

# Present Serviceability-Roughness Correlations Using Rating Panel Data

RAYMOND K. MOORE, G. NORMAN CLARK, AND GARY N. PLUMB

The Kansas Department of Transportation (KDOT) has completed an extensive study of pavement serviceability using 24-member rating panels. The AASHTO five-point segmented rating scale and the three-point segmented rating scale designed to develop serviceability estimates directly related to KDOT pavement management system roughness levels were used. The average standard deviation of individual panel ratings over all pavement types was approximately 12 percent of the maximum scale value. This value corresponds to 0.60 for the AASHTO five-point scale and 0.36 for the KDOT three-point scale; these standard deviations appear to be consistent for panel sizes  $\geq 24$ . The standard deviation of the individual panel ratings for a given test section appears to be independent of the mean panel rating. Although statistically significant linear, log-log linear, and exponential linear models were developed, they were not completely satisfactory for the prediction of the present serviceability index (PSI), given Mays ride meter (MRM) roughness values. None of these functions are conceptually correct for smooth pavements (low MRM values). A statistically significant correlation was established between the AASHTO five-point and KDOT three-point present serviceability rating (PSR) values. It appears that the three-point PSR data are consistent at terminal serviceability values associated with the AASHTO five-point scale.

The Kansas Department of Transportation (KDOT) has completed an extensive present serviceability study of selected in-service pavement sections using 24-member rating panels. The ratings were made during November and December in 1985. The strategic goal of the research effort was to develop statistical relationships between present serviceability rating (PSR) as estimated by the mean panel rating and pavement management system (PMS) survey data including roughness as measured by the Mays ride meter (MRM) in inches per mile. Two segmented rating scales were needed to fulfill research objectives.

The KDOT PMS network optimization system (NOS) uses three levels of pavement roughness based on MRM data (1). Level 1 roughness is associated with comfortable or satisfactory ride quality. Level 2 roughness is tolerable for the highway user. Level 3 roughness is judged to be uncomfortable and generally indicates a need for scheduling a pavement preservation action (although primary and secondary distress conditions are also considered).

A 0 to 3 scale was developed to study the relationship between PSR and NOS roughness levels that were initially assumed using prior research and engineering judgment. The panel rating card is shown in Figure 1. Numbers were omitted from the segmented scale, but numerical values were scaled

from the cards after the rating survey was completed. The use of this particular rating card has not been previously reported in the technical literature.

The second rating card used the five-point segmented scale developed by Carey and Irick (2) for the AASHO (now AASHTO) road test (3). Although initially criticized for many potential shortcomings by Hutchinson (4) and more recently by Weaver (5), this segmented scale has been the basis for most PSR reporting in the United States. Recent research reported by Nick and Janoff (6, 7) indicates that the AASHTO scale does not violate good psychometric principles if panel members are properly instructed and the survey is competently administered. The KDOT panel rating study incorporated the five-point scale for two reasons. First, an algorithm was needed to relate PMS survey data to PSR using a five-point scale as reported to the FHWA for Highway Performance Monitoring System (HPMS) pavement sections. Second, another objective was to correlate the PSR data using both scales to ascertain if the NOS roughness levels were consistent with the more frequently used AASHTO scale. The rating card is illustrated in Figure 2.

## SCOPE OF RESEARCH RESULTS

The research reported herein concerns five major topics related to the collection and analysis of panel data. These topics are (a) panel and test circuit design, (b) survey administration, (c) panel data statistics, (d) PSI-MRM roughness correlations, and (e)  $PSR_3$ - $PSR_5$  correlations. The use of these data within the

PERFECTLY SMOOTH

COMFORTABLE

TOLERABLE

UNCOMFORTABLE

IMPASSABLE AT 50MPH

DATE \_\_\_\_\_

SEC. NO. \_\_\_\_\_

CAR NO. \_\_\_\_\_

RATER NO. \_\_\_\_\_

FIGURE 1 KDOT scale rating card.

R. K. Moore, Department of Civil Engineering, University of Kansas, Lawrence, Kans. 66045. G. N. Clark and G. N. Plumb, Pavement Management Task Force, Kansas Department of Transportation, Topeka, Kans. 66611.

PERFECTLY  
SMOOTH

VERY GOOD

GOOD

FAIR

POOR

VERY POOR

IMPASSABLE  
AT 50MPH

DATE \_\_\_\_\_

SEC. NO. \_\_\_\_\_

CAR NO. \_\_\_\_\_

RATER No. \_\_\_\_\_

ACCEPTABLE?

YES

NO

UNDECIDED

FIGURE 2 AASHTO scale rating card.

KDOT PMS system is beyond the scope of this paper because preparatory work has not been completed.

### PANEL AND TEST CIRCUIT DESIGN

A panel size of 24 was selected using parametric theory of estimation as recommended by Zaniewski and Hudson (8). Panel size was determined based on the AASHTO scale because panel data have been previously published. Because the three-point scale was to be correlated with the AASHTO scale, the same panel size was used for both surveys.

Nick and Janoff (6) published data using the AASHTO scale and 36-member rating panels that had an average standard deviation of 0.61 for all pavement sections. Furthermore, Nick and Janoff (6) used a subset of Weaver's data (9) to calculate a standard deviation of 0.60. Although the exact panel size for Weaver's data was not given, his panels were much larger than 36. Therefore, using an assumed standard deviation of 0.60 with a maximum allowable error of 0.25, a minimum sample size of 23 is necessary to be 95 percent confident that the population mean falls within the allowable error relative to the mean panel rating.

The 24 panel members were assigned 3 to a car. Each car had a driver who served as part of the survey administration and did not rate pavements. Therefore, eight cars were used. The automobiles were 1985 Ford Tempo four-door sedans.

Three test circuits were designed to reflect the pavement design, traffic, and environmental differences that occur in Kansas. A circuit of test sections was developed from in-service pavements in KDOT Districts I and IV to represent eastern Kansas, in KDOT Districts II and V to represent central

Kansas, and in KDOT Districts III and VI to represent western Kansas. Each circuit comprised 36 0.5-mi test sections selected to represent the diversity in observed pavement condition. This selection criteria created large distances between test sections in some cases. Dummy sections were added when necessary to reorient panel members following extended travel times.

The central circuit comprised 8 to 10 sections of each of the four major pavement types used in the KDOT PMS. These are full-design bituminous pavement (FDBit), partial-design bituminous pavement (PDBit), portland cement concrete pavement (PCCP), and composite (COMP) pavement. FDBit and PCCP pavement sections were constructed based on conventional engineering thickness design. Composite pavements are PCCP pavements that have been overlaid; these are also fully designed. PDBit sections have built-up thicknesses that have evolved through repeated application of surface treatments or overlays. Although hot mix overlay or recycled resurfacing mixture and thickness design is based on current engineering practice, the complete pavement cross section has been constructed with only partial reliance on formal design procedures.

A balanced design (approximately the same number of test sections for each pavement type) was necessary for the central circuit because the three-point scale was used only on this circuit. Central Kansas has enough diversity in the four pavement types that a balanced circuit could be developed in this region, as presented in Table 1. However, PCCP and COMP sections are scarce in western Kansas. The western circuit had a majority of FDBit and PDBit sections (Table 2) and the eastern circuit was designed with emphasis on PCCP and COMP sections (Table 3).

The design was based on having a minimum of 24 test sections of each pavement type over all three circuits. From a statistical standpoint, correlations using 24 pairs of correlates are statistically significant ( $\alpha = 0.05$ ) if the absolute value of the correlation coefficient equals or exceeds 0.40 (10). However, the minimum absolute value of the correlation coefficient for engineering significance was set at 0.70 because a simple linear regression between the correlates would only account for about one-half of the total variation in the data set (i.e.,  $r^2 = 0.49$ ). This assumption is particularly important if the data are to be used as the basis of a predictive model to estimate future values of PSI given MRM roughness data.

### SURVEY ADMINISTRATION

The panel members were all KDOT employees who volunteered from the districts and from the headquarters organization in Topeka. Different panels were used for all four surveys (AASHTO scale applied to the eastern, central, and western circuits and the three-point scale applied only to the central circuit). The panel instructions were adapted from those used by Nick and Janoff (6, 7). A special effort was made to insure that the raters concentrated only on ride quality. They were instructed to ignore pavement appearance, cracking, patching, and so forth. As previously noted, the drivers were part of the survey administration and did not rate pavements.

The eastern and central circuits each required 2 days for evaluation. In the western circuit, 3 days were needed because of the location of the test sections. Each test section was rated

TABLE 1 CENTRAL KANSAS CIRCUIT, THREE-POINT SCALE

Test Section	PSR <sub>3</sub>	Standard Deviation	MRM Roughness (in./mi)
<b>FDBIT</b>			
C-9	1.08	0.30	148
C-10	0.95	0.33	137
C-11	0.95	0.28	141
C-12	1.07	0.35	84
C-13	0.87	0.30	124
C-14	1.95	0.38	77
C-15	1.97	0.38	70
C-26	1.15	0.33	131
C-33	2.33	0.26	31
C-38	1.26	0.37	165
<b>PDBIT</b>			
C-20	2.05	0.37	39
C-21	1.74	0.50	42
C-24	0.80	0.32	140
C-25	0.92	0.29	128
C-27	1.49	0.47	109
C-28	2.26	0.32	60
C-34	1.52	0.36	159
C-40	2.46	0.31	35
<b>PCCP</b>			
C-4	1.14	0.30	144
C-5	1.32	0.40	88
C-17	1.30	0.35	111
C-18	1.32	0.43	126
C-19	1.40	0.41	110
C-23	1.11	0.40	169
C-35	1.41	0.41	109
C-36	1.33	0.37	174
C-41	1.75	0.43	59
<b>COMP</b>			
C-6	1.70	0.38	38
C-7	1.71	0.38	47
C-8	1.72	0.41	31
C-22	1.38	0.43	108
C-29	1.42	0.37	129
C-30	1.76	0.39	90
C-31	1.70	0.42	90
C-37	1.22	0.26	108
C-39	2.18	0.28	54

at 50 mph by all panel members within a 30-min time period on the same day. NOS survey data, including roughness of the pavement sections, were collected within 2 days of the panel rating. The MRM roughness data represent the average of three runs over the 0.5-mi test section. Although the eastern circuit originally had 36 test sections, 5 of the sections were omitted from the data analysis because they were snow covered at the time of the survey.

## PANEL DATA STATISTICS

### Central Circuit, Three-Point Scale

Panel rating data for the three-point scale are given in Table 1. The average standard deviation over all pavement sections is 0.36. This represents 12 percent of the maximum scale value

(3.0). Figure 3 illustrates the association between PSR<sub>3</sub> (mean panel rating) and the standard deviation of the panel ratings for all test sections. The correlation coefficient of 0.11 was not statistically significant ( $\alpha = 0.05$ ). The variation in the panel ratings is independent of the mean present serviceability although extreme roughness and smoothness (PSR<sub>3</sub> near 0.0 or 3.0) were not represented in the data set. None of the correlation coefficients were significant ( $\alpha = 0.05$ ) when the data were stratified by pavement type.

### Western Circuit, AASHTO Scale

The panel rating statistics are given in Table 2. The average standard deviation over all pavement types is 0.63, or 13 percent of the maximum scale value of 5.0. The correlation coefficient between PSR<sub>5</sub> (mean panel rating) and the standard

TABLE 2 WESTERN KANSAS CIRCUIT, AASHTO SCALE

Test Section	PSR <sub>5</sub>	Standard Deviation	MRM Roughness (in./mi)
<b>FDBIT</b>			
W-4	2.58	0.55	84
W-13	2.22	0.78	166
W-16	2.64	0.68	130
W-17	3.32	0.62	74
W-19	2.10	0.71	97
W-20	1.81	0.63	171
W-24	3.00	0.60	68
W-25	1.95	0.61	88
W-26	2.08	0.92	180
W-29	1.96	0.65	143
W-30	3.00	0.62	135
W-41	3.27	0.64	106
W-42	2.47	0.64	44
<b>PDBIT</b>			
W-7	3.55	0.42	31
W-8	3.14	0.67	41
W-9	3.14	0.79	33
W-10	2.46	0.62	151
W-11	2.31	0.79	150
W-12	2.40	0.64	133
W-14	1.77	0.60	225
W-15	2.83	0.52	128
W-21	2.94	0.69	103
W-22	2.33	0.49	206
W-23	2.40	0.59	171
W-27	3.65	0.59	67
<b>PCCP</b>			
W-5	3.35	0.75	80
W-6	3.67	0.63	49
W-34	2.29	0.57	103
W-35	2.73	0.57	86
<b>COMP</b>			
W-31	1.87	0.68	165
W-33	2.95	0.57	37
W-36	3.08	0.52	61
W-37	2.75	0.60	94
W-38	2.85	0.62	89
W-39	2.92	0.51	94
W-44	3.98	0.58	38

TABLE 3 EASTERN KANSAS CIRCUIT, AASHTO SCALE

Test Section	PSR <sub>5</sub>	Standard Deviation	MRM Roughness (in./mi)
<b>FDBIT</b>			
E-4	3.08	0.59	50
E-5	2.91	0.61	50
E-6	2.77	0.62	39
E-23	2.78	0.65	107
<b>PDBIT</b>			
E-29	2.05	0.55	172
E-31	1.42	0.59	401
E-36	2.63	0.41	170
E-37	2.37	0.51	128
<b>PCCP</b>			
E-10	1.95	0.78	170
E-11	1.92	0.77	183
E-13	2.79	0.63	144
E-24	2.35	0.86	125
E-27	3.66	0.60	55
E-28	3.29	0.68	92
E-32	2.28	0.82	168
E-33	2.68	0.71	88
E-34	3.58	0.56	117
E-35	3.36	0.66	129
E-38	1.48	0.70	269
E-39	2.00	0.55	181
E-40	2.33	0.48	147
E-41	2.23	0.57	189
<b>COMP</b>			
E-7	2.15	0.54	86
E-8	2.25	0.67	141
E-9	2.90	0.52	65
E-14	3.86	0.49	72
E-15	3.55	0.68	84
E-20	2.27	0.62	94
E-21	2.57	0.57	149
E-25	2.82	0.67	164
E-26	3.20	0.57	116

deviation is  $-0.28$ , which is not significant ( $\alpha = 0.05$ ). Furthermore, none of the correlation coefficients for the data when stratified by pavement type were significant ( $\alpha = 0.05$ ). The dispersion of panel data is unaffected by the serviceability of the pavement as estimated by the mean panel rating.

#### Eastern Circuit, AASHTO Scale

The panel rating statistics are given in Table 3. The average standard deviation over all pavement sections is 0.62, or 12 percent of the maximum scale value of 5.0. The correlation coefficient between PSR<sub>5</sub> (mean panel rating) and the standard deviation of the panel ratings for all test sections is  $-0.20$ , which is not statistically significant ( $\alpha = 0.05$ ). None of the correlation coefficients were significant ( $\alpha = 0.05$ ) when the data were stratified by pavement type.

#### Central Circuit, AASHTO Scale

The panel rating statistics are given in Table 4. The average standard deviation over all pavement sections is 0.50, or 10 percent of the maximum scale value of 5.0. The correlation coefficient between PSR<sub>5</sub> (mean panel rating) and the standard deviation of the panel rating shown in Figure 4 for all test sections is  $-0.47$ , which was statistically significant ( $\alpha = 0.01$ ). This correlation suggests that the dispersion of individual ratings decreases as pavement smoothness increases. The correlation may have been the result of a data set representing a relatively smooth group of pavements. Only test section C-13 had a PSR<sub>5</sub> less than 2.0. When the data are subdivided by pavement type, the 10 FDBit pavement sections had a correlation coefficient of  $-0.75$ , which was significant ( $\alpha = 0.05$ ). None of the correlations between PSR<sub>5</sub> and standard deviation were significant ( $\alpha = 0.05$ ) for the other three pavement types.

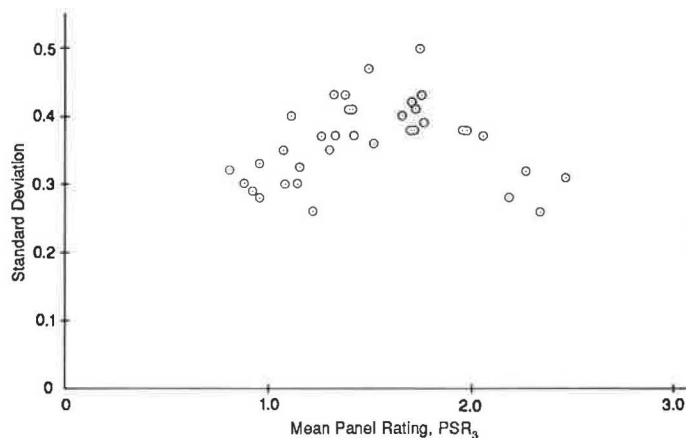


FIGURE 3 Standard deviation and PSR<sub>3</sub> correlation, Central Circuit.

TABLE 4 CENTRAL KANSAS CIRCUIT, AASHTO SCALE

Test Section	PSR <sub>5</sub>	Standard Deviation	MRM Roughness (in./mi)
<b>FDBIT</b>			
C-9	2.24	0.61	148
C-10	2.21	0.70	137
C-11	2.26	0.58	141
C-12	2.34	0.71	84
C-13	1.99	0.60	124
C-14	3.37	0.48	77
C-15	3.22	0.48	70
C-26	2.58	0.52	131
C-33	3.95	0.49	31
C-38	2.53	0.60	165
<b>PDBIT</b>			
C-20	3.52	0.40	39
C-21	3.14	0.48	42
C-24	2.05	0.52	140
C-25	2.22	0.57	128
C-27	3.03	0.47	109
C-28	3.90	0.42	60
C-34	3.04	0.65	159
C-40	4.27	0.40	35
<b>PCCP</b>			
C-4	2.65	0.52	144
C-5	2.68	0.41	88
C-17	2.76	0.52	111
C-18	2.76	0.52	126
C-19	2.73	0.51	110
C-23	2.31	0.48	169
C-35	2.66	0.37	109
C-36	2.72	0.38	174
C-41	3.36	0.38	59
<b>COMP</b>			
C-7	2.99	0.47	47
C-8	2.92	0.42	31
C-9	2.98	0.46	38
C-22	2.50	0.47	108
C-29	2.71	0.51	129
C-30	2.86	0.48	90
C-31	3.05	0.55	90
C-37	2.41	0.43	108
C-39	3.54	0.51	54

## Discussion

The dispersion of individual ratings can be reasonably assumed to be independent of the mean panel rating. Although the central circuit had a statistically significant negative correlation, this finding was not persuasive. A simple linear regression accounts for only 22 percent of the total variation in the data set.

A reasonable estimate of the standard deviation for a 24-member panel is about 12 percent of the maximum scale value using both the three-point and AASHTO scales. This characteristic appears to extend to larger panel sizes. As previously stated, data developed by Nick and Janoff (6) using 36-member and larger panels had average standard deviations of 0.60 using the AASHTO scale. This value of standard deviation also corresponds to 12 percent of the maximum scale value. As panel sizes become smaller, the standard deviation may increase as indicated in early research reported by Nakamura and Michael (11). For example, a table of recommended panel sizes that used a standard deviation of 0.84 was based on 10-member panels. However, this finding may be useful in planning future panel rating studies that focus on pavement ride quality.

Using theory of estimation, the three-point scale has a maximum allowable error of 0.15 at the 95 percent confidence level. This error for 24-member panel sizes is certainly satisfactory for PSR determinations.

## PSI-MRM ROUGHNESS CORRELATIONS

The following list of equations provides the various linear and transformed models developed from central circuit data that estimate present serviceability index PSI<sub>3</sub> given MRM roughness values (in inches per mile).

### FDBIT

$$\text{PSI}_3 = 2.47 - 0.0100\text{MRM} \quad (r = -0.82)$$

$$\log \text{PSI}_3 = 1.24 - 0.56 \log \text{MRM} \quad (r = -0.82)$$

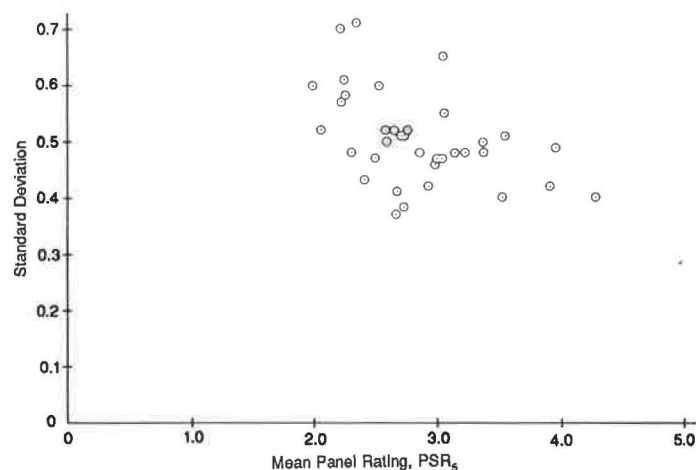


FIGURE 4 Standard deviation and PSR<sub>5</sub> correlation, Central Circuit.

$$[\text{PSI}_3 = 17.38 (\text{MRM}^{-0.56})]$$

$$\ln \text{PSI}_3 = 0.96 - 0.00647\text{MRM} \quad (r = -0.78)$$

$$[\text{PSI}_3 = 2.61e^{-0.00647\text{MRM}}]$$

## PDBIT

$$\text{PSI}_3 = 2.50 - 0.00949\text{MRM} \quad (r = -0.80)$$

$$\log \text{PSI}_3 = 1.14 - 0.51 \log \text{MRM} \quad (r = -0.78)$$

$$[\text{PSI}_3 = 13.80 (\text{MRM}^{-0.51})]$$

$$\ln \text{PSI}_3 = 0.99 - 0.00623\text{MRM} \quad (r = -0.77)$$

$$[\text{PSI}_3 = 2.69e^{-0.00623\text{MRM}}]$$

## PCCP

$$\text{PSI}_3 = 1.81 - 0.00384\text{MRM} \quad (r = -0.77)$$

$$\log \text{PSI}_3 = 0.79 - 0.32 \log \text{MRM} \quad (r = -0.82)$$

$$[\text{PSI}_3 = 6.17 (\text{MRM}^{-0.32})]$$

$$\ln \text{PSI}_3 = 0.62 - 0.00274\text{MRM} \quad (r = -0.77)$$

$$[\text{PSI}_3 = 1.86e^{-0.00274\text{MRM}}]$$

## COMP

$$\ln \text{PSI}_3 = 0.73 - 0.00319\text{MRM} \quad (r = -0.67)$$

$$[\text{PSI}_3 = 2.08e^{-0.00319\text{MRM}}]$$

The following list of equations provides the models that estimate  $\text{PSI}_5$  given MRM roughness values.

## FDBIT

$$\text{PSI}_5 = 3.49 - 0.00799\text{MRM} \quad (r = -0.68)$$

$$\log \text{PSI}_5 = 0.933 - 0.26 \log \text{MRM} \quad (r = -0.66)$$

$$[\text{PSI}_5 = 8.57 (\text{MRM}^{-0.26})]$$

$$\ln \text{PSI}_5 = 1.28 - 0.00302\text{MRM} \quad (r = -0.68)$$

$$[\text{PSI}_5 = 3.60e^{-0.00302\text{MRM}}]$$

## PDBIT

$$\text{PSI}_5 = 3.65 - 0.00697\text{MRM} \quad (r = -0.83)$$

$$\log \text{PSI}_5 = 1.08 - 0.031 \log \text{MRM} \quad (r = -0.85)$$

$$[\text{PSI}_5 = 12.02 (\text{MRM}^{-0.31})]$$

$$\ln \text{PSI}_5 = 1.34 - 0.00276\text{MRM} \quad (r = -0.87)$$

$$[\text{PSI}_5 = 3.82e^{-0.00276\text{MRM}}]$$

## PCCP

$$\text{PSI}_5 = 3.87 - 0.00925\text{MRM} \quad (r = -0.81)$$

$$\log \text{PSI}_5 = 1.32 - 0.44 \log \text{MRM} \quad (r = -0.81)$$

$$[\text{PSI}_5 = 20.89 (\text{MRM}^{-0.44})]$$

$$\ln \text{PSI}_5 = 1.44 - 0.00370\text{MRM} \quad (r = -0.84)$$

$$[\text{PSI}_5 = 4.22e^{-0.00370\text{MRM}}]$$

## COMP

$$\text{PSI}_5 = 3.53 - 0.00732\text{MRM} \quad (r = -0.57)$$

$$\log \text{PSI}_5 = 0.83 - 0.20 \log \text{MRM} \quad (r = -0.55)$$

$$[\text{PSI}_5 = 6.76 (\text{MRM}^{-0.20})]$$

$$\ln \text{PSI}_5 = 1.28 - 0.00264\text{MRM} \quad (r = -0.58)$$

$$[\text{PSI}_5 = 3.60e^{-0.00264\text{MRM}}]$$

These regressions are based on data collected from all three circuits and aggregated for the analysis. The correlation coefficients are significant ( $\alpha = 0.05$ ).

In general, the linear and exponential linear models underestimate serviceability for smooth pavements. A perfectly smooth pavement ( $\text{MRM} = 0$  in./mi) should yield a  $\text{PSI}$  that approaches 3.0 or 5.0, depending on the present serviceability scale. None of the linear or exponential models have this characteristic. The log-log linear model has a limit of infinity for MRM values approaching 0, which is obviously inconsistent with maximum serviceability of 3.0 or 5.0.

PSR<sub>3</sub>-PSR<sub>5</sub> CORRELATIONS

The central circuit used two different rating panels to evaluate the test sections. The first panel used the three-point scale and the second used the AASHTO scale. Figure 5 illustrates the correction which has a statistically significant ( $\alpha < 0.01$ ) correlation coefficient of 0.97. The simple linear regression to estimate  $\text{PSR}_3$  is as follows:

$$\text{PSR}_3 = -0.72 + 0.78\text{PSR}_5$$

AASHTO present serviceability values of 2.0 and 2.5 have been used as terminal serviceability indices for pavement design applications. If these values are used in the regression,  $\text{PSR}_3$  estimates of 0.84 and 1.23 are obtained. These values are slightly less than and greater than 1.00, which represents the lower bound of NOS Level 3 roughness and indicates that pavement preservation actions are needed. This indication suggests that the three-point scale produced reasonable serviceability results that correspond conceptually with the AASHTO scale.

## CONCLUSIONS

1. For panel sizes of 24, the average standard deviation of individual panel ratings over all pavement types is approximately 12 percent of the maximum scale value. This corre-

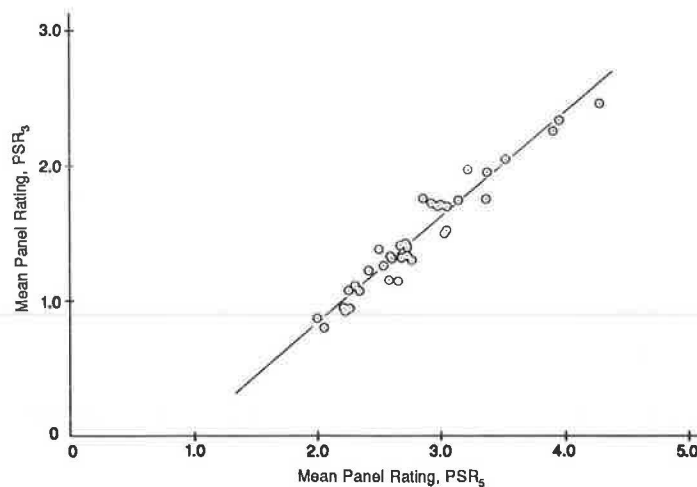


FIGURE 5 PSR<sub>3</sub>-PSR<sub>5</sub> correlation.

sponds to 0.60 for the five-point AASHTO scale and 0.36 for the three-point scale developed in this research effort.

2. The standard deviation of individual panel ratings appears to be independent of the mean panel rating for a given pavement section. The dispersion of individual panel ratings for a test section is not linearly associated with the mean panel rating.

3. Statistically significant linear, log-log linear, and exponential linear models are not completely satisfactory for the prediction of PSI given MRM roughness values. None of these functions are conceptually correct when the pavements are smooth (low MRM roughness values).

4. A statistically significant correlation was established between the AASHTO five-point scale and the KDOT three-point scale. The KDOT scale for Level 3 roughness ( $PSR_3 \leq 1.0$ ) corresponds well with the AASHTO estimates of terminal serviceability.

5. Survey administration guidelines as reported by Nick and Janoff (6, 7) and Zaniewski and Hudson (8) were successfully implemented. The recommendations relating to panel design, driver instructions, panel instructions, and test circuit construction were in part responsible for a successful serviceability study.

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