

Development of PCI Family Curves for Climatic Zones

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OVERVIEW: Pavement performance models are used in the StreetSaver® decision support software to predict the future pavement condition, identify needed treatments, and estimate budget needs over a period of time. Reliable pavement performance models are essential to support making cost-effective decisions for a pavement network. StreetSaver® performance models project the Pavement Condition Index (PCI) of individual management sections as a function of the age, and they are adjusted for individual sections after condition surveys and treatment applications. Climatic and environmental conditions influence the pavement performance, rate of deterioration of pavements. They also affect the performance and scheduling of maintenance and rehabilitation treatments. PCI family curves for different climatic zones were developed for use the StreetSaver® decision support software.

METHODOLOGY: PCI-Age data sets from agencies using StreetSaver® located in four climatic regions in the United States were gathered for the analysis. The climatic regions are described by FHWA in their document, “Evaluation of LTPP Climatic Data for Use in Mechanistic-Empirical Pavement Design Guide (MEPDG) Calibration and Other Pavement Analysis”. (FHWA-HRT-15-019). The four climatic regions, (1) Dry, Freeze; (2) Dry, Non-Freeze; (3) Wet, Freeze; and (4) Wet, Non-Freeze, are shown in Figure 1.

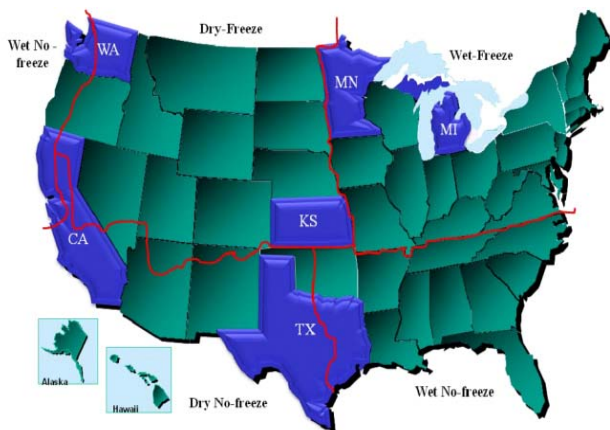


Figure 1. LTPP Climatic Zone Map

A total of 1,328,008 PCI-age historical records of field condition surveys were analyzed from 547 agencies using StreetSaver®. PCI-age records used in the study include only condition surveys field inspections after treatment and maintenance interventions. Table 1 shows the number of PCI data records used in the study for each climatic zone by functional class.

A comprehensive analysis was conducted to select only condition survey data from pavement sections with PCI records prior to the application of treatments.

Table 1. Summary of Pavement Distress Records.

| Functional Classification | Wet Freeze | Dry Freeze | Wet Non Freeze | Dry Non Freeze | Total |
|---------------------------|--------------|----------------|----------------|----------------|------------------|
| Arterial | 45 | 34,877 | 73,317 | 71,143 | 179,382 |
| Collector | 453 | 29,038 | 92,021 | 99,312 | 220,824 |
| Residential | 1,791 | 165,999 | 357,381 | 373,390 | 898,561 |
| Others | 32 | 1,177 | 15,172 | 12,860 | 29,241 |
| Total | 2,321 | 231,091 | 537,891 | 556,705 | 1,328,008 |

For each functional class, PCI-age data was grouped by pavement surface type: Asphalt Concrete (AC), Asphalt Concrete/Asphalt Concrete (AC/AC), Asphalt Concrete/Portland Cement Concrete (AC/PCC), Portland Cement Concrete (PCC) and Surface Treatment (ST).

Outliers outside PCI upper and lower limit boundaries as a function of age, as shown in Figure 2, were removed from the analysis.

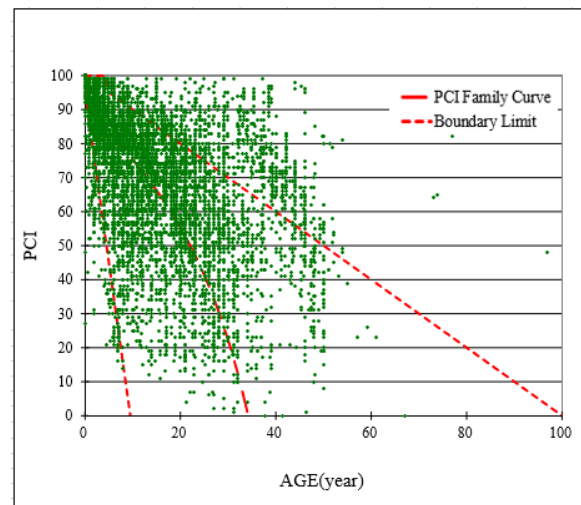


Figure 2: Example of PCI Data with Boundary Limits to Identify Outliers

A non-linear regression statistical analysis was performed to calculate the equation regression constants shown in Equation 1 for each functional class-pavement type combination family curve.

$$PCI = 100 - \frac{\rho}{\left(\ln\left(\frac{\alpha}{AGE}\right)\right)^{\beta}}$$

Where:

PCI = PCI value found at each value AGE for the PCI-AGE available analysis

α = regression constant that controls the age to which the curve is asymptotic

β = regression constant that controls how sharply the curve bends

ρ = regression constant that controls the age at which the inflection point in the curve occurs

AGE = age (time in decimal year values since surface construction) at which the PCI value was found during a condition survey included in the analysis

FINDINGS: PCI climatic family curves were developed for each functional class and surface type family. As shown in Figure 3, different performance curves were found for each of the climatic zones for the same pavement functional class-surface type family. In general, the pavements located in freeze climatic zones exhibited shorter lifespans than those located in non-freeze climatic zones.

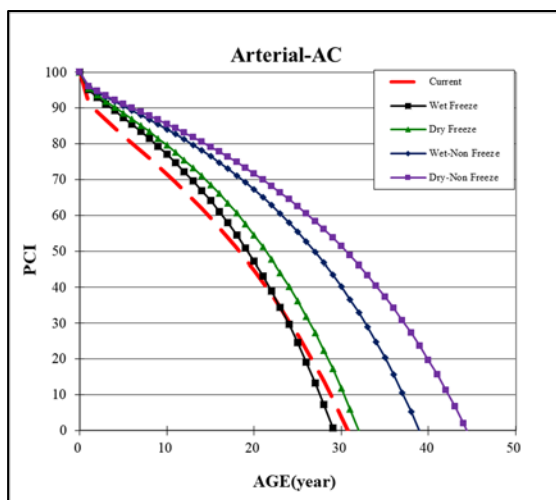


Figure 3. PCI Climatic Family Curves for Arterial AC

The PCI Drop in Year 1 was also revised based on statistical analysis, and a comparison of the updates is shown in Table 2.

Table 2. Comparison of the PCI Drop in Year 1

| Surface Type | Current PCI Family Curves (PCI Points) | Climatic PCI Family Curves (PCI Points) |
|--------------|--|---|
| AC | 4.9-8.2 | 3.7-4.9 |
| AC/AC | 7.2-9.1 | 3.3-4.7 |
| AC/PCC | 7.2-9.1 | 2.2-4.6 |
| PCC | 2.1-2.7 | 2.1-2.5 |
| ST | 23.3 | 6.3-8.8 |

IMPACT: The PCI family climatic curves will provide more accurate projections of the pavement condition. Consequently, the identification of maintenance and rehabilitation treatment needs and timing for the interventions will be better related to the pavement deterioration rate in each climatic zone.

RECOMMENDATIONS: The implementation of the PCI climatic family curves should lead to better inform pavement management decisions. However, pavement deterioration is affected by several factors and PCI projections using the PCI family curves should be adjusted for individual pavement sections. StreetSaver[®] has procedures to incorporate feedback from field inspections in the PCI projection for individual sections. Maintenance and rehabilitation treatments will also influence the PCI projections by potentially modifying the deterioration rate and the extending the service life. It is recommended to review the pavement family curves periodically as more data becomes available, and update the procedures to adjust PCI projections for individual sections based on visual inspections and maintenance and rehabilitation records.

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About the Researchers

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