EVALUATION OF CONCRETE PAVEMENT REHABILITATION IN PENNSYLVANIA

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ABSTRACT

Concrete pavement rehabilitation (CPR) is an engineered system of pavement rehabilitation with the purpose to repair rather than to overlay the pavement. Typically, full-depth patching, grinding, subsealing, spall repair, and joint sealing are CPR treatments. These techniques have been used for several years with varying degrees of success. In order to evaluate the use of CPR, it is necessary to have information about the life cycle of the treatments. This information will facilitate the economic analysis of CPR versus other rehabilitation strategies such as overlays.

This paper presents the results of a study performed in Pennsylvania on the life-cycle evaluation of CPR treatments. The paper focuses on full-depth patching, grinding, and subsealing. Project data collection included profiles, falling weight deflections, fault measurements, condition surveys, and cores. The objective of the research was to determine what performance characteristics and service life can be expected of each CPR treatment. To accomplish this objective, seven selected interstate CPR projects in Pennsylvania were reviewed. The projects were monitored from 1988 through 1990.

Considering the data from these sections, it is estimated that a concrete pavement rehabilitation treatment consisting of full-depth patching, subsealing, and grinding will have a service life of approximately five years. Despite the relatively short service life of the surveyed CPR sections, life-cycle cost analysis indicated that CPR is the most economical treatment based on a dollars-per-lane-mile capitalized cost evaluation, not considering user costs. The magnitude of user costs is extremely site-specific and must be considered on a case-by-case basis.

BACKGROUND

Concrete pavement rehabilitation (CPR) is an engineered system of pavement rehabilitation with the purpose to repair rather than overlay the pavement. Pennsylvania has been one of the more active States in performing CPR and the Pennsylvania Department of Transportation (PennDOT) wanted to know the life-cycle performance of the CPR activities. Specifically, are the CPR procedures used by PennDOT cost effective? In other words, what performance characteristics and service life can be expected of each CPR treatment?

To accomplish the objectives of this research, seven selected interstate CPR projects in Pennsylvania were reviewed. All were jointed reinforced concrete pavements, 10 in thick, with doweled joints, original joint spacing of 61.5 ft, and retrofitted subdrainage. Six of the projects were in service for up to 5 years. Two representative sections of each of these projects, as identified in Table 1, received detailed analysis. In addition, one of the CPR projects (I-80 eastbound, Union County, MP 194.5 to 197.0) was under construction during 1988, the first project year, which afforded the researchers the opportunity to evaluate the construction phases of CPR activities.

DATA COLLECTION

Historical data for the test sections were obtained, including longitudinal profile (profilograph and Mays Meter), condition surveys, contract documents, plans, and specifications for the CPR work. Other related information included traffic data and geographic information such as soil type and drainage. Mays Meter roughness data were obtained for 1983 through 1988.

A detailed condition survey of each section was performed to obtain the exact layout of each section, the location of all distresses, faulting measurements, and profilograph measurements. Between July and October 1988, initial surveys were completed on each of the six completed CPR projects. The entire length of each project was examined in order to select two representative test sections of approximately 1,000 ft each, as indicated in Table 1. Detailed surveys were completed in 1988, 1989, 1990. Faultmeter measurements were made approximately 1 ft from the right edge of the travel lane and 1 foot from the left edge of the passing lane at each joint. A summary of the faulting measurements is provided in Table 2. The profilograph was run in the right and left wheel paths of the travel lane in 1988, 1989, and 1990.

Falling weight deflectometer (FWD) and profilograph tests were performed on each section. The FWD testing was conducted in the fall of 1988. During the FWD testing, forward load transfer tests were performed at each joint. Void detection analysis was also performed on the joint tests. Center slab tests were performed on both original slabs and patches. These tests allowed for the backcalculation of slab modulus values and modulus of subgrade reaction values. Analysis of center slab tests was completed using ILLI-BACK. (1) The results of the backcalculation are suspect when the testing was done on short patches, as the deflections obtained do not truly represent a center slab loading condition. A summary of the results of the FWD analysis is shown in Table 3. A wide range of load transfer efficiencies was calculated for each section, with full-depth patch joints having significantly lower transfer efficiencies than original joints. The number of voids detected in each test section is also shown in Table 3. The transfer efficiencies and voids can be related to the number of patched joints created as indicated in Table 1.

Core specimens were obtained from several of the projects in order to verify concrete quality. Cores were taken through retrofitted dowels on the full-depth patches in order to examine placement, bonding, socket shape, etc. The core specimens were subjected to compressive strength testing, air void analysis, and petrographic examinations. No mixture problems were detected, but some problems with dowel bonding and sockets were noted.

Each of the projects was documented as an individual case study. In-depth performance history and construction information was assembled for each project. Consequently, the case studies have provided PennDOT with a significant set of CPR documentation.

PAVEMENT PERFORMANCE EVALUATION

As pointed out in the *AASHTO Pavement Design Guide*, in order to conduct life-cycle cost analyses and to make rational decisions about the best rehabilitation strategy, it is essential to be able to predict the lives of rehabilitation strategies. (2) Relationships having single dependent variables representing the deficiencies that are the reason for the CPR activities can provide the service life data needed for an evaluation of the economy of the CPR procedures. The CPR performed on these projects included grinding, subsealing, and full-depth patching. Individual variables examined included roughness, faulting, load transfer, and the presence of voids.

Grinding

The project on I-79 in Mercer County was diamond-ground, but test Section E has no full-depth patches and Section F has only one patch. The average faulting on these sections is only 0.01 inches 4 years after the grinding was performed; it can be concluded that this project is performing well and was a good selection for diamond grinding. Faulting after grinding can be expected to proceed at a rate considerably accelerated from the rate of faulting on the original pavement. Therefore, a pavement experiencing a high rate of faulting progression would not be a good candidate for grinding without additional CPR.

Full-Depth Patching and Subsealing

The projects on I-79 in Butler County (Sections G and H) and on I-80 in Columbia County (Sections I and J) were full-depth patched and subsealed but not diamond-ground. Historical Mays Meter measurements indicated that these projects were similar in roughness before rehabilitation was performed. However, the I-80 project has deteriorated rapidly, with the roughness levels almost immediately meeting or exceeding those observed before rehabilitation. One clear difference between these projects is the number of joints patched. On the sections on I-79, Butler County, approximately 25 percent of the original joints were patched. On the sections on I-80, Columbia County, more than 95 percent of the joints were patched. The I-79 sections are performing satisfactorily after 4 years of service; the I-80 sections can be considered failed after 6 years of service.

Combined CPR

Most of the study sections included grinding, subsealing, and full-depth patching in combination. The life predictions and economic analysis performed in this study considered the CPR process to include a combination of these techniques. Figures 1 and 2 illustrate the faulting and roughness measurements for the study sections on which combined CPR was performed. Again, a wide range of performance is illustrated. Note that the best performance was observed on Sections E and F, which contained no subsealing and very limited patching. Section L, on I-80, York/Cumberland counties, also performed well; only 20 percent of the joints on Section L were patched.

Several faulting criteria were considered to determine the effective life of the rehabilitation: average faulting of all joints, average faulting of patched joints, average faulting of patch approach joints, and average faulting of patch leave joints. As can be deduced by comparing Figures 3 and 4, average patch leave joint faulting is generally significantly greater than average patch approach joint faulting, which is consistent with other studies (3,4) It was considered that the worst faults would be the failure criterion for estimating service life.

For the study sections in this project, average faulting of patched joints was plotted versus years since rehabilitation in Figure 5. An average patched joint fault of 0.25 in could be considered to constitute a failed CPR, and an average fault of 0.1 in would result in some user dissatisfaction. Therefore, examining these figures, patch deterioration can be expected within 3 years, and the rehabilitation will have failed within 5 to 6 years.

The relationship of faulting to traffic levels was also considered. Figure 6 is a plot of average faulting of patched joints versus cumulative equivalent single-axle loads (ESALs) since rehabilitation. Examining this figure, some problems can probably be expected with 4 million ESALs, and the rehabilitation will have failed within 9 million ESALs. Figure 7 is a plot of profilograph roughness versus cumulative ESALs since rehabilitation. This figure illustrates an approximately exponential increase in roughness with traffic; after about 8 million ESALs, the roughness of the rehabilitated sections increases dramatically. The outlying point illustrated by the darkened square is Section K on I-83, York/Cumberland counties. Before the 1990 survey, this section was quick-patched with asphalt at the joints, immediately and drastically increasing the roughness. This roughness measurement is not indicative of the performance of the rehabilitation project.

CPR LIFE ESTIMATION

Considering all of the data from these sections, it is estimated that a concrete pavement rehabilitation treatment consisting of full-depth patching, subsealing, and grinding will have a service life of approximately 5 years. The comparatively good performance of Sections E, F, G, H, and L indicates that a greater service life can be expected when the CPR is performed at the first signs of deterioration. If a larger proportion of the original joints must be patched, the expected life is shortened. Unfortunately, most projects currently being performed in Pennsylvania are at the stage where most joints require full-depth patching.

Perhaps the most significant question to ask is: Why are the full-depth patches in Pennsylvania failing so rapidly? Are the results of this study applicable in other states? The answer can be found in part in the construction of the patches. These patches were constructed using current design standards 18-inch long, 1-1/2-inch diameter dowels, spaced 12" center-to-center. However, the case studies revealed several problems associated with PennDOT's patches. Load transfers were significantly lower for retrofitted joints than for original construction. First, in the typical failure mechanism for doweled patches, reported traffic loading creates a hole in the surrounding concrete via excessive bearing stresses. Any looseness in the dowel/concrete interface can cause rapid concrete deterioration. The case studies revealed (and the examination of cores confirmed) that for many of the dowel bars, the surrounding concrete exhibited significant holes around the dowel bar. This implies that the contractor is not ascertaining that the epoxy/grout is effectively surrounding the dowel bar during installation. Also, it was discovered that some dowels were installed out of alignment. When construction was monitored on one CPR project, it was observed that the exposed end of the dowel bar was coated with huge amounts of graphite, as shown in Figure 8. The graphite is supposed to break the concrete bond; however, when the graphite weathers away, the dowel bar is left in a pre-formed hole. The repeated action of large amounts of truck traffic coupled with poor patch construction workmanship has led to shortened full-depth patch life. The proper installation of the dowel bars for a given patch is extremely critical to the life of the patch.

To compare the performance of CPR in Pennsylvania to nationwide performance, faulting models developed in two Federal Highway Administration (FHWA) studies were considered. These models were plotted on Figure 9 for conditions corresponding to those occurring on the study sections in this project. The faulting model for new pavement was developed as part of the FHWA project "Performance of Jointed Concrete Pavements."*(3)* This model is provided as a basis of comparison for the performance of the rehabilitation projects. The models for diamond-grinding of pavements and for full-depth patching plus diamond-grinding were developed as part of the FHWA project "Rehabilitation of Concrete Pavements" and were configured to estimate average patch leave joint faulting. (4) The model for average faulting on full-depth patches incorporates consideration of the number of repairs placed. It should be noted that the patch life as predicted by the models would be seven years, by a similar failure criterion.

ECONOMIC ANALYSIS

Life-cycle costs of CPR and alternatives were compared on the basis of capitalized cost, that is, present worth for an infinite planning horizon. An interest rate of 4 percent was chosen as the value commonly considered to be the true cost of long-term capital, as recommended by the FHWA. Because this is presumed to be a "true" cost of borrowed capital, effects of

inflation were ignored. Historical cost data were corrected for inflation using factors derived from the FHWA Bid Price Index.

Most of the unit cost data used in this study were derived from data supplied by PennDOT. Specifically, the sources included cost data from the CPR projects studied, cost data printouts, and "Price History for '88-89 (2Q88/1Q89)," as well as certain individual items of information obtained on a verbal basis. A few of the items for which PennDOT data were not available were computed from University archival data. The unit of cost chosen for use was dollars per lane-mile ($/lane-mile), although a four-lane divided highway was assumed for cost calculations.

Two hypothetical sites for consideration of user delay costs were evaluated – an urban interstate and a rural interstate. The traffic volumes utilized were:

Daily Traffic (one direction)

Highway Classification	Cars	Single Unit Trucks	Combination Trucks
Rural Interstate	6,200	600	1,800
Urban Interstate	10,400	600	3,000

Actual traffic volumes and percent trucks for a specific site may vary greatly from these hypothetical situations. The distributions were, however, selected to be representative of average conditions. Only user costs during construction were considered.

Life-cycle cost calculations for the 13 alternatives defined in Table 4 were carried out using the cash flow element values presented in Tables 5 and 6. For all alternatives, CPR was assumed to be performed at time zero. Routine annual maintenance costs were ignored. PennDOT considers these to be uniform annual costs that are constant for pavement type. Therefore, all of the alternatives to be considered are affected in the same way and maintenance costs are irrelevant to the comparison.

A summary of the capitalized costs for the various alternatives is presented in Table 7. The three initial CPR scenarios were described in detail in Table 4. As shown in Table 7, alternative (a) for scenario 1 had the lowest capitalized direct cost at $520,077 per lane-mile. Alternative (a), in fact, had the lowest capitalized direct cost for the other two scenarios. This alternative represents a situation where CPR is done with subsequent patching, overlays, and eventual reconstruction.

In scenario 1, a difference of approximately $200,000 per lane-mile between CPR and overlays is indicated. Scenario 3 shows a difference of approximately $20,000 between CPR and overlay. Note that these costs do not include user costs; consequently, the cost of CPR can be high if user costs are included. Specific areas where user costs are high can justify the use of an overlay rather than CPR, especially when traffic must be interrupted every 5 years.

The capitalized costs including user costs for the various alternatives and for the two hypothetical cases are also presented in Table 6. Note that for scenario 3, alternative (c) had the lowest total capitalized costs for the rural interstate and almost equaled alternative (a) in total capitalized costs for the urban interstate. These hypothetical sites do not represent extreme conditions or extended construction periods. Actual user costs must be determined on a case-by-case basis.

CONCLUSIONS

Based on the information available for this study, the following conclusions were drawn for jointed reinforced concrete pavements in Pennsylvania:

1. The expected life for a full-depth patch on a Pennsylvania Interstate highway is approximately 5 years.
2. A full-depth patch begins to experience significant failure (0.1-in faulting) after 3 years of service.
3. The service life of CPR treatments such as subsealing and grinding are limited by the service life of simultaneous full-depth patching.
4. CPR is more effective if it is done early when only minimum distress is associated with the pavement. Sections with a minimum number of patches (less than 5 percent) at the time of the study demonstrated good performance. CPR was performed too late, after major deterioration, for most of the sections in this study.
5. CPR is the most economical treatment based on a dollars-per-lane-mile capitalized direct cost evaluation, not considering user costs. The inclusion of user costs in the analysis can easily justify the use of overlays rather than CPR treatments in some cases. User costs are extremely difficult to quantify, vary from site to site, and can significantly alter any cost analysis.

REFERENCES

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4. M. D. Snyder, M. J. Reiter, K. T. Hall, and M. I. Darter. *Rehabilitation of Concrete Pavements, Volume I: Repair Rehabilitation Techniques*. Report No. FHWA/RD-88-071. FHWA, U.S. Department of Transportation, 1989.

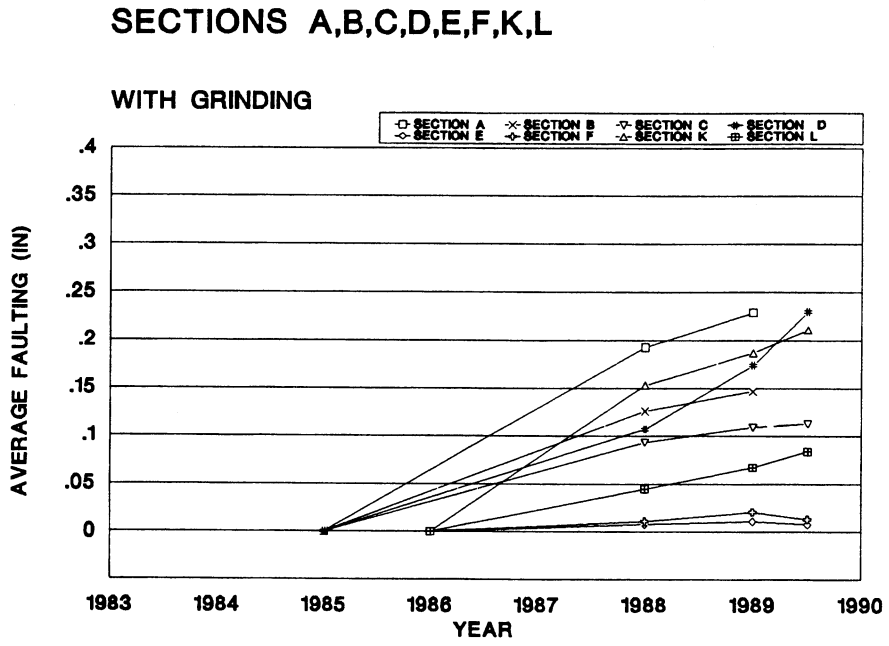


Figure 1 Average faulting on study sections with grinding

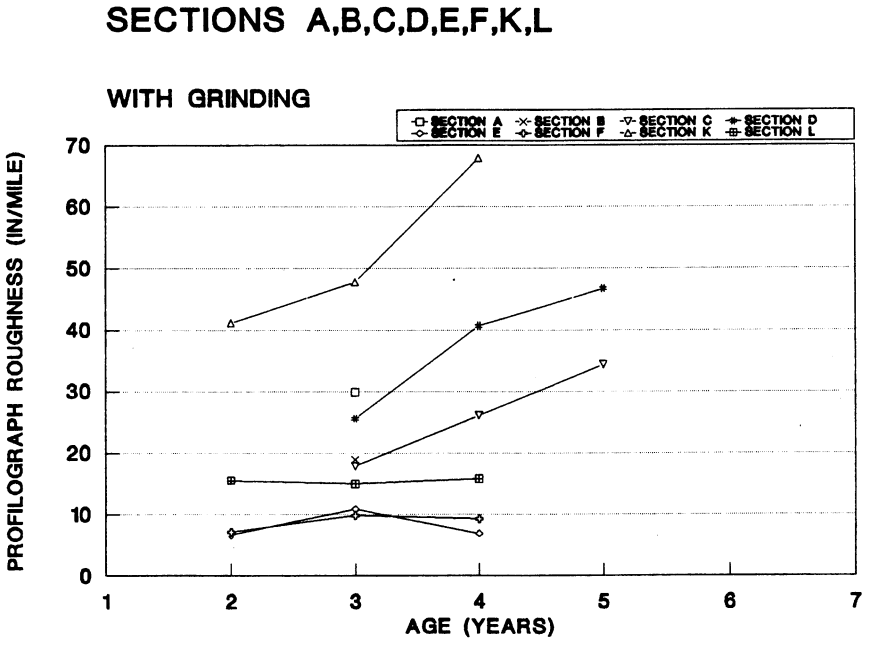


Figure 2 Profilograph roughness on study sections with grinding

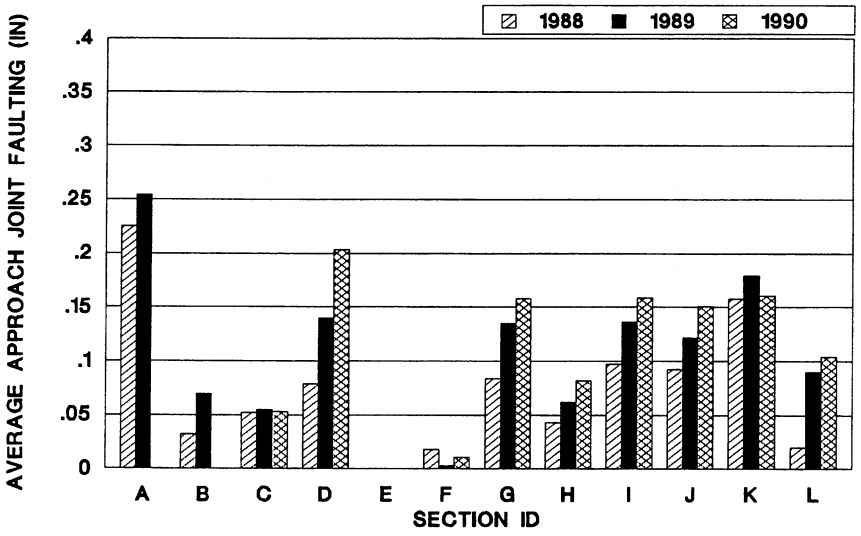


Figure 3 Average approach joint faulting

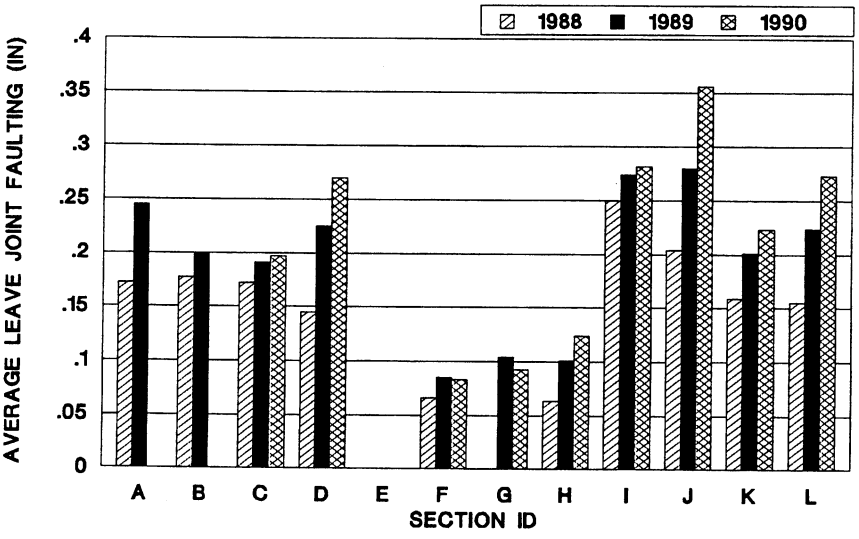


Figure 4 Average leave joint faulting

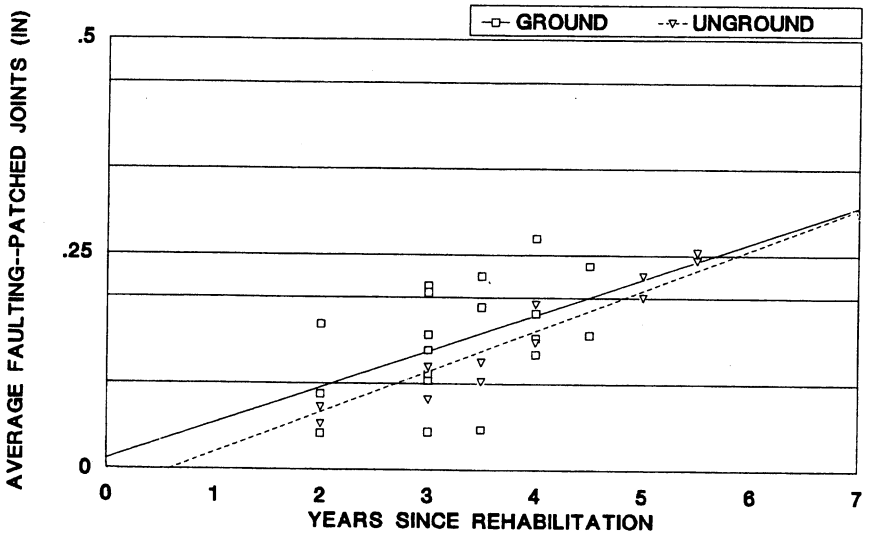


Figure 5 Average faulting of patched joints versus rehabilitation age

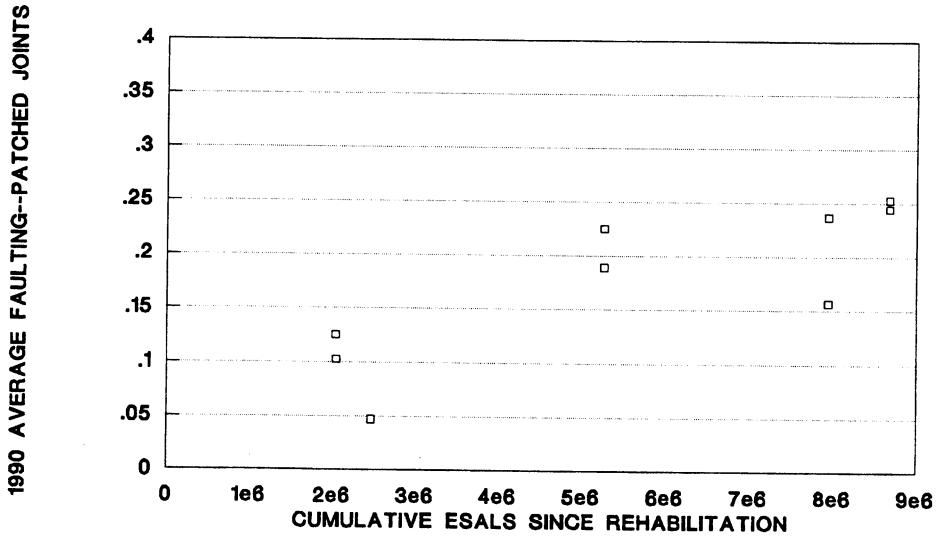


Figure 6 Average faulting of patched joints versus traffic

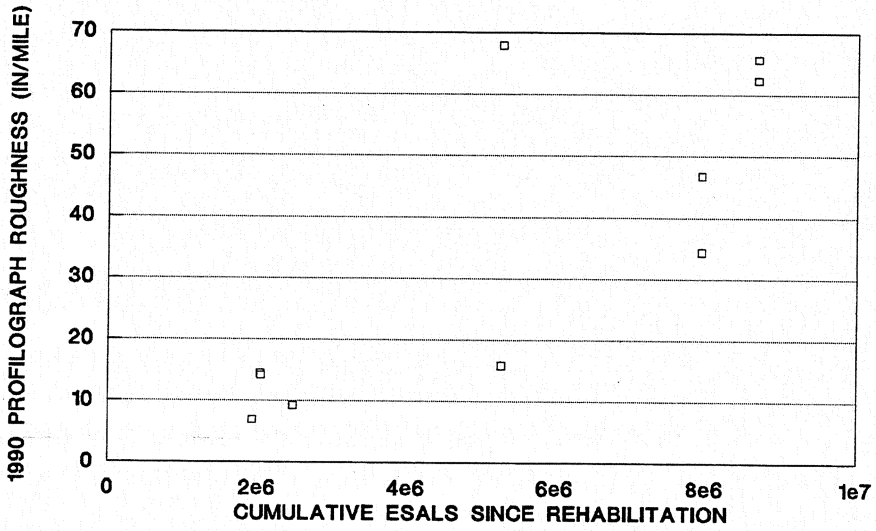


Figure 7 Profilograph roughness versus traffic

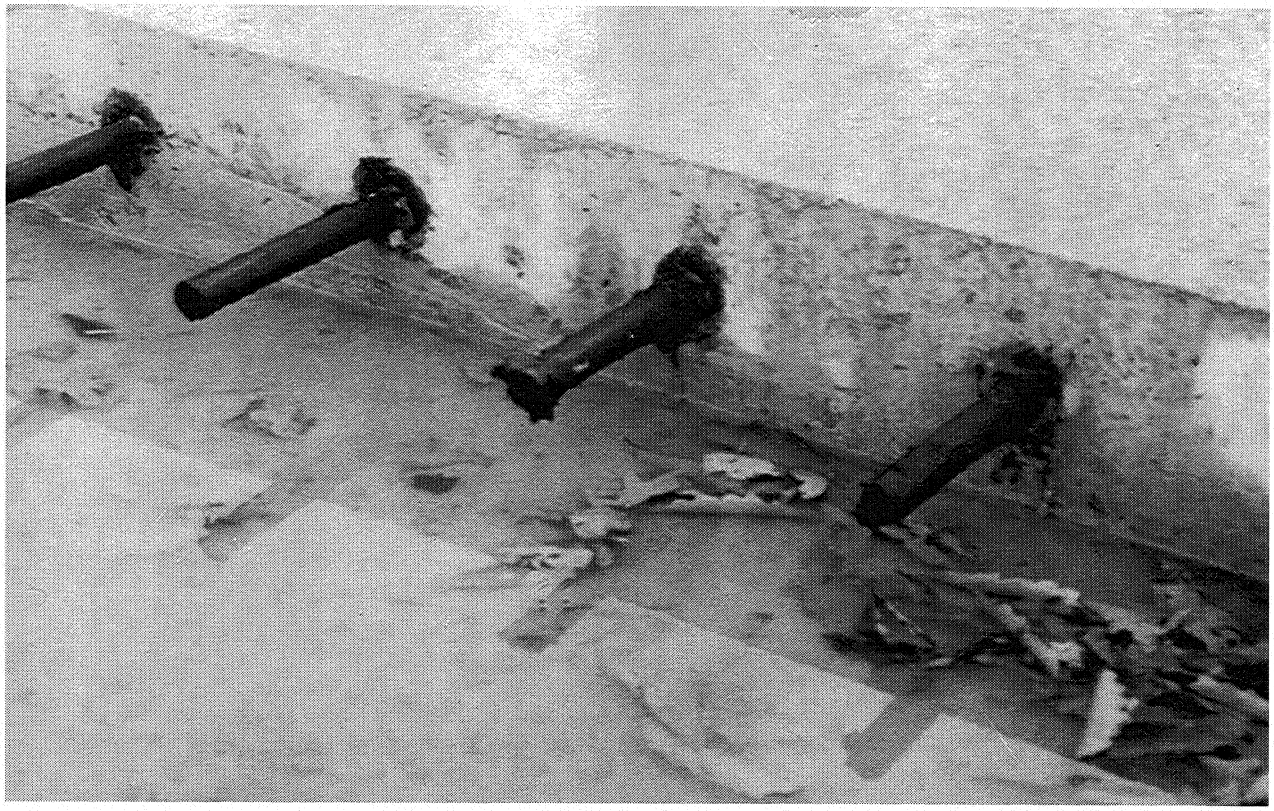


Figure 8 Illustration of excess graphite on dowels

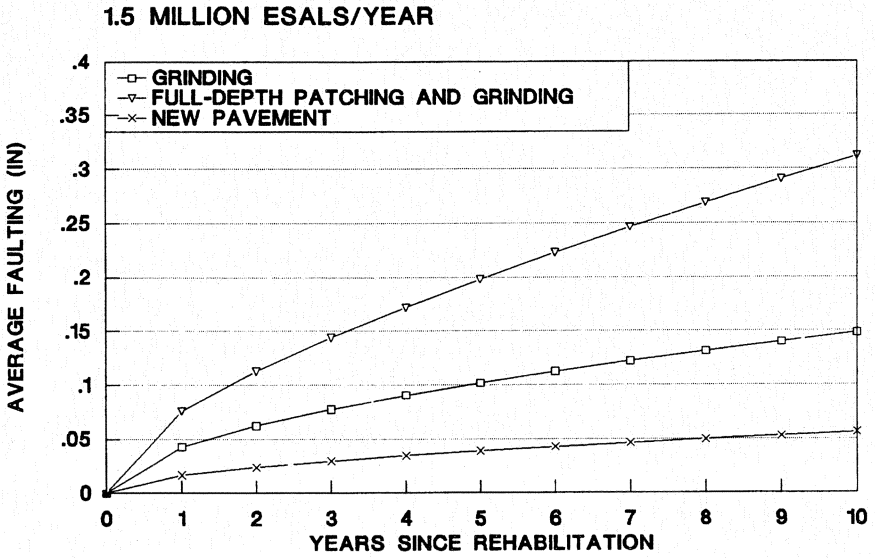


Figure 9 Faulting models developed in FHWA studies, as plotted for conditions comparable to those of the study sections in this project

Table 1. Sections identified for detailed surveys, testing, and analysis.

Section ID	Highway Number	District	County Number	Total Miles	Project Beginning Milepost	Project Ending Milepost	Direction	Section Beginning Milepost	Section Ending Milepost	Section Length (ft)	Original Number of Slabs	Number of Slabs after CPR	Pavement Width (ft)	CPR Date
A	80	10	10	3.7	42.3	46.0	WB	44.1	43.9	990	16	25	24	1985
B	80	10	10	3.7	42.3	46.0	EB	42.8	43.0	989	16	23	24	1985
C	80	1	43	15.4	0.0	15.4	WB	9.1	8.9	991	16	25	24	1985
D	80	1	43	15.4	0.0	15.4	EB	6.0	6.2	1,000	16	35	24	1985
E	79	1	43	6.8	110.3	116.6	SB	112.0	111.8	989	16	19	24	1986
F	79	1	43	6.8	110.3	116.6	NB	113.0	113.2	988	16	19	24	1986
G	79	10	10	12.5	93.3	105.5	SB	102.0	101.8	987	16	24	24	1986
H	79	10	10	12.5	93.0	105.5	NB	101.0	101.2	1,045	17	27	24	1986
I	80	3	19	5.9	247.2	241.3	WB	245.0	244.8	1,000	16	31	24	1984
J	80	3	19	5.9	247.2	241.3	WB	242.8	242.6	996	16	35	24	1984
K	83	8	67	5.2	36.0	42.0	SB	38.3	38.1	1,000	16	29	24	1986
L	83	8	67	5.2	36.0	42.0	NB	37.4	37.6	1,000	16	22	24	1986

Table 2. Faulting measurements (in).

Section ID		Outer Edge Travel Lane			Inner Edge Passing Lane		
		High	Low	Avg	High	Low	Avg
A	1988	0.417	0.005	0.192	0.140	0.002	0.041
	1989	0.461	0.000	0.229	0.195	0.000	0.050
	1990	-----	-----	-----	-----	-----	-----
B	1988	0.299	0.000	0.126	0.117	0.001	0.047
	1989	0.310	0.004	0.147	0.143	0.001	0.047
	1990	-----	-----	-----	-----	-----	-----
C	1988	0.509	0.007	0.093	0.088	0.000	0.034
	1989	0.546	0.010	0.109	0.117	0.007	0.044
	1990	0.559	0.000	0.113	0.160	0.000	0.045
D	1988	0.346	0.005	0.107	0.097	0.000	0.022
	1989	0.472	0.000	0.174	0.130	0.000	0.025
	1990	0.510	0.041	0.230	0.140	0.000	0.029
E	1988	0.018	0.000	0.008	0.028	0.003	0.013
	1989	0.031	0.000	0.011	0.039	0.002	0.016
	1990	0.018	0.000	0.008	0.047	0.000	0.015
F	1988	0.066	0.000	0.011	0.032	0.000	0.011
	1989	0.045	0.000	0.021	0.040	0.000	0.019
	1990	0.083	0.000	0.013	0.033	0.000	0.013
G	1988	0.151	0.000	0.036	0.031	0.000	0.010
	1989	0.215	0.000	0.056	0.119	0.003	0.018
	1990	0.240	0.000	0.061	0.166	0.000	0.019
H	1988	0.119	0.000	0.031	0.030	0.000	0.008
	1989	0.160	0.000	0.043	0.040	0.000	0.019
	1990	0.191	0.000	0.053	0.043	0.000	0.015
I	1988	0.684	0.000	0.175	0.325	0.000	0.146
	1989	0.610	0.019	0.202	0.313	0.026	0.160
	1990	0.659	0.011	0.220	0.413	0.021	0.174
J	1988	0.350	0.000	0.146	0.255	0.010	0.091
	1989	0.445	0.000	0.197	0.283	0.000	0.109
	1990	0.541	0.000	0.243	0.306	0.004	0.112
K	1988	0.360	0.000	0.153	-----	-----	-----
	1989	0.420	0.000	0.187	-----	-----	-----
	1990	0.466	0.000	0.211	-----	-----	-----
L	1988	0.260	0.000	0.045	-----	-----	-----
	1989	0.361	0.000	0.067	-----	-----	-----
	1990	0.340	0.000	0.084	-----	-----	-----

Table 3. FWD analysis summary.

Section	Modulus of Subgrade Reaction (pci)	Original PCC Modulus (psi)	Range of Load Transfers (%)	Detected Number of Voids
A	337	1,944,000	0.20-0.90	0
B	204	5,600,000	0.15-0.95	1
C	276	1,770,000	0.05-0.95	8
D	211	2,039,000	0.05-0.85	24
E	390	2,254,000	0.70-1.00	2
F	327	2,056,000	0.50-1.00	16
G	308	3,260,000	0.15-1.00	7
H	196	5,608,000	0.20-0.95	7
I	322	3,925,000	0.05-0.80	5
J	298	4,866,000	0.10-0.85	1
K	578	2,058,000	0.20-0.95	12
L	311	2,185,000	0.30-0.90	12

Table 4. Scenarios and alternatives.

Scenario (Present Condition in Terms of CPR Requirements)*			Alternative	Subsequent Activities					
				Years From Present					
						Bituminous Conc. Overlay			
No.	Full-Depth Patching (%)	Sub-Sealing (%)		CPR	Full-Depth Patch Only	1st	2nd	Rebuild	End of Cycle
1	5%	15%	(a)	0	5	10	18	26	56
			(b)	0	5	--	--	10	40
			(c)	--	--	0	8	16	46
			(d)	--	--	--	--	0	30
2	25%	35%	(a)	0,5	--	10	18	26	61
			(b)	0	--	5	13	21	56
			(c)	0	--	--	--	5	40
			(d)	--	--	0	8	16	51
			(e)	--	--	--	--	0	35
3	75%	85%	(a)	0	--	5	13	21	61
			(b)	0	--	--	--	5	45
			(c)	--	--	0	8	16	56
			(d)	--	--	--	--	0	40

*Also includes 100% diamond grinding and 10 spall repairs/1,000'--two lanes.

Table 5. Summary of cost elements of cash flow activities.

Cost Elements of Cash Flow Activity	Cost of Cash Flow Activity ($/ln-mile)						
	CPR 5% Patch 15% Subseal	CPR 25% Patch 35% Subseal	CPR 75% Patch 85% Subseal	5% Full-Depth Patch Only	Bituminous Conc. Overlay		Rebuild
					1st	2nd	
	(A)	(B)	(C)	(D)	(E)	(F)	(G)
Type 1 of Full Depth Patching	2,816	14,084	42,253	2,816			
Patching Joints	1,267	6,336	19,008	1,267			
Spall Repairs	1,205	1,205	1,205	1,205			
Type 1 Joint Rehab	2,508	1,980	660	2,508			
Long Jts.--Clean and Seal	2,640	2,640	2,640	2,640			
Shoulder Jts.--Saw and Seal	3,960	3,960	3,960	3,960			
100% Diamond Grinding	19,360	19,360	19,360				
Subsealing	1,727	4,029	9,784				
Deflection Testing	704	704	704				
Leveling Course					7,181		

Table 5. Summary of cost elements of cash flow activities (continued).

Cost Elements of Cash Flow Activity	Cost of Cash Flow Activity ($/ln-mile)						
	CPR 5% Patch 15% Subseal	CPR 25% Patch 35% Subseal	CPR 75% Patch 85% Subseal	5% Full-Depth Patch Only	Bituminous Conc. Overlay		Rebuild
					1st	2nd	
	(A)	(B)	(C)	(D)	(E)	(F)	(G)
4" ID-2 Binder					83,873		
2" ID-2 Wearing					47,671		
Saw & Seal Joints (overlay)					13,464	13,464	
Adjust Guide Rails					7,722		
Cold Mill 3" Deep						16,256	
3" ID-2 Wearing						71,506	
Class IB Pavement Excavating							124,663
Rebuild							537,500
Traffic Maint. & Prot.	903	1,355	2,484	359	3,989	2,525	*
Mobilization	2,158	3,239	5,940	859	9,539	6,039	*
TOTAL	39,248	58,892	107,998	15,614	173,439	109,790	662,163

*Included in rebuild cost.

Table 6. Road user costs and total activity costs ($/ln-mile).

		Road User Cost		Total Costs	
Activity	Basic Cost	Rural	Urban	Rural	Urban
A	39,248	6,433	7,525	45,681	46,773
B	58,892	19,300	16,125	78,192	75,017
C	107,998	25,734	24,188	133,732	132,186
D	15,614	5,361	7,525	20,975	23,139
E	173,439	7,291	18,320	180,730	191,759
F	109,790	9,436	23,708	119,226	133,498
G	662,163	19,300	48,494	681,463	710,657

Table 7. Summary of capitalized costs of the various alternatives ($/ln-mile).

			Including User Costs	
Scenario (Initial Condition)	Alternative	Direct Costs (no user costs)	Hypothetical Rural Interstate	Hypothetical Urban Interstate
1. 5% Patching/15% Subsealing	(a) CPR/Patch/AC Overlays/Rebuild	520,077	550,783	582,157
	(b) CPR/Patch/Rebuild	630,791	660,949	689,485
	(c) AC Overlays/Rebuild	726,808	756,123	800,465
	(d) Rebuild	957,322	985,225	1,027,432
2. 25% Patching/35% Subsealing	(a) CPR/CPR/AC Overlays Rebuild	569,515	626,419	647,594
	(b) CPR/AC Overlays/Rebuild	627,667	672,038	702,719
	(c) CPR/Rebuild	673,363	806,156	832,451
	(d) AC Overlays/Rebuild	761,745	730,540	773,381
	(e) Rebuild	702,217	912,820	951,925
3. 75% Patching/85% Subsealing	(a) CPR/AC Overlays/Rebuild	668,052	718,524	750,330
	(b) CPR/Rebuild	786,915	837,102	864,186
	(c) AC Overlays/Rebuild	683,090	710,642	752,316
	(d) Rebuild	836,312	860,688	897,560