Development of Performance Prediction Models for Airfield Pavements

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ABSTRACT

Data for developing performance prediction models were obtained from 12 U.S. Air Force bases located throughout the United States. The data were used to develop performance prediction models for asphalt and concrete pavements. Data were also collected at a later date from 5 of the 12 bases originally surveyed to verify all developed models. It was found that the performance models do an adequate job of predicting pavement condition but that these models may not be precise enough for project level management. The concept of local modeling, which is the development of different models for each base, was investigated and the results appear promising. Local modeling has the advantage that factors such as construction methods, maintenance policies, and environmental factors do not need to be considered; in universal modeling, these factors are probably not accounted for fully. The performance of pavements as presented herein is measured by the pavement condition index that was developed for the U.S. Air Force and recently published by the FAA as an advisory circular.

The main objective of the prediction models is to forecast the condition of the pavement given different traffic, age, and environmental factors. Such models would help greatly in deciding what maintenance and repair (M&R) alternative to recommend for a specific pavement section (feature). The models should be capable of forecasting the performance of the pavement if current local routine maintenance policies are continued, if major maintenance is applied, if overall M&R (such as overlay, recycling, or reconstruction) is applied, or if a change in traffic occurs. The models should also provide insight into variables that cause deterioration of pavements and therefore could be used to predict the performance of new pavements for a variety of designs. To measure and predict the performance of a pavement, a repeatable condition rating system must be used.

MEASURING PAVEMENT PERFORMANCE

The performance of a pavement, as presented herein, is measured by the pavement condition index (PCI), which indicates the present condition of the pavement in terms of structural integrity and surface operational condition. The PCI was developed for the U.S. Air Force (1) for both asphalt and concrete surfaced pavements.

The condition survey for airfield pavements consists of the following:

1. The pavement must be divided into uniform sections or "features" (based on consistent structural thickness, design, and materials) that were constructed at the same time and that serve similar traffic types (aircraft) and volumes.
2. These uniform sections are divided into "sample units" consisting of approximately 20 slabs (concrete) or 2,500 ft^2 (asphalt). To save time and money, random sampling of units is used to obtain a 95 percent confidence of the true PCI of the entire uniform section or feature.
3. Each pavement feature is then inspected, and existing distress types, severity levels, and densities are recorded. See Shahin et al. (2) for a list of the guidelines required for performing this inspection.
4. A deduct value is determined from the appropriate curve for each distress type, density, and severity level.
5. The total deduct value (TDV) is determined by summing all deduct values from each distress condition observed.
6. The corrected deduct value (CDV) is determined based on the TDV and the number of distress conditions observed with individual deduct values greater than five points.
7. The pavement condition index (PCI) is calculated as PCI + 100 - CDV.

The PCI allows the engineer to objectively set priorities for maintenance and repair for a given feature and to rationally compare the condition of pavements from base to base. The PCI has been recently published by FAA as an advisory circular (3).

DATA COLLECTION

Airfield pavement data were obtained from 12 Air Force bases throughout the United States. A complete historical set of information about each pavement feature included feature identification; pavement layer information, including all overlays; joint design for concrete pavements; foundation soils; traffic for each mission (type, annual operations); past maintenance; current PCI and distress; and climatic variables (precipitation, temperature) and other geographic variables.

Air Force bases having both asphalt and concrete pavements were selected over a range of climates and traffic. An average of 27 features was obtained from each base, for a total of 327 features. These features are divided into pavement types and uses as follows:

Pavement Type	Feature (%)
PCC	60
PCC over PCC	1
PCC over AC	1
AC	10
AC over PCC	9
AC over AC	18
Other (e.g., AC sandwich construction)	1
Total	100

Use	Feature (%)
Runway	35
Taxiway	46
Apron	19
Total	100

The data for these features were obtained from (a) Air Force pavement evaluation reports, (b) construction records in the base engineering office and other historical records, and (c) current traffic records and the recollections of employees about past traffic missions. The traffic data were difficult to obtain, but even subjective estimates were considered better than no data at all.

All pavement features were surveyed using the PCI method, and existing distresses were recorded on the data collection sheets. Tables 1 and 2 give summaries of the means and ranges of some key variables. The predictive models are based on the collected data and are therefore limited by the ranges of the variables included in the data bank. The data represent a broad range of pavements constructed by the Air Force during the past 30 years.

TABLE 1 Means and Ranges of Key Rigid Pavement Variables

Variable	Mean Value	Range
Layer information variables		
Age (yr)	18.0	2-37
PCC thickness (in.)	15.3	2-24
Modulus of rupture (lb/in^2)	701	480-992
Base thickness[a] (in.)	12.7	2-55
Modulus of subgrade reaction (K)[b] lb/in^3	240	15-500
Environmental variables		
Average annual temperature (°F)	60.0	38.8-65.8
Average annual precipitation (in.)	29.7	3.8-52.1
Freezing index (degree days)	127.4	0-1,980
Freeze-thaw cycles (2-in. depth)	25.8	0-111
Water table (ft)	100	4-500
Mechanistic variables		
Fatigue	68,430	315-612,654
Damage	425.86	0-26,420

[a] Mean value does not include those features with no base course; 68 features had no base course.
[b] K-value on top of layer on which PCC surface rests.

DATA ANALYSIS

In addition to the collected field data, a number of mechanistic variables were also computed. Following is a description of these variables for both rigid [portland cement concrete (PCC) and asphalt concrete (AC)/PCC] and flexible (AC and AC/AC) pavements.

Rigid (PCC and AC/PCC) Pavements

The maximum free edge stress at the bottom of the concrete slab was selected as the main response parameter for rigid pavement analyses. Charts for 41 different aircraft were prepared to compute the edge stress as a function of slab thickness and of the modulus of subgrade reaction using the H51 program (4). The program models the PCC pavement structure as a rigid slab resting on an elastic (Winkler-type) foundation. A constant E-modulus of 4 million lb/in^2 and a Poisson's ratio of 0.15 were assumed for the PCC slab.

Figure 1 shows how the maximum free edge stress varies with slab thickness and subgrade support for the B-29 aircraft. The figure also shows the relative orientation of the main gear with respect to the free edge. In all computations, a circular tire imprint was assumed.

Two variables, computed using the edge stress, that were found to correlate with pavement perfor-

TABLE 2 Means and Ranges of Key Flexible Pavement Variables

Variable	Mean Value	Range
Layer information variables		
Age (yr)	10.58	0-27
Original AC thickness (in.)	3.80	2.0-7.0
Total AC thickness (in.)	5.85	2.0-14.0
Base CBR[a] (%)	85.13	20-100
Total select thickness (in.)	30.62	0.0-67.0
Subgrade CBR (%)	17.80	6-88
Environmental variables		
Average annual temperature (°F)	54.2	38.0-65.8
Average annual temperature range (°F)	45.2	31.6-54.2
Average daily temperature range (°F)	23.4	19.1-28.5
Average annual precipitation (in.)	26.2	3.8-52.1
Average annual solar radiation (langleys)	407	325-520
Freezing index (degree days)	491	0-1,980
Freeze-thaw cycles (2-in. depth)	26.5	0-99
Water table (ft)	100	4-500
Mechanistic variables		
Weighted average surface deflection—present period (in./ESWL)	0.001	0-0.005
Weighted average surface deflection[b]—first previous period (in./ESWL)	0.001	0-0.002
Weighted average vertical stress on base—present period (PS)	86.2	0-175
Weighted average vertical stress on base[a]—first previous period[b]	59.7	0-203
Cumulative vertical stress on base—present period (lb/in^2 x no. of passes)	1.039 x 10	0-1.414 x 10
Cumulative vertical stress on base—first previous period[b]	6.841 x 10	0-1.163 x 10
Cumulative vertical strain on subgrade—present period (0.001 in. x no. of passes)	6.067 x 10	0-8.881 x 10
Cumulative vertical stress on subgrade—first previous period[b] (0.0001 in. x no. of passes)	4.771 x 10	0-1.274 x 10

[a] Mean value does not include features with no base (four features have no base).
[b] A period is defined by the age of the surface or overlay. If no overlay exists and therefore there is no previous period, the value for this variable for that particular feature is recorded as 0. These features are included in the calculation of the mean value.

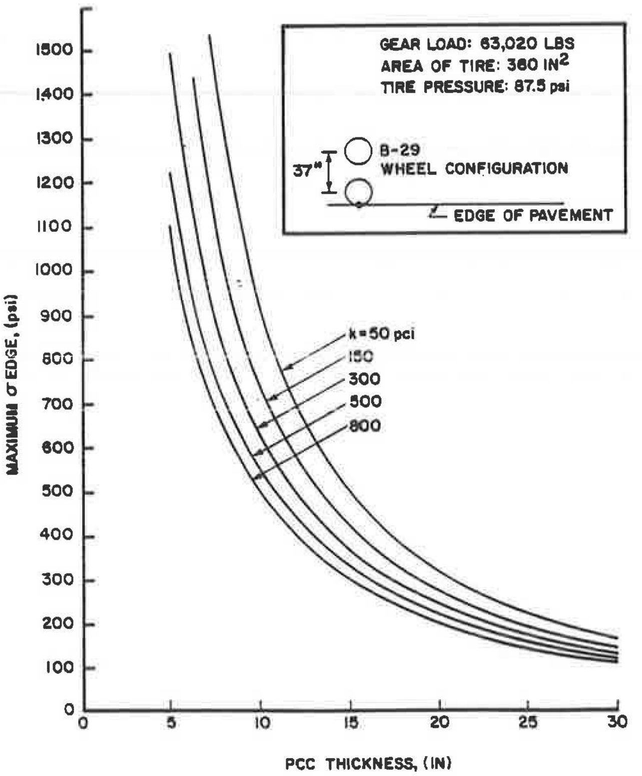

FIGURE 1 Edge stress at bottom of concrete slab as a function of slab thickness and modulus of subgrade reaction for a B-29 aircraft.

mance and pavement distress are FATAGE, a fatigue variable, and DAMAGE, which reflects a preestablished relationship between fatigue and cracking. The variables were computed as follows:

$$\mathrm{FATAGE} = \sum_{i=1}^{a} [(0.75 \times \sigma_{e_i})/\mathrm{MR}] \times n_i \times \mathrm{AGE}$$

$$\mathrm{DAMAGE} = \sum_{i=1}^{a} (n_i/N_i) \times \mathrm{AGE}$$

where

a = number of different aircraft using the feature;
AGE = time (years since original construction or, if overlaid, time since overlay construction);
σ_{e_i} = edge stress caused by aircraft i as computed by H51 computer program (lb/in.^{2});
MR = modulus of rupture of concrete (lb/in.^{2});
n_i = total number of passes per year (not coverages) of aircraft i over pavement feature; and
N_i = number of repetitions of aircraft i to cause failure of concrete $= 10^{(17.61 - 0.01761 \times \sigma_{e_i})}$.

Note that if the edge stress < 500, n/N is assumed to be negligible. If $(17.61 - 0.01761 \times \sigma_e) < 0$, N is assumed to be equal to 1.

For asphalt overlaid concrete (AC/PCC) pavements, a transformed section analysis for stress determination was used to convert asphalt thickness to an equivalent concrete thickness (5). The FATAGE and DAMAGE variables were then computed as described earlier.

Flexible (AC and AC/AC) Pavements

The analysis of flexible pavements was based on linear elastic-layered theory using the BISAR computer program (6). The AC elastic modulus was estimated for each feature based on thickness of AC layer, mean annual temperature, and mean annual solar radiation. The elastic modulus for granular bases was estimated based on type of aircraft, thickness of AC layer, and elastic modulus of the AC layer. The developed procedures for estimating the AC and granular moduli are presented by Shahin et al. (7). Four response parameters were computed: (a) the maximum surface deflection, (b) the vertical stress at the top of the base layer, (c) the radial strain at the bottom of the AC layer, and (d) the vertical strain at the top of the subgrade. Response parameter computations were carried out using the BISAR computer program.

The data were also analyzed to compare the average life of asphalt pavements with and without overlay. It was found that, for those pavements that were overlaid with AC at least once, the average original asphalt surface had a life of 15.7 yr; an asphalt pavement that had been overlaid once had a life of 9.72 yr before being overlaid for the second time, and the life of an asphalt pavement that had been overlaid twice had an average of 7 yr. This general trend (Figure 2) suggests that, on the average, an asphalt surface layer will not last as long as the underlying layer. The reason may be that asphalt overlays were underdesigned or that the damage to a previous layer was not properly accounted for, causing the newer asphalt surface to fail earlier than expected.

MODEL DEVELOPMENT

The first step of model development was the establishment of correlation matrices between variables. Scattergrams were used to determine ranges and general trends of the variables. Various variable transformations and interactions were also investigated. The second step was to perform a stepwise regression analysis for the model development.

The stepwide regression analysis procedure starts with the simple correlation matrix between the dependent variable and each independent variable. It enters into regression the independent variables most highly correlated with the dependent variable. Using partial correlation coefficients, it then selects the next variable to enter regression (i.e., the variable whose partial correlation is highest with the dependent variable). At every step, the program reexamines the variables included in the equation in previous steps by testing each variable at each stage as if it were the last to enter and by checking its contribution by means of the partial F-test. Thus, some variables may be removed from the

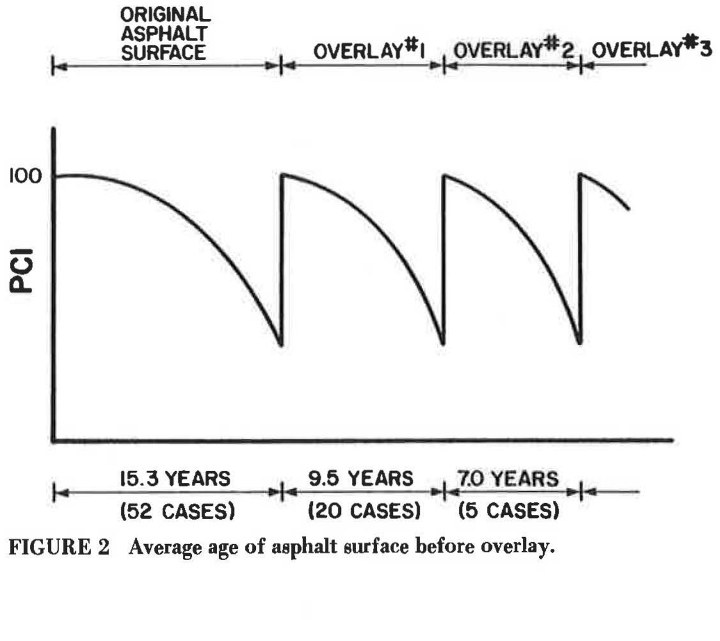

FIGURE 2 Average age of asphalt surface before overlay.

equation after they have been entered. After many attempts, the best linear regression model was selected on combined statistical and engineering criteria. A nonlinear regression analysis was then performed using the same variables that were used in the linear model in order to improve the prediction parameters. The SPSS statistical package (8) was used in all phases of model development. The two models presented herein are for PCI prediction of rigid and flexible pavement, respectively.

Rigid Pavement PCI Model

A model was developed for predicting the PCI for both PCC pavements and PCC pavements overlaid with asphalt. Initially, a separate model for AC/PCC pavements was considered, but the limited number of cases (only 25) for this pavement type made this impractical. Using a transformed section analysis for stress determination (5), the AC/PCC pavement features were combined with the PCC pavement features, and a PCC prediction model was developed to include both.

Data for developing the PCI prediction model were collected for 162 pavement features, 137 PCC pavements and 25 PCC pavements overlaid with asphalt. Table 3 gives some of the pertinent statistical data.

TABLE 3 Statistics for Pertinent Rigid Pavement Variables

Variable	Average Value	Standard Deviation	Low Value	High Value
No Overlays (19 cases)				
PCI	76.652	14.740	24	98
PCC THICK	15.625	3.858	6	24
AGE	17.978	7.353	2	37
MR	702.023	65.920	480	992
K-VALUE	239.606	116.162	15	500
PASSES/YR	17001.250	19804.793	0	75000
FATAGE	75716.871	120166.366	0	612654
DAMAGE	449.761	2773.442	0	26420
One AC Overlay (6 cases)				
PCI	66.520	16.187	17	87
PCC THICK	7.360	1.229	6	12
AC THICK	3.920	2.494	1.5	8
AGE	15.680	6.644	6	24
AGECOL	16.200	6.696	7	30
MR	554.167	237.860	450	900
K-VALUE	244.333	81.520	100	350
PASSES/YR	9780.000	12665.100	255	48150
FATAGE	151746.600	176564.628	3149	658325
DAMAGE	47880.252	77662.703	0	251360
DAMCOL	77998.633	160064.248	0	568460

The final model for PCI prediction was obtained as follows:

$$
\begin{aligned}
\mathrm{PCI} = 99.503 &- 2.4837 \times \mathrm{AGE}^{0.55857} \times \mathrm{LDAMAGE}^{0.6} \\
&- 0.00020334 \times \mathrm{AGE}^{0.5} \times \mathrm{FATAGE}^{0.74987} \\
&- 0.0028494 \times \mathrm{AGE}^{1.0} \times \mathrm{AAPREC}^{1.2188} \\
&- 0.028872 \times \mathrm{AGE}^{1.7366} \times \mathrm{FTC} \\
&- 0.076824 \left[(\mathrm{AGE}^{5}\ \mathrm{AGECOL}^{0.76544}\ \mathrm{LDAMCOL}^{1.0}) \right. \\
&\quad \left. \div \mathrm{THICK}^{1.6035} \right]
\end{aligned}
$$

$R^2 = 0.72155$

$\overline{\sigma} = 8.77083$ (standard error of estimate)

where

AAPREC = average annual precipitation (in.);

FTC = a freeze-thaw cycle discrete variable that is 1 if the number of freeze-thaw cycles in a PCC pavement at a 2-in. depth is greater than or equal to 10 and 0 if the number of freeze-thaw cycles in a PCC pavement at a 2-in. depth is less than 10 or if the existing surface is an asphalt overlay;

THICK = thickness of concrete pavement or, if overlaid, the most recent overlay thickness;

LDAMAGE = $\log_{10}$ (DAMAGE + 10);

LDAMCOL = $\log_{10}$ (DAMCOL + 10); and

DAMCOL = cumulative damage before last overlay.

The other variables in the PCI equation are defined as follows:

PCI = pavement condition index;

PCC THICK = thickness (in.) of the original PCC surface;

AC THICK = thickness (in.) of the most recent AC overlay;

AGECOL = age of the PCC slab, in years, at the time it is overlaid; if no overlay exists, AGECOL is zero;

MR = modulus of rupture (lb/in.^{2}) of the PCC slab;

K-VALUE = modulus of subgrade reaction (lb/in.^{3}); reading is taken on the surface immediately below the PCC surface;

PASSES/YR = reported annual traffic; this number represents the average number of passes per year the pavement services for the combined total of all aircraft types;

FATAGE = a mechanistic input variable used in the PCI prediction model; it represents the total critical stresses to which the pavement has been subjected;

DAMAGE = a mechanistic input variable used in the PCI prediction equation; using a given procedure, it determines the number of passes each aircraft can make over a given feature before structural damage occurs; the variable DAMAGE records how many times this number has been reached; and

DAMCOL = same as DAMAGE but records only the number before the pavement is overlaid (i.e., DAMAGE is damage since overlay or, if no overlay, since original construction and DAMCOL is damage before overlay).

Figure 3 is a scattergram of predicted versus actual PCI. The predicted values are plotted along the horizontal scale, and the actual values are plotted along the vertical scale. As the figure shows, the model is fairly good at predicting values above 65 but becomes less accurate at lower PCI values.

A sensitivity analysis was performed to evaluate the model response to changes in traffic, structure, foundation, material properties, and the environment.

Traffic and Pavement Structure

The variables DAMAGE, FATAGE, and DAMCOL are directly influenced by traffic and pavement structure. Figure 4 shows the effect of PCC thickness on the PCI. The figure shows that within the design range for each aircraft, the PCC thickness has a major impact. When a certain thickness is reached, the PCI value levels off. Because all three aircraft approach the same value for upper and lower bounds,

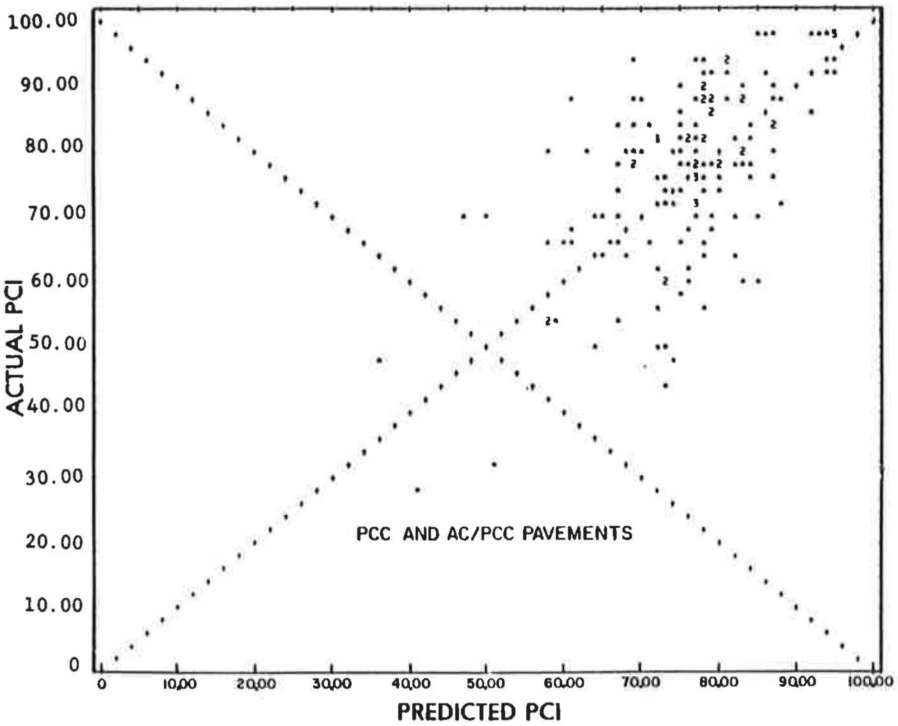

FIGURE 3 Actual PCI versus predicted PCI for PCC and AC/PCC pavements.

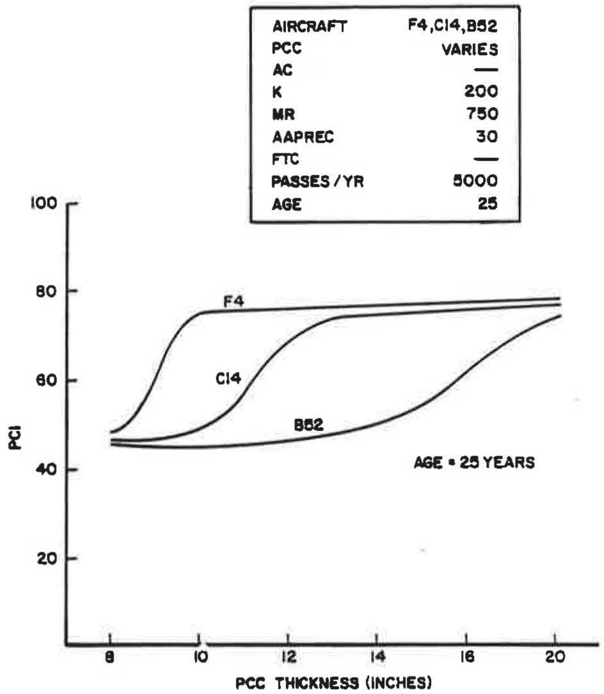

FIGURE 4 Effect of aircraft type on PCI as a function of PCC thickness.

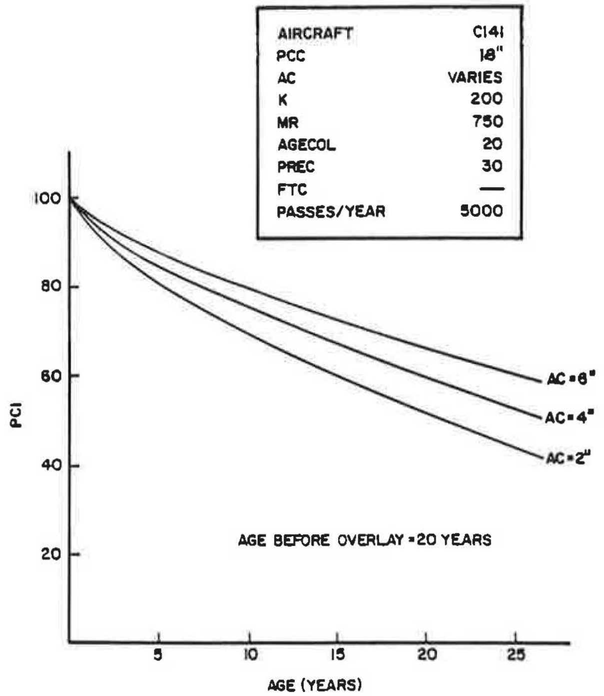

FIGURE 5 Effect of asphalt overlay thickness on PCI as a function of age.

the PCI loss at the upper level can most likely be attributed to the effects of age and environment. Figure 5 shows the effect of the AC overlay thickness for AC/PCC pavements. Figure 6 shows the possible effects of increases in the number of passes for a given pavement structure and aircraft, and Figure 7 shows the effects of different traffic types on a pavement.

Foundation

The only input that relates to the foundation is the K-value (modulus of subgrade reaction) of the layer directly beneath the concrete slab. The K-value is a measure of the layer's relative stiffness and plays an important role in determining the edge stress caused by a given pavement-aircraft combination. In

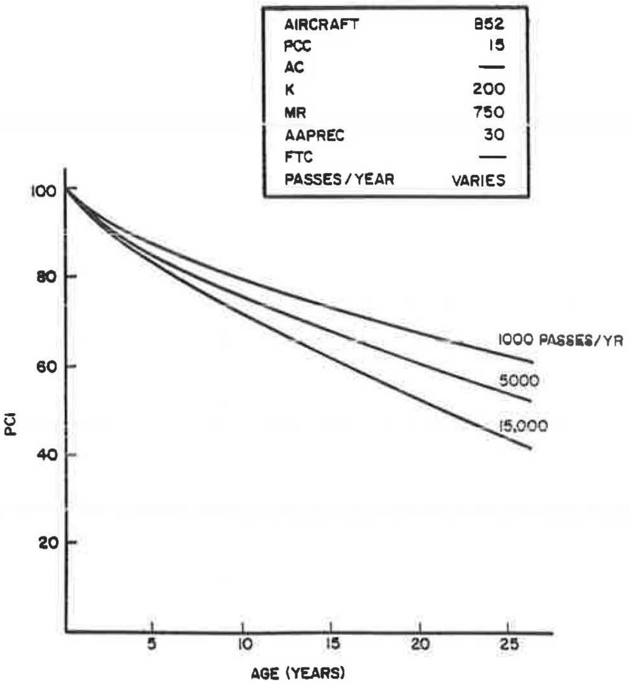

FIGURE 6 Effect of traffic volume (passes) on PCI as a function of age.

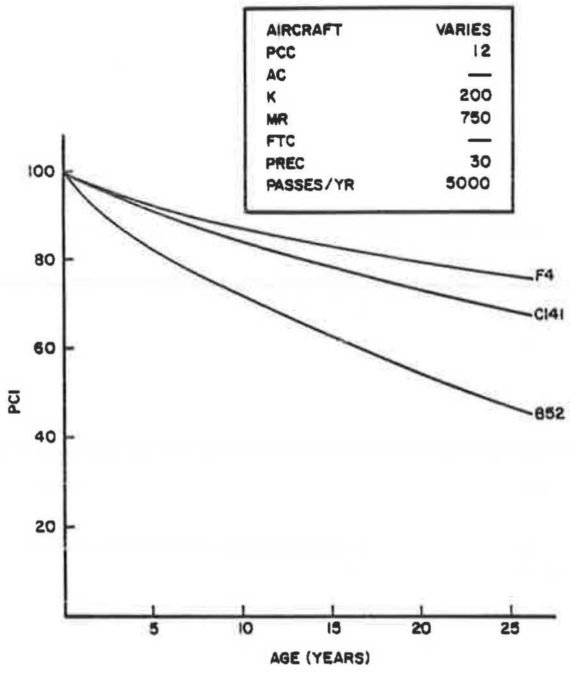

FIGURE 7 Effect of aircraft type on PCI as a function of age.

the ranges of concrete thickness where the PCI would vary if the concrete thickness were altered slightly, the K-value has a major impact. Figure 8 shows this effect. The pavement structure used in Figure 9 is well above that needed for the F-4 aircraft, and the K-value has little influence on the PCI. Figure 9 shows that if values of PCC thickness were chosen that were not at the upper or lower limits for PCI values of the B-52 and F-4 aircraft, the K-value would also show a significant effect for these aircraft.

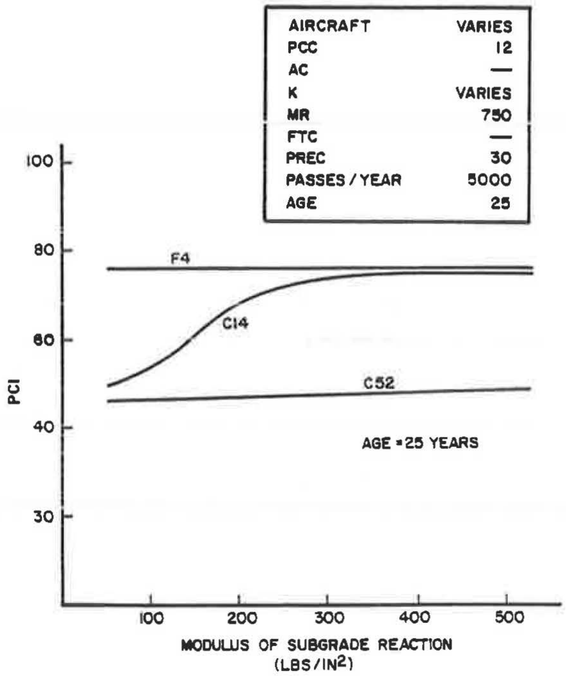

FIGURE 8 Effect of aircraft type on PCI as a function of modulus of subgrade reaction.

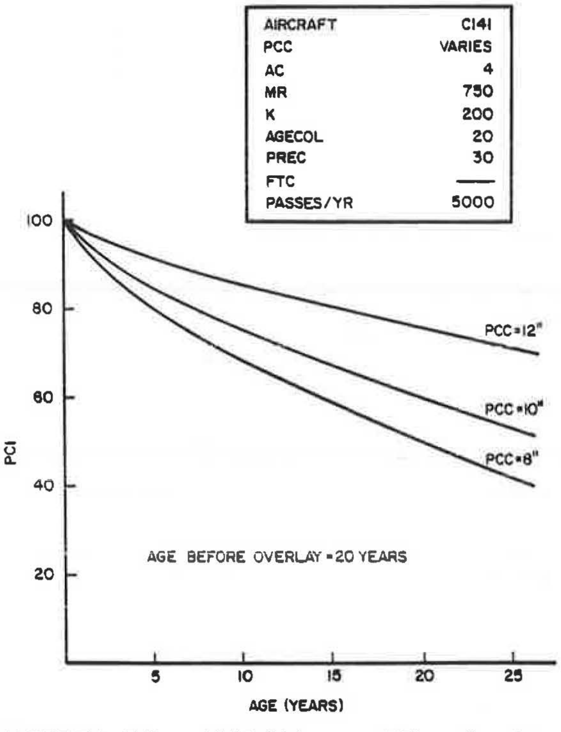

FIGURE 9 Effect of PCC thickness on PCI as a function of age.

Material Properties

The material property that influences the model is the modulus of rupture (MR) of the concrete. A sensitivity analysis shows that for MRs ranging from 500 to 900 psi, the difference in PCI at an age of 25 years was only five points. This, plus the fact that there are no other variables relating to material properties and quality of construction, shows that the model is lacking in this area.

Environment

The environmental variables are precipitation and the freeze-thaw cycle. Figure 10 shows the varying effect of these variables. The top three lines of the graph show the effects of varying amounts of rainfall with no freeze-thaw cycles. The bottom line shows the effect of freeze-thaw cycles at a rainfall of 50 in. per year.

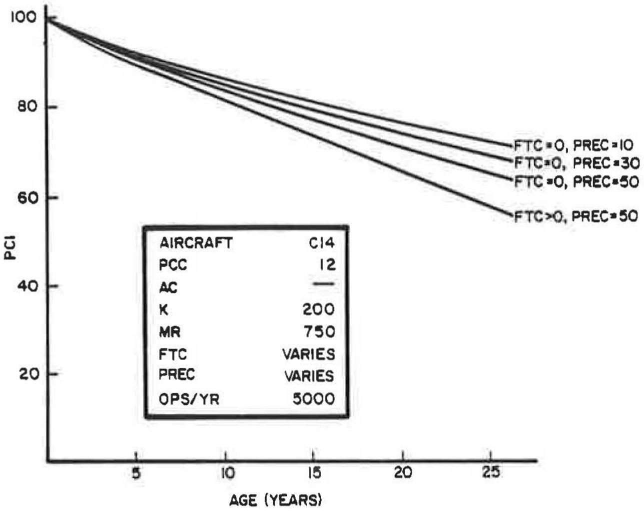

FIGURE 10 Effect of rainfall and freeze-thaw cycles on PCI as a function of age.

TABLE 4 Statistics for Pertinent Flexible Pavement Variables

Variable	Average Value	Standard Deviation	Low	High
No Overlays (26 cases)				
PCI	67.308	17.756	31	100
SURTHICK	3.808	0.708	2	5.5
PMAOPS	8371.808	14460.075	100	64200
AGE	17.077	8.727	0	27
SGCBR	13.269	8.151	6	35
BTHICK	7.135	3.719	6	24
1 Overlay (26 cases)				
PCI	72.615	12.989	39	100
SURTHICK	3.731	0.962	2	7
OL1THICK	1.942	1.061	1	6
AGE	7.115	4.625	0	26
AGECOL	17.038	5.524	6	27
2 Overlays (12 cases)				
PCI	77.667	12.886	46	99
SURTHICK	4.167	1.642	2	7
OL1THICK	2.517	1.329	1	5
OL2THICK	1.833	0.718	1.5	4
AGE	6.667	3.229	1	11
AGECOL	10.750	5.610	4	25
3 Overlays (5 cases)				
PCI	81.200	9.834	67	92
SURTHICK	3.200	1.643	2	5
OL1THICK	3.600	1.517	2	5
OL2THICK	1.660	0.144	1.3	2
OL3THICK	1.900	0.652	1.5	3
AGE	7.200	4.604	2	12
AGECOL	7.000	2.121	4	9

Flexible Pavement PCI Model Presentation

A model for predicting the PCI for AC and AC/AC pavements was developed. Data were collected from 69 asphalt pavement features, 26 nonoverlaid pavements and 43 features with one or more asphalt overlays. Table 4 gives statistical data on these features. In Table 4

PCI = pavement condition index;
SURTHICK = thickness of original asphalt pavement (in.);
PMAOPS = present mission annual operations in passes per year;
SGCBR = subgrade California bearing ratio percent;
BTHICK = base thickness (in.);
OL1THICK = thickness (in.) of the first asphalt overlay;
AGE = age, in years, since original construction or, if overlaid, since the most recent overlay construction (see Figure 11);
AGECOL = age, in years, from the second most previous overlay, or construction date, to the most recent overlay; if no overlay exists, AGECOL=0 (see Figure 11);
OL2THICK = thickness (in.) of the second asphalt overlay; and
OL3THICK = thickness (in.) of the third asphalt overlay.

The developed model was as follows:

$$\text{PCI} = 99.824036 - 9.214053 \text{ x AGE}^{0.38719987} \text{ x ADSUR}^{0.1} \text{ x AVSUR}^{0.19120227} - 1.0144967\text{E-05 x AGE}^{1.7160520} \text{ x VCOL}^{0.59024368}$$

$R^2 = 0.83389$

$\overline{\sigma} = 7.19736$ (standard error of estimate)

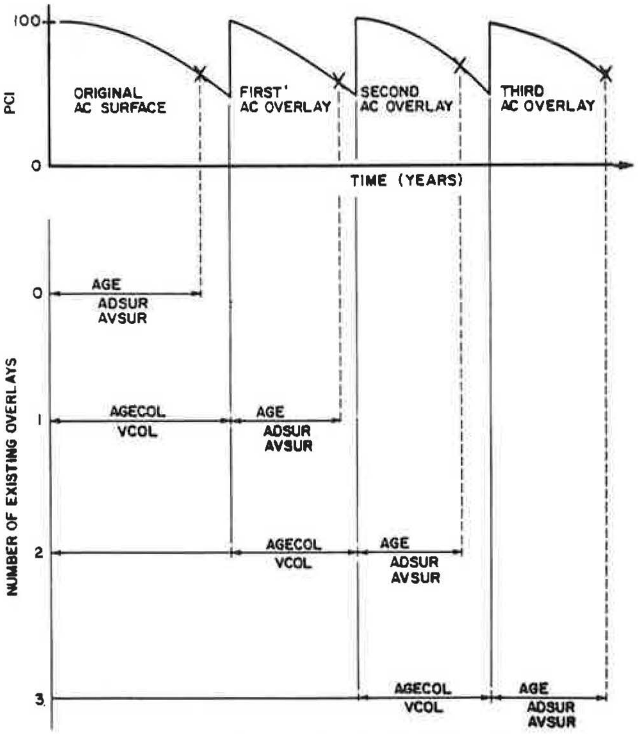

FIGURE 11 Time variables associated with PCI prediction variables.

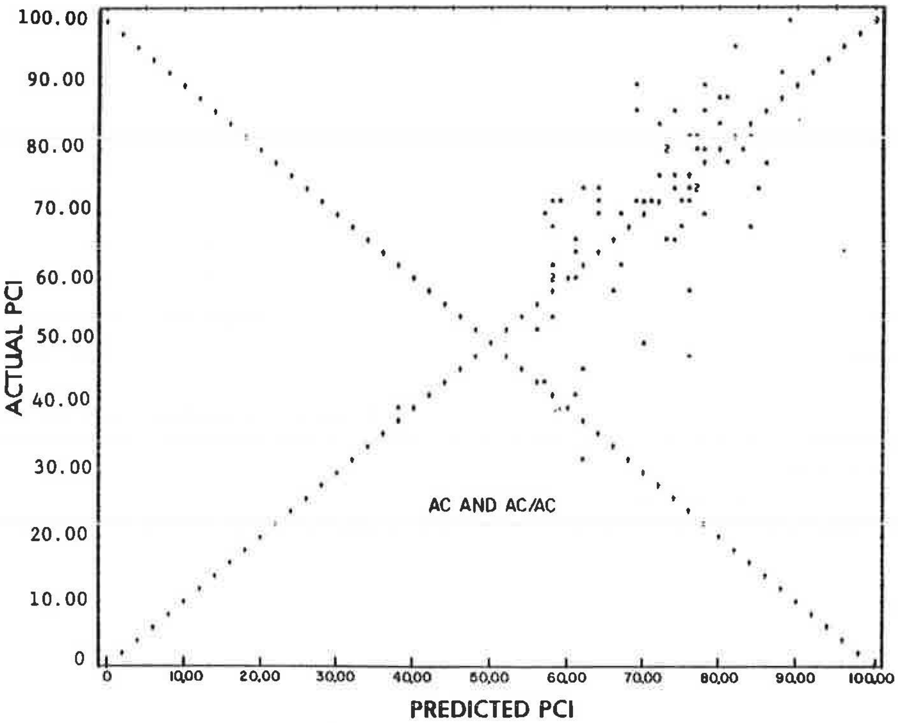

FIGURE 12 Actual PCI versus predicted PCI for AC and AC/AC pavements.

where

ADSUR = function of the weighted average surface deflection divided by the equivalent single-wheel load;
AVSUR = weighted average vertical stress on the base course (layer of material directly beneath the lowest asphalt layer); and
VCOL = cumulative amount of vertical stress on top of the base course before pavement was overlaid; if not overlaid, VCOL = 0; Figure 11 shows COL variables and the time periods they represent.

Figure 12 is a scattergram of the predicted PCI versus the actual PCI. Above the value of about 50, the model does remarkably well in predicting PCI. Below 50, the model tends to predict PCIs a little higher than they actually are, but overall the figure is very encouraging.

Sensitivity analyses were performed on the developed model to observe how pavement structure and foundation and environmental factors affect the PCI. Figure 13 shows the influence of asphalt thickness on the PCI. Figures 14 and 15 show the influence of age before overlay (AGECOL) and number of traffic passes, respectively.

The environmental effects are included in the model in terms of average daily temperature and solar radiation, both of which are inputs for determining the E-modulus for asphalt. The model contains no direct environmental variables.

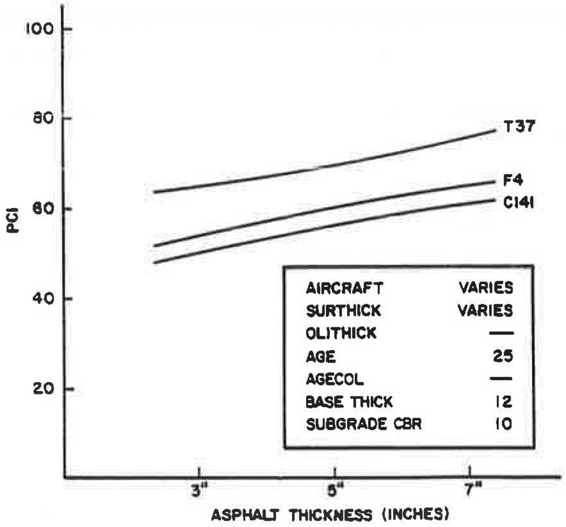

FIGURE 13 Effect of aircraft type on PCI as a function of asphalt thickness (age = 25 years).

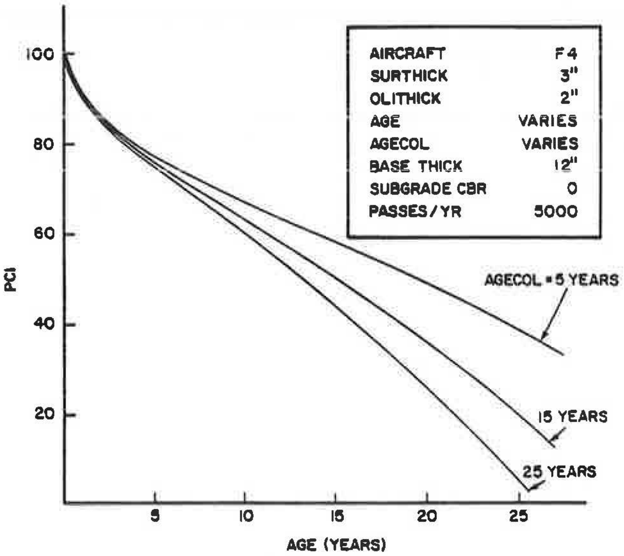

FIGURE 14 Effect of AGECOL on PCI as a function of age.

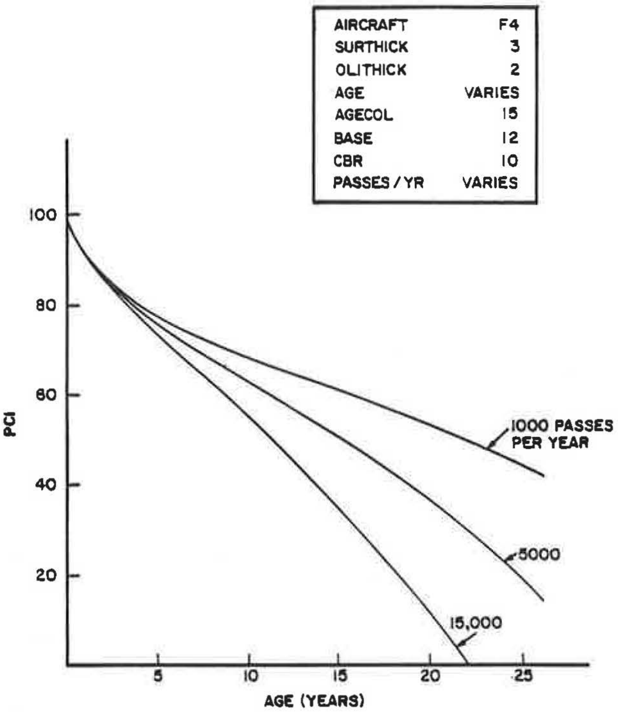

FIGURE 15 Effect of traffic volume on PCI as a function of age.

INTRODUCTION TO LOCAL MODELING

On the basis of the data analysis and model development, it became apparent that with a wide range of climatic, soil, traffic, and other variables the development of a precise universal prediction model (one model developed using data from numerous bases) is a difficult if not impossible task. A solution to this problem was found in developing prediction models for each base. The local models were developed using the same independent variables used in the universal (12-base) model with the exception of climatic variables. Table 5 gives a summary of the comparison of PCI prediction statistics for two of the Air Force bases using both the universal and localized models. The comparison shows that localized models give better predictions than universal models.

TABLE 5 Statistics for the Rigid and Flexible PCI Models Developed Using Localized Modeling

	Model Developed with Data from 12 Bases			Model Developed with Data from 1 Base		
	R^2	Standard Deviation	No. Cases	R^2	Standard Deviation	No. Cases
Universal model (12 bases)	0.721	8.73	322			
Dover AFB	0.638	8.58	32	0.749	7.67	32
Robins AFB	0.831	5.86	56	0.917	4.19	56

Traffic is suspected to be a large factor behind the improvement of localized models over universal models. In gathering traffic information from each Air Force base, percentages and approximate volumes of aircraft that use each pavement feature were gathered. The percentage breakdown of aircraft traffic is probably more accurate than the approximate volume of traffic, thus the traffic volume is not a good predictor when considering more than one base.

Another reason for favoring localized modeling is that, for a given base, construction methods, maintenance procedures and policies, environmental factors, and drainage conditions are relatively uniform. In the universal models developed, these differences were probably not accounted for fully.

The concept of local modeling appears to be promising and is currently being further developed.

CONCLUSIONS AND RECOMMENDATIONS

Extensive data were collected from 327 airfield pavement features at 12 U.S. Air Force bases. The data, which provided a wide range of information on designs, materials, traffic, and climate, were used to develop PCI and key distress prediction models for both rigid and flexible pavements. Only the PCI models are presented in this paper.

Evaluation of these models showed that predictions for some of the bases were much better than for others, possibly because climatic factors and traffic conditions in certain bases were not well represented in the overall model. Thus, it was concluded that localized modeling could provide much more accurate predictions. Furthermore, the concept of localized modeling offers the extra advantage of being able to update the models as more condition surveys are performed at a given base.

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Publication of this paper sponsored by Committee on Pavement Maintenance.