Concrete Pavement Rehabilitation for the Texas State Department of Highways and Public Transportation

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In order to formulate recommendations for rehabilitation strategies that should be considered for concrete pavements the author has: (a) Reviewed the performance of different solutions used in Texas, (b) Reviewed the performance of other methodologies in other states, and (c) Examined costs of several recent projects in Texas and Kentucky. This paper summarizes the findings and recommendations.

Historically, rehabilitation of concrete pavements has consisted of (1) attempts to stabilize pumping with asphalt undersealing, joint sealing, and grouting; (2) repairs varying from spall repairs to joint replacement to full slab replacement; (3) leveling attempts include grinding, mudjacking, and thin asphalt overlays; and (4) strengthening with thick asphalt overlays, bonded and unbonded concrete overlays, and retrofitted tied portland cement concrete (PCC) shoulders.

Recent work by the concrete paving industry has lumped many of these items into a program called concrete pavement restoration (CPR). The author feels this program, properly applied, is a viable approach to contracting for deferred maintenance, and that CPR should often be used to restore the pavement to an acceptable operating condition. It is also believed that the reason such maintenance is often deferred in Texas is the difficulty of performing such maintenance under heavy traffic. It is further believed that soon after completion of CPR there will again arise the need for maintenance and it will be again deferred. In other words, there comes a time in the life of all heavily trafficked concrete pavements when either strengthening or replacement is needed. This paper deals with those situations.

The following types of PCC pavements have been built in Texas and are discussed hereafter. They are plain concrete pavements (CPCD) with a variety of load transfer devices and active joints from twenty to fifty feet; jointed reinforced concrete pavements (JRCP), with 50- to 60½-ft joint spacing; and continuously reinforced concrete pavements (CRCP).

The following rehabilitation solutions have been considered:

1. Simple asphalt overlays,
2. Asphalt overlays with crack relief layers,
3. Asphalt overlays after cracking and seating the PCC,
4. Bonded concrete overlays, and
5. Unbonded concrete overlays.

Within certain limits it is believed all of the above solutions can provide a viable extension of life of the existing pavement. It is also believed that a sixth solution, complete reconstruction, will ultimately be necessary. The expected performance of each type of rehabilitation for each type of pavement is discussed briefly below.

Reflected joints through simple asphalt overlays have usually been the scourge of this solution for jointed PCC pavements. Water enters the broken asphalt at the reflection crack, and potholing, crack spalling, and stripping often follow.

Simple asphalt overlays should, therefore, be limited to pavements with less traffic and good load transfer across the joints. The only reasons that justify the need for such overlays, then, are slickness and roughness. In summary, a slick or rough, but sound, jointed PCC might be successfully overlaid with asphalt concrete pavement (ACP). (Sawing of the ACP over the old joints is being researched in some states. This may be an improvement on this technique.)

Texas' experience has indicated that simple asphalt overlays have been very successful when placed over repaired CRCP. Based on the performance of more than 20 such projects ranging in age from one to eighteen years, it appears conservative to expect a ten-year life for such solutions (results of unpublished condition surveys conducted on asphalt overlays of 8-in CRCP in Texas in 1986). Thickness of the asphalt overlays has varied from 1 inch to 6½ inches. Current recommendations are to carefully repair the CRCP with full-depth, fully reinforced patches and place a 3½-in to 4½-in ACP overlay.

One asphalt overlay with a crack relief layer has been tried in Texas. Several projects in Arkansas and other states have also been built (*1*). Mixed success has been reported. One factor that has not been completely resolved with this technique is how much joint movement—both horizontally and vertically—can be accommodated by what size aggregate in the crack relief layer. Additionally, the crack relief layer acts as a drainage layer with all the attendant problems associated with outlets. In summary, enough success has been reported with this technique to not rule it out, but specific recommendations on optimizing the design are not possible.

Many projects using the "crack and seat" or "break and seat" technique followed by an asphalt overlay have been built in recent years. California and Kentucky (*2*) have been leading states using this method. Existing PCCs in California

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are plain pavements without reinforcement and only aggregate interlock for load transfer. Stabilized subbases are usually present. Kentucky, on the other hand, uses mesh reinforcement and dowels. The California overlays are approximately 3½-in, plus a fabric reinforcement. The Kentucky overlays are approximately 6½-in thick. Other states are also trying this technique.

Questions related to factors that should be optimized include:

1. How close should one be to crack the pavement?
2. How thick should the ACP overlay be?
3. How much difference does reinforcement make?
4. How should breaking or cracking and the seating operation be inspected?
5. Is the fabric needed or beneficial?
6. Is drainage necessary?
7. What will the ultimate wearout and, thus, future rehabilitation be like?

Even with these uncertainties, it appears the technique used in Kentucky is a viable one for rehabilitating CPCD and JRCP pavements.

Bonded concrete overlays are being tried more and more on highway pavements. This technique, developed to strengthen sound airfield pavements to handle heavier aircraft, was first used in the highway field for bridge deck repair. Many projects have been placed in the Midwest on jointed concrete pavements (*3*). Two critical elements must be present, however, for bonded concrete overlays to be successful. Most engineers believe that bonding to an existing pavement is a process that requires a sound existing pavement. Unfortunately, these same engineers will likely differ widely in what they determine to be a sound pavement. Second, bonded is the critical word in bonded concrete overlay. Very careful construction is necessary to achieve bonding.

Two full-scale bonded PCC overlays of CRCP were built in the late 1970s in Minnesota and Iowa, another in 1983–84 in Wisconsin, and one in 1986–1987 in Houston, Texas. Some debonding is being experienced on the Houston project at this time. As will be shown later, this technique has an economic advantage over unbonded PCC overlays in urban freeway construction if it performs well.

Unbonded PCC overlays (*4*) have been used many times throughout the United States. Provided the designer recognizes that the existing pavement provides only an excellent base upon which to build a new PCC and, therefore, does not try to make the overlay too thin, unbonded PCC overlays should last as long as a new PCC pavement.

COST PERFORMANCE

In order to determine the cost-effectiveness of some of the previously mentioned techniques, fifteen full-scale Texas freeway rehabilitation projects were studied. Additionally Drake (*2*) provided data on 12 projects using the break and seat technique. Table 1 summarizes the 27 projects. The projects from Texas include two simple-asphalt overlays, one ACP overlay plus extensive repairs, one bonded PCC over CRCP, six unbonded overlays, and five reconstruction projects. Twelve crack and seat projects from Kentucky are shown. Five of the Texas projects are capacity improvement projects: two change from a six-lane freeway to an eight-lane freeway plus an authorized vehicle lane (AVL); two change from a four-lane freeway to an eight-lane freeway; and one changes from a four- to a six-lane freeway. In Texas, three of the old pavements were plain, eight were jointed reinforced, and five were CRCP. All the old Kentucky pavements were 25-ft, jointed, mesh-doweled pavements. Data on six "Texas Comparison Projects" are also supplied. These were not PCC-rehabilitation projects and are not discussed. The data are provided so the reader can make comparisons, if desired.

Table 2 summarizes bid prices for these projects. The column labeled "Unit Bid" shows the bid per square yard for all paving items used on the main lanes and shoulders. The column labeled "Total Cost of Paving" attempts to isolate all costs associated with pavement rehabilitation. This column includes repairs, mobilization, traffic handling, and pavement markings for the Texas projects. It excludes drainage structures, grading, and frontage roads except where upgrading the frontage road was explicitly required for traffic handling. Figure 1 shows that the total cost of paving exceeds the unit bid by significant amounts.

In order to develop a better estimate for optimal solutions, estimates of pavement life were made as shown in Table 3. Thirty-year, life-cycle cost calculations were made using these estimates and a discount rate of 5 percent. The column labeled "Net Present Worth" shows these results.

Note that the expected life estimates are the author's and are based only on very limited evidence for most of the techniques. Unfortunately, it is necessary to make decisions on enormous construction outlays based on limited data.

These calculations indicate tremendous advantages for solutions that incorporate significant portions of the existing pavement into the new pavement, in other words the ACP overlays, the ACP plus crack and seat, and the bonded PCC overlay. Many engineers, including the author, believe another factor, reliability, or the probability that the design will perform as expected, should be considered (*5*). Reliability should be high whenever the consequences of failure are critical. This factor, as well as the cost of delay for rehabilitation construction, has not been quantified but has subjectively influenced the recommendations that follow.

Annual cost per-vehicle-mile, per-lane using present ADT for the thirty-year cycle were computed and are also shown in Table 3. Texas State Department of Highways and Public Transportation rehabilitation funds are currently allocated on a basis that is closely related to this number. The basis for allocation is 50 percent for lane-miles and 50 percent for vehicle-miles. Highways (or districts) with heavier traffic receive more rehabilitation funds.

The recommendations that conclude this paper are based on the following assumptions:

1. The previously stated assumptions about pavement life, interest rate, etc., are accurate enough to be useful.
2. There is not enough rehabilitation money available to select the longer life/higher life-cycle cost solutions for rural freeway projects.
3. The potential cost savings for the bonded PCC overlay outweighs the uncertainty associated with it.
4. The urban freeway capacity improvement projects are not wholly funded with rehabilitation funds. Their excessive costs must be balanced by the opportunity to effect user delay

TABLE 1 SUMMARY OF CONCRETE REHABILITATION PROJECTS—TEXAS PROJECTS

JOB #	EXISTING PAVEMENT	DESCRIPTION	SHOULDERS	TYPE	(E) # LANES	ADT	LENGTH (MILES)	(C) TOTAL BID (10^6)	DATE LET
1	CRCP	3" ACP O.L.	4" ACP O/L	RURAL	4/4	15,000	14.1	$6.2	SEP 85
2	CRCP&JRCP	4" ACP O.L.	4" ACP	URBAN	8/8	80,000	3.3	$6.3	OCT 83
3	JRCP	3" ACP O.L. & REPAIRS (3.1)*	3" ACP O/L	RURAL	4/6	26,000	3.9	$20.5	SEP 86
4	CRCP	4" BONDED CRCP O.L.	4" ACP	URBAN	8/8	165,000	3.4	$10.8	APR 85
5	JRCP	10" CRCP O.L.	10" CRCP	RURAL	4/4	17,000	14.9	$21.2	APR 85
6	CPCD	10" CRCP O.L. (6.1)	10" CRCP	RURAL	4/4	15,000	9.5	$18.6	OCT 85
7	CPCD	10" CPCD O.L. (7.1)	8"&10" CPCD	RURAL	4/4	21,000	10.7	$28.4	AUG 86
8	CRCP	10" CPCD O.L. (8.1)	10" ACP	RURAL	4/4	16,000	6.3	$12.2	AUG 85
9	CPCD	13" CPCD RECONSTR (9.1)	1" ACP	URBAN	4/4	20,000	6.5	$16.4	OCT 85
10	JRCP	13" CRCP RECONSTR	13" CRCP	URBAN	4/8	135,000	2.7	$50.0	OCT 85
11	JRCP	10" CRCP O.L. (11.1)	10" CRCP	URBAN	6/8+AVL	127,000	4.7	$34.1	APR 85
12	JRCP	11" CRCP O.L. (12.1)	11" CRCP	URBAN	6/8+AVL	175,000	4.1	$70.0	JAN 86
13	JRCP	14" CRCP RECONSTR (13.1)	14" CRCP	RURAL	4/6	26,000	1.5	$20.5	SEP 86
14	CRCP	12" CRCP RECONSTR (14.1)	12" CRCP	URBAN	4/8	73,000	3.4	$45.8	JAN 86
15	JRCP	13" CRCP RECONSTR (15.1)	13" CRCP	URBAN	8/8	73,000	2.5	$68.9	MAR 87
		TEXAS COMPARISON PROJECTS							
16	ACP	3" ACP O.L.	3" ACP	RURAL	4/4	14,000	4.2	$3.4	MAR 87
17	ACP	4" ACP O.L. & 15" WIDEN (17.1)	1.5"&4" ACP	URBAN	4/6	90,000	5.6	$15.4	SEP 86
18	ACP	COMPLETE ACP RECONSTR (18.1)	2" ACP	RURAL	4/4	11,000	8.3	$ 8.6	MAR 85
19	ACP	10" CRCP RECONSTR (19.1)	10" CRCP	RURAL	4/6	7,000	8.8	$11.2	SEP 86
20	NEW	12" CPCD	12" CPCD	RURAL	4/4	35,000	4.3	$18.5	NOV 85
21	CRCP	8" CRCP WIDENING (21.1)	8" CRCP	URBAN	6/8	90,000	1.9	$16.6	AUG 86
		KENTUCKY PROJECTS							
1	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	RURAL	4/4	11,000	13.2	$8.0	FEB 82
2	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	RURAL	4/4	21,000	19.1	$9.3	JUL 82
3	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	URBAN	4/4	38,000	2.4	$1.5	MAY 83
4	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	RURAL	4/4	12,000	7.5	$4.9	JUN 83
5	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	RURAL	4/4	12,000	12.5	$7.1	JUN 83
6	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	URBAN	4/4	45,000	7.9	$6.2	JUL 83
7	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	RURAL	4/4	22,000	11.3	$6.9	JUL 83
8	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	RURAL	4/4	13,000	15.4	$8.3	AUG 83
9	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	RURAL	4/4	19,000	14.5	$8.8	SEP 83
10	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	URBAN	4/4	30,000	16.3	$8.6	SEP 83
11	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	RURAL	4/4	21,000	5.1	$4.0	NOV 83
12	JRCP	6.5" ACP W/ CRACK & SEAT	6.5" ACP	RURAL	4/4	21,000	11.1	$6.8	JUN 84
	AVERAGE:	6.5" ACP W/ CRACK & SEAT			4/4	22,000	11.4	$6.677,937.80	

*See "Notes for Tables" for additional project specific information.

TABLE 2 SUMMARY COSTS FOR CONCRETE REHABILITATION PROJECTS—TEXAS PROJECTS

JOB #	EXISTING PAVEMENT	DESCRIPTION	TYPE	(A) UNIT BID ($/SY)	(B) UNIT COST OF PAVING ($/SY)	UNIT BID UNIT COST	(D) COST/MILE (4 LANES)
1	CRCP	3" ACP O.L.	RURAL	5.56	8	0.70	357,000
2	CRCP&JRCP	4" ACP O.L.	URBAN	9.85	13	0.76	580,000
3	JRCP	3" ACP O.L. & REPAIRS	RURAL	6.03	20	0.30	892,000
4	CRCP	4" BONDED CRCP O.L.	URBAN	17.79	25	0.71	1,115,000
5	JRCP	10" CRCP O.L.	RURAL	19.13	25	0.77	1,115,000
6	CPCD	10" CRCP O.L.	RURAL	15.96	34	0.47	1,516,000
7	CPCD	10" CPCD O.L.	RURAL	20.44	36	0.57	1,605,000
8	CRCP	10" CPCD O.L.	RURAL	23.94	38	0.63	1,694,000
9	CPCD	13" CPCD RECONSTR	URBAN	33.13	41	0.81	1,828,000
10	JRCP	13" CRCP RECONSTR	URBAN	35.28	55	0.64	2,452,000
11	JRCP	10" CRCP O.L.	URBAN	35.80	56	0.64	2,497,000
12	JRCP	11" CRCP O.L.	URBAN	39.32	57	0.69	2,541,000
13	JRCP	14" CRCP RECONSTR	RURAL	41.77	57	0.73	2,541,000
14	CRCP	12" CRCP RECONSTR	URBAN	38.81	61 (14.2)	0.64	2,720,000
15	JRCP	13" CRCP RECONSTR	URBAN	28.68	65	0.44	2,898,000
		TEXAS COMPARISON PROJECTS					
16	ACP	3" ACP O.L.	RURAL	4.06	7	0.58	312,000
17	ACP	4" ACP O.L. & 15" WIDEN	URBAN	11.45	14	0.82	624,000
18	ACP	COMPLETE ACP RECSTR	RURAL	13.21	18	0.73	803,000
19	ACP	10" CRCP RECONSTR	RURAL	18.55	24	0.77	1,070,000
20	NEW	12" CPCD	RURAL	24.10	48	0.50	2,140,000
21	CRCP	8" CRCP WIDENING	URBAN	38.05	58	0.66	2,586,000
		KENTUCKY PROJECTS					
1	JRCP	6.5" ACP W/ CRACK & SEAT	RURAL	6.22	14	0.44	601,000
2	JRCP	6.5" ACP W/ CRACK & SEAT	RURAL	7.79	11	0.71	488,000
3	JRCP	6.5" ACP W/ CRACK & SEAT	URBAN	9.61	15	0.64	639,000
4	JRCP	6.5" ACP W/ CRACK & SEAT	RURAL	8.33	13	0.64	646,000
5	JRCP	6.5" ACP W/ CRACK & SEAT	RURAL	7.74	13	0.60	567,000
6	JRCP	6.5" ACP W/ CRACK & SEAT	URBAN	6.29	15	0.42	777,000
7	JRCP	6.5" ACP W/ CRACK & SEAT	RURAL	6.36	12	0.53	610,000
8	JRCP	6.5" ACP W/ CRACK & SEAT	RURAL	6.67	12	0.56	538,000
9	JRCP	6.5" ACP W/ CRACK & SEAT	RURAL	9.88	17	0.58	605,000
10	JRCP	6.5" ACP W/ CRACK & SEAT	URBAN	6.41	11	0.58	526,000
11	JRCP	6.5" ACP W/ CRACK & SEAT	RURAL	6.87	16	0.43	763,000
12	JRCP	6.5" ACP W/ CRACK & SEAT	RURAL	6.93	13	0.53	614,000
	AVERAGE:	6.5" ACP W/ CRACK & SEAT		7.42	14	0.55	614,500

TABLE 3 COST ANALYSES—TEXAS PROJECTS

JOB #	EXISTING PAVEMENT	TYPE	DESCRIPTION	EXPECTED LIFE	UNIT BID	TOTAL COST OF PAVING ($/SY)	NET PRESENT WORTH $/SY)*	ANNUAL COST /LN MI /VEHICLE (1986 $)	ADT	ADT /LANE
1	CRCP	RURAL	3" ACP O.L.	10	5.56	8	16	1.00	15,000	3,750
2	CRCP&JRCP	URBAN	4" ACP O.L.	10	9.85	13	26	0.61	80,000	10,000
3	JRCP	RURAL	3" ACP O.L. & REPAIRS	10	6.03	20	40	2.16	26,000	4,330
4	CRCP	URBAN	4" BONDED CRCP O.L.	15	17.79	25	37	0.42	165,000	20,630
5	JRCP	RURAL	10" CRCP O.L.	30	19.13	25	25	1.38	17,000	4,250
6	CPCD	RURAL	10" CRCP O.L.	30	15.96	34	34	2.13	15,000	3,750
7	CPCD	RURAL	10" CPCD O.L.	30	20.44	36	36	1.61	21,000	5,250
8	CRCP	RURAL	10" CPCD O.L.	30	23.94	38	38	2.23	16,000	4,000
9	CPCD	URBAN	13" CPCD RECONSTR	30	33.13	41	41	1.92	20,000	5,000
10	JRCP	URBAN	13" CRCP RECONSTR	30	35.28	55	55	0.76	135,000	16,880
11	JRCP	URBAN	10" CRCP O.L.	30	35.80	56	56	0.93	127,000	14,110
12	JRCP	URBAN	11" CRCP O.L.	30	39.32	57	57	0.69	175,000	19,440
13	JRCP	RURAL	14" CRCP RECONSTR	30	41.77	57	57	3.09	26,000	4,330
14	CRCP	URBAN	12" CRCP RECONSTR	30	38.81	61	61	1.57	73,000	9,130
15	JRCP	URBAN	13" CRCP RECONSTR	30	28.68	65	65	1.67	73,000	9,130
			TEXAS COMPARISON PROJECTS							
16	ACP	RURAL	3" ACP O.L.	10	4.06	7	14	0.93	14,000	3,500
17	ACP	URBAN	4" ACP O.L.&15" WIDEN	10	11.45	14	28	0.44	90,000	15,000
18	ACP	RURAL	COMPLETE ACP RECOSTR	20	13.21	18	27	2.33	11,000	2,750
19	ACP	RURAL	10" CRCP RECONSTR	30	18.55	24	24	4.81	7,000	1,170
20	NEW	RURAL	12" CPCD	30	24.10	48	48	1.29	35,000	8,750
21	CRCP	URBAN	8" CRCP WIDENING	30	38.05	58	58	1.21	90,000	11,250
			KENTUCKY PROJECTS							
1	JRCP	RURAL	6.5" ACP W/ CR & SEAT	15	6	14	21	1.77	11,000	2,750
2	JRCP	RURAL	6.5" ACP W/ CR & SEAT	15	8	11	16	0.73	21,000	5,250
3	JRCP	URBAN	6.5" ACP W/ CR & SEAT	15	10	15	22	0.55	38,000	9,500
4	JRCP	RURAL	6.5" ACP W/ CR & SEAT	15	8	13	19	1.51	12,000	3,000
5	JRCP	RURAL	6.5" ACP W/ CR & SEAT	15	8	13	19	1.51	12,000	3,000
6	JRCP	URBAN	6.5" ACP W/ CR & SEAT	15	6	15	22	0.46	45,000	11,250
7	JRCP	RURAL	6.5" ACP W/ CR & SEAT	15	6	12	18	0.76	22,000	5,500
8	JRCP	RURAL	6.5" ACP W/ CR & SEAT	15	7	12	18	1.28	13,000	3,250
9	JRCP	RURAL	6.5" ACP W/ CR & SEAT	15	10	17	25	1.24	19,000	4,750
10	JRCP	URBAN	6.5" ACP W/ CR & SEAT	15	6	11	16	0.51	30,000	7,500
11	JRCP	RURAL	6.5" ACP W/ CR & SEAT	15	7	16	24	1.06	21,000	5,250
12	JRCP	RURAL	6.5" ACP W/ CR & SEAT	15	7	13	19	0.86	21,000	5,250
AVERAGE:			6.5" ACP W/ CR & SEAT		7	14	20	1.02	22,000	5,520

savings by "fixing it right the first time" and by the need for greater reliability in the design solution.

RECOMMENDATIONS

Various concrete rehabilitation strengthening solutions have been discussed and costs compared. For Texas, the following recommendations are made.

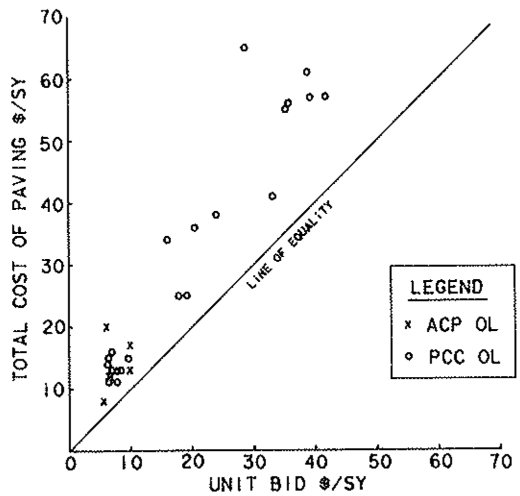

FIGURE 1 Total cost versus unit bid.

1. For non-freeway jointed pavements that must be overlaid due only to slickness or roughness, use 1½- to 3½-in ACP.
2. For all rural CRCP pavements experiencing punchouts or spalling, repair the punchouts, full depth, fully reinforced, and immediately overlay with 3½- to 4½-in ACP.
3. For urban CRCP pavements, fully repair all structural distress and then overlay with 3½- to 4½-in ACP or bonded CRCP.
4. For rural JRCP or CPCD, either use the crack and seat or combine the crack and seat with the Arkansas crack relief layer.
5. For urban freeway capacity-improvement projects, consider widening unbonded overlays now and in the future, as well as unbonded overlays now.

Applying these recommendations to the projects reviewed, in retrospect, one sees in Table 4 that six of the Texas selected solutions were acceptable, four were marginal, and five would not have been recommended.

NOTES FOR TABLES

Tables 1 and 4

(3.1) The ACP O/L and CRCP work for this job have been separated into two separate projects for this analysis. Also, the cost for the ACP O/L included $1,330,425.00 for repairing the existing concrete pavement.

TABLE 4 COST ANALYSES

JOB #	EXISTING PAVEMENT	TYPE	DESCRIPTION	UNIT COST OF PAVING ($/SY)	NET PRESENT WORTH ($/SY)	ANNUAL COST/LN MI /VEHICLE (1986 $)	ADT	
4	CRCP	URBAN	4" BONDED CRCP O.L.	25	37	0.42	165,000	OK for use
2	CRCP	URBAN	4" ACP O.L.	13	26	0.61	80,000	OK for use
12	JRCP	URBAN	11" CRCP O.L. (12.1)	57	57	0.69	175,000	OK for use
10	JRCP	URBAN	13" CRCP RECONSTR	55	55	0.76	135,000	OK for use
*	JRCP/CPCD	R OR U	6.5" ACP W/ CRACK & SEAT*	14	20	0.85	22,000	OK for use
11	JRCP	URBAN	10" CRCP O.L. (11.1)	56	56	0.93	127,000	OK for use
1	CRCP	RURAL	3" ACP O.L.	8	16	1.00	15,000	OK for use
5	JRCP	RURAL	10" CRCP O.L.	25	25	1.38	17,000	marginal
14	CRCP	URBAN	12" CRCP RECONSTR (14.1)	61	61	1.57	73,000	marginal
7	CPCD	RURAL	10" CPCD O.L. (7.1)	36	36	1.61	21,000	marginal
15	JRCP	URBAN	13" CRCP RECONSTR (15.1)	65	65	1.67	73,000	marginal
9	CPCD	URBAN	13" CPCD RECONSTR (9.1)	41	41	1.92	20,000	not recommended
6	CPCD	RURAL	10" CRCP O.L. (6.1)	34	34	2.13	15,000	not recommended
3	JRCP	RURAL	3" ACP O.L.& REPAIRS (3.1)	20	40	2.16	26,000	not recommended
8	CRCP	RURAL	10" CPCD O.L. (8.1)	38	38	2.23	16,000	not recommended
13	JRCP	RURAL	14" CRCP RECONSTR (13.1)	57	57	3.09	26,000	not recommended

* AVERAGE VALUES FOR KENTUCKY PROJECTS

(6.1) 5 percent of job is 13-inch CRCP Reconstruction (22, 173 sy).

(7.1) The project includes 8-inch CONC PAV for shoulders and 13-inch CONC PAV RECONSTRUCTION.

21 percent of job is CRCP Reconstruction (57,674 sy). Primary Bid Item quantity does not include 81,312 sy of AC shoulders.

(9.1) 10 feet of the old 10-inch PCC was left in place for outside shoulder base.

(11.1) Added 10-inch CRCP AVL.

(12.1) Added 11-inch CRCP AVL, only 25 percent of bond breaker/level up was included when calculating the costs for rehabilitating the roadway since only 4.451 MI was overlaid of the 16.012 miles leveled up. The bond breaker/level up was let in DEC 83 as a separate O/L contract to Williams Bros. Constr. Co. The table combines both projects together for cost analysis.

(13.1) Same as Note (3.1). The job included a weigh station and frontage road work, which was not included when totaling the costs for rehabilitating the roadway, the 10- and 12-inch concrete paving were substantial amounts of concrete used in the frontage roads.

(14.1) The ramps for the highway are constructed with 8-inch CRCP.

(15.1) All 13-inch CRCP work was included while all 8-inch CRCP work was excluded. The project included a major interchange at IH 20 and IH 35.

(17.1) The project includes some inlays and variable thickness overlays.

(18.1) The description of COMPLETE ACP RECONSTRUCTION includes: 2-inch ACP surf (new), a fabric underseal, 8-inch hot recycled ACP, 6-inch lime treated base, and 6-inch existing base. The project had a substantial amount of salvaging and treating of existing base and subgrade.

(19.1) The project included an immigration station, which was not included in the rehabilitation costs for the roadway.

(21.1) The project is an addition of new lanes (from 4 to 6 lanes) to the highway without overlaying the existing lanes.

Table 2

(6.2) The ratio is low due to substantial costs for shoulder and fr. road work, which increased the UNIT COST FOR PAVING, but was not included in the UNIT BID.

(14.2) The 8-inch CRCP cost is included in the UNIT COST OF PAVING but is not included in the UNIT BID.

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