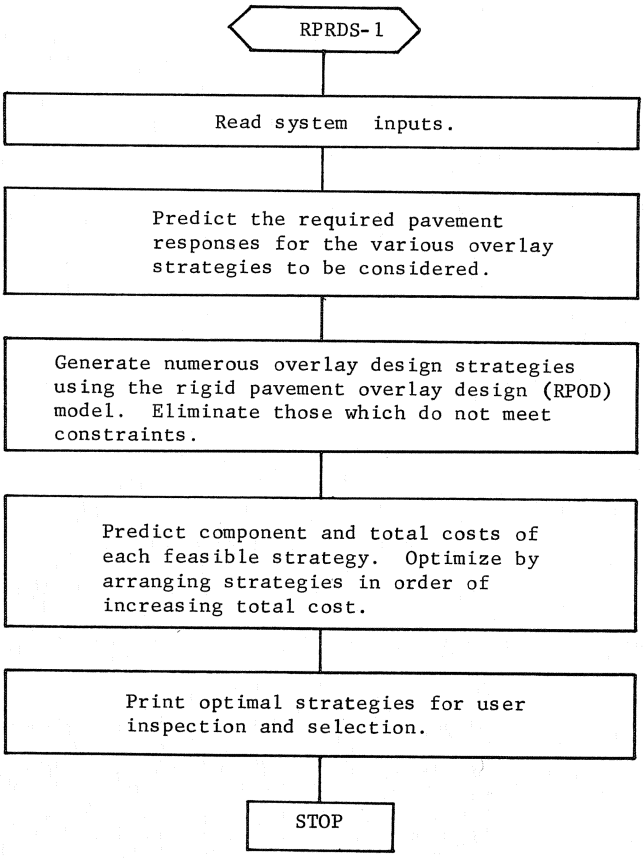


Figure 2. General flow diagram of RPRDS-1.



Description of Inputs

The inputs to RPRDS-1 can be broken down into eleven categories for ease of discussion. They will be described briefly next, and the application of most will be discussed in later sections of this paper.

Project Description. This category refers to the information required to identify the design problem. Generally, this will include data such as the date and the location of the project.

Original Pavement. This category refers to the information required to describe the original or existing pavement. Basically, this data includes pavement type, number of lanes, number of pavement layers, project length, lane width, pavement layer thicknesses and material properties, and various distress criteria.

Traffic Variables. This data relates to traffic, both vehicle and truck, that is to be carried by the facility over the analysis period. The specific variables considered include 1) average daily traffic (ADT), 2) ADT growth rate, 3) initial yearly 18-kip equivalent single axle loads (18-kip ESAL), 4) 18-kip ESAL growth rate, and 5) directional and lane distribution factors.

Time Constraints. This data is used as limiting criteria for all design strategies considered. These constraints include the length of the analysis period, the minimum time between overlays, and the maximum allowable number of years of heavy maintenance. The latter constraint allows certain borderline strategies to be considered, keeping in mind that they will require a certain period of heavy maintenance to last the analysis period. A strategy is said to be feasible then, if it meets these constraints.

Remaining Life Variables. These variables are used to define the different times at which an overlay may be placed. Since a value of pavement remaining life (expressed as a fraction) corresponds to a certain level of pavement damage, it can be used in conjunction with the traffic variables to identify an approximate year of overlay construction. This allows the user to consider the trade-offs between the time value of money and the increased cost of the thicker overlay required if overlay construction is delayed.

Overlay Characteristics. This category refers to the set of input variables which identify what types of overlay strategies are to be considered and what properties are to be used for each.

Fig 3 illustrates what types of overlay strategies can be considered by RPRDS-1. Note that as many as two overlays during the analysis period may be considered, but no more than one may be portland cement concrete. There are five types of first overlay which may be considered, ACP, bonded CRCP, unbonded CRCP, bonded JCP, and unbonded JCP. The second overlay, if considered, may be either ACP, CRCP, or JCP.

Other overlay characteristics which are required by RPRDS-1 include thicknesses, thickness constraints, elastic material properties, concrete flexural strengths, and critical stress factors. The latter refers to adjustment factors developed from finite-element theory, which will be discussed later.

Overlay Construction Cost Variables. This category refers to the input data required to define the cost of overlay construction. These will be discussed later in this paper in the section on cost prediction, but basically they include site establishment cost, surface preparation cost, thickness costs, and reinforcement cost.

Traffic Delay Cost Variables. This category refers to the set of input variables required to predict the maintenance cost of each overlay strategy. The model used to predict these costs (discussed in greater detail later) is highly exogenous and therefore requires a lot of user input on the rate of pavement distress development as well as the costs to maintain or repair.

Cost Returns. This category refers to the negative cost or return associated with overlay salvage value and the value of the extended life (beyond the analysis period) provided by some overlay strategies.

Combined Interest and Inflation Rate. This data basically consists of one variable used to estimate the time value of money. In this case, this refers to the value (in terms of other investment opportunities) of delaying overlay construction.

Prediction of Pavement Response

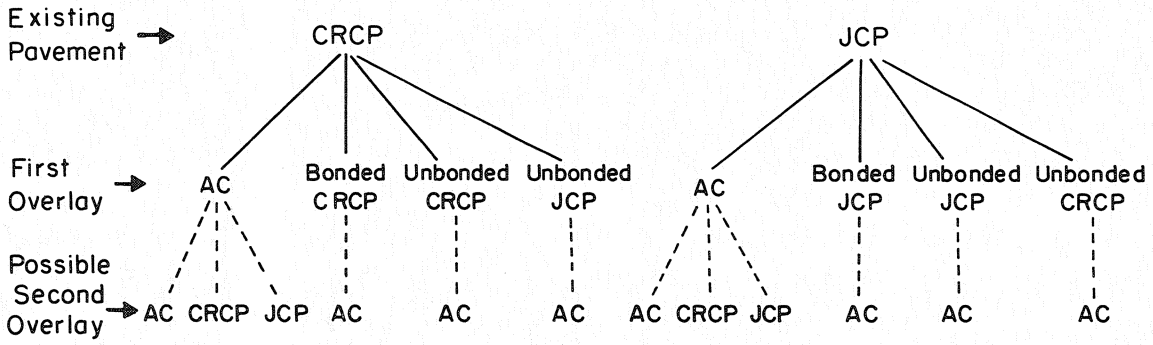
In order to predict how a pavement structure will perform during its lifetime, it is necessary in any rational design method to predict how the pavement will respond under load. The purpose of this section, then, is to describe the mechanism through which these type responses, i.e., stress, strain, and displacement, are generated for use in RPRDS-1.

Basically, RPRDS-1 uses a combination of elastic layer theory and finite-element theory to predict the critical pavement response required for estimating the life of a given overlay strategy. The combined use of these two theories may be described as follows. A prediction model based on layer theory is first used to predict the pavement response for the interior condition (away from an edge, corner, or crack). Then, this interior response is adjusted for the critical condition using relationships developed from finite-element theory in which the response at a discontinuity is correlated with the interior pavement response. For example, if the stress near the edge of a CRCP is required, it would be determined by computing the interior CRCP stress using the layer theory model and then multiplying it by an edge stress factor developed from finite-element theory.

In order to give the reader a feel for the use of the two theories, a brief discussion of each is provided next.

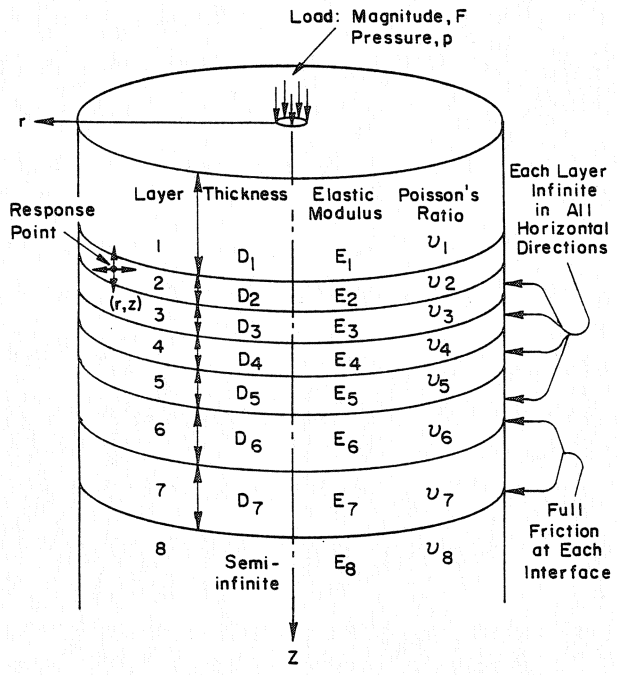
Elastic Layer Theory. The history of the development of layer theory is well documented by McCullough (9) and only the version of the elastic layer model used in RPRDS-1 will be described here.

Figure 3. Illustration of the overlay design strategies available in RPRDS-1 with regard to existing pavement and overlay type.



Basically, the model is a modified version of the CHEV15L program developed by CHEVRON (20). The modified model, called LAYER, consists of a modular subroutine package in RPRDS-1 and is capable of handling a pavement with up to eight layers. Fig 4 illustrates an elastic layer system which can be simulated by LAYER. Fig 4 also shows the inputs that are required as well as some of the assumptions and/or boundary conditions inherent in layer theory. The inputs include load magnitude and pressure, layer thicknesses, elastic moduli and Poisson's ratios and the radial coordinates (r, z) of where the responses (i.e., stresses, strains, and displacements) are desired. Note also that since LAYER can only simulate the effect of one load, it is necessary in RPRDS-1 to use the principle of superposition to simulate the effect of an 18-kip (80-KN) single axle load.

Figure 4. Illustration of an elastic layer system.



Before continuing to the discussion of finite-element theory, it should be pointed out once again that the LAYER model can only be used to determine the interior response for a given pavement structure.

Finite-Element Theory. As pointed out earlier, it is necessary to use finite-element theory to develop stress factors which will account for the difference between the critical stress and the interior stress predicted by layer theory (computer models based on slab theory were rejected for this analysis since they are not capable of considering the effect of an overlay layer). The Static Analysis Program, SOLID SAP (11) was used to generate a table of stress factors for all possible overlay strategies considered in RPRDS-1. The development of these factors is best illustrated by means of an example.

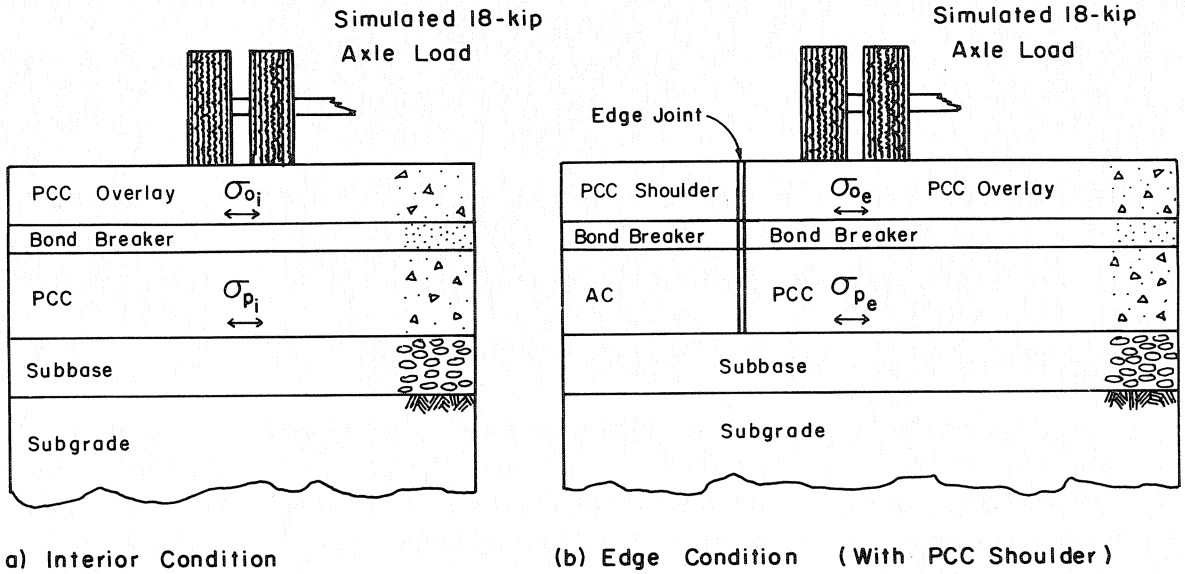
For an unbonded CRCP overlay strategy (with a CRCP shoulder), stress factors are required for both the overlay and original PCC to adjust the stress predicted by layer theory for the edge-joint discontinuity between the outside lane and shoulder (see Fig 5). A suitable pavement structural model is then selected and prepared for analysis by SOLID SAP. Then, once the maximum edge and interior stresses are determined, the critical stress factor is simply the ratio of the edge (critical) stress to the interior stress. By varying certain sensitive parameters such as the elastic moduli of specific elements, some distress mechanisms such as loss of support or loss of load transfer can be simulated and a range of critical stress factors established. It is then left up to the user to select a value which corresponds to the pavement's environment.

Prediction of Fatigue Life

The method used in RPRDS-1 for predicting the fatigue life of an overlay strategy is basically that incorporated in the RPOD (rigid pavement overlay design) procedure computer program. (A chronological list of the references which document the development of the procedure is as follows: 9, 5, 6, 7, and 1.) Due to the large number of possible overlay strategies, a detailed description of the method is not feasible for this paper. Consequently, only a general discussion using a specific example will be provided here.

In order to predict pavement fatigue life, it is first necessary to select fatigue equations which are compatible with the predicted elastic layer/finite-element responses discussed earlier. The equations used in RPRDS-1 are shown in Figs 6 and 7, which are for portland cement concrete (PCC) and asphaltic concrete (AC) pavements, respectively. Note that the early ARE PCC equation developed for the Federal Highway Administration (5) is only provided for comparison and is not used in RPRDS-1.

Figure 5. Illustration of interior and edge stress conditions for one of the overlay strategies considered in RPRDS-1 (an existing PCC pavement with an unbonded PCC overlay with PCC shoulders). The ratio of edge to interior stress is used for adjusting stress predicted by elastic layer theory.



(a) Interior Condition (b) Edge Condition (With PCC Shoulder)

Figure 6. PCC fatigue equations.

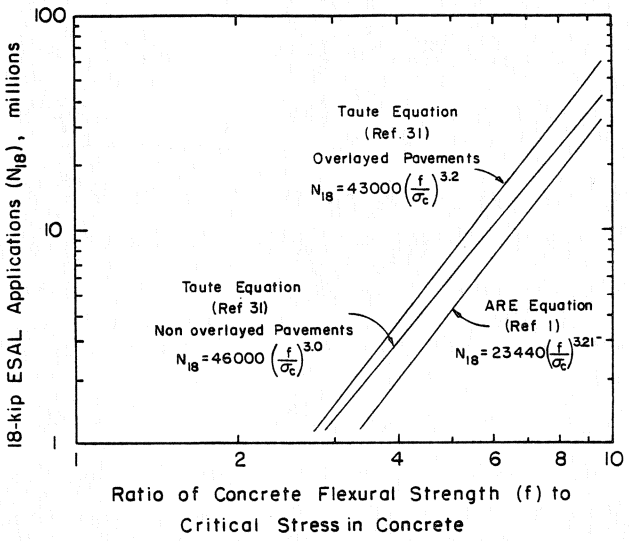
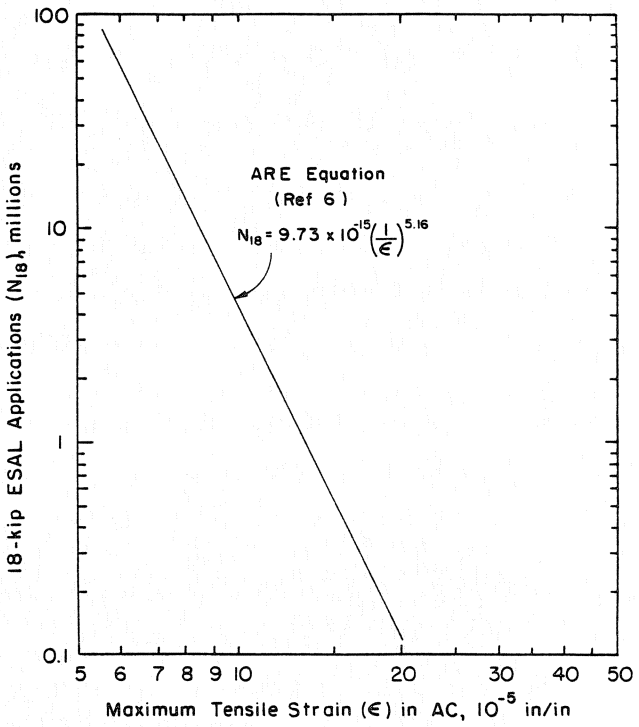


Figure 7. AC fatigue equation used in RPRDS-1.

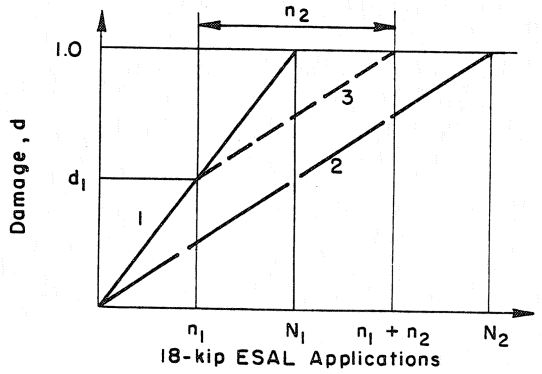


The Taute equations (7) were selected for use since they were developed from a detailed analysis of AASHO Road Test data and were shown to estimate pavement fatigue life more precisely than the original ARE equation for both AASHO Road Test sections and interstate highway pavements in Texas.

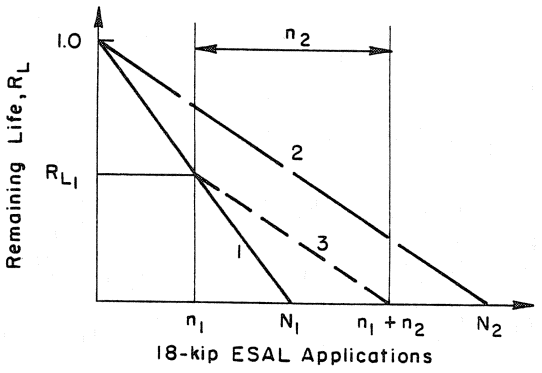
The prediction of fatigue life for a pavement which is never overlayed is a simple matter of determining the concrete flexural strength, f, calculating the critical stress, σ_c, and then plugging them into the appropriate PCC fatigue equation. The process is not quite so simple for an overlayed pavement. It first requires the assumption that Miner's linear damage hypothesis is applicable for highway pavements.

Consider Fig 8a, which is a plot of pavement damage, d, versus 18-kip ESAL applications where the incremental damage, d_i, due to a certain number of 18-kip ESAL cycles, n_i, is defined as the ratio of n_i to N_i, the allowable number of cycles predicted by the fatigue equation. If line 1 represents the deterioration of the original pavement (with no overlay), then the damage, d_1, at the time of overlay placement is equal to n_i divided by N_i. If line 2 represents the deterioration of the original pavement (with the overlay on from initial construction), then Miner's hypothesis makes it possible to compute the additional number of 18-kip cycles, n_2,

Figure 8. Graphs illustrating the deteriation of a PCC pavement using the damage/remaining life concept.



(a) Plot of Damage versus 18-kip ESAL Applications



(b) Plot of Remaining Life versus 18-kip ESAL Applications

the pavement can carry if it is overlayed when the damage is equal to d_i:

$$n_2 = (1 - d_i) \times N_2 \quad (1)$$

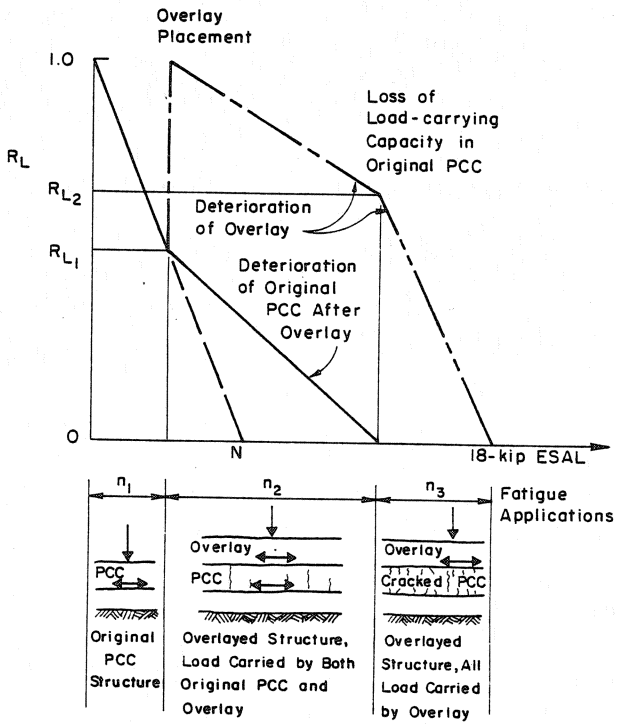
Line 3, then, represents the deterioration of the original pavement after overlay placement.

Frequently, pavement damage is expressed (from an optimistic view) as remaining life, R_L, and is simply defined as one minus the damage (or 1 - d). This allows Fig 8a to be inverted (as shown in Fig 8b) and the user to get an idea of the meaning of the remaining life variables discussed earlier.

There is still one more component of the life of an overlay strategy which has not yet been discussed, and that is the additional life left in the overlay after the original pavement has lost its load-carrying capacity ($R_L = 0$, no remaining life). Fig 9 illustrates this additional component, n_3, on a graph of remaining life versus 18-kip ESAL applications. This component represents a recent addition to the design model (1) and is often quite significant, especially for unbonded PCC overlays.

This basically describes the method used in RPRDS-1 for predicting the life of an overlay strategy. The reader should realize, however, that the design model is much more complex since it must consider the effects of 1) a possible second overlay, 2) varying overlay type, 3) varying overlay thickness, 4) varying overlay flexural strength, 5) time of overlay placement, and 6) overlay flexural strength. The effects of these should be apparent to the reader and due to space limitations, they will not be discussed.

Figure 9. Plot of remaining life versus 18-kip ESAL applications which illustrates the different components which make up the life of an overlayed PCC pavement.



Cost Components

The cost components of the various RPRDS-1 overlay strategies were highlighted earlier in the discussion of the input variables. The purpose of this section of the paper, then, is to describe in more detail how these costs are considered.

Traffic Delay Cost. Like the model for predicting the overlay fatigue life, this traffic delay cost model has also experienced a significant amount of development (12, 3, 4, 13, and 1). The model consists of a single subroutine and is adaptable to other traffic delay cost applications.

Basically, the model first predicts the delay times incurred by a vehicle as it passes through the restricted overlay zone. Since daily distributions of traffic for rural and urban areas of Texas as well as incremental user delay costs (per unit time) are built into the program, they can be combined with the results of the first step and the user-specified traffic volumes and delay periods to determine the total overall delay cost. The cost is then converted to a per square yard basis and brought back to net present value.

Overlay Construction Cost. The cost of overlay construction is broken down in four categories within RPRDS-1:

1. Site establishment - This refers to the cost of mobilizing the men and equipment necessary to perform the overlay construction.
2. Surface preparation - This refers to the cost of any cleaning and milling which must be

performed prior to overlay.

3. Overlay and shoulder thickness - This refers to the actual placement cost of a specific thickness of overlay and shoulder. Both fixed and variable components of this cost are allowed by the program. The cost of shoulder construction is included to allow the comparison of flexible (AC) shoulder strategies with those which require a concrete choulder.

4. Steel reinforcement - This refers to the material and placement costs of steel reinforcement in PCC overlay strategies. It is a simple model which only requires the cost per pound of in-place steel and the steel percentages required for the different PCC overlay types.

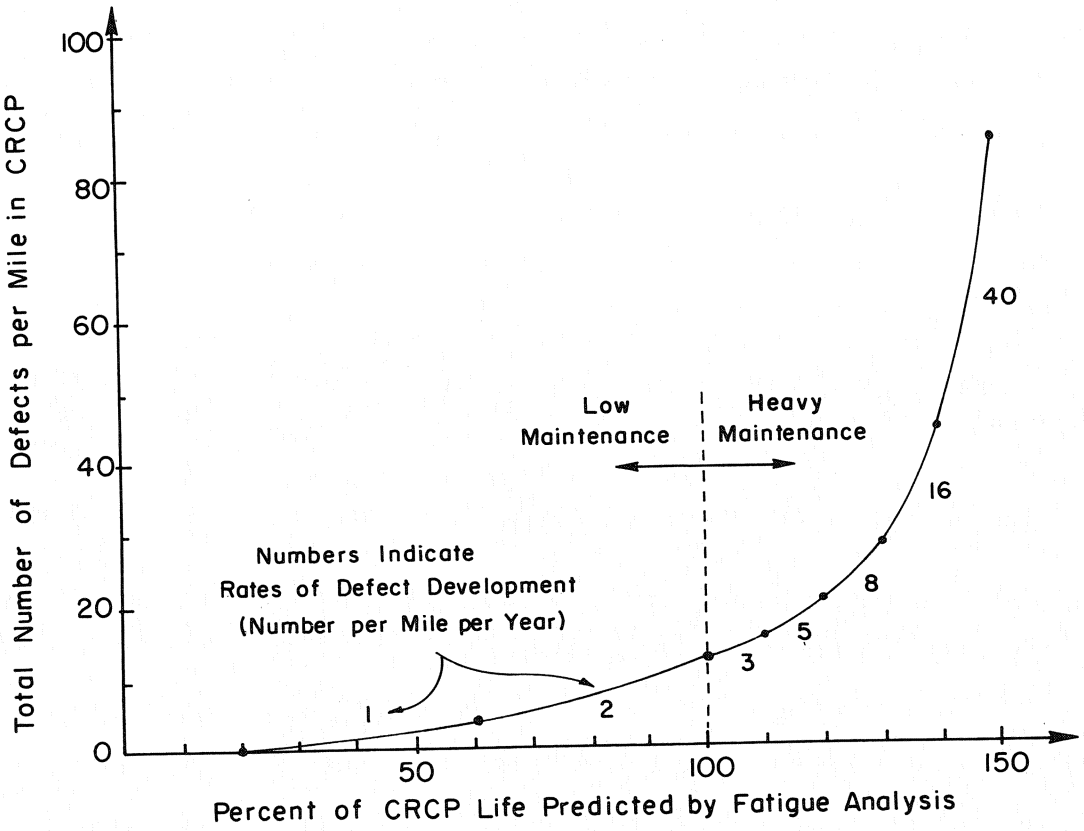
Distress/Maintenance Cost. This submodel was developed on the basis of an analysis by Taute (7) of a statewide condition survey of CRC pavements in Texas (14). As a result, it is largely exogenous and requires much user input on the rates distress occurrence during different stages of the pavement's life. Fortunately, though, this approach is general enough to allow for future improvements in the areas of distress prediction.

The mechanics of the model are simple and can be described with the aid of Fig 10. The user defines distress rates (or rates of defect development) for different stages of a pavement's life and the cost of repairing a single defect. RPRDS-1 then computes the cost of repairs (maintenance) for each year and performs a summation to get the total cost. Fig 10 provides some recommended distress rates for CRC pavements in Texas. Note that very little maintenance is required if the percent of the predicted fatigue life is less than 100 percent. After that point, however, distress and therefore maintenance cost increase rapidly. In spite of this, it may be feasible to consider certain overlay strategies which may require a year or two of heavy maintenance to last the analysis period. Unfortunately, due to a lack of available data, little guidance is provided in the RPRDS-1 documentation (1) for distress rates of pavements other than CRCP.

Value of Extended Life. This quantity represents a cost return resulting from the additional years of service past the end of the analysis period that some strategies will provide due to the fact that they are "over-designs." This is different from salvage value and comes about because of the nature of the input thicknesses in RPRDS-1. While one overlay thickness strategy may not last the analysis period, the next (which may be only one inch thicker) may last an additional five to ten years, depending on the traffic. Obviously, it is not reasonable to eliminate these strategies from consideration (since the cost of the additional inch of thickness may be small) nor is it fair not to allow the consideration of these additional years of service. Consequently, provision is made in RPRDS-1 for the user to assign some (on a per square yard basis) to each additional year of service.

Net Present Value. This submodel within RPRDS-1 is used to account for the time value of money and is a little different from discount rate since the effect of inflation is considered. Basically, the user specifies the difference between the prime interest rate (or the opportunity cost of capital)

Figure 10. Normalized graph of the development of CRCP defects in Texas.



and the inflation rate. This value is then used in the same way as a discount rate to bring all future costs back to net present value.

Sample RPRDS-1 Print-Out

In order to give the reader an idea of RPRDS-1 computer program printout, Figs 11 and 12 have been provided. Fig 11 represents the first page of the input summary and Fig 12 represents an optimal overlay design strategy generated by the program. Note that all significant data relative to the strategy is printed for user inspection. SI units are not given in these figures, since their purpose is only to illustrate the RPRDS-1 output.

Summary

The rigid pavement rehabilitation design system, RPRDS-1, has been developed to aid the engineer in selecting an optimum rigid pavement rehabilitation strategy. This paper highlights many of the significant aspects of the program which was developed using the systems methodology to incorporate several advanced technical models into a comprehensive computer package. The program was developed with the aid of The University of Texas CDC Cyber 170 computer, but every effort was made to insure its transportability to other computer installations, including IBM.

This paper is intended to provide a basis for understanding the concepts of the RPRDS program and its capabilities for analyzing a broad spectrum of design criteria associated with overlay placement.

Figure 11. First page of RPRDS-1 printout (page 1 of input summary).

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RPRDS1 - RIGID PAVEMENT REHABILITATION DESIGN SYSTEM - VERSION 1, NOV 1980
CENTER FOR TRANSPORTATION RESEARCH
UNIVERSITY OF TEXAS AT AUSTIN


**************************************
R P R D S   I N P U T   S U M M A R Y
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NOTE - VARIABLE NUMBERS CORRESPOND TO THOSE IN RPRDS USERS MANUAL

  PROJECT DESCRIPTION
  *******************

    1.1  TITLE
  RPRDS1 TEST - REDESIGN FOR FRATT INTCHNG O/L PROJECT, S A TX, SBS/11/80


  ORIGINAL PAVEMENT
  *****************

     2.1  SURFACE TYPE                                          JCP
     2.2  CONCRETE SHOULDER                                     NO
     2.3  NO. OF LANES (ONE DIRECTION)                          4
     2.4  NO. OF PAVEMENT LAYERS                               3

     3.1  PROJECT LENGTH, MILES                                 2.50
     3.2  LANE WIDTH, FEET                                     12.0
     3.3  TOTAL SHOULDER WIDTH, FEET                           3.

          PAVEMENT STRUCTURE

                                    5.0
                    4.0           ELASTIC          6.0
            LAYER   THICKNESS     MODULUS          POISSONS
             NO.      (IN)        (PSI)            RATIO
            -----  ----------  --------  --------
              1       10.5      5000000.    .15
              2       14.0        50000.    .40
              3   SEMI-INFINITE    6000.    .45


     7.1  CONCRETE FLEXURAL STRENGTH, PSI                       600.
     7.2  CRITICAL STRESS FACTOR                               1.40
     7.3  CONCRETE STIFFNESS AFTER CRACKING, PSI               500000.

     8.1  NO. OF EXISTING DEFECTS PER MILE                     10.
     8.2  COST OF REPAIRING A DEFECT, DOL                      2000.
     8.3  RATE OF DEFECT DEVELOPMENT, NO./YR/MILE              4.
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Figure 12. Sample printout of an RPRDS-1 optimal strategy.

RPRDS1 - RIGID PAVEMENT REHABILITATION DESIGN SYSTEM - VERSION 1, NOV 1980
CENTER FOR TRANSPORTATION RESEARCH
UNIVERSITY OF TEXAS AT AUSTIN

PROJECT DESCRIPTION
RPRDS1 TEST - REDESIGN FOR FRATT INTCHNG O/L PROJECT, S A TX, SBS/11/80

OPTIMAL STRATEGY NO. 1

	COMPONENT OF STRATEGY	QUANTITY
1.	EXISTING PAVEMENT REMAINING LIFE AT 1ST OVERLAY, PERCENT	0.
2.	YEAR OF 1ST OVERLAY PLACEMENT	2.
3.	TOTAL 18-KIP ESAL CYCLES (NOW TILL 1ST OVERLAY), MILLIONS	1.17
4.	COST OF MAINTAINING EXISTING PAVEMENT, DOL/SQ YD	1.24
5.	1ST OVERLAY TYPE	UNR CRCP
6.	TYPE OF SHOULDER	PCC
7.	1ST OVERLAY THICKNESS, INCHES	6.0
8.	PCC FLEXURAL STRENGTH OF 1ST OVERLAY, PSI	620.0
9.	FATIGUE LIFE AFTER 1ST OVERLAY, YEARS	29.6
10.	FATIGUE LIFE AFTER 1ST OVERLAY, 18-KIP ESAL IN MILLIONS	21.03
11.	1ST OVERLAY CONSTRUCTION COST, DOL/SQ YD	12.28
12.	1ST OVERLAY TRAFFIC DELAY COST, DOL/SQ YD	.72
13.	1ST OVERLAY MAINTENANCE COST, DOL/SQ YD	.54
14.	1ST OVERLAY REMAINING LIFE AT 2ND OVERLAY, PERCENT	---
15.	YEAR OF 2ND OVERLAY PLACEMENT	---
16.	TOTAL 18-KIP ESAL CYCLES (NOW TILL 2ND OVERLAY), MILLIONS	---
17.	2ND OVERLAY TYPE	---
18.	TYPE OF SHOULDER	---
19.	2ND OVERLAY THICKNESS, INCHES	---
20.	PCC FLEXURAL STRENGTH OF 2ND OVERLAY, PSI	---
21.	FATIGUE LIFE AFTER 2ND OVERLAY, YEARS	---
22.	FATIGUE LIFE AFTER 2ND OVERLAY, 18-KIP ESAL IN MILLIONS	---
23.	2ND OVERLAY CONSTRUCTION COST, DOL/SQ YD	---
24.	2ND OVERLAY TRAFFIC DELAY COST, DOL/SQ YD	---
25.	2ND OVERLAY MAINTENANCE COST, DOL/SQ YD	---
26.	VALUE OF EXTENDED LIFE, DOL/SQ YD	.73
27.	OVERLAY SALVAGE VALUE, DOL/SQ YD	.54
28.	TOTAL NET PRESENT VALUE OF STRATEGY, DOL/SQ YD	13.56

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