1985 PAVEMENT EVALUATION SYSTEM
ANNUAL REPORT

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and Public Transportation

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INTRODUCTION

The Pavement Evaluation System (PES) is a combination of field evaluations and computer programs which describe statewide pavement condition and determine statewide rehabilitation needs.

PES uses two types of data to define pavement condition: visual surface distress data and ride quality data. Surface distress and ride data are obtained by District personnel who are specially trained in pavement evaluation once each year.

Each year PES identifies a list of pavement sections to be rated, based on a statistical sample. Pavement condition cannot be determined until both the visual and the ride data have been collected, entered, and stored into the system. Pavement sections are usually about two miles long and are defined by mileposts at both the beginning and the end of the section.

The cycle of visual and ride quality evaluations occurs once each year, usually beginning in September and lasting until early January.

PES provides a consistent method of describing the condition of a pavement section in any part of the state. Traffic, environmental, and functional class factors are combined with the visual and ride data into a "pavement score", which is a measure of a section's relative need for rehabilitation. However, it does not include all of the factors which should be considered in selecting sections for rehabilitation. The consistency of the PES calculations enable its use at the Administrative level in guiding statewide policy decisions.

Pavement condition data is essential to any pavement-related planning activity. PES provides a means whereby such data can be reliably collected and used -- it is not a new concept to be learned, but instead is just a method for documenting what has always been done in the past.

It is realized that the current system does not always provide data that agrees with field experience. The real worth of PES will ultimately depend on how it is improved to meet the needs of its users.

CHAPTER 1 -- Yearly Sample Sizes

Each year a certain percentage of total roadway mileage on each highway system is selected for evaluation. The PES program attempts to select 100 percent of the Interstate mileage, 50 percent of the State and US highway mileage, and 20 percent of the Farm-to-Market road mileage. This results in a yearly sample size of approximately 30,000 lane miles.

The total length of pavement, in lane miles, evaluated over the past three years is shown in Table 1. Three tables are presented, each representing one year's sample distribution. The top table illustrates the sample distribution for 1983, the second, 1984, and the third, 1985. Three surface types, ACP, meaning asphalt surfaced pavements, CRC, or continuously reinforced portland cement concrete surfaced pavements, and JCP, or jointed portland cement concrete surfaced pavements, are delineated in the left column of each table. Each table is further subdivided into highway systems along the top row. The three systems represented are IH, or Interstate Highways, US/SH, or US and State Highways, and FM, or Farm-to-Market Highways. Each cell of the table represents the actual mileage over which the visual evaluation was performed for that particular system and pavement type.

For various reasons, this sample size has changed from year to year. Prior to 1984, no portland cement concrete pavement sections were included in the evaluation, since evaluation procedures for this type of pavement had yet to be developed. In 1984, it was intended that all sections of portland cement pavements in existence be included in the evaluation, however some were missed and turned up in the 1985 evaluation. This has had a serious effect on the yearly sample distribution.

When the portland cement concrete pavement sections were included in the evaluation in 1984, the sample distribution for all three systems was adversely affected. It added 1300 lane miles to the Interstate sample, 1400 miles to the US & SH sample, and reduced the sample size of the FM system by approximately 4000 lane miles.

Furthermore, in 1985, when the program attempted to select only the JCP and CRCP sections which were missed in 1984, the sample size for the US & SH system was reduced significantly from the previous year. In 1984 the total JCP and CRCP mileage evaluated was roughly 1360 lane miles, while in 1985 this was reduced to a total of 200 lane miles.

The effects of yearly variations in sample distributions on the ability of PES to quantify the condition of the roadway system is unknown. However, these variations should be kept in mind while interpreting the results of the analysis in this report.

Table 1. Total Length of Pavement Evaluated Each Year From 1983 to 1985 (Lane Miles).

	1983		
SURFACE	IH	US/SH	FM
ACP	3317	14606	13464
CRCP	-	-	-
JCP	-	-	-

	1984		
SURFACE	IH	US/SH	FM
ACP	4053	16756	8497
CRCP	1287	739	-
JCP	273	623	21

	1985		
SURFACE	IH	US/SH	FM
ACP	4196	14594	8492
CRCP	1270	74	2
JCP	199	134	25

CHAPTER 2 -- Current Condition of the Highway System

The PES parameter which indicates the current condition of the pavement is the unadjusted pavement score (UPS). UPS ranges from 0 for a bad pavement to 100 for a good pavement. UPS is a function of ride quality and visible distress on the pavement surface. The distribution of the 1985 statewide UPS values provides insight into the current condition of the Texas highway system.

Interstate Highway System

Asphalt Pavements -- Fully 53 percent of the mileage has a UPS of 100. This comprised 2098 of a total of 3944 lane miles rated. Only 45 lane miles scored low enough to be considered for rehabilitation. Rutting, longitudinal cracking, and transverse cracking were the most common forms of distress on the Interstate ACP sections. Generally, the asphalt Interstate pavements are in excellent condition, both from a distress and a ride quality standpoint.

Continuously-Reinforced Concrete -- 22 percent (256 lane-miles) of CRCP on the Interstate has a UPS of 100. 18 percent was found to be in poor condition. The remaining mileage was evenly distributed between good and poor.

CRCP has poorer ride quality as compared to ACP. Whereas 69 percent of asphalt pavements had a ride quality of 3.5 or greater, only 56 percent of the CRCP fell into this range.

From a visual distress standpoint, most CRCP sections are in excellent condition; however, there were a higher number of sections in poor condition when compared with asphalt pavements. Punchouts were the most common form of distress on CRC pavements, although significant quantities of asphalt patching were also found.

Jointed Concrete Pavements -- The distribution of UPS scores for JCP are significantly lower than the other two pavement types. In fact, more sections of JCP are in the lower UPS ranges than in the upper. This is primarily due to the impact of poor ride quality on JCP pavements and its effect on UPS score.

Visual distress on jointed Interstate highways was higher than that observed on ACP or CRCP, but not excessively so. However, JCP ride quality was, on the average, considerably poorer. Poor ride quality is the major contributor to the low condition scores on the interstate.

Failed joints and pavement failures were the most common forms of distress found on JCP on the Interstate System.

U.S. and State Highway Systems

Asphalt Pavements -- Greater than 33 percent of the rated asphalt pavements on the US and SH systems were found to be in excellent condition with 5 percent in poor condition. These sections were also found to be in excellent condition from the standpoint of visual distress. The distribution of ride quality values centered around 3.5, with most of the sections scoring within a range of 2.5 to 4.5. Overall, asphalt pavements on the U.S. and State highway systems were found to be in very good condition. Rutting, patching, longitudinal cracking, and transverse cracking were the most prevalent distress types.

Continuously-Reinforced Concrete -- The CRCP sections on the US & SH systems displayed a nearly uniform distribution between zero and 100. Half of the sections have a UPS below 60. Approximately 18 percent of the sections surveyed were in very poor condition.

Poor ride quality was the primary cause of the low condition scores. 60 percent of the sections rated had a ride value of 3.0 or less.

Spalled cracks and punchouts were the most prevalent of the distress types found.

Jointed Concrete Pavements -- JCP sections on the US and SH system are in worse condition than the other two pavement types. The occurrence of visual distress is somewhat low, however the ride quality is poor. As on the Interstate JCP sections, ride quality is the major cause of low condition scores on jointed U.S. and State highway sections.

The most common distress types found on JCP U.S. and SH sections were failed joints and pavement failures.

Farm to Market System

The Farm-to-Market system is composed primarily of Asphaltic Concrete Pavements and as a result the CRCP and JCP sample sizes are much too small to be of any value in predicting pavement condition on a network basis. Thus, discussion of pavement condition on the FM system will be limited to asphalt pavements.

Asphalt Pavements -- The Farm-to-Market system ranks lowest of all systems, when considered as a whole, for overall pavement condition. Nearly 7 percent of the system is in very poor condition while 22 percent is in excellent condition. This is not to say, however, that the FM system is in poor condition. 50 percent of the section had a UPS value of 85 or more and 80 percent of the sections had a ride value of 2.5 or greater.

Rutting and patching were the most prevalent distress types found on asphalt FM pavements.

Summary of Current Condition of Texas Highways

The relative condition of the different highway systems and pavement types throughout the state can be ranked from best to worst, by UPS, as follows:

1. IH ACP (Best)
2. US ACP
3. FM ACP
4. IH CRCP
5. US CRCP
6. US JCP
7. IH JCP (Worst)

It should be kept in mind that the results shown above are an indication of the functional performance of the pavement systems, i.e. how well the pavements serve the user. Ride quality is the dominant characteristic used to describe the functional performance. As a result, the jointed concrete pavements, which have the poorest ride quality in comparison with other pavement types, are severely penalized, even though they may be structurally similar or superior to the other pavement types.

Structural performance (amount and severity of visual distress) has been taken into account in the survey, but the level of distresses found were not severe enough to overcome the effects of poor ride quality on the rankings.

CHAPTER 3 -- Trends in Pavement Condition

An inspection of the data collected over the past three years was performed to determine whether the overall condition of the highway system is improving or deteriorating. Unadjusted pavement score was again used as a criterion. UPS is a function of both visual distress and ride quality.

Interstate Highway System

Asphalt Pavements -- Asphalt pavements on the Interstate system have shown consistently high scores over the past three years. Slight deterioration was evident between 1983 and 1984; however, the problems seem to have been corrected and the deterioration checked by 1985.

Continuously-Reinforced Concrete -- Only two years of data are available for CRCP on the Interstate system. A comparison of the data indicates a sharp decline in condition. The declining condition appears to be due to an increase in visual distress combined with a slight decrease in ride quality.

Jointed Concrete Pavements -- Due to changes in the PES rating scheme and inconsistency of sample size, no reliable conclusions concerning trends in JCP condition can be drawn.

U.S. and State Highway Systems

Asphalt Pavements -- Asphalt pavements on the US and SH systems showed a slight decline in condition in 1984 but recovered in 1985. The decline was small enough (± 5 points) to be attributable to error in the PES rating procedure. Thus it may be concluded that the US and SH condition is neither improving nor deteriorating, but is remaining constant with time.

Continuously-Reinforced Concrete -- No indication of any decline or improvement is evident from the data collected over the past two years.

Jointed Concrete Pavements -- Due to changes in the PES rating scheme and inconsistency of sample size, no reliable conclusions concerning trends in JCP condition can be drawn.

Farm-to-Market System

Asphalt Pavements -- There is evidence from three years of data that the FM system condition is in equilibrium. In 1983, 2 percent of the rated sections were in poor condition from a visual distress standpoint. In 1984, the figure rose to 6 percent and declined to 4 percent in 1985. Ride quality has not changed significantly over the past three years.

Summary of Trends in Texas Highway Condition

PES data collected over the past three years indicates that, for the most part, the condition of the highway network is in a state of dynamic equilibrium. Although overall condition has improved since 1984, the improvement has not been great enough to offset the deterioration observed from 1983 to 1984. It is hoped that continuation of existing funding in 1986 will result in overall highway condition being restored to 1983, or better, levels.

CHAPTER 4 -- Estimate of Statewide Pavement Rehabilitation Needs

Annual statewide pavement rehabilitation needs were estimated using the following equation:

Total Statewide Rehabilitation Cost = $SUM(M_{ij})$, where:

$M_{ij} = MRR_{ij} / MTR_{ij} \times TLM_{ij} \times C_{ij}$ and;

MRR = total mileage rated in need of rehabilitation,
MTR = total mileage rated,
TLM = total lane mileage,
C = rehabilitation cost per lane mile,
i = system (FM, US & SH, or IH)
j = surface type (ACP, JCP, or CRC).

MRR is a sum of the lengths of all the pavements rated each year within a particular system and pavement type, whose pavement score has been calculated to be 34 or below. This information is presented in Table 2.

MTR is the sum of the lengths of all the pavement sections rated within a particular system and surface type for a given year (see Table 1).

TLM is the total length in lane miles in the state for a given surface type on a given system. This is estimated from our files by multiplying the total length of all PES sections by the number of mainlanes on each section. Frontage road lane mileage was estimated from the design type number from the D-10 RI files. TLM is tabulated in Table 3.

C represents the costs in dollars to rehabilitate 1 lane mile of pavement. It is a function of the surface type and the system. Table 4 shows the rehab costs as a function of pavement type and system.

Table 2. Total Length of Pavement Rated Each Year Found to be in Need of Rehabilitation (Lane Miles).

	1983		
SURFACE	IH	US/SH	FM
ACP	81	954	949
CRCP	-	-	-
JCP	-	-	-

	1984		
SURFACE	IH	US/SH	FM
ACP	204	1397	748
CRCP	207	179	-
JCP	139	304	10

	1985		
SURFACE	IH	US/SH	FM
ACP	112	997	630
CRCP	261	15	-
JCP	147	65	14

Table 3 - Total Statewide Lane-Mileage Assumed by System and Surface Type for Estimate of Rehabilitation Needs.

SURFACE	IH	US/SH	FM	TOTAL
ACP	9554.8	66373.8	80994.4	156923.0
CRC	3872.6	1803.9	11.5	5688.0
JCP	610.7	1566.1	230.0	2406.8
TOTAL	14038.1	69743.8	81235.9	165017.8

Table 4 - Rehabilitation Costs per Lane Mile ($1000)

SURFACE	IH	US/SH	FM
ACP	143.0	166.0	67.0
CRC	161.0	161.0	134.0
JCP	524.0	509.7	134.0

The product of MRR X MTR X TLM represents the total lane mileage in need of rehabilitation for each system and pavement type. The result is shown in Table 5. The table illustrates that asphalt pavements on the US and SH systems contribute to most of the rehab mileage in the state.

Table 5. Total Projected Mileage in State In Need of Rehabilitation (Lane Miles).

	1983		
SURFACE	IH	US/SH	FM
ACP	232	4335	5709
CRCP	-	-	-
JCP	-	-	-

	1984		
SURFACE	IH	US/SH	FM
ACP	482	5533	7126
CRCP	623	438	-
JCP	312	764	108

	1985		
SURFACE	IH	US/SH	FM
ACP	255	4532	5708
CRCP	796	373	-
JCP	452	753	128

The total estimated rehabilitation cost for all systems and surface types combined is as follows:

1983 -- $1.1 Billion
1984 -- $2.2 Billion
1985 -- $2.0 Billion

The increase from 1983 to later years is a direct result of including concrete pavements to the survey. Improvements in pavement scores of asphalt pavements are totally responsible for the $200 million decrease in estimated rehab needs from 1984 to 1985. The decrease in total costs occurred despite the fact that the rehab needs for concrete pavements increased. The breakdown of needs by pavement type and system is shown in Table 6.

Table 6 - Estimated Rehabilitation Needs Estimates for 1983 to 1985 (in thousands).

SURFACE	IH	US/SH	FM	TOTAL
1983				
ACP	33203	719631	382532	1135366
CRC	0	0	0	0
JCP	0	0	0	0
1984				
ACP	68865	918390	477439	1464694
CRC	100272	70446	0	170718
JCP	163523	389570	14433	567526
1985				
ACP	36536	752420	382462	1171418
CRC	128143	60115	0	188258
JCP	236702	383964	17081	637747

CHAPTER 5 -- Recommended Methods of Improving Accuracy of PES Condition and Rehabilitation Needs Estimates

This report has demonstrated the use of PES data to obtain general estimates of statewide pavement condition and rehabilitation needs. Although these estimates are useful for initial pavement management and planning, several improvements could be made to increase the accuracy and reliability of the estimates.

Increase and Balance PES Sample

It is clear from the information presented in this report that the sample selection criteria and size is quite variable from year to year. For instance, of the total mileage surveyed in 1983, roughly 40 percent of the mileage consisted of FM roads. This number dropped to 20 percent in 1984 when the concrete was introduced into the system. Additionally, in 1984, concrete pavements accounted for approximately 9 percent of the total lane mileage rated. In 1985 this dropped to 6 percent. The effort should be made in the future to insure a higher level of consistency in the sample. It is thought that 50 percent of each highway system should be sampled in order to improve PES to the point at which the Districts will find it useful.

Problems such as non-uniformity of the sample distributions across the Districts and Counties are inherent in the PES at this time. These problems are insignificant at the statewide or network level, however if PES is to be of use at the District level these issues must be resolved. Typical problems include counties in which no sample sections are chosen in a given year and uneven percentages of system mileage rated from District to District.

Develop Roadway Inventory Data

An integrated roadway inventory data file is needed to determine the surface type, number of lanes, pavement widths, and shoulder widths for all PES sections. This information is vital to the development of accurate rehabilitation estimates and is currently not available.

Improve Safety and Reliability of Urban Area Ratings

Our current pavement evaluation procedures are most inaccurate in the urban areas. High traffic volumes make it difficult to perform thorough pavement evaluations without seriously endangering the safety of the raters. In general, high traffic areas experience the most rapid pavement deterioration rates, are in the poorest condition, and have the highest unit costs for rehabilitation. This combination of factors magnifies the effect of rater error and thus reduces the reliability of the PES condition and rehabilitation estimates. D-18P is currently in the process of obtaining high-speed data collection equipment to address these needs.

Improve Measurement of Ride Quality

This report has demonstrated the importance of ride quality as a measure of pavement condition. In many cases, low UPS values on Texas highways can be attributed directly to poor ride quality. However, current ride quality measurements are subject to three major errors: poor calibration, narrow frequency range, and inability to operate at variable speeds. Future versions of PES will probably utilize a new factor, surface profile, to characterize ride quality. Surface profile measurements will be obtained at variable highway speeds using a self-calibrating roughness measuring device. The roughness measuring device will also record roughness at various frequencies, thus distinguishing between roughness caused by joints or cracks from roughness caused by settlement or clay swells. These improvements should reduce measurement error and increase the reliability of PES ride quality and condition data.