NDT GUIDELINES FOR MATERIALS CHARACTERIZATION OF IN-SERVICE RIGID PAVEMENTS

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Abstract

This paper presents the derivation of expressions for computing the number of deflection measurements required for materials characterization of in-service rigid pavements. Both a normal and a Student's t distribution are considered in the analysis and comparisons are made between estimates resulting from both approaches. Guidelines are provided for estimating the number of deflection measurements for rigid pavements based on the findings stemming from this study. Likewise, figures are presented as an alternate method for determining deflection sample size.

Deflections measured near the pavement edge are influenced by the temperature gradient in a concrete slab. This paper also presents a method that predicts temperatures in the concrete slab in order to apply a suitable temperature correction.

Introduction

Nondestructive testing (NDT) methods have become very popular in the assessment of pavement rehabilitation needs and the design of overlays, and many overlay-design procedures are based, to a large extent, on deflections taken on the existing pavement. The size of the sample of pavement deflections has generally been estimated through expressions that assume a normal distribution for the deflection population and require estimates of the mean and variance and the selection of an allowable error and a confidence level. However, estimates do not account for the fact that for most overlay-design sections, the population size is a finite number, requiring the application of a multiplier to estimate the sample size required for a given set of conditions.

The purpose of this paper is to provide pavement-design engineers with expressions for computing the number of deflection measurements required for rigid-pavement materials characterization purposes. Estimates are based, among other factors, on the design-section length for both continuously reinforced concrete pavements (CRCP) and jointed concrete pavements (JCP). Design sections are commonly selected on the basis of stratified variation of deflection data, which may or may not be available from previous measurements. Deflection at the sensor 1 location is the parameter used to estimate the required number of deflection measurements. Guidelines are provided for Dynaflect measurements; however, the proposed expressions can also be used to estimate the deflection sample size for other NDT devices, such as the falling weight deflectometer (FWD).

A computer program, PTEMP, has been developed to estimate temperatures within a concrete slab. An example of the application of temperature correction to edge deflections is also presented here.

Computation of Deflection Sample Size

In this section, first, mathematical equations are developed to permit the user to estimate the sample size required to adequately characterize the deflection profile of a section of highway. This is followed by a brief discussion of these equations.

Development of Expressions

Several attempts have been made in the past to estimate the size of the sample of pavement deflections under the assumption that deflection measurements are normally distributed. Generally, if the value of σ (universe standard deviation) is known, a level of confidence is specified, and the allowable error (e) in estimating μ (universe mean) is given ,then a confidence interval of μ can be produced by selecting a sample of the correct size (1).

The formal expression to determine the required sample size is written as

$$n_r = \left[\frac{Z_\alpha \sigma}{e} \right]^2 \tag{1}$$

where

n_r = required sample size

Z_α = abscissa of the normal curve that cuts off an area (level of significance α), at the tails, and

e = allowable error.

The unbiased estimate of the universe standard deviation, and is obtained from a representative sample by

$$\hat{\sigma} = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n-1}} \qquad (2)$$

where

$\hat{\sigma}$ = unbiased estimate of the universe standard deviation,

X_i = value of the sample's i^{th} observation,

n = sample size, and

$\overline{X}$ = sample mean.

Since $\hat{\sigma}$ is the parameter commonly available, a Student's t distribution should be used according to statistical theory. Thus, Eq 1 can be modified as follows:

$$n_r = \left[\frac{t_\alpha \hat{\sigma}}{e}\right]^2 \qquad (3)$$

where

t_α = t-value corresponding to a certain combination of level of significance, α, and number of degrees of freedom.

Number of degrees of freedom (d.f.) is defined as the sample size minus one (n_r - 1).

Equation 1 is generally used to compute the number of deflections required for a particular pavement section if $\hat{\sigma}$ is considered instead of the universe standard deviation for samples with a large number of deflection measurements. Equation 3 is very seldom used because t_α is a function of the sample size, which is what must be determined. Thus an iterative process needs to be followed until the value of t_α that is input is equal to that corresponding to the final sample size minus one (n_r - 1).

However, either Eq 1 or Eq 3 provides an estimate of the required sample size for a given section, disregarding its length. Hence, in general, for sections with similar standard deviations, allowable errors, and Z_α (or t_α) values, basically the same number of required deflections is obtained for both a short section and a considerably longer section (Figure 3). This serious incongruity can be surmounted by considering the fact that for characterization of materials in rigid pavements the universe or population of deflections is a finite number for a given design section, which makes necessary the application of a finite multiplier, namely,

$$\frac{N - n_r}{N - 1} \qquad (4)$$

where

N = population size

n_r as previously defined

Deflections for materials characterization purposes are generally taken at a midslab position to minimize the effect of discontinuities and temperature on recorded deflections. For practical purposes, only one measurement is required between successive discontinuities in the longitudinal direction along a certain lane and within a selected pavement design section. An interior loading position should be approximated in the field in order to use elastic layered theory to back-calculate the pavement layer stiffnesses.

N can be computed by means of Eq 5 for both CRC and JC pavements.

$$N = \frac{L}{\overline{S}} \qquad (5)$$

where

L = pavement section length, feet, and

$\overline{S}$ = average spacing between successive discontinuities in the longitudinal direction, feet.

$\overline{S}$ can be determined from condition survey information. In the case of continuously reinforced concrete pavements, the average crack spacing should be used, whereas for jointed pavements the average joint spacing should be used.

It must be pointed out that it is assumed that sample size is to be computed after pavement design sections are established. The common procedure followed for selecting design sections is to plot previous deflection measurements to scale as a function of distance; the roadway can then be divided into sections based on stratified variation of deflection data. Sections are selected subjectively, according to the plotted profile of the deflection parameters. The reader should consult References 2 and 3 for a more detailed explanation about the selection of design sections.

If σ is unknown, the estimated standard error of the mean of a finite universe is computed by

$$\hat{\sigma}_{\bar{x}} = \frac{\hat{\sigma}}{\sqrt{n_r}} \sqrt{\frac{N - n_r}{N - 1}} \quad (6)$$

where

$\hat{\sigma}_{\bar{x}}$ = estimated standard error of the mean, and all other terms are as previously defined.

Now, a new expression to determine the required number of Dynaflect deflections can be derived.

Let the allowable error, e, be equal to

$$e = \bar{x} - \mu \quad (7)$$

where all terms are as previously defined.

e can also be expressed as

$$e = t_{\alpha} \frac{\hat{\sigma}}{\sqrt{n_r}} \sqrt{\frac{N - n_r}{N - 1}}$$

or

$$e = t_{\alpha} \hat{\sigma} \sqrt{\frac{N}{n_r (N-1)} - \frac{1}{N - 1}} \quad (8)$$

Solving for n_r, after some algebraic simplifications,

$$n_r = \frac{N t_{\alpha}^2 \hat{\sigma}^2}{(N-1) e^2 + t_{\alpha}^2 \hat{\sigma}^2} \quad (9)$$

By dividing both the numerator and the denominator of the right-hand side of Eq 9 by $t_{\alpha}^2 \hat{\sigma}^2$, the following alternate equation is obtained:

$$n_r = \frac{N}{\frac{(N-1) e^2}{t_{\alpha}^2 \hat{\sigma}^2} + 1} \quad (10)$$

In Reference 2, slab thickness variation was correlated with sensor 1 mean deflection. Furthermore, since allowable error is often expressed as a percent of sensor 1 mean deflection, it was found that an allowable error of 5 percent in the sensor 1 mean deflection resulted in a ± 0.5-inch variation in thickness. This variation can be expressed as a percent of the sensor 1 mean deflection (Table 2).

Computations were made to find the required number of deflection measurements for various combinations of values of $\hat{\sigma}$, e, and N, and for two different confidence levels (90 and 95 percent). Figures 1 and 2 show these results. Both the x and y axes were deformed so that the wide range of values corresponding to N and n_r could be accommodated. Deflection sample sizes shown in these figures were first arranged as in Table 1.

The confidence interval was defined as

$$\mu \leq \bar{x} + t_{\alpha} \hat{\sigma}_{\bar{x}} \quad (11)$$

Hence, one-tail hypothesis tests were used to determine sample size, for which the major concern was to be able to state at a given confidence level that μ was less than or equal to the upper limit of the interval corresponding to that confidence level.

Likewise, the required deflection sample size can also be computed using a normal distribution approach. Assuming that σ is equal to $\hat{\sigma}$, Eq 10 can be modified as follows:

$$n_r = \frac{N}{\frac{(N-1) e^2}{Z_{\alpha}^2 \hat{\sigma}^2} + 1} \quad (12)$$

The above equation has an advantage over the Student's t distribution approach in that Z_{α} is solely dependent on the particular confidence level selected, while t_{α} is obtained for a given combination of confidence level and number of degrees of freedom.

In order to determine n_r when employing the Student's t distribution approach, an iterative procedure was followed because number of degrees of freedom is equal to sample size minus one (n_r - 1) and n_r is unknown at the outset of the analysis. First, a value of t was assumed in Eq 10 to obtain an initial n_r; the t_{α} corresponding to the initial n_r was input into the same equation to compute a second n_r, and this process was repeated until the number of degrees of freedom plus one (d.f. + 1) was approximately equal to the resulting n_r. It is important to mention that n_r was rounded up to the next integer because sample size for deflection measurements is always an integer number.

Table 1 presents a comparison between the deflection sample sizes obtained from the Student's t and normal distributions for various combinations of $\hat{\sigma}$ and e, a 95 percent confidence level, and a population size of 500.

Generally, the size of the population is sufficiently large so that the difference between N and N-1 is negligible. Hence, the finite multiplier can be modified:

$$\frac{N - n_r}{N-1} \cong \frac{N - n_r}{N}$$

Finally, a less complicated version of Eq 12 is obtained:

$$n_r = \frac{1}{\left[\frac{e}{Z_{\alpha} \hat{\sigma}}\right]^2 + \frac{1}{N}} \quad (13)$$

Values for Z_α depending on the selected confidence level are provided in Table 3. In some instances a required sample size of less than two measurements can be obtained; however, a minimum value of two should always be used.

If no previous deflection information about a particular pavement section is available, its required number of deflections could be estimated as the testing is conducted by continuously computing $\hat{\sigma}$ and $\bar{x}$ corresponding to the sensor 1 deflection. This should be done for every additional deflection until both $\hat{\sigma}$ and $\bar{x}$ remained reasonably constant. The process described above could be made very simple by connecting a microcomputer to the device in which the deflections are permanently recorded. Likewise, if this improvement were made, either Eq 12 or 13 could be easily included in a computer program to calculate the required number of deflection measurements.

Although this study is primarily focused on the estimation of the sample size of Dynaflect deflections, equations presented herein could also be applied to deflections obtained from other nondestructive testing devices, such as the falling weight deflectometer.

Discussion of Results

Expressions to estimate the number of deflection measurements required for materials characterization of in-service rigid pavements, in which a finite deflection population has been considered, have been derived. Figure 3 shows the estimated sample size for both an infinite and a finite deflection population at different section lengths for a CRCP with an average crack spacing of 5 feet, and a particular combination of allowable error and sensor 1 standard deviation. It can be observed that for short-length sections, the assumption of an infinite deflection population causes a significant overestimation of the number of deflection measurements required. This trend is also true for other combinations of deflection parameters.

Table 1 indicates that equations that assume a normal distribution produce results similar to those obtained from the Student's t distribution. Additionally, the coefficient representing the selected confidence level does not vary with sample size in the normal distribution, which greatly simplifies computations. Results from both statistical distributions are approximately the same for the numerous combinations of deflection parameters analyzed in this study.

It must be pointed out that the estimation of the population size is based on the assumption that, for practical purposes, only one deflection measurement between successive discontinuities in the longitudinal direction is necessary to characterize that pavement portion bounded by these discontinuities. Hence, if the average crack spacing or the average joint spacing can be computed, the size of the population of deflection measurements can be subsequently estimated.

<u>Guidelines for Estimating Deflection Sample Size</u>

In this section, a step-by-step procedure is provided for estimating the required sample size of deflections in rigid pavements. This procedure is applicable to any piece of equipment, provided that the deflection at the sensor 1 location is available.

Note that some of the equations presented in this section appear in the section on the development of expressions but are repeated and renumbered herein for simplicity.

1. For a given design section, determine its length (L) and the average spacing between successive discontinuities in the longitudinal direction (S).

2. Use the following equation to compute the size of the population of deflection measurements, N:

$$N = \frac{L}{\bar{S}} \tag{14}$$

where

L = pavement-section length, feet,

$\bar{S}$ = average spacing between successive discontinuities in the longitudinal direction, feet.

A minimum section length of 1000 feet is recommended. $\bar{S}$ can be obtained from condition survey data corresponding to average crack spacing for CRCP and average joint spacing for JRCP or JCP.

3. Compute $\hat{\sigma}$, the unbiased estimate of the standard deviation of the population of sensor 1 deflections, by means of Eq 15:

$$\hat{\sigma} = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}} \tag{15}$$

where

x_i = value of the sample's i^{th} sensor 1 deflection, mils,

n = number of sensor 1 deflections taken in the sample that is being used to estimate the required number of deflections, and

$\bar{x}$ = sensor 1 mean deflection, mils.

$$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i \tag{16}$$

4. Select an allowable error, e, expressed as a function of sensor 1 mean deflection. This parameter can be related to variation in slab thickness if the guidelines provided in Table 2 are followed.

5. Obtain Z_α from Table 3 according to the desired confidence level. A confidence level of 90 or 95 percent is commonly selected.

6. Determine the required number of deflections by using Eq 17; Figures 1 and 2 are provided as an alternate method for determining sample size for confidence levels of 90 and 95 percent.

$$n_r = \frac{1}{\left[\frac{e}{Z_\alpha \hat{\sigma}}\right]^2 + \frac{1}{N}} \tag{17}$$

where

n_r = required number of deflections, and

Z_α = the abscissa of the normal curve that cuts off an area α (level of significance) at the tails, as obtained from Table 3.

Temperature Correction of Edge Deflections

Deflection measurements for material characterization on a concrete pavement are made away from the pavement edge so that they are independent of temperature (4). Deflection measurements made for the purpose of void detection must be corrected to remove the influence of temperature differential (4). Hence, measurement of the temperatures at the top and bottom of the concrete slab occurs simultaneously with the use of the deflection measurement equipment. This section describes an alternate procedure for estimating temperature in the concrete slab based on climatological data and thermal properties of concrete. The development of the temperature prediction model is described in detail in Reference 7.

Estimation of Temperature in Concrete Pavements

Different climatological information from daily weather reports and material properties required to estimate temperature in concrete pavement are presented in this section.

The model requires daily maximum and minimum air temperatures, which are included in daily weather reports. Solar radiation is a major contributor to temperature changes in concrete pavement, and the local weather stations record total solar radiation in Langleys per day. Average wind speed is also an input in the model because it influences the surface temperature. Table 4 presents the thermal properties of concrete and typical values for pavement-quality concrete.

The theoretical model described by Shahin and McCullough (5) is based on Barber's work (6) and has been revised by Uddin et al (4) for its applicability in concrete pavements. The mathematical model is based on the theory of conduction of heat through a semi-infinite homogeneous mass. The conceptual form of the model is presented below.

$$T\,(x,\,t) = f \quad T_A,\ T_r,\ R,\ h,\ k,\ s,\ w,\ x.\ t \tag{18}$$

where

$T(x,t)$ = temperature of the mass at a depth, x, and time, t.

T_r and T_A are daily air temperature range and mean air temperatures, respectively. R includes the effects of solar radiation, and h is the surface coefficient, which is as function of wind speed. Thermal properties of concrete are reflected in such terms as k, s, and w, which represent the thermal conductivity of concrete.

The computer program PTEMP based on the theoretical model is described in Reference 4 and examples of input and output are given. A simplified flow chart of the program is presented in Figure 4. Temperature parameters of the concrete slab of a CRC pavement section at Columbus, Texas, in August 1981 have been estimated using computer program PTEMP. The climatological data, thermal properties and calculated hourly distribution of temperatures are given in the example output in Table 5. The estimated and measured temperature data are plotted in Figure 5 for comparison. Weather data were obtained from weather reports published by NOAA (7).

Temperature Correction Procedure

Temperature differential, DT, is the most important parameter that influences deflections measured at the pavement edge. DT is the difference in temperatures at the top and bottom of a concrete slab. DT is generally zero within two hours after sunrise and reaches a peak positive value in the afternoon hours. The deflections measured at any temperature differential should be corrected to bring them to the condition of zero temperature differential, as outlined below.

1. Collect replicate Dynaflect deflections at a location at or near the pavement edge.
2. Estimate the hourly distribution of temperature differential by obtaining climatological data for the test site and making use of the computer program PTEMP.
3. Develop a simple linear regression equation with the sensor 1 deflection as dependent variable and DT as the independent variable.
4. Correct the measured deflections at sensor 1 to the zero temperature differential condition using the relationship developed in step 3. In the case of a positive value of DT, the corrected deflection will be larger than the measured deflection, or, in other words, the correction will be additive (4).

Summary and Conclusions

Summary

Design section length has been incorporated in the estimation of the number of deflection measurements required for materials characterization of in-service rigid pavements. Expressions based on both a Student's t distribution and a normal distribution have been derived, and sample sizes resulting from them for various combinations of allowable error, sensor 1 standard deviation, confidence level, and population size have been compared. Findings have been included in the guidelines for estimating sample size. A temperature prediction procedure has been described for estimating temperatures in a concrete pavement in order to apply temperature correction to edge deflections.

Conclusions

1. The population size of deflection measurements can be estimated from design section length and average spacing between successive discontinuities in the longitudinal direction. Population size is used in the equations derived in this study to estimate the required number of deflection measurements.

2. If an infinite deflection population is assumed, sample size will be overestimated for short-length sections; however, the difference between this approach and that based on a finite deflection population will decrease as population size increases.

3. The number of deflection measurements required for materials characterization increases with increasing sensor 1 standard deviation, population size, and confidence level but decreases with increasing allowable error.

4. The normal-distribution approach results in sample sizes similar to those obtained from the expression (Eq 10) based on the Student's t distribution. Furthermore, the confidence-level coefficient (Z_{α}) is the same for any sample size. This convenient property of the normal distribution considerably simplifies the estimation of deflection sample size.

5. Information based on climatological data and thermal properties of concrete can be used to estimate temperatures in a concrete pavement so that deflections measured near the pavement edge can be corrected.

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Disclaimer

The contents of this paper reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This paper does not constitute a standard, specification, or regulation.

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Figure 1. Required deflection sample size for various combinations of $\hat{\sigma}$, e, and N and a 90 percent confidence level (e is given in mils).

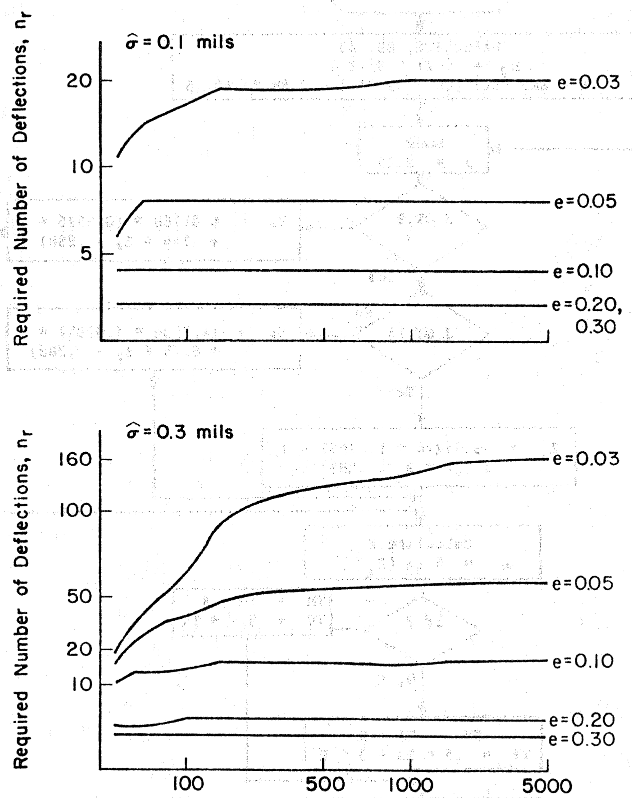

Figure 2. Required deflection sample size for various combinations of $\hat{\sigma}$, e, and N and a 95 percent confidence level (e is given in mils).

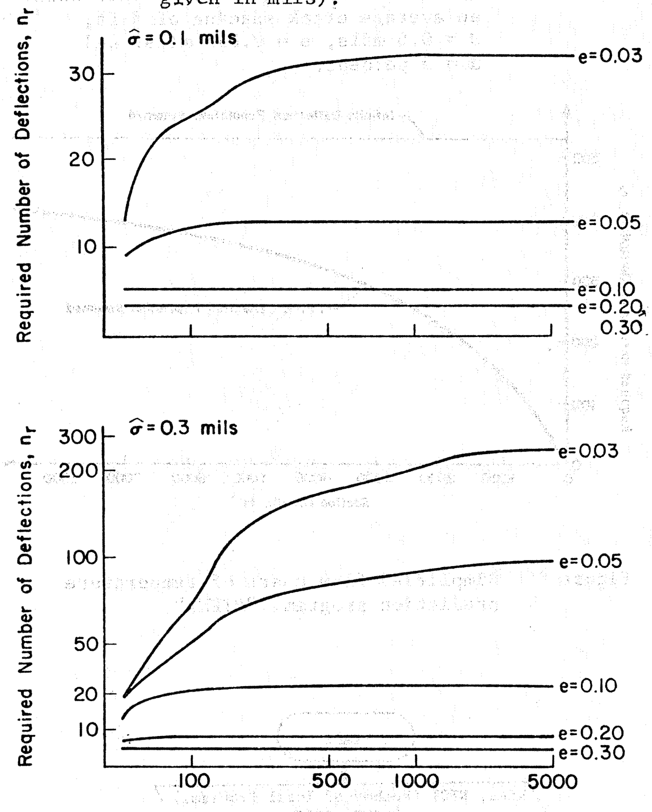

Figure 1. (Continued).

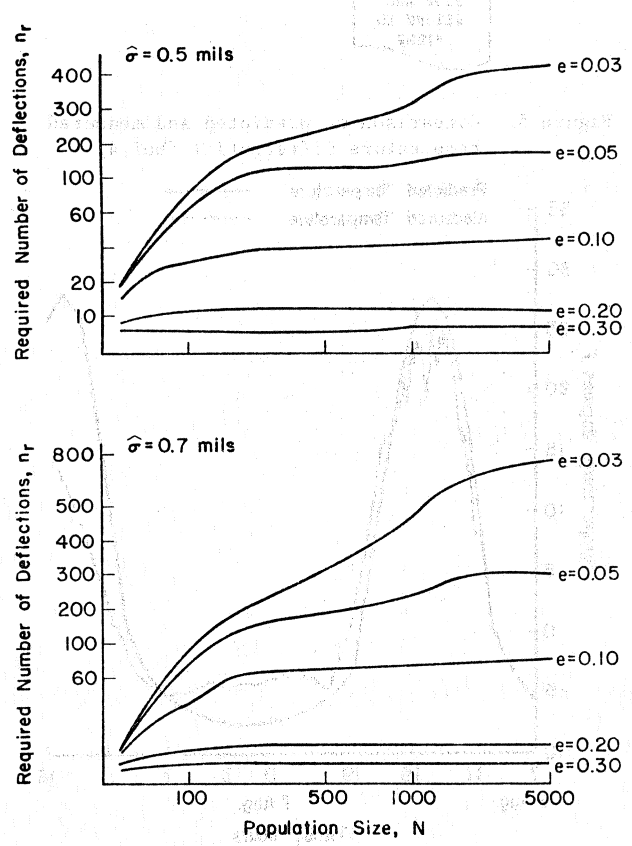

Figure 2. (Continued).

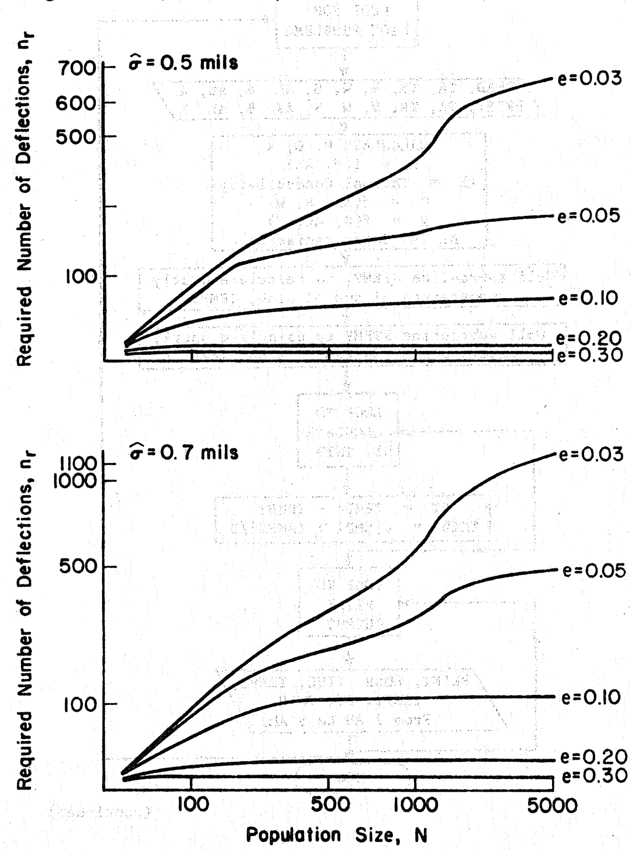

Figure 3. Comparison between deflection sample size resulting from the traditional approach and that obtained by applying the finite multiplier for a CRCP with an average crack spacing of 5 ft, σ = 0.5 mils, e = 0.035 mils, and α = 5 percent.

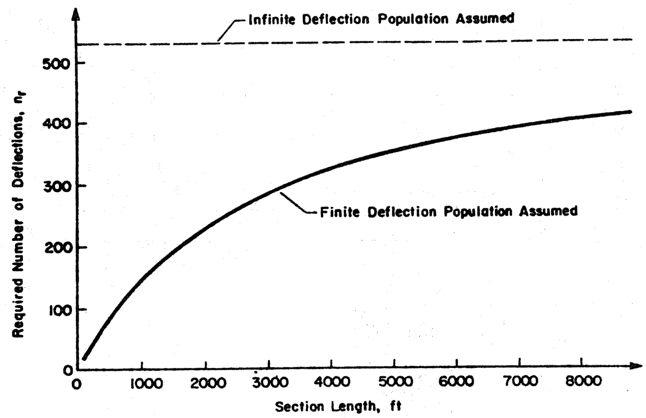

Figure 4. Simplified flow chart of temperature prediction program, "PTEMP".

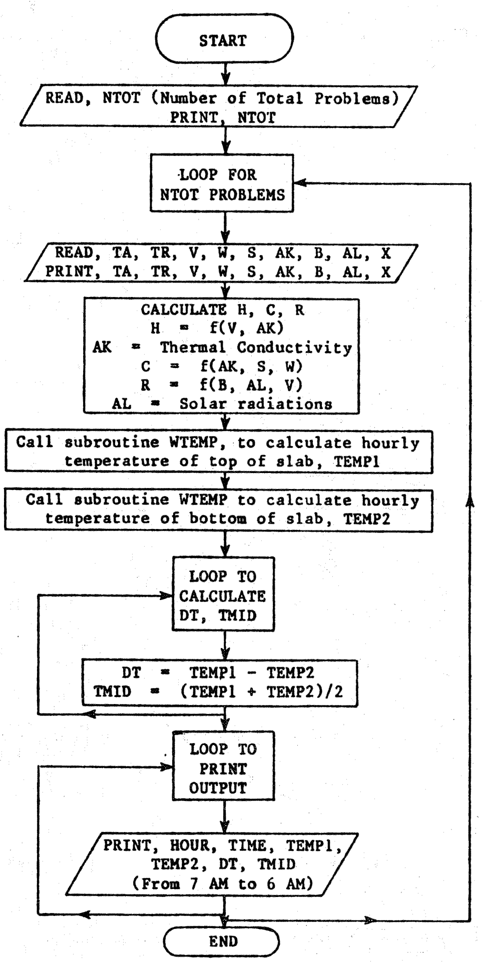

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Figure 4. (Continued).

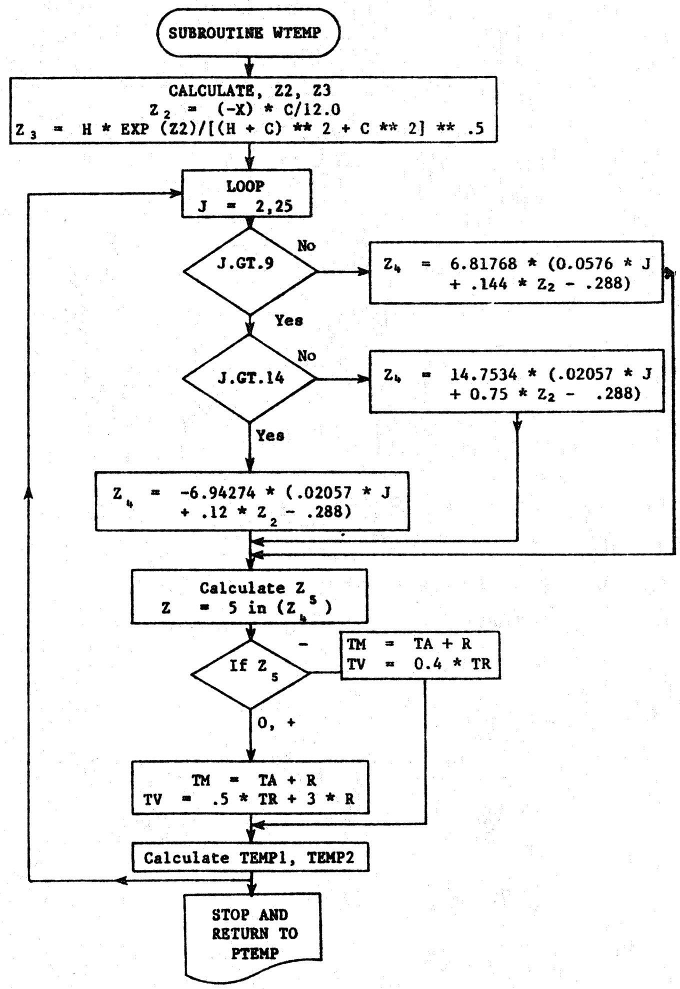

Figure 5. Comparison of predicted and measured temperature differential (Ref 4).

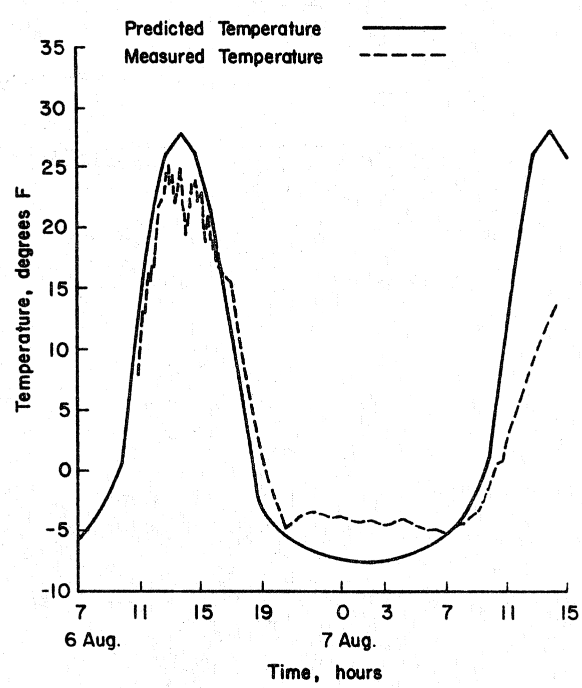

TABLE 1. DEFLECTION SAMPLE SIZE OF RIGID PAVEMENTS FOR VARIOUS COMBINATIONS OF $\hat{\sigma}$, e, AND A 95 PERCENT CONFIDENCE LEVEL, N = 500

		Student's t Distribution Approach		Normal Distribution Approach	
$\hat{\sigma}$, mils	e mils	t_{95}	n_r	Z_{95}	n_r
	0.03	1.697	31		29
	0.05	1.782	13		11
	0.10	2.132	5		3
	0.15	2.353	4		2
	0.20	2.910	3		2*
	0.25	2.910	3		2*
	0.30	2.910	3		2*
	0.35	2.910	3		2*
	0.03	1.658	178		176
	0.05	1.666	84		82
	0.10	.1708	36		24
	0.15	1.782	13		11
	0.20	1.895	8		7
	0.25	2.015	6		4
	0.30	2.132	5		3
	0.35	2.132	5		2
	0.03	1.658	303		301
	0.05	1.658	178		176
	0.10	1.671	62		60
	0.15	1.697	31		29
	0.20	1.734	19	1.645	17
	0.25	1.782	13		11
	0.30	1.833	10		8
	0.35	1.895	8		6
	0.03	1.658	375		374
	0.05	1.658	260		258
	0.10	1.661	107		105
	0.15	1.675	55		53
	0.20	1.694	33		32
	0.25	1.717	23		21
	0.30	1.746	17		15
	0.35	1.782	13		11
	0.03	1.658	430		429
	0.05	1.658	344		343
	0.10	1.658	178		176
	0.15	1.663	99		97
	0.20	1 671	65		60
	0.25	1.683	43		40
	0.30	1.697	31		29
	0.35	1.714	24		22

*n_r as obtained from Eq 12 less than 2.

TABLE 2. RELATIONSHIP BETWEEN ALLOWABLE ERROR, e, AND VARIATION IN SLAB THICKNESS

e, mils	Variation in Slab Thickness, in.
0.025 $\bar{x}$	0.25
0.050 $\bar{x}$	0.50
0.100 $\bar{x}$	1.00

$\bar{x}$ - sensor 1 mean delfection, mils.

TABLE 3. VALUES OF Z_α FOR VARIOUS CONFIDENCE LEVELS

Confidence Level, α, Percent	Z_α
80.0	0.842
85.0	1.036
90.0	1.282
95.0	1.645
97.5	1.960
99.0	2.326

TABLE 4. THERMAL PROPERTIES OF PAVEMENT QUALITY PC CONCRETE

Properties	Pavement Quality P. C. Concrete	Asphaltic Concrete
Absorptivity of surface to solar radiation	0.65 - 0.80	0.95
Thermal Conductivity (BTU/ft^2/hr, °F)		0.7
Aggregates:		
Gravel	0.9	
Igneous	0.83	
Dolomite/limestone	2.13	
Specific heat (BTU/lb, °F)	0.20 - 0.28	0.22

TABLE 5. EXAMPLE OUTPUT

PROB. NO. 1 COLUMBUS BYPASS SH 71 AUG,06,1981

AVE. AIR TEMP.	=	85.500	DEG.F
TEMP.RANGE	=	25.000	DEG.F
WIND VELOCITY	=	8.300	MPH.
MATL. DENSITY	=	150.000	PCF.
SPECIFIC HEAT	=	.240	BTU.PER POUND DEG.F
CONDUCTIVITY	=	.900	BTU.,HOUR,FT.,DEG.F
ABSORBTIVITY	=	.750	
SOLAR RAD.	=	575.000	LANGLEYS PER DAY
DEPTH	=	10.000	INCHES

HOURS	HOUR OF DAY		TEMP,TOP DEG.-F	TEMP,BOTTOM DEG.-F	DT DEG.-F	TMID DEG.-F
1	7	A.M.	89.8	95.6	-5.9	92.7
2	8	A.M.	91.1	95.3	-4.1	93.2
3	9	A.M.	93.2	95.0	-1.7	94.1
4	10	A.M.	95.7	94.8	.9	95.3
5	11	A.M.	106.4	94.8	11.6	100.6
6	12	NOON	115.4	94.9	20.5	105.1
7	1	P.M.	121.4	95.1	26.3	108.3
8	2	P.M.	123.5	95.4	28.1	109.5
9	3	P.M.	121.8	95.5	26.2	108.7
10	4	P.M.	117.7	96.2	21.5	106.9
11	5	P.M.	111.6	97.4	14.2	104.5
12	6	P.M.	104.0	98.5	5.6	101.2
13	7	P.M.	95.7	99.3	-3.5	97.5
14	8	P.M.	94.8	99.8	-5.0	97.3
15	9	P.M.	93.9	99.7	-5.8	96.8
16	10	P.M.	93.0	99.5	-6.5	96.3
17	11	P.M.	92.2	99.2	-7.0	95.7
18	12	MIDNIGHT	91.5	98.9	-7.4	95.2
19	1	A.M.	90.8	98.5	-7.6	94.7
20	2	A.M.	90.3	98.0	-7.7	94.1
21	3	A.M.	89.8	97.5	-7.7	93.7
22	4	A.M.	89.5	96.9	-7.4	93.2
23	5	A.M.	89.3	96.4	-7.0	92.8
24	6	A.M.	89.3	95.8	-6.5	92.5