Results of Unsurfaced-Road Rating Surveys

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A method for rating unsurfaced roads has been developed, and a field manual has been prepared, to assist county, municipal, military, and township highway agencies in managing the maintenance of such roads. The rating method and strategies are compatible with the PAVER pavement management system developed by the U.S. Army Corps of Engineers and the American Public Works Association. An unsurfaced roads component of micro-PAVER is available, providing highway agencies with a more comprehensive roadway management system. This methodology has been implemented at a number of military installations throughout the continental United States and Alaska, as well as on the Dalton Highway in Alaska. These installations include Fort Riley, Kansas; Fort Ord, California; Fort Carson, Colorado; and Forts Wainwright and Greely, Alaska. The rating surveys and data gathered from these surveys have been analyzed.

About two-thirds of the highway systems in the United States and 90 percent of all roads worldwide are unsurfaced or lightly surfaced low-volume roads. No single, recognized management system is being used to effectively maintain these roads. The U.S. Army Corps of Engineers, the American Public Works Association, and others have developed pavement management systems (PMSs) for use on paved roads. Currently, these PMSs cannot be used for unsurfaced roads; however, a revised version of the U.S. Army Construction Engineering Research Laboratory's (CERL) Micro-PAVER that includes an unsurfaced-road component has been developed. An unsurfaced-road component that can stand alone or be used with any of these PMSs would give local highway agencies a comprehensive roadway management system more suitable for their needs.

The research effort to develop a method for rating and managing the maintenance of unsurfaced roads has been divided into three phases: Phase I, field manual development; Phase II, field validation and deduct-value model development; and Phase III, method implementation and development of PMS-software-compatible packages. Actual field survey results using this unsurfaced-road rating methodology have been obtained.

Phases I and II resulted in the publication of a field manual (*1*). The manual explains how to do a field inspection and calculate the unsurfaced road condition index (URCI), which is a measure of the road's overall condition and which corresponds to the pavement condition index (PCI) used in PAVER.

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The field inspections consist of windshield inspections and detailed measurements. Windshield inspections are performed by driving the full length of an unsurfaced road at 25 mph to determine the overall surface and drainage conditions four times a year (once each season). General estimates of maintenance needs and priorities can be made from this initial inspection. Measurements are the collection of detailed data on the roadway's surface and drainage conditions. After the initial inspection ride, a representative 100-ft-long section of road is selected for the actual measurements of distresses. The section should be permanently marked, so that future measurements will be taken in exactly the same location. In general, two sections per mile are enough.

The Phase I field manual identified six unsurfaced-road distresses and two drainage-related distresses, each with a separate index. As a result of the Phase II field validation (*2*), the two indices were combined. The manual currently lists the following seven distresses:

1. Improper cross section,
2. Inadequate roadside drainage,
3. Corrugations,
4. Dust,
5. Potholes,
6. Rutting, and
7. Loose aggregate.

For each distress, the severity and density are measured, and the deduct value is determined from graphs. The URCI can then be determined from all the deduct values.

Phase III was the development of a PMS-software-compatible package (*3*) and the implementation of the method at a number of locations throughout the United States. As previously mentioned, a PMS-software-compatible package based on the methodology in the Phase I manual has been developed by CERL and is available as micro-PAVER Version 2.1. The second objective of Phase III was the implementation of the method.

The method has been implemented at six locations. These sites are the Dalton Highway, Alaska (*4–6*); Fort Riley, Kansas (*7,8*); Ford Ord, California (*9*); Fort Carson, Colorado (*10,11*); Fort Wainwright, Alaska (*12,13*); and Fort Greely, Alaska (*14,15*). The individual site surveys provided the necessary data (distress measurements and deduct values) to establish unsurfaced-road data bases. These data were used to develop, assess, and modify maintenance practices. In addition, the data can be used as the basis for developing maintenance practices throughout the world.

TABLE 1 SAMPLE UNIT RATING FREQUENCIES FOR THE DALTON HIGHWAY, ALASKA

Sample unit ratings	No. of sample units 1986	1988	1989
Excellent	1	1	0
Very good	10	7	10
Good	10	13	10
Fair	0	0	1
Poor	0	0	0
Very poor	0	0	0
Failed	0	0	0
Total	21	21	21

TABLE 2 URCIs FOR THE DALTON HIGHWAY, ALASKA

Sample unit location (mi)	URCI 1986	1988	1989
16.5	86	69	73
30.0	80	82	74
61.0	72	55	58
79.0	67	68	78
88.0	74	75	69
134.0	65	75	77
149.0	65	73	53
203.5	76	65	78
216.0	65	69	70
229.5	60	72	61
255.5	72	65	55
266.0	74	62	67
281.0	68	57	73
301.0	66	61	68
310.0	85	87	78
313.0	78	62	76
334.0	72	71	56
355.5	75	66	59
370.0	69	66	64
383.5	68	57	59
395.5	61	70	70
Mean	71[1]	68.0[2]	67.4[2]
Std. dev.	7.2	8.0	8.2

[1] very good.
[2] good.

The survey data were analyzed manually as well as by the PAVER PMS. The individual site data were analyzed, and trends in the network ratings were related to maintenance allocations and practices. Finally, the ratings of the various site surveys were compared. Discussions on the results of the site survey data are presented in the following sections.

SITE SURVEYS

Dalton Highway, Alaska

The Dalton Highway, the only site with three years of data, was surveyed in 1986, 1988, and 1989. Table 1 presents a frequency distribution of sample unit ratings. These sample unit ratings are the URCIs calculated using the deduct values, which are based on the individual distress measurements. For the Dalton Highway sample units, ratings were recorded as excellent, very good, good, and fair. The data in Table 1 indicate that individual sample unit ratings have remained relatively constant or have deteriorated only minimally. Table 2 presents the individual URCI ratings for each sample unit, as well as the mean of each year's survey results. From these data, the ratings appear to have dropped slightly (71.2 for 1986, 68.0 for 1988, and 67.4 for 1989). Discussions with Alaska Department of Transportation personnel indicate that these slight drops in URCI may be attributable to reductions in maintenance funds and hence reduced maintenance actions. There is concern that if funding reductions continue, greater road degradation may result.

Fort Riley, Kansas

Fort Riley's unsurfaced-road network was rated in 1988 and 1989. The summaries presented in Table 3 indicate that during the 1988 survey all the poor, very poor, and failed sample units were tank trails, and all but one of the fair sample units

TABLE 3 SAMPLE UNIT RATING FREQUENCIES FOR FORT RILEY, KANSAS

	No. of sample units						No. of branches with average weighted URCI					
	All data		Tank trails		Roads and parking areas		All data		Tank trails		Roads and parking areas	
Rating	1988	1989	1988	1989	1988	1989	1988	1989	1988	1989	1988	1989
Excellent	48	41	21	26	27	15	5	1	1	0	1	4
Very good	108	114	49	58	59	56	20	22	6	7	14	15
Good	22	41	13	19	9	22	5	8	1	3	5	4
Fair	14	16	13	13	1	3	2	2	2	0	2	0
Poor	16	8	16	7	0	1	0	0	0	0	0	0
Very poor	3	1	3	0	0	1	0	0	0	0	0	0
Failed	1	0	1	0	0	0	0	0	0	0	0	0
Total	212	221	116	123	96	98	32	33	10	10	22	23

TABLE 4 DISTRESS MEASUREMENT SUMMARY FOR FORT RILEY, KANSAS

Branch	No. of sections	No. of sample units	Length of branch (mi)	Average weighted branch URCI 1988	1989
1STEF	2	3	0.95	67.7	75.3
AHAAR	1	2	0.40	79.5	78.0
AHASA	1	–[1]	–	–	–
CRSHA	3	7	4.34	78.2	54.8
DSTEF	1	1	0.12	67.0	78.0
EMPRC	3	3	0.95	80.3	84.4
GT11R	1	4	2.45	77.0	75.0
LMPRC	1	1	0.15	85.0	78.0
MPRC1	1	5	0.52	85.0	83.0
MPRC2	1	6	1.14	85.0	79.8
MPRC3	1	4	0.44	86.2	84.0
MPRC4	1	12	2.08	82.0	87.1
MPRCA	5	7	2.45	78.2	74.4
MPRCB	4	6	2.20	78.4	75.7
MPRCC	7	9	2.82	77.8	77.7
MPRCD	3	6	2.16	81.5	73.1
MPRCE	4	5	1.44	77.3	68.1
MPRCF	2	2	0.31	76.9	66.8
MPRCG	4	6	2.17	74.8	63.8
MPRCW	2	2	0.80	70.1	70.8
SRMAF	1	2	1.01	–	78.5
TTBLA	4	14	9.03	58.3	55.2
TTBRA	3	13	8.30	46.6	57.4
TTBUA	6	26	16.10	51.6	65.3
TTGRA	1	8	7.02	78.6	79.3
TTPUA	1	5	5.87	74.2	77.0
TTPUB	1	1	0.25	73.0	81.0
TTPUC	2	2	0.36	84.9	84.6
TTREA	5	28	20.31	77.7	81.4
TTYEA	3	23	19.34	78.6	80.8
TTYEB	1	3	2.20	86.0	81.7
WSEGR	1	2	0.30	68.5	66.5
WSSAR	1	1	0.07	65.0	54.0
WSTAR	1	2	0.60	74.5	68.5
Total	79	221	118.65	70.4[2]	72.8[2]
Sample unit std. dev.				10.4	9.0

[1] No data.
[2] Very good.

were also tank trails. The URCI data in Table 4 indicate that the tank trail branches (those branches with names that begin with TT) were in worse condition than the roadways and parking areas. The average weighted URCI was 68.5 for the tank trails and 78.1 for the roadways. On the basis of these results, the 1988 survey report recommended that repairs be made to the tank trails to accommodate the heavier traffic loads. Fort Riley road engineers accepted this recommendation, and the tank trails were repaired. The 1989 URCI ratings presented in Tables 3 and 4 indicate an improvement in the overall network from 70.4 to 72.8. The 1989 URCI for tank trails was 73.0, compared with 72.4 for roadways. This exemplifies the benefits a PMS can provide when used properly.

Fort Ord, California

The unsurfaced roads at Fort Ord were surveyed in 1988. Fort Ord is the only site that has been inspected just once. This road network was well maintained but needs to be reevaluated. Funding limitations have prevented a second survey. Table 5 presents the sample unit rating frequency distribution, with 20 of the 29 sample units inspected having very good ratings. Table 6 presents a summary of the branch ratings. The average weighted network URCI was 71.5.

TABLE 5 SAMPLE UNIT RATING FREQUENCIES FOR FORT ORD, CALIFORNIA

Rating	No. of sample units	No. of branches with average weighted URCI
Excellent	2	0
Very good	20	7
Good	4	2
Fair	3	1
Poor	0	0
Very poor	0	0
Failed	0	0
Total	29	10

TABLE 6 DISTRESS MEASUREMENT SUMMARY FOR FORT ORD, CALIFORNIA

Branch	No. of sections	No. of sample units	Length of branch (mi)	Average weighted branch URCI
AROWE	2	4	3.80	76.4
ARSKE	1	3	3.00	78.3
ARGDE	1	2	1.80	66.5
ARECE	1	2	1.50	75.0
ARCBE	3	5	2.60	74.2
ARWGE	1	2	1.40	81.5
ARPFE	3	4	1.30	78.9
AROCE	1	2	1.80	46.0
ARPF5	1	2	1.90	56.5
ARPCE	1	3	2.90	82.0
Total	15	29	22.00	71.5
Sample unit std. dev.				12.5

TABLE 7 SAMPLE UNIT RATING FREQUENCIES FOR FORT CARSON, COLORADO

Rating	No. of sample units 1987	1988
Excellent	4	6
Very good	18	38
Good	29	20
Fair	12	1
Poor	2	0
Very poor	0	0
Failed	0	0
Total	65	65

Fort Carson, Colorado

Fort Carson's unsurfaced roads were inspected in 1987 and 1988. The 1987 inspection indicated that road maintenance needed to be improved, because the network condition appeared to be in a downward trend. Significant reconstruction took place in 1988, and material was added to many of the branches. This repair substantially improved the overall road ratings. These improvements can be observed in summary results presented in Tables 7 and 8. Table 7 indicates that 12 sample units had fair ratings in 1987, as opposed to only 1 in 1988. In 1987, 29 units received good ratings, versus 20 in 1988. However, only 18 very good samples were taken in 1987, versus 38 in 1988. This data indicates the general improvement in sample unit ratings. Another indication of road condition improvement is presented in Table 8. The overall weighted network URCI was 67.6 in 1987 and 74.7 in 1988. These improvements, once again, are evidence of the benefits that can be reaped from using PMSs.

Fort Wainwright, Alaska

Fort Wainwright's unsurfaced-road network was inspected in 1988 and 1989. There is concern that road conditions at Fort Wainwright are deteriorating significantly. Tables 9 and 10 summarize the 1988 and 1989 road surveys. Road conditions significantly degraded between those two surveys. From Table 10, the average weighted URCI in 1988 was 77.6, versus 66.8 in 1989. In 1988, Fort Wainwright's unsurfaced-road network was one of the best, yet in 1989 this same network had the worst URCI of any survey presented here. Certainly this sig-

TABLE 8 DISTRESS MEASUREMENT SUMMARY FOR FORT CARSON, COLORADO

Branch	No. of sections	No. of sample units	Length of branch (mi)	Average weighted branch URCI 1987	1988
VR010	2	5	6.51	64.7	66.7
VR020	1	2	2.63	73.5	65.0
VR030	1	2	1.34	82.0	72.0
VR040	5	9	6.91	69.7	75.1
VR060	2	3	3.48	73.0	82.7
VR080	3	6	3.98	71.0	78.1
VR811	1	2	1.13	60.5	82.0
VR090	2	3	1.77	72.7	73.9
VR100	1	1	0.15	56.0	65.0
VR110	5	12	14.90	72.9	77.0
VR120	1	5	4.22	61.2	74.4
VR130	1	3	3.15	55.0	75.7
VR140	1	5	5.83	73.6	74.6
VR14A	1	2	1.90	61.5	74.5
VR150	1	3	3.00	54.3	68.7
VR15A	1	3	2.05	42.0	83.3
Total	29	65	62.95	67.6	74.7
Sample unit std. dev.				12.9	7.6

TABLE 9 SAMPLE UNIT RATING FREQUENCIES FOR FORT WAINWRIGHT, ALASKA

Rating	No. of sample units 1988	No. of sample units 1989	No. of branches with average weighted URCI 1988	No. of branches with average weighted URCI 1989
Excellent	11	0	4	0
Very good	28	24	9	8
Good	6	16	3	6
Fair	5	8	1	3
Poor	0	2	0	0
Very poor	0	0	0	0
Failed	0	0	0	0
Total	50	50	17	17

nificant decline in ratings can be partially blamed on the extremely harsh winter of 1988 and 1989. However, the primary factor causing this degradation can be traced to budget and personnel cuts, which directly affect the amount and quality of maintenance. Efforts to restore some of these cuts are recommended.

Fort Greely, Alaska

Fort Greely's unsurfaced roads were also surveyed in 1988 and 1989. The results of these surveys are presented in Tables 11 and 12. The unsurfaced roads at Fort Greely are very well maintained. In fact, the 1988 rating was the highest of all the

TABLE 10 DISTRESS MEASUREMENT SUMMARY FOR FORT WAINWRIGHT, ALASKA

Branch	No. of sections	No. of sample units	Length of branch (mi)	Average weighted branch URCI 1988	Average weighted branch URCI 1989
PVES0	3	3	0.75	87.0	73.0
PRIV0	4	6	3.65	80.7	62.8
PSAG0	1	3	2.55	72.7	65.3
PCAN0	1	1	1.00	88.0	72.0
PTAN0	5	7	2.70	83.2	73.1
PSKI0	2	2	0.60	85.5	57.3
PFRO0	1	2	0.75	82.0	82.0
PAPP3	1	1	0.30	73.0	68.0
PASP0	3	4	2.00	91.7	78.7
PPER0	2	4	1.65	62.2	54.0
PBIR0	1	2	0.65	60.0	42.0
PBIL0	2	3	0.70	70.0	69.9
PGLA0	1	2	1.00	69.5	79.0
PALD0	1	3	1.40	71.0	42.3
POAK0	1	1	0.25	42.0	80.0
POLD0	1	2	1.10	80.0	67.5
PCHI0	1	4	1.40	77.8	77.3
Total	31	50	22.45	77.6	66.8
Sample unit std. dev.				12.4	13.7

TABLE 11 SAMPLE UNIT RATING FREQUENCIES FOR FORT GREELY, ALASKA

Rating	No. of sample units 1988	No. of sample units 1989	No. of branches with average weighted URCI 1988	No. of branches with average weighted URCI 1989
Excellent	14	10	10	7
Very good	19	18	10	12
Good	2	7	1	2
Fair	0	0	0	0
Poor	0	0	0	0
Very poor	0	0	0	0
Failed	0	0	0	0
Total	35	35	21	21

sites surveyed, and the 1989 rating was the highest for that year. However, the rating was 81.4 in 1988 and dropped to 76.5 in 1989. Facility maintenance personnel attributed this significant decline to budget and personnel cuts, which resulted in a reduction in road repairs. On the basis of these results, a 1990 survey is very important.

SUMMARY

Table 13 presents a summary of the results of all the unsurfaced-road surveys conducted to date. The average weighted URCIs of each survey are presented as a function

TABLE 12 DISTRESS MEASUREMENT SUMMARY FOR FORT GREELY, ALASKA

Branch	No. of sections	No. of sample units	Length of branch (mi)	Average weighted branch URCI 1988	1989
PMEAO	1	6	7.40	75.5	66.0
PBOLO	1	2	1.65	72.5	68.0
PBEAO	1	4	4.10	86.3	80.0
PWESO	1	1	0.50	78.0	79.0
P3170	1	1	0.10	71.0	87.0
PPINO	1	1	0.20	93.0	81.0
PBUTO	1	2	0.70	85.0	82.5
PSIXO	1	1	0.25	93.0	98.0
PASTO	1	1	0.30	77.0	77.0
PCSTO	1	1	0.25	82.0	80.0
PDSTO	1	1	0.10	87.0	85.0
PEVEO	1	1	1.00	76.0	91.0
PDEHO	1	1	0.15	79.0	91.0
PFIRO	1	2	0.40	85.5	82.5
PEASO	1	1	1.00	92.0	91.0
PINCO	1	1	0.04	80.0	79.0
PSENO	1	1	0.45	83.0	81.0
PSHAO	1	1	0.30	86.0	84.0
P6320	1	1	0.05	65.0	74.0
P33MO	1	3	1.15	87.7	82.7
PLANO	1	2	1.35	95.0	90.0
Total	21	25	21.44	81.4[1]	76.5[1]
Sample unit std. dev.				10.0	9.5

[1]Very good.

of site and year of the survey. The 12 surveys produced average URCIs ranging from 66.8 (good) to 81.4 (very good). The rating of the individual sites appeared to be comparable. When proper maintenance was available, the URCI showed improvement; conversely, when the URCI declined, further study found that maintenance funds and personnel had been cut. The Alaska sites should be carefully monitored to further assess the effect of budget and personnel cuts.

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TABLE 13 NETWORK AVERAGE-WEIGHTED URCI COMPARISONS

Location	1986	1987	1988	1989
Dalton Highway, AK	71.2	–[1]	68.0	67.4
Ft. Riley, KS	–	–	70.4	72.8
Ft. Ord, CA	–	–	71.5	–
Ft. Carson, CO	–	67.6	74.7	–
Ft. Wainwright, AK	–	–	77.6	66.8
Ft. Greely, AK	–	–	81.4	76.5

[1] No data.

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