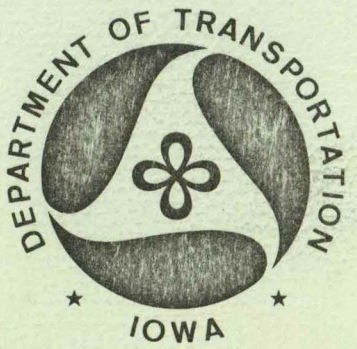
1979 PAVEMENT SMOOTHNESS MEASUREMENTS



HIGHWAY DIVISION
OFFICE OF MATERIALS

FEBRUARY 1980

1979 IJK Roadmeter (PSI) Testing
On P.C.C. Slipform Paving

	Contractor	Miles Tested	Number Of Projects	High	Low	Wtd. Avg.
1	Hallett	27.30	7	4.68	4.29	4.51
2	Central	33.60	8	4.91	4.24	4.45
3	Fred Carlson	66.06	12	4.70	4.18	4.43
4	Boswell	7.94	3	4.72	3.98	4.33
5	Quad City	26.63	5	4.53	4.18	4.32
6	Irving F. Jensen	21.82	9	4.70	4.06	4.31
7	Allied	1.25	1	4.21	4.21	4.21
8	Koss	4.49	1	4.04	4.04	4.04
		189.09	46			4.40

1979 BPR Roughometer (Inches/Mile)
Testing on P.C.C. Slipform Paving

	Contractor	Miles Tested	Number Of Projects	Max. RRI (In/Mi)	Min. RRI (In/Mi)	Avg. RRI (In/Mi)
1	Fred Carlson	78.69	16	86	55	72
2	Central Paving	41.87	12	98	69	79
3	Progressive	2.05	1	88	88	88
4	Hallett	39.38	13	115	79	89
5	Quad City	18.73	3	100	85	91
6	Jensen	22.46	11	108	79	94
7	Boswell	13.91	6	139	79	104
8	Allied	1.25	1	117	117	117
9	Anderson	1.15	2	125	124	124
		219.49				83

02/07/80

Chuck & Bernie:

Please review this report of 1980 Pavement Smoothness Measurements. Pages will be numbered after review and corrections are made.

Significant findings include:

1. Primary rural p.c.c. slipform paving improved from 86 inches/mile in 1978 to 82 inches/mile in 1979.

2. Secondary p.c.c. slipform paving roughness increased from 75 inches/mile in 1978 to 82 inches/mile in 1979.

3. Please note that primary and secondary p.c.c. slipform paving averaged the same (82 inches/mile) in 1979.

4. Primary rural a.c. resurfacing averaged 79 inches/mile-about the same as new p.c.c. slipform paving. This was due mostly to sprinkle treatment.

5. Although studies do not indicate that transverse grooving increases BPR Roughometer readings, increasing use of transverse grooving has corresponded chronologically with a higher average Road Roughness Index for p.c.c. slipform paving.

6. CF Joints probably cause higher BPR Roughometer readings although the magnitude could not be determined last year. A maintenance pressure relief project will be selected in 1980 for "before and after" BPR Roughometer readings.

7. Projects with CD Joints have been rougher than projects without CD Joints for 3 years in a row.

1979 PAVEMENT SMOOTHNESS MEASUREMENTS

By

C. J. Potter

February, 1980

Iowa Department of Transportation

Highway Division

Office of Materials

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515-296-1232

DISCLAIMER

The contents of this report reflect the views of the author and do not necessarily reflect the official view or policy of the Iowa Department of Transportation. This report does not constitute a standard, specification or regulation.

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1979 PAVEMENT SMOOTHNESS MEASUREMENTS

INTRODUCTION

The Materials Department of the Iowa State Highway Commission began pavement smoothness measurements of new construction in 1955 and performed this inventory yearly until 1972 when it was discontinued. Several noticeably rough new primary paving projects revived pavement smoothness testing in 1978 on all new 1977 and 1978 portland cement concrete slipform paving projects, one mile or longer in length. During the 1979 testing season, the Special Investigations Section of the Office of Materials tested approximately one thousand miles of new construction on two hundred and twenty-five individual projects. Results of this 1979 pavement smoothness inventory are tabulated herein.

PAVEMENT SMOOTHNESS MEASURING EQUIPMENT

Bureau of Public Roads (BPR) Roughometer:

The BPR Roughometer was used for 1979 pavement smoothness testing since its results are highly repeatable, it correlates well with the CHLOE Profilometer (1979 correlation coefficient = 0.9745), and it was used in past years on new construction projects. The Roughometer was developed by the Bureau of Public Roads in 1941, and the Iowa State Highway Commission built its first Roughometer according to Bureau of Public Roads plans in 1953. The BPR Roughometer consists of a single-wheeled trailer towed behind a test van at 20 m.p.h. An integrator accumulates vertical movement in one direction only of the test wheel axle relative to the BPR trailer frame. When one inch of movement is accumulated, the integrator sends an electrical impulse to counters in the test van. The resulting Road Roughness Index (R.R.I.) is reported in Inches/Mile; lower BPR Roughometer numbers indicate smoother paving or resurfacing.

The integrator on the BPR Roughometer detects and accumulates short wavelength bumps up to 14 feet and minor surface deviations such as marks caused by screed settlement, straightedges, mops, vibratory rollers, stop-go movement of astro-turf drags, etc. The effect of longer wavelength bumps from 14 feet to 18 feet may be exaggerated, and long wavelength bumps over 22 feet are relatively

ignored by the BPR Roughometer at 20 m.p.h. The BPR Roughometer is repeatable, rugged and reliable, but has the pitfall of not detecting long wavelength bumps.

California Cox 25' Profilograph or Profilometer:

The Cox 25' Profilometer consists of a lightweight aluminum truss supported at the end points by six (6) averaging wheels and pushed at walking speed. A bicycle wheel measures deviations from a 25' reference plane and is connected to a graphical recording box. The resulting 25' Profilometer trace has a scale of 1 inch = 25 feet horizontally, and 1 inch = 1 inch or full scale vertically.

Minor deviations less than 0.20" are "blanked out" on the 25' Profilometer trace and discounted. 25' Profilometer results are reported in Inches/Mile; lower 25' Profilometer readings indicate smoother paving.

The 25' Profilometer produces a graphical output, which is good to use diagnostically on short sections of pavement but is too time-consuming and costly to obtain for pavement smoothness inventory purposes.

Iowa Johannsen Kirk (IJK) Roadmeter:

The IJK Roadmeter was developed in the Iowa State Highway Commission Materials Laboratory in 1971. It operates at 50 m.p.h. and replaces the old PCA type roadmeter which was sensitive to wind. The IJK Roadmeter consists of an electro-mechanical device bolted directly to the differential housing of an ordinary

passenger car. A cantilevered sprung mass moves along a contact board as bumps are encountered and sends electrical impulses to counter banks in the passenger compartment. Counters are numbered from one to ten and produce a sum/length value which is converted to a Present Serviceability Index (PSI) for reporting purposes. Higher P.S.I.'s indicate smoother paving.

The IJK Roadmeter is more sensitive to long wavelength bumps than to short wavelength bumps and minor surface deviations. IJK Roadmeter data is fast and economical to obtain and simulates what the travelling public feels at 50 m.p.h. The problem with roadmeters has been poor repeatability. Trunk access to check the oil level in the IJK Roadmeter dampening mechanism several times daily has improved repeatability in 1979, but erroneous results late in the year precluded using the IJK Roadmeter as the only pavement smoothness measuring device on new construction in 1980.

Iowa Motorcycle Ride Meter:

A Honda motorcycle with an accelerometer mounted on the rear axle was used experimentally in 1979 on new portland cement concrete paving. This device is intended to provide an early indication of pavement smoothness to the contractor. Lower readings (counts/mile) indicate smoother paving with the Honda motorcycle. Further development of this unit is necessary before it can be used routinely on new construction.

1979 PAVEMENT SMOOTHNESS COMPARED TO PAST YEARS

Figure #1 illustrates pavement smoothness trends from 1955 to 1979 for new portland cement concrete slipform paving, asphaltic concrete paving, and asphaltic concrete resurfacing. 1978 and 1979 portland cement concrete slipform paving is about 7-9 inches/mile rougher than experienced in past years. Primary p.c.c. slipform paving smoothness improved from 86 inches/mile in 1978 to 82 inches/mile in 1979. Secondary p.c.c. slipform paving smoothness declined from 75 inches/mile in 1978 to 82 inches/mile in 1979.

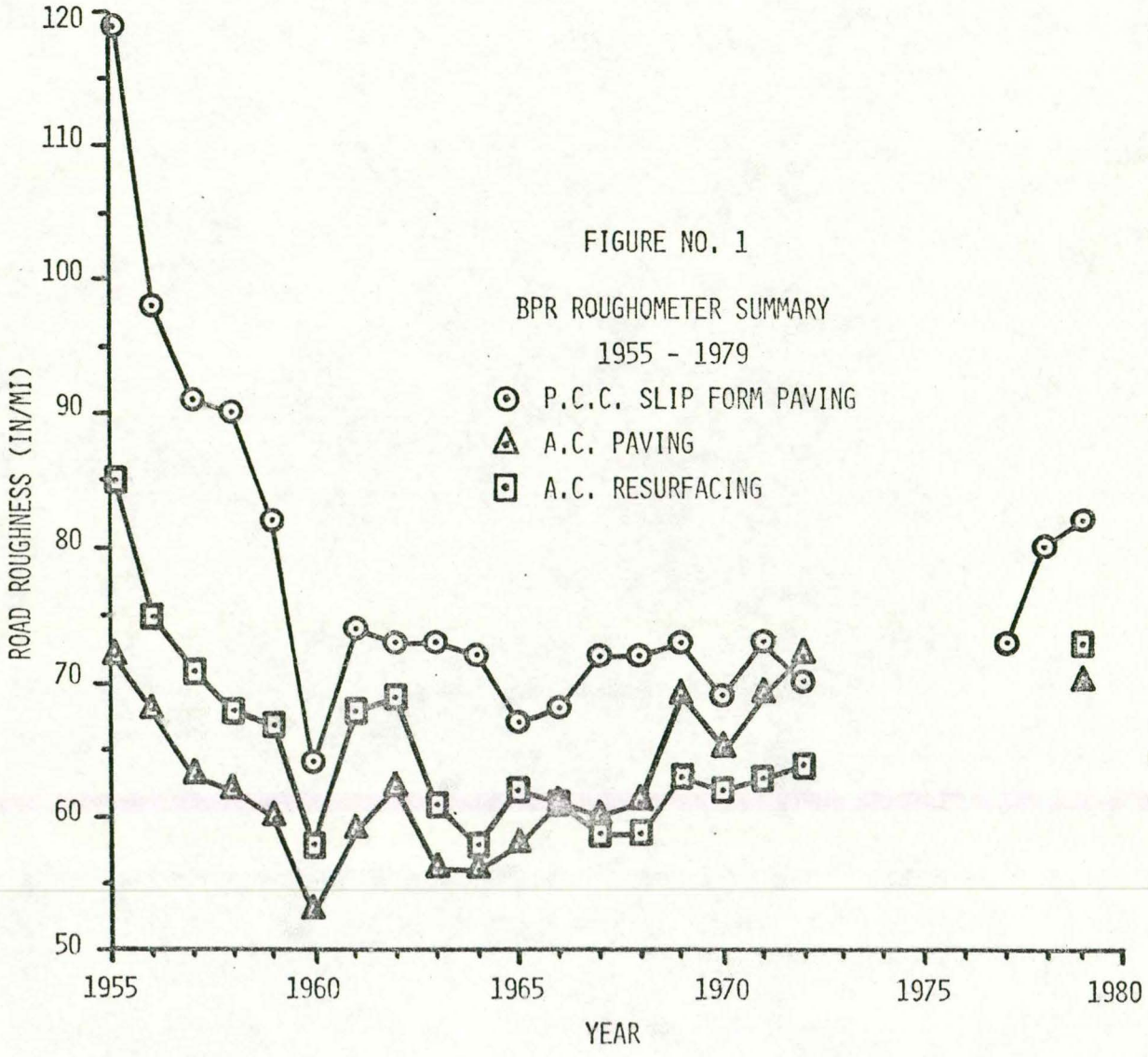

FIGURE NO. 1

BPR ROUGHOMETER SUMMARY

1955 - 1979

Asphaltic concrete paving smoothness averaged 69 inches/mile in 1979, which is about the same as the 72 inches/mile average in 1972 when pavement smoothness measurements were discontinued.

Asphaltic concrete resurfacing averaged 73 inches/mile in 1979, which is about 10 inches/mile rougher than experienced in past years.

EFFECT OF TRANSVERSE GROOVING, SPRINKLE TREATMENT, CF JOINTS, AND CD JOINTS ON PAVEMENT SMOOTHNESS MEASUREMENTS

Increased roughness on new portland cement concrete slipform paving and asphaltic concrete resurfacing may be due in part to transverse grooving and sprinkle treatment, respectively, for improved wet weather pavement frictional qualities. Although a study of 1977 and 1978 p.c.c. paving projects with and without transverse grooving indicated that transverse grooving has no apparent effect on pavement smoothness, increased roughness on 1978 and 1979 p.c.c. slipform paving has corresponded with the advent of transverse grooving. One 1977 transversely grooved paving project tested as low as 46 inches/mile, and while the uniform texture of transverse grooving should not cause a problem, it can affect pavement smoothness when it is excessively deep or coarse.

Primary rural asphaltic concrete resurfacing projects with sprinkle treatment averaged 88 inches/mile in 1979 compared to 73 inches/mile for similar projects without sprinkle treatment. Sprinkle treatment appears to account for much of the increased roughness on 1979 rural asphaltic concrete resurfacing projects.

Several primary rural resurfacing projects tested in 1979 had 4 inch pressure relief joints (CF Joints). These CF Joints appeared to cause higher BPR Roughometer readings, but the magnitude of this effect could not be determined. Further research concerning the effect of CF Joints on pavement smoothness measurements will be conducted in 1980.

A study of 1977 and 1978 primary p.c.c. slipform paving projects with load transfer dowel baskets (CD Joints) indicated that projects with CD Joints were considerably rougher than projects without CD Joints. Approximately 26% of 1979 primary rural p.c.c. slipform paving had CD Joints; projects without CD Joints averaged 79 inches/mile and projects with CD Joints averaged 91 inches/mile. Small bumps may be caused by restricted concrete movement around CD dowel basket assemblies and how the concrete extrudes from the paving machine screed.

Other factors affecting pavement smoothness measurements which occurred in 1979 include poor subgrade conditions, insufficient stringline tension, stop-go paving machine operation, and stop-go movement of astro-turf drags.

AVERAGE PAVEMENT SMOOTHNESS BY CLASS AND TYPE OF CONSTRUCTION

Class of Construction	Type of Pavement	Number of Projects	Tested Length (Miles)	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
Primary Rural	P.C.C. Slip Form	12	57.78	105	64	82
Primary Urban	P.C.C. Slip Form	5	5.66	139	82	107
Primary Urban & Urban	P.C.C. Fixed Form	5	2.97	167	70	119
Secondary	P.C.C. Slip Form	52	156.05	125	55	82
Primary Rural	A.C. Paving	7	40.42	77	58	66
Primary Rural	A.C. Re-Surfacing	30	239.58	107	64	79
Primary Urban	A.C. Re-Surfacing	2	3.56	103	93	96
Secondary	A.C. Paving	17	73.97	93	54	71
Secondary	A.C. Re-Surfacing	95	426.29	106	52	69

P.C.C. - Portland Cement Concrete

A.C. - Asphaltic Concrete

AVERAGE PAVEMENT SMOOTHNESS BY CONTRACTOR FOR EACH CLASS AND TYPE OF CONSTRUCTION

PRIMARY RURAL
PORTLAND CEMENT CONCRETE SLIP FORM PAVING

Contractor	Number Of Projects	Tested Length (Miles)	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
Fred Carlson	7	39.13	86	64	77
Hallett	3	11.08	98	79	87
Quad City	1	5.59	100	100	100
Irving F. Jensen	1	1.98	105	105	105
		57.78			82

PRIMARY URBAN
PORTLAND CEMENT CONCRETE SLIP FORM PAVING

Contractor	Number Of Projects	Tested Length (Miles)	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
Fred Carlson	1	0.67	82	82	82
Progressive	1	2.05	88	88	88
Allied	1	1.25	117	117	117
Boswell	2	1.69	139	123	133
		5.66			107

PRIMARY URBAN & URBAN
PORTLAND CEMENT CONCRETE FIXED FORM PAVING

Contractor	Number Of Projects	Tested Length (Miles)	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
Metro	1	0.36	70	70	70
Cedar Valley	2	1.37	116	99	109
Fred Carlson	1	0.71	128	128	128
Manatt-Carter	1	0.53	167	167	167
		2.97			119

SECONDARY PORTLAND CEMENT CONCRETE
SLIPFORM PAVING

Contractor	Number Of Projects	Tested Length (Miles)	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
Fred Carlson	9	38.89	81	55	67
Central Paving	12	41.87	98	69	79
Quad City	3	13.14	91	85	87
Hallett	11	28.30	115	83	89
Irving F. Jensen	10	20.48	108	79	93
Boswell	5	12.22	112	79	100
Anderson	2	1.15	125	124	125
		156.05			82

PRIMARY RURAL
ASPHALTIC CONCRETE PAVING

Contractor	Number Of Projects	Tested Length (Miles)	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
Cessford	1	13.04	58	58	58
Rohlin	2	9.40	68	62	65
J. P. Strother	1	2.18	65	65	65
Fred Carlson	2	14.88	72	72	72
Everds Bros.	1	0.92	77	77	77
		40.42			66

PRIMARY RURAL
ASPHALTIC CONCRETE RESURFACING

Contractor	Number Of Projects	Tested Length (Miles)	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
Judd Brown	2	16.23	69	60	64
Cessford	2	30.22	81	55	69
Iowa Road Builders	2	14.86	85	71	72
Henningsen	2	10.91	81	71	72
Western Engineering	2	13.86	81	75	76
Norris	9	67.65	107	60	80
Hallett	2	17.99	85	65	82
Midwest Limestone	1	12.81	82	82	82
Des Moines Asphalt & Paving	1	9.76	83	83	83
Rohlin	2	11.53	97	70	84
Cedar Rapids Asphalt & Paving	1	4.31	85	85	85
ASPRO	1	6.65	87	87	87
W. Hodgman & Sons	1	8.28	89	89	89
Fred Carlson	1	11.89	103	103	103
Tschiggfrie Excavating	1	2.63	107	107	107
		239.58			79

PRIMARY URBAN
APHALTIC CONCRETE RESURFACING

Contractor	Number Of Projects	Tested Length (Miles)	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
Norris	2	3.56	103	93	96
		3.56			96

SECONDARY ASPHALTIC CONCRETE PAVING

Contractor	Number Of Projects	Tested Length (Miles)	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
Western Engineering	2	16.09	69	64	66
Norris	2	4.81	72	64	66
Everds Bros.	1	1.98	66	66	66
Cessford	3	6.70	72	67	68
Fred Carlson	1	7.99	70	70	70
Graves & Midwest Paving	2	16.66	76	69	74
Rohlin	2	2.80	86	54	75
W. Hodgman & Sons	3	15.83	77	75	76
Iowa Road Builders	1	1.11	93	93	93
		73.97			71

SECONDARY ASPHALTIC CONCRETE RESURFACING

Contractor	Number of Projects	Tested Length (Miles)	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
L.L. Pelling	2	5.12	58	56	57
Weaver	1	2.41	60	60	60
Everds Bros.	17	78.03	85	54	65
W. Hodgman & Sons	5	31.93	77	54	65
Judd Brown	2	8.79	69	63	65
Western Engineering	1	5.68	65	65	65
P & M Stone	3	15.53	67	64	66
Rohlin	24	112.85	95	52	68
Henningsen	2	13.72	74	65	68
Cessford	12	59.13	80	54	70
Norris	7	33.61	90	63	70
Hallett	1	1.44	71	71	71
Graves & Midwest Paving	6	30.28	88	65	74
Midwest Limestone	3	2.84	85	75	78
Iowa Road Builders	6	19.26	106	76	82
Des Moines Asphalt & Paving	3	5.67	98	87	93
		426.29			69

PAVEMENT SMOOTHNESS BY INDIVIDUAL PROJECT FOR EACH CLASS AND TYPE OF CONSTRUCTION

PRIMARY RURAL
PORTLAND CEMENT CONCRETE SLIP FORM PAVING

Project #	County	Tested Length (Miles)	Contractor	High R.R.I (In/Mi)	Low R.R.I. In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
F-21-4(6)	Benton	4.72	Fred Carlson	73	60	64
TQF-520-7(10) TQF-520-4(18)	Buchanan	11.56	Fred Carlson	85	62	73
DP-F-520-4(16)	Hamilton	4.37	Hallett	116	64	79
FN-63-4(6)	Poweshiek	7.45	Fred Carlson	98	68	80
FN-63-5(29)	Tama	6.71	Fred Carlson	95	67	80
FN-2-9(11)	Lee	5.74	Fred Carlson	102	70	80
FN-2-9(17)	Lee	2.95	Fred Carlson	100	76	86
F-FG-65-4(18)	Polk	4.93	Hallett	103	73	90
FN-17-3(11)	Hamilton	1.78	Hallett	116	86	98
I-IR-80-2(81)	Adair-Dallas Madison	5.59	Quad City	116	87	100
F-6-2(14)	Cass	1.98	Irving F. Jensen	130	76	105
		57.78				82

PRIMARY URBAN
PORTLAND CEMENT CONCRETE SLIPFORM PAVING

Project #	County	Tested Length (Miles)	Contractor	High R.R.I (In/Mi)	Low R.R.I (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
FN-9-9(19)	Allamakee	0.67	Fred Carlson	96	68	82
FU-57-2(5)	Black Hawk	2.05	Progressive	100	74	88
FN-218-9(14)	Floyd	1.25	Allied	136	88	117
FN-169-4(17)	Dallas	0.62	Boswell	152	104	123
F-9-7(10)	Howard - Mitchell	1.07	Boswell	146	124	139
		5.66				107

PRIMARY URBAN AND URBAN
PORTLAND CEMENT CONCRETE FIXED FORM PAVING

Project	County	Tested Length (Miles)	Contractor	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
M-6352(1)	Washington	0.36	Metro	79	60	70
FN-63-7(9)	Bremer	0.55	Cedar Valley	115	92	99
M-TQM-0717(1)	Linn	0.82	Cedar Valley	128	100	116
F-9-9(17)	Allamakee	0.71	Fred Carlson	152	108	128
M-3661	Poweshiek	0.53	Manatt-Carter	188	152	167
		2.97				119

SECONDARY PORTLAND CEMENT CONCRETE SLIP FORM PAVING

Project #	County	Tested Length (Miles)	Contractor	High R.R.I (In/Mi)	Low R.R.I (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
RS-1624(1)	Chickasaw	3.99	Fred Carlson	58	53	55
RS-4637(3)	Delaware	3.99	Fred Carlson	67	51	58
RS-4862(3)	Delaware	2.91	Fred Carlson	80	54	61
LP-781	Mitchell	1.97	Fred Carlson	68	58	63
SOS-FM-92(5)	Washington & Keokuk	5.61	Fred Carlson	71	59	65
FM-28(1)	Delaware	2.10	Fred Carlson	79	62	67
SN-1505(3)	Mitchell	7.11	Fred Carlson	81	62	69
RS-4733(1)	Jones	5.27	Fred Carlson	81	55	69
RS-7857(3)	Wayne	1.75	Central Paving	82	60	69
RS-7606(1) RS-7853(2)	Wayne	3.90	Central Paving	80	64	72
RS-6057(1)	Cass	6.33	Central Paving	91	68	76
L-989(2)	Warren	4.41	Central Paving	87	62	77
RS-6338(1)	Madison	4.84	Central Paving	90	67	78
RS-6061(3)	Cass	6.31	Central Paving	112	64	79
RS-6157(1)	Adams	2.87	Irving F. Jensen	90	70	79
FM-67(4)	Monona	2.42	Boswell	93	72	79
RS-1764(1)	Allamakee	5.94	Fred Carlson	92	72	81
SN-6085(4)	Adair	4.75	Central Paving	101	70	81
RS-7626(1)	Wayne	1.78	Central Paving	114	70	81
L-177(2)	Madison	1.47	Central Paving	102	66	81
L-78-P2	Adams	1.00	Irving F. Jensen	88	76	82

Boswell Showed Improvement Toward End of Year

SECONDARY PORTLAND CEMENT CONCRETE SLIP FORM PAVING (Cont)

Project #	County	Tested Length (Miles)	Contractor	High R.R.I (In/Mi)	Low R.R.I (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
L-1-PC-78	Cherokee	3.19	Hallett	96	70	83
L-79-5-1	Webster	1.93	Hallett	104	72	83
FM-94(5)	Webster	6.26	Hallett	109	66	84
L-78-P3	Adams	1.09	Irving F. Jensen	88	72	84
RS-4982(1) RS-4986(1)	Jackson	8.57	Quad City	101	70	85
FM-37(3)	Greene	4.99	Hallett	96	75	85
L-P-79-35	Greene	0.97	Hallett	94	80	85
SN-3265(2)	Greene	3.93	Hallett	99	79	87
SN-6217(3)	Taylor	3.42	Central Paving	95	78	87
FM-97(5)	Woodbury	3.29	Irving F. Jensen	102	81	87
FM-81(4)	Sac	1.84	Boswell	96	79	88
RS-7702(3)	Jasper	4.57	Quad City	101	83	91
RS-3070(1)	Woodbury	1.39	Irving F. Jensen	102	84	91
L-79-11 L-79-1	Guthrie	1.30	Hallett	104	84	93
L-6242(2)	Taylor	2.69	Central Paving	126	78	94
RS-3070(2)	Cherokee	0.97	Irving F. Jensen	110	82	96
FM-2(2)	Adams	4.93	Irving F. Jensen	122	86	98
L-2-75	Madison	0.22	Central Paving	107	89	98
FM-97(6)	Woodbury	0.91	Irving F. Jensen	116	84	102
FM-18(1)	Cherokee	3.97	Hallett	132	82	103
SN-117(1)	O'Brien	2.82	Irving F. Jensen	116	98	104

SECONDARY PORTLAND CEMENT CONCRETE SLIP FORM PAVING (Cont)

Project #	County	Tested Length (Miles)	Contractor	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
L-79-14	Guthrie	1.86	Boswell	126	86	104
FM-71(2)	O'Brien	1.21	Irving F. Jensen	112	106	108
FM-49(2)	Jackson	3.19	Boswell	128	100	111
L-79-12	Guthrie	0.76	Hallett	128	92	111
FM-81(5)	Sac	2.91	Boswell	130	93	112
L-79-13	Guthrie	1.00	Hallett	128	100	115
SN-3025(4)	Plymouth	0.57	Anderson	128	120	124
SN-3001(3)	Plymouth	0.58	Anderson	132	108	125
		156.05				82

PRIMARY RURAL
ASPHALTIC CONCRETE PAVING

Project #	County	Tested Length (Miles)	Contractor	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)	
F-9-6(151)	Mitchell	13.04	Cessford	70	52	58	
F-13-3(22)	Clayton	4.85	Rohlin	71	55	62	
EACF-38-3(22)	Jones	2.18	J. P. Strother	74	55	65	
F-13-3(23)	Clayton	4.55	Rohlin	81	64	68	
F-9-9(17) FN-9-9(18)	Allamakee	14.88	Fred Carlson	91	64	72	(S)
FN-332-1(1)	Winnebago	0.92	Everds Bros.	84	65	77	
		40.42				66	

(S) Sprinkle Treatment On These Projects

PRIMARY RURAL
ASPHALTIC CONCRETE RESURFACING

Project #	County	Tested Length (Miles)	Contractor	High R.R.I (In/Mi)	Low R.R.I (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)	
FN-101-1(12)	Benton	13.60	Cessford	69	51	55	
FN-136-3(5)	Dubuque	8.96	Judd Brown	66	53	60	
FN-38-2(15)	Cedar	6.55	Norris	68	54	60	
MP-3889-69-11	Buena Vista	2.54	Hallett	72	57	65	
FN-1-6(5)	Linn	7.27	Judd Brown	77	57	69	
FN-218-7(37)	Black Hawk	5.75	Rohlin	76	63	70	(S)
FN-169-4(25)	Dallas	13.32	Iowa Road Builders	83	55	71	
FN-44-1(2)	Harrison	9.48	Henningsen	80	66	71	
FN-2-7(13)	Appanoose-Davis	8.38	Norris	89	62	72	
MP-5857-69	Louisa	7.35	Norris	80	69	74	
FN-10-3(6)	Clay	10.97	Western Engineering	95	68	75	
FN-149-1(25)	Keokuk	9.07	Norris	93	68	78	
FN-218-3(10)	Washington	13.26	Norris	95	66	79	
FN-218-6(20)	Benton	16.62	Cessford	106	64	81	(S)
I-EACIR-80-1(127)	Cass	2.89	Western Engineering	89	75	81	
FN-6-2(16)	Cass	1.43	Henningsen	106	75	81	
FN-18-3(34)	Palo Alto	12.81	Midwest Lime-stone	90	73	82	(S)
I-IR-35-2 (157)	Clarke	9.76	Des Moines Asphalt & Paving	99	62	83	(S)
FN-202	Davis - Appanoose	10.45	Norris	105	71	84	
FN-20-2(13)	Ida-Sac	15.45	Hallett	101	70	85	

(S) Sprinkle Treatment On These Projects

PRIMARY RURAL
ASPHALTIC CONCRETE RESURFACING (Cont)

Project #	County	Tested Length (Miles)	Contractor	High R.R.I (In/Mi)	Low R.R.I In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
FN-30-7(54)	Linn	4.31	Cedar Rapids Asphalt & Paving	99	78	85 Ⓢ
I-IR-35-4(37)	Polk	1.54	Iowa Road Builders	106	77	85
FN-58-1(6)	Black Hawk	6.65	ASPRO	97	82	87 Ⓢ
F-65-4(19)	Jasper	4.20	Norris	101	76	87 Ⓢ
FN-65-7(7)	Franklin	8.28	W. Hodgman & Sons	98	79	89 Ⓢ
F-65-4(22)	Polk	2.43	Norris	98	88	92 Ⓢ
FN-3-6(21)	Bremer	5.78	Rohlin	115	89	97 Ⓢ
FN-18-6(14)	Floyd	11.89	Fred Carlson	119	81	103 Ⓢ
FN-34-8(11)	Jefferson	5.96	Norris	134	95	107 Ⓢ
FN-3-8(10)	Delaware	2.63	Tschiggfrie Excavating	124	82	107
		239.58				79

Ⓢ Sprinkle Treatment On These Projects

PRIMARY URBAN
ASPHALTIC CONCRETE RESURFACING

Project #	County	Tested Length (Miles)	Contractor	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
FN-34-7(26)	Wapello	2.44	Norris	116	76	93
FN-1-2(12)	Jefferson	1.12	Norris	124	80	103
		3.56				96

SECONDARY ASPHALTIC CONCRETE PAVING

Project #	County	Tested Length (Miles)	Contractor	High R.R.I. (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
M-6159(1)	Clay	0.93	Rohlin	64	52	54
RS-3383(2)	Shelby	9.93	Western Engineering	75	58	64
SN-7634(4)	Appanoose	3.86	Norris	76	56	64
L-P-1-95	Winnebago	1.98	Everds Bros.	84	56	66
RS-3185(1)	Hamilton	2.97	Cessford	70	62	67
RS-3484(1)	Hamilton	2.91	Cessford	72	60	67
FM-11(2)	Buena Vista	6.16	Western Engineering	79	64	69
L-3-79	Sioux	5.75	Graves & Midwest Paving	85	63	69
SN-1720(1)	Winneshiek	7.99	Fred Carlson	77	63	70
SOS-LS58(2)	Louisa	0.95	Norris	76	68	72
L-79-2	Tama	0.82	Cessford	85	64	72
FM-55(5)	Kossuth	2.78	W. Hodgman & Sons	80	70	75
FM-84(6)	Sioux	10.91	Graves & Midwest Paving	86	62	76
RS-274(1)	Kossuth	8.90	W. Hodgman & Sons	90	61	76
SN-1532(2)	Cerro Gordo	4.15	W. Hodgman & Sons	83	73	77
FM-11(3)	Buena Vista	1.87	Rohlin	94	78	86
RS-7597(5)	Muscatine	1.11	Iowa Road Builders	116	68	93
		73.97				71

SECONDARY ASPHALTIC CONCRETE RESURFACING

Project #	County	Tested Length (Miles)	Contractor	High R.R.I (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
SN-162(1)	Clay	2.00	Rohlin	58	46	52
SN-133(3)	Clay	5.50	Rohlin	64	47	53
SN-61(4)	Winnebago	8.87	Everds Bros.	64	48	54
LRS-1139	Kossuth	6.86	W. Hodgman & Sons	63	48	54
SN-146(3)	Clay	4.89	Rohlin	67	48	54
SR-245(1)	Buena Vista	3.98	Rohlin	63	48	54
SN-4709(1)	Benton	2.38	Cessford	61	50	54
SN-4906(1)	Johnson	3.38	L.L. Pelling	61	53	56
LRS-63	Kossuth	2.93	W. Hodgman & Sons	68	52	56
SN-1(2)	Winnebago	10.83	Everds Bros.	63	53	57
SN-1(3)	Winnebago	2.93	Everds Bros.	59	52	57
SN-374(2)	Winnebago	2.92	Everds Bros.	62	50	57
FM-6(3)	Benton	6.06	Cessford	62	54	58
SR-150(2)	Buena Vista	4.96	Rohlin	66	54	58
FM-98(4)	Worth	4.49	Everds Bros.	64	54	58
SN-7932(2)	Johnson	1.74	L.L. Pelling	62	54	58
SN-3(1)	Winnebago	0.99	Everds Bros.	63	52	58
SN-176(1)	Clay	7.00	Rohlin	67	52	59
SR-1663(1)	Franklin	8.88	W. Hodgman & Sons	67	54	60
FM-42(6)	Hardin	2.41	Weaver	68	54	60
M-L159(1)	Clay	0.66	Rohlin	69	56	60
FM-98(3)	Worth	4.37	Everds Bros.	66	56	61

SECONDARY ASPHALTIC CONCRETE RESURFACING (Cont)

Project #	County	Tested Length (Miles)	Contractor	High R.R.I (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
L-BV-5-79	Buena Vista	4.97	Rohlin	72	53	62
SR-97-(1)	Hancock	6.97	Everds Bros.	71	58	63
SN-1639(1)	Chickasaw	6.32	Judd Brown	71	58	63
SN-7638(1)	Appanoose	3.86	Norris	69	61	63
SN-174(1)	Clay	5.53	Rohlin	76	49	64
L-B-79-2	Humboldt	4.86	P & M Stone	68	57	64
SN-7634(4)	Appanoose	3.86	Norris	76	56	64
SN-1695(2)	Butler	13.18	Cessford	75	57	65
LC-7912B	Pottawattamie	9.47	Henningsen	72	54	65
L-ACR-279	Plymouth	9.16	Graves & Midwest Paving	74	55	65
SN-198(2)	Clay	8.34	Rohlin	73	56	65
SN-3262(2)	Buena Vista	5.68	Western Engineering	70	57	65
SN-4793(1)	Marshall	3.85	Cessford	70	61	65
SN-122(1)	O'Brien	6.86	Rohlin	80	52	66
FM-46(3)	Humboldt	6.77	P & M Stone	80	60	66
SN-161(5)	O'Brien	6.68	Rohlin	74	57	66
LP-1-95	Winnebago	1.98	Everds Bros.	84	56	66
SN-334(2)	Hancock	10.47	Everds Bros.	71	59	67
SN-109(2)	Clay	4.63	Rohlin	77	59	67
FM-46(4)	Humboldt	3.90	P & M Stone	70	60	67
SN-3070(2)	Cherokee	2.99	Rohlin	72	63	67

SECONDARY ASPHALTIC CONCRETE RESURFACING (Cont)

Project #	County	Tested Length (Miles)	Contractor	High R.R.I (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
SN-161(4)	Clay	0.50	Rohlin	72	60	67
SR-3061(1)	Woodbury	8.20	Graves & Midwest Paving	79	61	68
SN-7952(1)	Henry	7.04	Norris	75	62	68
SN-4582	Marshall	2.88	Cessford	78	52	68
SR-4962(2)	Cedar	8.66	Norris	88	59	69
SN-189(2)	Clay	5.03	Rohlin	81	61	69
FM-19(1)	Chickasaw	2.47	Judd Brown	79	62	69
RS-312	Kossuth	8.38	Everds Bros	79	62	70
SR-4913(9)	Cedar	5.91	Norris	87	62	70
FM-71(4)	O'Brien	5.37	Rohlin	76	65	70
SN-3025(6)	Cherokee	4.03	Rohlin	77	56	70
SR-149(1)	Cerro Gordo	3.89	W. Hodgman & Sons	80	61	70
SN-7789(1)	Henry	1.12	Norris	76	60	70
TG-2-79	Carroll	1.44	Hallett	100	60	71
SN-4757(1)	Benton	9.88	Rohlin	89	59	72
SN-4685(1)	Hardin	4.71	Cessford	81	68	72
SN-4881(1)	Tama	7.68	Cessford	81	69	73
FM-36(2)	Fremont	4.25	Henningsen	79	68	74
SN-89(1)	Hancock	2.94	Everds Bros.	82	68	74
SN-35(1)	Emmet	1.89	Midwest Limestone	82	67	75
SN-3061(2)	Woodbury	3.91	Graves & Midwest Paving	91	66	76

SECONDARY ASPHALTIC CONCRETE RESURFACING (Cont)

Project #	County	Tested Length (Miles)	Contractor	High R.R.I (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
SN-3034(1)	Woodbury	1.01	Graves & Midwest Paving	89	64	76
L-LA-179-73	Story	1.93	Iowa Road Builders	80	72	76
SR-1631(3)	Cerro Gordo	5.37	W. Hodgman & Sons	87	69	77
FM-9(4)	Bremer	2.20	Rohlin	86	70	77
SN-64(4)	Marshall	5.06	Cessford	85	72	78
SN-4865(2)	Marshall	3.94	Cessford	83	72	78
SN-4689(2)	Hardin	5.48	Cessford	89	71	79
L-6073(1)	Madison	5.31	Iowa Road Builders	86	71	79
LCO-479	Hancock	3.31	Everds Bros.	85	71	79
SN-4666(1)	Tama	1.94	Cessford	86	70	79
FM-41(6)	Hancock	0.89	Everds Bros.	88	72	79
SN-8040(1)	Muscatine	5.14	Iowa Road Builders	90	71	80
SN-4617(1)	Grundy	1.97	Cessford	90	70	80
RS-3025(3)	Cherokee	1.12	Rohlin	90	72	80
LCO-379	Hancock	0.47	Everds Bros.	92	73	80
L-179	Wright	0.95	Rohlin	80	72	81
LCO-478	Hancock	0.69	Everds Bros.	87	76	82
SR-17(1)	Emmet	0.49	Midwest Lime-stone	99	68	82
FM-95(3)	Winnebago	5.06	Everds Bros.	98	74	84
SR-7569(3)	Muscatine	4.00	Iowa Road Builders	91	77	84
SR-8000(1)	Muscatine	2.99	Iowa Road Builders	106	72	84

SECONDARY ASPHALTIC CONCRETE RESURFACING (Cont)

Project #	County	Tested Length (Miles)	Contractor	High R.R.I (In/Mi)	Low R.R.I. (In/Mi)	Wtd. Avg. R.R.I. (In/Mi)
LCO-279	Hancock	1.47	Everds Bros.	90	78	85
L-FM-479	Emmet	0.46	Midwest Lime-Stone	102	73	85
FM-9(3)	Bremer	2.90	Rohlin	94	83	86
SR-237(1)	Wright	5.89	Rohlin	92	79	87
SN-3399(1)	Polk	2.50	Des Moines Asphalt & Paving	98	78	87
SN-3125(2)	Woodbury	7.08	Graves & Midwest Paving	96	81	88
SN-3066(2)	Woodbury	0.92	Graves & Midwest Paving	104	76	88
FM-4(3)	Appanoose	3.16	Norris	95	84	90
SR-261(1)	Wright	5.99	Rohlin	102	85	95
FM-77(2)	Polk	0.93	Des Moines Asphalt & Paving	108	92	97
SN-7549(1)	Polk	2.24	Des Moines Asphalt & Paving	104	90	98
L-C-1-78	Story	0.89	Iowa Road Builders	120	88	106
		426.29				69