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OVERLAY DEFLECTION DESIGN METHOD FOR ARIZONA

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16. Abstract

A new Structural Overlay Design for Arizona (Soda) was developed. This design method is based upon Dynaflect deflection data being correlated to field performance. To derive the best fit equation, over thirty (30) variables and 170 observations were reviewed. The recommended equation contains five variables including traffic, spreadability index, roughness, region, and the number five geophone deflection. The correlation was acceptable and the final equation appears practical to use.

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METRIC CONVERSION FACTORS

1 mil = 0.0254 mm

1 inch = 2.54 cm

1 foot = 0.305 m

1 yd^2 = 0.836 m^2

1 mph = 0.447 m/sec

1 psi = 6.9 kN/m^2

1 ksi = 6.9 MN/m^2

1 kip = 4.45 kN

1,000 pounds = 1 kip

OVERLAY DEFLECTION DESIGN METHOD FOR ARIZONA

INTRODUCTION

The ability to accurately and objectively establish existing pavement rehabilitative requirements is essential. Since the number of major new construction projects is decreasing, it is evident that more money and reources will be expended on upgrading and restoring existing facilities. With the sharp increase in cost of materials and the steady depletion of natural resources, it is imperative that decisions on allocation of these natural resources and money be made in a logical and objective manner. Arizona, like other states, is faced with preserving its highway network. To do this, a myriad of overlay design strategies are employed. With regard to preservation two critical questions need to be addressed: which miles of highway need overlaying and how much overlay is needed? The Arizona pavement management system addresses which miles of highway need overlaying. The deflection overlay design method should address how much overlay is needed for structural integrity.

The purpose of this project was to analyze the past overlay deflection data developed as part of the Arizona Department of Transportation (DOT) pavement evaluation and research effort (1) (2) and from this analysis develop an overlay deflection design method for Arizona.

LITERATURE REVIEW

An enormous body of literature concerning deflection testing, analysis and design has been generated by researchers and practitioners over the years. Reference (3) through (10) refer to the large number of papers reviewed for this project. Particular attention was given to references 6 - 10 that appeared as part of a 1961 Association of Asphalt Paving Technologists preceedings entitled, "Symposium on Flexible Pavement Bahavior as Related to Deflection". The central concept behind highway design and construction is to build a structure which can accommodate the applied loads without undue deformation or distress for the expected life of the pavement. Figure 1 represents this concept wherein stresses generally diminish with increased structural thickness at increased depth.

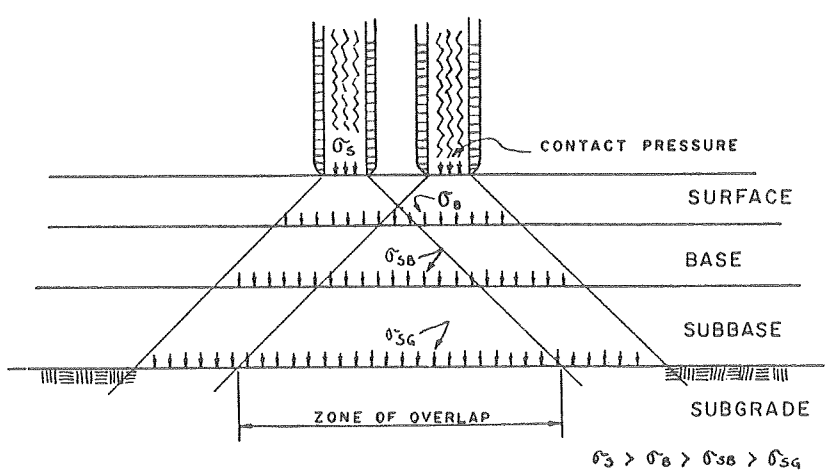


Fig. 1. Sketch Illustrating Simple Stress Distribution Through a Flexible Pavement.

A general solution for stress and deflection in a two layer system was developed by Burmister and later extended to three layers and then to N layers.

Deflection equations for flexible pavements take the following general form:

$$D = \frac{Pa}{E} \times F$$

where

D is deflection
P is contact pressure
a is radius of contact (circular)
E is modulus of elasticity of the subgrade
F is a dimensionless factor accounting for depth and the ratio of moduli of elastacity, pavement layers and subgrade (Ref. 28)

In general the deflection of each layer contributes to the measured surface deflection as shown in Figure 2.

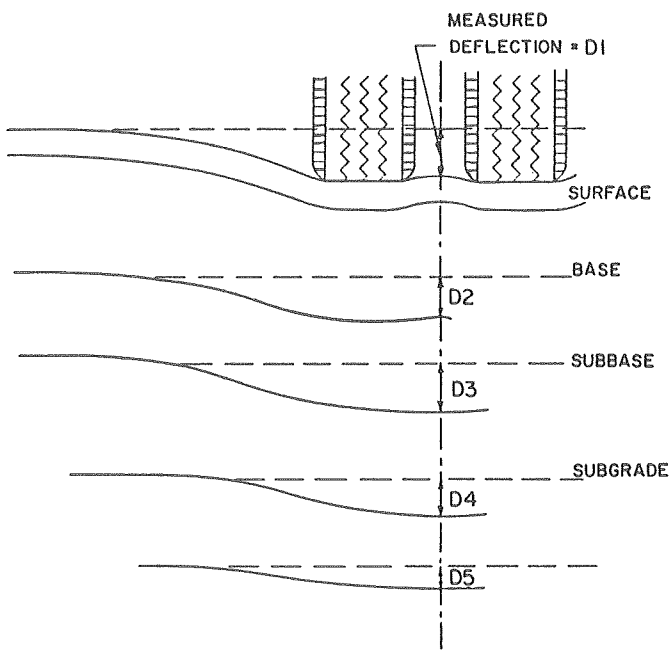


Fig. 2. Deflection Profiles.

Hence, D1 = D2 + D3 + D4 + D5

This simple concept of stress and deflections has lead to some very complicated mathematics and physics in order to analyze a set of static or dynamic deflections. This occurs because typically only the thickness of each layer and surface deflection are known.

Other important information such as layer modulus, state of stress and modulus/stress relationship are generally unknown.

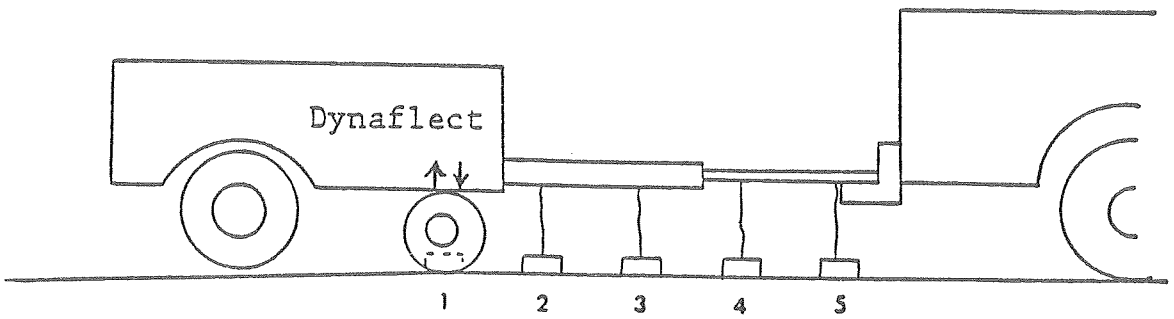
Over the years considerable work has been done to develop improved non-destructive testing devices (NDT) which determine the surface deflection. The emphasis of this work has been on portability and convenience to the user. Efforts have been made to simplify the mathematics of the deflection analysis in terms of layered properties and other pavement response. A host of NDT deflection devices have been developed. The Dynaflect, Road Rater, La Croix Deflectograph and Falling Weight Deflectometer are commonly used devices for highway design work. Heavier NDT deflection devices have been developed for the Federal Highway Administration, U.S. Army Corps of Engineers for airfields and a heavy load simulator for South Africa. Extensive literature has been written concerning the development and use of this equipment (Ref. 11 - 14).

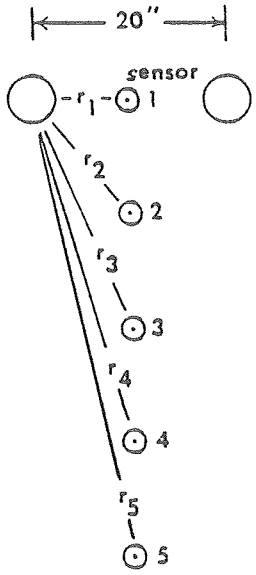
Arizona acquired a Dynaflect in 1972 and a Falling Weight Deflectometer in 1980. Although both pieces of equipment measure deflection they are quite different. The Dynaflect applies a 1,000 pound force peak to peak sinusoidal load at a frequency of 8 Hertz. The load is applied to two force wheels (Figure 3) 20 inches apart. Transducers called geophones are arrayed between the force wheels in such a manner that a deflection basin can be recorded. The Falling Weight Deflectometer (FWD), Figure 4, was developed to simulate the pulse load applied by an 18 kip axle load moving at approximately 55 mph. A weight is raised up a mast and dropped onto a spring loaded plate approximately 12 inches in diameter. This action develops a pulse wave that is detected by transducers located at the center of the plate as well as at various distances away from the plate. Considerable theoretical and practical verification (Ref. 15) were involved in developing this device, such that a physical and mathematical evaluation of the deflection basin is possible.

The role that deflections play in overlay design is varied. Ideally there would be a link between deflection and performance, however, it has been extremely difficult to verify this physical relationship due to the complexity of the problem. A number of empirical relationships have been developed and applied to overlay design problems. Arizona at present uses the empirical relationships developed by California (Ref. 16) which use the Dynaflect geophone centered between the force wheels (d1) deflection and the traffic level to estimate the amount of overlay thickness needed for a cracked asphaltic concrete (AC) pavement. The larger the deflection and/or traffic the greater the thickness of overlay needed. Rather than attempting to revise the California method to reflect Arizona's experience it was decided that the new Arizona Deflection Method should reflect the findings developed from actual field performance tests.

FIGURE 3

DYNAFLECT





r_1 = 10.0"

r_2 = 15.6"

r_3 = 26.0"

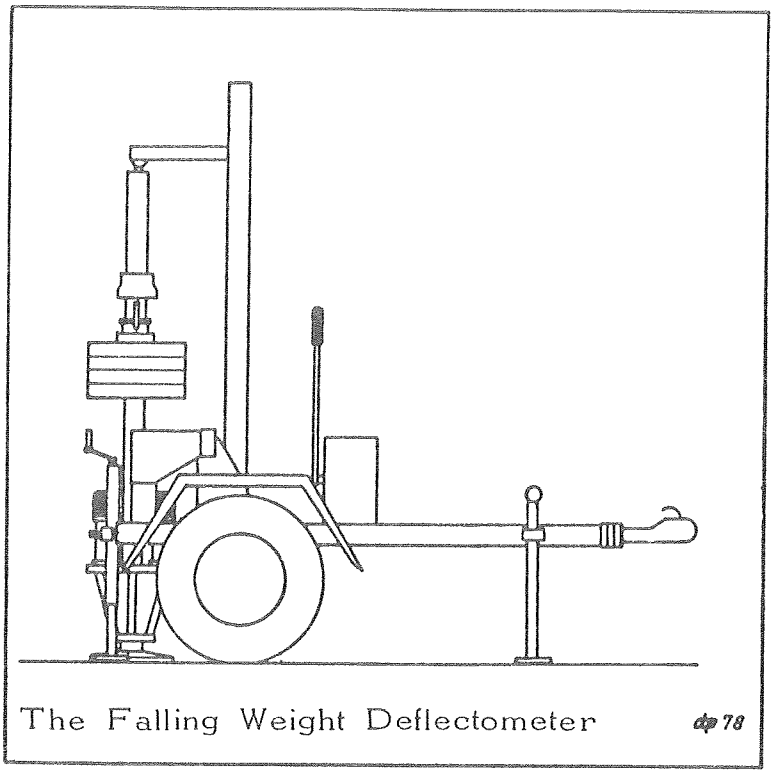
r_4 = 37.4"

r_5 = 49.0"

* 8 Hertz Oscillating Load
* 1000 pound peak to peak force
* Five geophones arrayed as shown between two force wheels

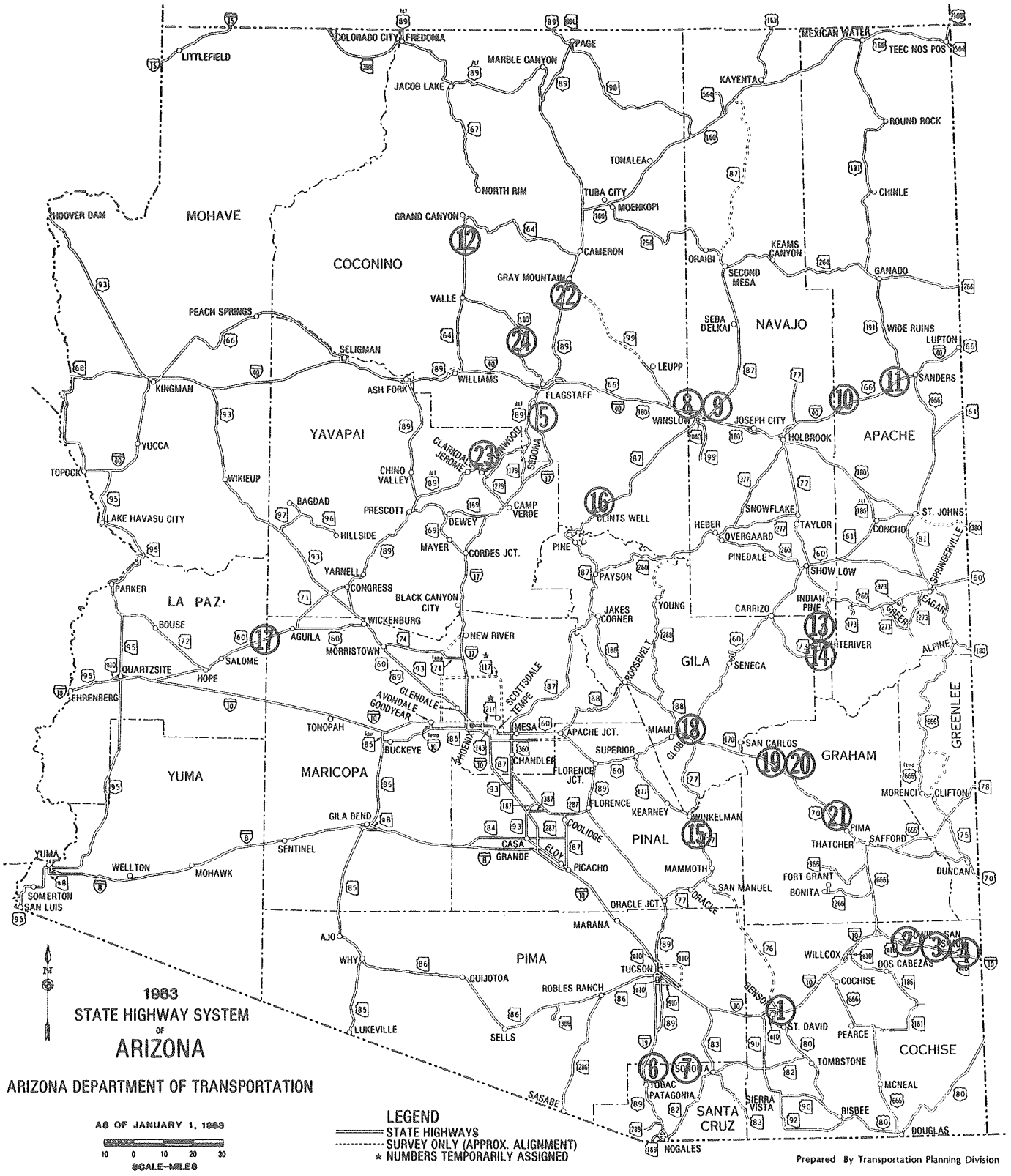
FIGURE 4

FALLING WEIGHT DEFLECTOMETER



* Variable pulse load by adjusting drop height of weight load can vary from 0 - 11,000 pounds force.
* Accelerometer at center of loaded plate. Additional accelerometers spaced out to a distance of about 7 plate radii.
* Plate approximately 12 inches in diameter
* Loaded plate simulates load from an 18 kip single axle load

FIGURE 5
OVERLAY SITES



SITE DESCRIPTION AND FIELD DATA

Nine interstate and thirteen non-interstate overlay projects were selected to develop the new overlay design method. Projects were selected because they represented standard overlays where before and after deflections as well as performance were known. Figure 5 shows the location of each project. Table 1 describes each site and assigns a number to each site. For all sites, except the three starred (*) sites (5,8,9), the last surfacing before overlay was the original construction. For sites 5, 8 and 9 an overlay was placed on the original surface and then subsequently overlaid again. There are eleven (11) interstate locations representing about 114 centerline miles. The average time between overlays is thirteen (13) years for the interstate and nineteen (19) years for the non-interstate. The relative amount of time between overlays is not necessarily an indicator of how well each highway performed. Table 2 is a general site description which gives elevation, regional factor, 1982 ADT, 1982 annual 18 kip single axle equivalent loads (SAEL), year built, material structural layers and thickness of each layer. Table 3 is a review of Dynaflect data gathered for each site.

The average first geophone (D1) deflection was less after the overlay for all 24 sites. The average project maximum Dynaflect deflection (D1) ranged from .73 mils to 3.73 mils before overlay and .57 mils to 2.06 mils after overlay.

Tables 4 and 5 are a review of actual ride and cracking conditions for all sites from year 1972 to 1982. Table 6 is review of age, ride, cracking, rut depth and present serviceability index (PSI) before overlay. The following table is an average condition before overlay.

AVERAGE PAVEMENT CONDITION BEFORE OVERLAY

	Interstate 11 Sites	Non Interstate 13 Sites	All 24 Sites
Age, Years	13	19	16
Percent Cracking	11	21	16
Ride, MAYS RIDE-METER Inches/Mile	175	177	176
Rut Depth, Inches	0.17	0.21	0.19
PSI	2.93	2.85	2.89

DATA ANALYSIS AND INTERPRETATION

Data from the 24 sites was assembled into a regression matrix of 170 mile post location and 31 variables (Appendix A). The 31 variables represent either physical measurements or their concomitant calculated values. The 31 variables included in the regression analysis were:

1. Regional Factor (R).
2. Spreadability Index before the overlay (SIB). See equation 6.
3. Tensile strain at the bottom of the existing AC pavement before the overlay. See Appendix B.
4. Vertical strain on the subgrade before the overlay. See Appendix B.
5. Modulus of AC pavement before the overlay. See Appendix B
6. Modulus of the unbound base before the overlay. See Appendix B.
7. Modulus of the subgrade (Esg) before the overlay. The Esg was determined by fitting theoretical deflection basins to the measured Dynaflect deflection basins through the technique described in Appendix B. Linear bivariate regression models were fitted to these data; Esg was the dependent variable and the fifth Dynaflect sensor deflection (D5) was the independant variable. A reciprocal transformation of the dependent variable, Esg, resulted in the relationships:

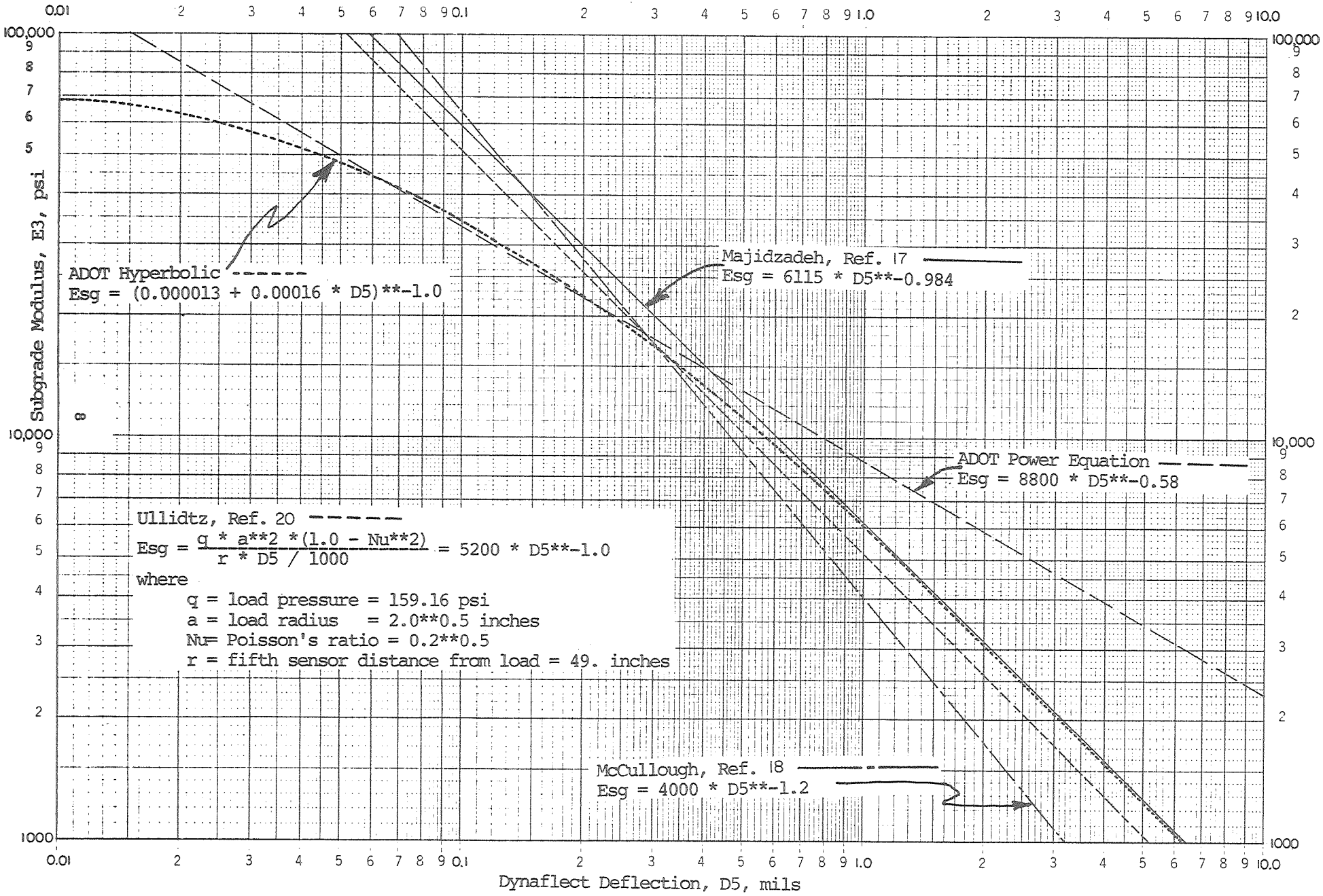


Figure 6 Fifth Sensor Deflection - Subgrade Modulus Relationship

$$(Esg, psi)^{-1} = 0.000013 + 0.00016 \times (D5, mils) \qquad \text{EQ. 1}$$

Standard Error of Estimate = 0.00001

Coefficient of Determination = 0.82

This relationship is compared with the finding of others (Ref. 17, 18 and 20) in Figure 6.

8. Surface Curvature Index (SCI) before the overlay, Calculated by subtracting Dynaflect sensor two deflection (D2) from Dynaflect sensor one deflection (D1).
9. Dynaflect sensor one deflection (D1) before the overlay.
10. Dynaflect sensor five deflection (D5) before the overlay.
11. Existing AC pavement age at the time of the overlay.
12. Accumulated 18,000 pound single axle equivalent load coverages on the existing pavement before the overlay.
13. Slope of a linear least-squares regression with Mays roughness before the dependent variable and pavement age in years the independent variable i.e., change in roughness/year.
14. Intercept (Age = 0) of the regression equation described in # 13.
15. Thickness of the existing AC pavement before the overlay.
16. Thickness of the existing unbound base.
17. Roughness of the existing AC pavement just before the overlay. (Po). This value was found by using the Pavement Performance Information System (PMIS) data bank which included Mays Ride Meter roughness (MR) values for the years 1972 through 1982. Most of the 170 milepost locations included in the regression data set were "as-built" (year of the last major construction activity prior to the overlay) before 1972. An MR of 50 was assumed for the as-built pavements (Age = 1). Actual MR values for the years 1972-1982s were used as the dependent variable values and the respective ages in years from the as-built year were the independent variable observations. A bivariate linear least-squares regression model was fitted to these observations. For the regression equations with zero or negative slopes, the slope was set to zero. The intercept for these cases was the arithmetic mean of the MR. The Po values used in the multiple regression model were calculated by substituting the pavement age at the time of the overlay into the bivariate linear equation as the independent variable and solving for the dependent variable, Po.
18. AC overlay thickness (T).
19. Speadability Index after the overlay (SIA).
20. Tensile strain at the bottom of the existing AC pavement after the overlay. See Appendix B.
21. Vertical strain on the subgrade after the overlay. See Appendix B.
22. Effective modulus of the composite of the existing AC pavement and the AC overlay. See Appendix B.
23. Modulus of the unbound base after the overlay. See Appendix B.
24. Modulus of the subgrade after the overlay. See Appendix B.
25. SCI (see #8) after the overlay.
26. D1 after the overlay
27. D5 after the overlay
28. Equivalent thickness of the AC overlay (ET). From Kirk and Ullidtz (Ref. 19, 20 and 21) the equivalent thickness of the pavement structure above the subgrade was defined as:

$$ET,m = f(H1(E1 / Em)^{0.33} + H2(E2/Em)^{0.33} \ldots Hm\text{-}1(Em\text{-}1/Em)^{0.33}) \qquad \text{Eq. 2}$$

In this study,

m = 4
E4 = subgrade layer modulus and
E3,H3 = unbound base modulus and thickness
E2,H2 = existing AC pavement modulus and thickness
E1,H1 = AC overlay modulus and thickness
f = an adjustment factor, assumed to be unity

The equivalent thickness of the AC overlay is obtained by calculating ET,m with and without the overlay and subtracting; since E2,H2,E3,H3, and E4 are treated as constants before and after overlay, the equivalent AC overlay thickness (ET) equation reduces to:

$$ET = T\,(Eov/Esg)^{0.33} \qquad \text{Eq. 3}$$

Where

T = the AC overlay thickness, inches.
Eov = modulus of the AC overlay, ksi
Esg = modulus of the subgrade, ksi; determined from D5. See equation 1.

29. Slope of a linear least-squares regression with Mays roughness as the dependent variable and pavement age after the overlay as the independent variable (i.e., change in roughness/year).

30. Intercept (Age = 0) of the regression equation described in #29.

31. Expected 18000 pound single axle equivalent loads on the overlaid AC pavement during the design period in thousands (the common logarithm of this value is the dependent variable in the regression model, L). To determine this value a bivariate linear least-squares regression line was fitted to the MR values for each year subsequent to the AC overlay; i.e., the dependent variable was MR and the independent variable was the time or age in years since the overlay. The linear equation was then used to solve for the number of years until the expected MR would reach 260 inches. The number of years was constrained to be 30. The accumulated loads L in thousands during this time was calculated from:

$$L = AADL \times t \times (200 + t \times GF) \times 0.000005 \qquad \text{Eq. 4}$$

Where

AADL = the average annual 18000 SAEL in the overlay year
t = the design period or the time until the MR reaches a value of 260 (Subject to a maximum of 30).
GF = the traffic loads growth factor, expressed as a percentage of the beginning AADL. The Arizona DOT GF is linear, i.e., the change in traffic volume and loads is the same for each year under consideration.

Within the multiple regression analysis, variables number 1 through 30 were regressed against number 31. The intent of this analysis was to determine whether deflection and/or deflection derived values were significantly related to the number of loads to failure. It was determined that of all the deflection variables, Spreadability Index was the most significantly correlated to the dependent variable. Further analysis was performed to derive a general Arizona overlay equation.

STRUCTURAL OVERLAY DESIGN FOR ARIZONA (SODA)

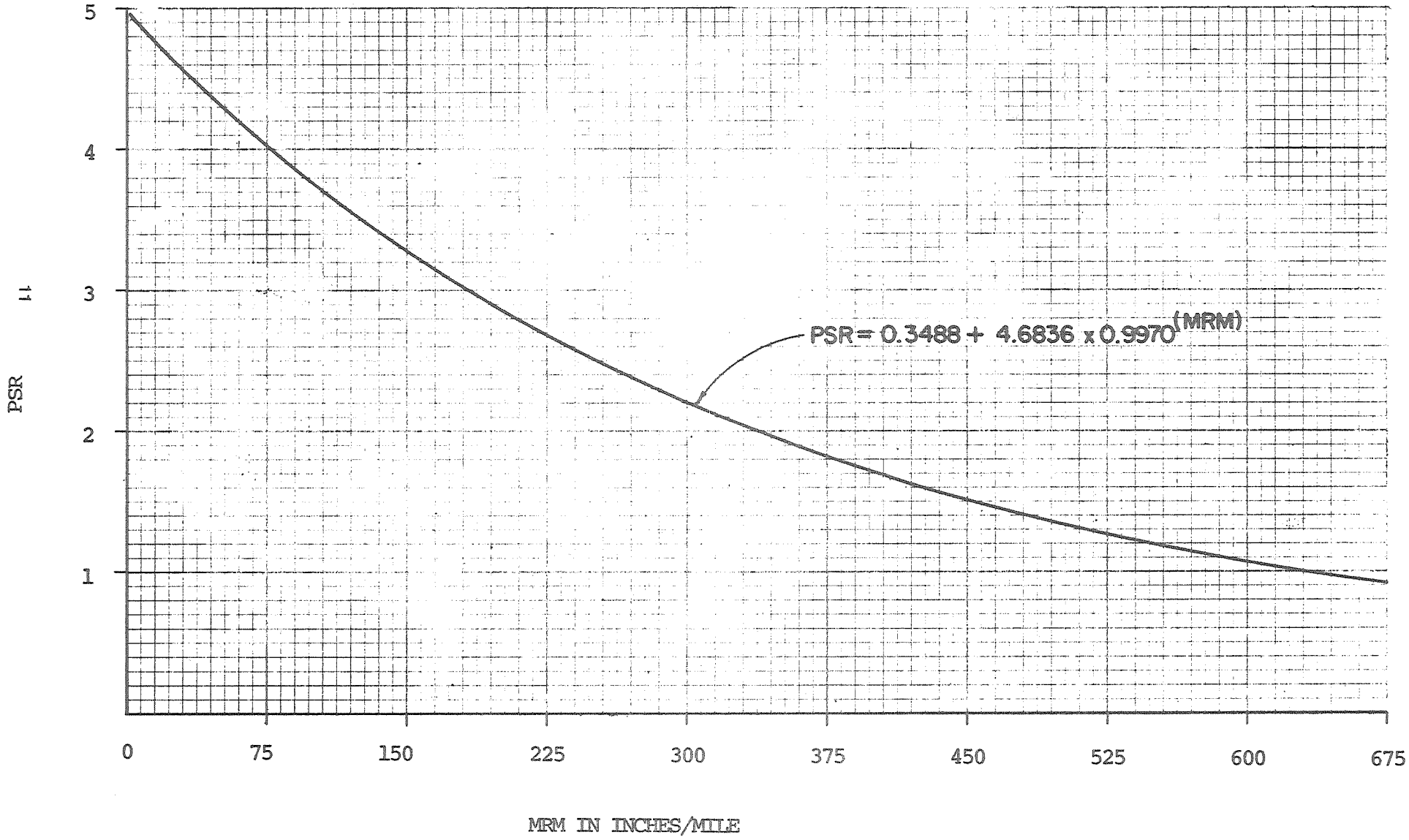
An AC overlay performance prediction model based on Dynaflect deflections and actural field data was derived by using multiple regression. The general form of the overlay equation is:

$$Pt = f\,(R,D,Po,L,T) \qquad \text{Eq. 5}$$

FIGURE 7

PRESENT SERVICEABILITY RATING

RELATED TO MAYS RIDE METER ROUGHNESS



where

Pt = a pavement performance measurement characteristic over time t
R = an environmental factor
D = deflection measurements
Po = the level of the pavement performance characteristic for the existing pavement before the overlay is placed.
L = the expected traffic loading on the overlaid pavement during time t
T = the AC overlay thickness

For the ADOT overlay design based on Dynaflect deflections, these variables are defined as follows:

t is the actual or extrapolated time in years until the overlaid pavement reaches 260 inches of roughness measured by the Mays Ridemeter (MR). An MR of 260 is equivalent to a Present Serviceability Rating (PSR) of 2.5 which is considered the limiting PSR for all pavements on the State highway system. See Figure 7.

R is equivalent to the Regional Factor developed at the AASHTO Road Test. At the Arizona DOT R is a funtion of the climatological area, the average annual rainfall, and the elevation of the project pavement (refer to the Materials Design Manual (Ref. 23)).

D is the five Dynaflect deflection measurements in mils, expressed as the Spreadability Index (SI). (Ref. 24)

$$SI = \frac{D1 + D2 + D3 + D4 + D5}{5 \times D1} \times 100 \qquad \text{Eq. 6}$$

Po is the Mays Ridemeter inches of roughness on the existing pavement before the overlay is placed.

L is the 18000 pound SAEL's expected on the overlaid pavement during the design period, in thousands.

T is the thickness (inches) of the AC overlay that will provide the required time until the pavement is expected to reach 260 inches of roughness (PSR = 2.5).

The multiple regression analysis performed on the data from the 24 projects (170 milepost observations) produced the following functional relationships:

$$\log L = -0.104 \times R - 0.000578 \times Po + 0.0653 \times SIA \qquad \text{Eq. 7}$$

Where

SIA = SIB + 0.899 x ET and
ET = T x $(Eov/Esg)^{0.333}$ and
Esg = $(0.013 + 0.16 \times D5)^{-1}$
D5 is fifth Dynaflect sensor deflection, mils.
Esg is the estimated modulus of the subgrade, ksi
log is the common logarithm with Base 10.
Eov is the estimated modulus of the AC overlay; for ADOT it is a constant 200 ksi
ET is the equivalent thickness of the AC overlay, inches.
SIB is the spreadability index of the existing pavement before the AC overlay.
SIA is the predicted spreadability index of the overlaid AC pavement.
By substitution, combining terms, and rearranging these equations we obtain:

$$T = \frac{\log L + 0.104 \times R + 0.000578 \times Po - 0.0653 \times SIB}{0.0587 \times (2.6 + 32.0 \times D5)^{0.333}} \qquad \text{Eq. 8}$$

SENSITIVITY ANALYSIS

The relative effect of the independent variables on overlay thickness, ordered by decreasing importance is:

1. L, the number of 18000 pound SAEL's (thousands)
2. SIB, the spreadability index before the overlay.
3. R, the Regional Factor
4. D5, Dynaflect sensor #5 deflection, mils.
5. Po, Mays Ridemeter roughness in inches.

An inspection of Table 7 and Table 8 reveals that variable L and variable SIB have practically an equal effect on overlay thickness and that these two variables have double or triple the effect of any of the other three variables.

D5 and Po have an almost equal effect on overlay thickness for typical ranges in value of these two variables.

DISCUSSION

The inclusion of the Spreadability Index (SIB) in the overlay equation is indicative of its importance and rationality as a parameter to represent the load-carrying capacity of a pavement. However, it does not sufficiently reflect fundamental materials properties and the inter-related pavement structure stresses and strains to justify its use as the sole indicator of pavement performance. For example, since spreadability is a function of the ratio of E1, E2, and E3 it is possible for a pavement structure with three week layers to have the same spreadability as a pavement structure with three proportionally strong layers. This shortcoming of the overlay design equation could likely be corrected by the inclusion of Dynaflect sensor 1 (D1) deflection as a separate variable in the overlay design equation. Unfortunately, for the data set used in this study, the D1 value was found to be statistically insignificant during the multiple regression analysis. Another candidate variable that could have made up for the inadequacies of the spreadability index, SCI, also proved to be statistically insignificant.

It is important to note that the sensor 5 deflection (D5) appears in the denominator of the overlay equation. This parameter is assumed to be significantly sensitive only to the modulus of the subgrade; this has been confirmed during the course of this study and other deflection related investigations at Arizona DOT. D5 is inversely related to the subgrade modulus; directly related to the effective thickness of the AC overlay; and therefore indirectly related to the overlay thickness requirement estimated by the full equation. The incorporation of D5 as a separate deflection variable in the overlay equation tends to ameliorate the limitations of the Spreadability index as an indicator of pavement structural performance. Future improvement to the overlay design procedure will quite likely focus on the inclusion of a parameter that is more sensitive to the individual stiffnesses of the pavement layers.

The modulus of the AC overlay (Eov) was treated as a constant (200 ksi) in this study (Ref. 25). Some laboratory testing in conjunction with in-situ deflection measurements should be undertaken to provide a reasonable estimate of the Eov. Empirical equations that use the results of relatively routine tests to estimate AC modulus are appealing from a practical and implementable approach. For example, from Reference 26:

$$\text{Log } E = -0.124262 + 1.25469 \times K - 0.0616215 \times V$$

Where

E = dynamic modulus, 10^5 psi (at 4 Hertz loading frequency)
K = log of Marshall stability (lb.) divided by 100 times Marshall flow (0. 01 inch)
V = percent air voids for the modulus speciment minus percent air voids for the Marshall test specimen.
log = common logarithm (base 10)

The principal advantage gained by making use of these test results to elimate modulus is the relative ease with which they can be incorporated into a specification plan. The importance of having some degree of construction control on the AC mix characteristics used during the overlay design procedures cannot be over-emphasized.

The final overlay equation represents not only the best fit multiple regression solution, but also the end product of many hours of group discussion concerning overlay design experience and philosophy. The reliablility of the final equation can be no better than the data used to develop it. The 170 observations represents about a two percent sampling of ADOT's highway system. One of the problems in developing the equation was that the thickness of overlay was not uniformly distributed over a large range; rather there were clusters of thickness generally less than 3 inches. To account for this each of the 170 mileposts observation sets was weighted in the regression program (Ref. 27 and Ref. 28) by the reciprocal of the total number of times that a particular thickness occurred in the data set. Even though attempts were made to smooth the data, the final equation can give unreasonable overlay thicknesses, thus the range of thickness solutions has been constrained between zero and six inches.

Before the regression analysis began, it was necessary to identify the controlling failure mode. Both cracking and ride were considered, however, due to the small amount of cracking that had occurred after overlay (Table 6), cracking was eliminated. Certainly cracking is important, but this data set unfortunately did not provide sufficient history. In addition, Arizona's policy of using a special treatment (surface recycling or asphalt rubber) for highways with greater than 10 percent cracking could be a significant contributing factor to restrain cracking. After examining the Mays ridemeter roughness data it was decided that it would be the controlling failure mode. From previously conducted studies (Ref 2, 22) a value of 260 inches of roughness was selected as the pavement terminal roughness. This value corresponds to a 2.5 present serviceability rating, which is consistent with the AASHTO Road Test terminal serviceability index or TSI. Since the failure point was set at 260 inches/mile roughness, when in fact the average overlay was placed at 170 inches/mile, the solution tends to be on the conservative (thicker) side.

One of the concerns when using deflection data for design of overlays is the possibility that the test results are not a true representation of the worst case conditions and consequently the overlay will be inappropriately designed. Many schemes have been devised to adjust the observed values to a standard set of conditions. Most are based on temperature correction factors or adjustments for "critical" season.

Previous studies in Arizona have shown that the temperature correction factors are unreliable and their use has been discontinued. These earlier Arizona studies were concerned with the maximum deflection only. Since the SODA method uses the complete basin rather than only the maximum deflection a new study was made of the influence of temperature and/or season versus spreadability. Details are contained in Appendix D.

The results indicate that there is a seasonal effect that is related to asphaltic concrete thickness. Attempts to isolate this effect in terms of temperature were not successful. Based on the available information it is believed appropriate testing seasons can be established.

CONCLUSION

The purpose of this research was to use Arizona data to derive an Arizona overlay deflection method. Such a method has been developed and documented. The method is a combination of empirical and theoretical concepts and is built around the Dynaflect deflection device. In addition, it has been developed in such a way that other devices can be used. Arizona has a Falling Weight Deflectometer and its use will be integrated into the new overlay method. The new overlay method is intended to be used to identify the thicknesses of overlay needed to structurally accommodate the anticipated 18 Kip SAEL for the specified design period. It should not be used as the sole determinant of whether an overlay is needed. If no overlay thickness is indicated for structural reasons, an overlay may still be placed to correct other problems such as excessive cracking, roughness, rutting, bleeding and/or ravelling. The method does not address the structural requirements of a recycling design at this time.

RECOMMENDATIONS

*The results of this study should be considered for imediate implementation on State-funded overlay projects. A BASIC computer program has been written and is available for use (appendix C).

* Approval for use on Federal aid projects should be requested.

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TABLE 1

OVERALL SUMMARY OF SITES

SITE #	ROUTE #	DIRECTION	MILEPOST BEGIN	MILEPOST END	YEAR NEW SURFACE BEFORE OVERLAY	OVERLAID
1	I-10	WB	297	301	1967	3/1976
2	I-10	EB	368	376	1962	9/1975
3	I-10	EB	376	378	1966	9/1975
4	I-10	WB	368	376	1962	9/1975
5	I-17	NB	313	323	11/1966*	8/1977
6	I-19	NB	37	39	8/1953	6/1976
7	I-19	NB	39	40	11/1953	6/1976
8	I-40	EB	259	264	1972*	12/1980
9	I-40	EB	264	268	1972*	12/1980
10	I-40	EB	311	318	1960	8/1974
11	I-40	WB	313	318	1960	8/1974
12	SR-64		224	237	1956	6/1975
13	SR-73		351	358	1952	10/1975
14	SR-73		350	351	1967	1975
15	SR-77		120	135	1964	3/1977
16	SR-87		292	305	1964	6/1975
17	US-60		50	62	1968	6/1975
18	US-60		245	247	1966	6/1975
19	US-70		300	306	1959	6/1977
20	US-70		306	314	1959	6/1978
21	US-70		331	335	1952	6/1978
22	US-89		451	458	1937	8/1976
23	US-89A		356	370	1937	2/1977
24	US-180		223	235	1958	7/1976

* LAST NEW SURFACE WAS AN OVERLAY

TABLE 2
SITE GENERAL DESCRIPTION

SITE NUMBER AND NAME EXACT LOCATION AND PROJECT NUMBER	ROUTE	ELEV. FT. (METERS)	REG. FACTOR	1982 ADT	1982 18 kip SAEL	DATE BUILT	THICKNESS IN INCHES*									
							ACFC	SEAL COAT	AC	PCCP	BTB	BSB	CTB	AB	SM	SGS
1. Benson MP 296.7-301.3	I-40 WB	4200 (1280)	1.9	14,200	360,674	1965 1976	.5 .5		2.5 1.3					4	13	
2. Bowie - 1 MP 367.7-375.9	I-10 EB	3690 (1125)	1.7	8,580	216,027	1962 1975	 .5		3.0 1.3					4	12	
3. Bowie - 2 MP 375.9-378.3	I-10 EB	3600 (1097)	1.7	8,580	216,027	1966 1975	.5 .5		3.5 1.3					6	21	
4. Bowie - 3 MP 367.7-378.3	I-10 WB	3645 (1111)	1.7	8,580	216,027	1962 1975	 .5		3.0 1.3					4	12	
5. Munds Park MP 312.9-323.0	I-17 NB	6412 (1954)	3.9	7,200	92,907	1962 1966 1977	 .5		 5.5 1.5	 RM		2		5	9	12
6. Tubac - 1 MP 37.1-39.0	I-19 NB	2925 (892)	2.0	7,200	71,390	1953 1976	 .5		 4.8			2		3	12	
7. Tubac - 2 MP 39.0 - 40.0	I-19 NB	2900 (884)	1.8	9,200	91,223	1953 1976	 .5		 6.5			2		2	4	
8. Winslow - 1 MP 259.0 - 264.4	I-40 EB	4885 (1489)	1.7	8,345	220,272	1958 1975 1980	 .5 .5		3.5 1.3 6.0		3				6	
9. Winslow - 2 MP 264.4-268.2	I-40 EB	4885 (1489)	1.7	8,345	220,272	1962 1972 1974 1980	 .5 .5	 .3	4.0 1.5 6.0	 RM				6	6	

HS - Heater Scarification
RM - Rubber Membrane

TABLE 2
SITE GENERAL DESCRIPTION

SITE NUMBER AND NAME EXACT LOCATION AND PROJECT NUMBER	ROUTE	ELEV. FT. (METERS)	REG. FACTOR	1982 ADT	1982 18 kip SAEL	DATE BUILT	THICKNESS IN INCHES*									
							ACFC	SEAL COAT	AC	PCCP	BTB	BSB	CTB	AB	SM	SGS
10. Holbrook - 1 MP 311.2 - 317.8	I-40 EB	5625 (1715)	1.8	8390	272,021	1960 1974	.5		4.0 2.8				6		9	
11. Holbrook - 2 MP 312.5 - 317.6	I-40 WB	5625 (1715)	1.8	8390	272,021	1960 1974	.5		3.0 3.3		5				4	
12. Grand Canyon MP 224.0 - 237.1	SR 64		2.6	2595	3,915	1956 1973 1975		.3 .3	3.0			2			6	
13. White River -1 MP 348.9 - 350.1 MP 351.1 - 357.7	SR 73	5220 (1591)	4.1	2030	9,959	1952 1975 1981	.5		2.0	HS		2			12	
14. Whiteriver - 2 MP 350.1 - 351.1	SR 73	5220 (1591)	4.1	2030	9,959	1967 1972 1975 1977	.5	.3 .3	2.0	HS		2.5			17	
15. Winkelman MP 120.4 - 134.7	SR 77	2100 (640)	2.0	2,350	16,685	1964 1977	.5		2.0 1.5	HS				4	9	
16. Clints Well MP 292.4 - 304.6	SR 87	7271 (2216)	3.8	509	8,838	1964 1975		.3	2.0			1.0			21	
17. Salome MP 49.7 - 62.4	US 60	1900 (579)	1.0	1845	73,394	1958 1968 1975	.5	.3	1.5 1.2	HS		2.0		3	9	

HS - Heater Scarification

TABLE 2
SITE GENERAL DESCRIPTION

SITE NUMBER AND NAME EXACT LOCATION AND PROJECT NUMBER	ROUTE	ELEV. FT. (METERS)	REG. FACTOR	1982 ADT	1982 18 kip SAEL	DATE BUILT	THICKNESS IN INCHES*									
							ACFC	SEAL COAT	AC	PCCP	BTB	BSB	CTB	AB	SM	SGS
18. Globe MP 245.2 - 247.3	US 60	3430 (1046)	1.7	17,150	135,443	1966 1975	.5 .7		4.0 1.5	HS				4	9	
19. San Carlos - 1 MP 300.1 - 306.4	US 70	2690 (820)	2.0	2,285	16,842	1959 1977			1.5	RM		2.5			21	
20. San Carlos -2 MP 306.4 - 314.2	US 70	2730 (832)	1.8	2,285	16,842	1959 1978 1979		 .3	1.5			2.5		3	9	
21. Pima MP 330.9 - 335.6	US 70	3374 (1029)	1.6	4,140	30,513	1951 1978 1980		 .3	3.0			2.0			9	
22. Gray Mtn. MP 450.5 - 458.0	US 89	4936 (1505)	1.8	5,405	49,912	1937 1976		 .3	1.5	RM		1.0		2	4	
23. Cottonwood MP 356.1 - 370.2	US89A	4372 (1333)	2.2	4,625	12,415	1937 1970 1977 1978		 .3 .3 .3	 1.5	 RM		1.5			5	
24. Flagstaff MP 222.9 - 235.3	US 180	7970 (2430)	3.9	2,525	3,893	1958 1971 1976 1976		.3 .3 .3 .3	 3.0	 RM		1.0		2	9	

HS - Heater Scarification
RM - Rubber Membrane

TABLE 3

AVERAGE DYNAFLECT DEFLECTION

B - Before Overlay
A - After Overlay

SITE	MONTHS	TYPE	# OF TESTS	GEOPHONE #1	#2	#3	#4	#5
1	-27	B	46	.70	.49	.28	.18	.12
1	-3	B	12	.92	.63	.38	.23	.16
1	Overlay		3/1976					
1	+23	A	13	.61	.44	.25	.18	.13
2	-30	B	90	1.22	.64	.29	.20	.15
2	Overlay		9/1975					
2	+3	A	24	.61	.46	.29	.21	.15
3	-30	B	29	1.89	.97	.48	.29	.23
3	Overlay		9/1975					
3	+3	A	8	.82	.63	.37	.25	.19
4	-30	B	88	1.20	.66	.33	.22	.17
4	Overlay		9/1975					
4	+3	A	24	.74	.54	.34	.24	.16
5	-27	B	30	.73	.55	.33	.21	.13
5	Overlay		8/1977					
5	+8	A	30	.63	.47	.25	.15	.09
6	-31	B	8	.89	.45	.21	.14	.09
6	Overlay		6/1976					
6	+20	A	6	.59	.42	.27	.21	.14
7	-31	B	3	1.00	.55	.27	.18	.14
7	Overlay		6/1976					
7	+20	A	3	.76	.55	.35	.23	.15
8	-79	B	79	1.89	1.39	.87	.62	.44
8	-70	B	79	1.95	1.44	.95	.72	.52
8	-67	B	78	1.72	1.27	.84	.59	.45
8	-49	B	17	1.52	1.11	.79	.50	.37
8	-20	B	17	1.53	1.07	.65	.45	.34
8	Overlay		12/1980					
8	+1	A	16	.64	.54	.44	.38	.32
8	+5	A	17	.88	.68	.53	.46	.35

TABLE 3

AVERAGE DYNAFLECT DEFLECTION

B - Before Overlay
A - After Overlay

SITE	MONTHS	TYPE	# OF TESTS	GEOPHONES #1	#2	#3	#4	#5
9	-79	B	9	1.36	.83	.45	.31	.23
9	-70	B	9	1.95	1.28	.73	.50	.32
9	-67	B	9	1.38	.87	.50	.34	.26
9	-49	B	11	1.30	.89	.60	.32	.24
9	-20	B	11	1.20	.75	.47	.28	.22
9	Overlay		12/1980					
9	+1	A	11	.57	.45	.34	.28	.21
9	+5	A	11	.81	.64	.44	.31	.24
10	-15	B	58	1.32	1.01	.69	.45	.29
10	Overlay		8/1974					
10	+12	A	16	1.13	.90	.69	.48	.30
10	+45	A	16	.99	.75	.55	.38	.27
11	-11	B	45	1.64	.99	.54	.31	.21
11	Overlay		8/1974					
11	+12	A	13	1.62	1.03	.61	.35	.20
11	+45	A	13	1.38	.92	.50	.34	.23
12	+14	B	137	1.64	.72	.28	.16	.10
12	Overlay		6/1975					
12	+11	A	37	1.01	.63	.27	.15	.10
12	+47	A	37	.78	.42	.26	.13	.08
13	-5	B	20	2.30	1.18	.59	.34	.23
13	Overlay		10/1975					
13	+22	A	20	1.25	.70	.41	.21	.14
14	-5	B	4	2.15	1.03	.44	.22	.13
14	Overlay		10/1975					
14	+22	A	5	1.12	.63	.38	.19	.12
15	-36	B	42	1.11	.59	.29	.21	.14
15	-14	B	43	1.22	.57	.30	.18	.13
15	Overlay		3/1977					
15	+20	A	43	.66	.42	.20	.14	.10

TABLE 3

AVERAGE DYNAFLECT DEFLECTION

B - Before Overlay
A - After Overlay

SITE	MONTHS	TYPE	# OF TESTS	GEOPHONES #1	#2	#3	#4	#5
16	-12	B	116	.85	.49	.26	.16	.11
16	Overlay		6/1975					
16	+27	A	36	.73	.40	.19	.13	.08
16	+47	A	36	1.00	.55	.22	.14	.09
17	-14	B	34	.96	.53	.27	.18	.13
17	Overlay		6/1975					
17	+9	A	34	.78	.54	.32	.18	.13
17	+38	A	26	.76	.51	.29	.20	.15
18	-17	B	4	1.76	1.16	.56	.36	.23
18	Overlay		6/1975					
18	+8	A	4	1.40	.92	.64	.42	.30
18	+41	A	4	.94	.71	.48	.35	.24
19	-40	B	19	1.40	.85	.48	.34	.25
19	-16	B	19	2.02	1.27	.69	.47	.33
19	Overlay		6/1977					
19	+17	A	19	1.11	.79	.46	.37	.25
20	-52	B	22	1.17	.82	.56	.42	.33
20	-28	B	23	1.61	1.14	.71	.53	.40
20	Overlay		6/1978					
20	+5	A	19	1.08	.78	.54	.46	.35
21	-52	B	10	1.46	1.01	.66	.53	.39
21	-28	B	10	1.73	1.21	.79	.61	.45
21	Overlay		6/1978					
21	+5	A	10	1.20	.85	.52	.42	.32
22	-24	B	14	1.89	.99	.50	.31	.19
22	Overlay		8/1976					
22	+11	A	14	.63	.38	.23	.14	.09
22	+32	A	14	.87	.44	.24	.13	.08

TABLE 3

AVERAGE DYNAFLECT DEFLECTION

B - Before Overlay
A - After Overlay

SITE	MONTHS	TYPE	# OF TESTS	GEOPHONE #1	#2	#3	#4	#5
23	-9	B	42	1.65	.90	.43	.23	.14
23	Overlay		2/1977					
23	+19	A	42	.90	.54	.29	.16	.10
24	-23	B	36	3.73	1.50	.57	.27	.20
24	Overlay		7/1976					
24	+1	A	36	2.06	.90	.37	.16	.10
24	+25	A	36	1.31	.76	.34	.20	.09

TABLE 4

AVERAGE RIDE

SITE	72	73	74	75	76	77	78	79	80	81	82
1	47	46	46	61	43*	39	34	23	55	73	43
2	77	104	183	45*	47	47	51	52	72	89	67
3	64	92	173	41*	43	45	45	45	72	96	81
4	91	102	179	38*	43	42	51	47	65	73	64
5	44	59	66	63	74	54*	48	48	72	87	79
6	232	224	237	292	42*	46	52	50	58	81	78
7	191	164	213	230	44*	45	50	45	55	99	70
8	27	57	63	100	136	179	187	131	56*	86	90
9	19	48	77	104	114	160	158	101	59*	85	96
10	211	259	43*	46	59	123	100	121	132	145	129
11	186	215	42*	47	61	145	122	148	156	184	166
12	154	137	144	131*	116	124	150	137	140	154	153
13	219	192	222	189	69*	127	103	84	87	89	69
14	178	163	232	152	74*	125	84	76	82	77	110
15	115	116	115	98	104	80*	80	90	90	87	105
16	227	199	194	194	108*	132	158	135	146	180	158
17	60	88	86	108	48*	104	77	59	82	85	57
18		92									99
19	126	106	116	101	115	139	113*	106	101	95	112
20	158	132	132	127	131	167	99*	94	94	88	101
21	191	160	147	155	142	194	88*	71	73	67	73
22	157	161	163	208	93*	64	86	79	90	90	81
23		194	199	231	172	85*	115	102	127	110	107
24	387	318	362	424	85*	87	114	116	129	137	134

* YEAR OF OVERLAY

TABLE 5

AVERAGE CRACKING

SITE	72	73	74	75	76	77	78	79	80	81	82
1	3	1	1	1	0*	0	0	3	0	.3	.3
2		20	20	0*	0	0	0	.2	.4	.3	.4
3		1	1	0*	0	0	0	.5	.5	.5	0
4		21	21	0*	0	0	.2	.5	.6	.7	1.0
5	0	0	1	.8	.8	0*	0	0	.1	.2	0
6	2	2	2	2	0*	0	0	0	0	0	1.0
7	2	2	2	2	0*	0	0	0	0	1.0	1.0
8		0					1.4	0	0*	0	0
9		.3					.8	0	0*	0	2.5
10		10	0*	0	0	0	0	.2	5.5	.2	.1
11		45	0*	0	0	0	.2	1.2	7.0	1.4	11.8
12		49	49	0*	0	0	0	.7	.7	.5	.6
13		30	30	30	0*	0	0	.9	.9	1.7	.3
14	0	0		0	0*	0	0	0	0	0	0
15	1.5	1.5	1.1	1.0	1.2	0*	.1	.2	.9	.9	.9
16		2.2	2.2	2.2	0*	0	.3	.3	.2	1.6	2.8
17		39	39	39	0*	0	0	0	0	0	.1
18											1.5
19	8.3	7.0	6.7	5.3	9.7	9.7	0*	2.5	1.5	4.7	5.8
20	3.0	3.0	3.3	2.8	6.5	6.5	0*	.9	1.0	.8	1.0
21	6.0		0	6.0	17.5	24.0	0*	0	0	0	0
22		11	11	11	0*	0	0	0	0	0	0
23			3.6	10.4	5.9	0*	0	0	0	0	2.5
24		95	95	95	0*	0	0	0	.4	0	0

* YEAR OF OVERLAY

TABLE 6

AVERAGE PAVEMENT CONDITION BEFORE OVERLAY

SITE	AGE YEARS	PERCENT CRACKING	RIDE INCHES/MILE	RUT DEPTH INCHES	PSI
1	9	1	61	.25	3.94
2	13	25	185	.30	2.66
3	9	1	174	.20	2.84
4	13	21	179	.25	2.74
5	11	1	74	.10	3.83
6	23	2	292	.20	2.20
7	23	2	230	.25	2.47
8	8	1	131	.05	3.22
9	8	1	101	.05	3.51
10	14	12	269	.15	2.31
11	14	53	225	.10	2.51
12	19	49	131	.30	3.04
13	23	30	189	.20	2.70
14	8	0	152	.15	3.03
15	13	1	104	.15	3.46
16	11	2	194	.35	2.59
17	7	39	108	.15	3.36
18	9	8	117	.15	3.31
19	18	9	141	.15	3.09
20	19	5	170	.25	2.82
21	27	24	194	.10	2.71
22	39	11	208	.15	2.63
23	40	6	172	.25	2.81
24	18	95	424	.35	1.54

TABLE 7

SENSITIVITY ANALYSIS

		Regional Factor (R) = 1								
		SIB = 30			SIB = 43			SIB = 56		
		D5=0.1	D5=0.2	D5=0.3	D5=0.1	D5=0.2	D5=0.3	D5=0.1	D5=0.2	D5=0.3
L = 100	Po=100	1.93	1.66	1.50	0.0	0.0	0.0	0.0	0.0	0.0
	Po=200	2.47	2.14	1.93	0.0	0.0	0.0	0.0	0.0	0.0
	Po=300	3.02	2.61	2.36	0.0	0.0	0.0	0.0	0.0	0.0
L = 1000	Po=100	6.00	6.00	6.00	3.36	2.90	2.62	0.0	0.0	0.0
	Po=200	6.00	6.00	6.00	3.91	3.37	3.05	0.0	0.0	0.0
	Po=300	6.00	6.00	6.00	4.45	3.85	3.48	0.0	0.0	0.0
L = 3000	Po=100	6.00	6.00	6.00	6.00	6.00	6.00	0.0	0.0	0.0
	Po=200	6.00	6.00	6.00	6.00	6.00	6.00	0.38	0.33	0.30
	Po=300	6.00	6.00	6.00	6.00	6.00	6.00	0.93	0.80	0.72

L = 18000 pound single axle equivalent loads, thousands
Po = Mays Ridemeter roughness in inches
SIB = Spreadability index before the overlay
D5 = Dynaflect sensor #5 deflection, mils

Table 8

SENSITIVITY ANALYSIS

		Regional Factor (R) = 3								
		SIB = 30			SIB = 43			SIB = 56		
		D5=0.1	D5=0.2	D5=0.3	D5=0.1	D5=0.2	D5=0.3	D5=0.1	D5=0.2	D5=0.3
L = 100	Po=100	3.90	3.37	3.04	0.0	0.0	0.0	0.0	0.0	0.0
	Po=200	4.45	3.84	3.47	0.0	0.0	0.0	0.0	0.0	0.0
	Po=300	5.00	4.31	3.90	0.0	0.0	0.0	0.0	0.0	0.0
L = 1000	Po=100	6.00	6.00	6.00	5.33	4.61	4.16	0.0	0.0	0.0
	Po=200	6.00	6.00	6.00	5.88	5.08	4.59	0.0	0.0	0.0
	Po=300	6.00	6.00	6.00	6.00	5.55	5.02	0.0	0.0	0.0
L = 3000	Po=100	6.00	6.00	6.00	6.00	6.00	6.00	1.81	1.56	1.41
	Po=200	6.00	6.00	6.00	6.00	6.00	6.00	2.36	2.03	1.84
	Po=300	6.00	6.00	6.00	6.00	6.00	6.00	2.90	2.51	2.27

L = 18000 pound single axle equivalent loads, thousands
Po = Mays Ridemeter roughness in inches
SIB = Spreadability Index Before the overlay
D5 = Dynaflect sensor #5 deflection, mils

APPENDIX A
DATA FOR REGRESSION ANALYSIS

Data displayed in Appendix A falls into two groups. Pages 32 - 34 contain data before overlay. Pages 33 - 36 contain data after overlay.

DEFINITIONS FOR PAGES 32 THROUGH 34.

R - AASHTO Regional Factor
AADL - Average number of 18 kip single axle equivalent loads (SAEL) per day for the as-built year.
GF - Traffic load growth factor in percent.
TSAEL - Cumulative 18 kip SAEL in thousands from the as-built year to year of overlay.
YEAR AS - as-built year (year highway constructed).
YEAR OV - Year highway overlaid.
THICK BASE - Unbound crushed stone base in inches.
THICK AC - Asphaltic concrete surface thickness.
MAYS ROUGHNESS BY YEAR - Mays meter roughness in inches/mile.
DYNAFLECT DEFLECTIONS - All five geophone deflections in mils.
SPREAD - Spreadability Index.

Page 33 - 35

All definitions the same as pages 30 - 32 except for the following:

AADL - average number of 18 kip SAEL per day for the year 1982.
TSAEL - Cumulative 18 kip SAEL in thousands for a ten year design period starting at the year of overlay.
THICK ACT - Actual constructed overlay thickness
THICK DES - Design thickness from SODA.
MAYS DES - Mays roughness used for design.

Before Overlay

ROUTE	MILE	R	AADL	GF	TSAEL	YEAR AS	YEAR OV	THICK BASE	THICK AC	MAYS ROUGHNESS BY YEAR 72	73	74	75	76	77	78	79	80	81	82	DYNAFLECT DEFLECTIONS D1	D2	D3	D4	D5	SPREAD
I 10 W	297	1.9	624	1.9	3044.7	65	77	13	3.0	44	49	52	55	47	36	32	20	52	58	38	0.88	0.60	0.39	0.24	0.18	52.0
I 10 W	298	1.9	753	1.4	3575.2	65	77	13	3.0	48	42	36	59	45	34	26	18	39	71	36	0.83	0.67	0.49	0.33	0.25	61.9
I 10 W	299	1.9	753	1.4	3575.2	65	77	13	3.0	60	50	59	76	47	37	37	26	56	82	51	0.88	0.58	0.33	0.20	0.14	48.4
I 10 W	300	1.9	562	2.0	2756.9	65	77	22	3.0	37	43	36	53	55	47	40	28	72	80	48	0.96	0.65	0.36	0.21	0.13	48.1
I 10 E	368	1.7	343	2.1	1849.7	62	75	19	3.0	80	45	147	40	58	52	53	54	83	109	63	1.23	0.62	0.27	0.18	0.14	39.7
I 10 E	369	1.7	343	2.1	1849.7	62	75	19	3.0	111	136	166	49	62	47	59	66	61	87	65	1.57	0.68	0.29	0.19	0.15	36.7
I 10 E	370	1.7	343	2.1	1849.7	62	75	16	3.0	87	141	190	51	58	46	49	43	62	58	63	1.59	0.73	0.29	0.18	0.13	36.7
I 10 E	371	1.7	343	2.1	1849.7	62	75	16	3.0	85	129	215	46	49	43	47	49	76	69	64	1.17	0.66	0.28	0.19	0.14	41.7
I 10 E	372	1.7	343	2.1	1849.7	62	75	16	3.0	63	114	192	37	52	44	43	47	64	89	68	1.01	0.58	0.26	0.17	0.12	42.4
I 10 E	373	1.7	343	2.1	1849.7	62	75	16	3.0	63	87	181	46	52	49	57	57	69	108	79	0.74	0.47	0.24	0.17	0.12	47.0
I 10 E	374	1.7	343	2.1	1849.7	62	75	16	3.0	69	91	200	53	59	53	61	62	84	102	81	0.82	0.50	0.27	0.20	0.16	47.6
I 10 E	375	1.7	343	2.1	1849.7	62	75	16	3.0	88	108	190	47	50	46	49	51	77	72	61	1.12	0.66	0.35	0.24	0.20	45.9
I 10 E	376	1.7	393	2.1	1413.0	66	75	27	4.0	68	84	182	40	51	46	47	50	66	90	78	1.79	0.93	0.46	0.27	0.20	40.8
I 10 E	377	1.7	393	2.1	1413.0	66	75	27	4.0	60	101	165	43	46	45	44	41	78	103	87	1.81	0.90	0.43	0.27	0.22	40.1
I 10 W	368	1.7	343	2.1	1849.7	62	75	19	3.0	61	82	145	32	46	39	53	45	58	60	77	1.08	0.57	0.28	0.20	0.15	42.2
I 10 W	369	1.7	343	2.1	1849.7	62	75	19	3.0	125	146	204	28	46	39	59	42	59	56	64	1.29	0.70	0.34	0.20	0.16	41.7
I 10 W	370	1.7	343	2.1	1849.7	62	75	16	3.0	192	101	219	39	52	39	49	44	70	80	56	1.73	0.82	0.40	0.24	0.18	39.0
I 10 W	371	1.7	343	2.1	1849.7	62	75	16	3.0	153	170	201	41	47	46	47	44	69	86	51	1.42	0.75	0.39	0.25	0.17	42.0
I 10 W	372	1.7	343	2.1	1849.7	62	75	16	3.0	77	105	169	41	46	43	43	42	72	70	55	1.16	0.62	0.28	0.17	0.13	40.7
I 10 W	373	1.7	343	2.1	1849.7	62	75	16	3.0	56	69	158	42	46	50	57	54	74	67	77	0.73	0.48	0.25	0.18	0.14	48.8
I 10 W	374	1.7	343	2.1	1849.7	62	75	16	3.0	54	85	190	44	62	53	61	63	69	79	87	1.08	0.66	0.32	0.22	0.17	45.4
I 10 W	375	1.7	343	2.1	1849.7	62	75	16	3.0	47	68	168	36	46	37	49	34	49	51	54	1.02	0.62	0.36	0.25	0.20	48.0
I 17 N	313	3.9	152	2.6	697.5	66	77	27	8.3	60	72	81	74	80	60	64	72	87	115	87	1.01	0.82	0.52	0.23	0.14	53.9
I 17 N	314	3.9	152	2.6	697.5	66	77	24	8.0	42	49	51	56	62	42	51	53	74	105	91	1.12	0.91	0.63	0.37	0.21	57.9
I 17 N	315	3.9	152	2.6	697.5	66	77	24	8.0	34	39	61	61	88	46	44	45	65	62	64	1.21	0.92	0.62	0.37	0.22	55.2
I 17 N	316	3.9	152	2.6	697.5	66	77	26	8.0	26	39	57	55	75	52	36	33	79	90	77	0.53	0.40	0.24	0.18	0.11	55.1
I 17 N	317	3.9	141	2.8	653.3	66	77	26	8.0	35	52	63	70	71	52	49	37	71	104	94	0.65	0.52	0.35	0.29	0.23	62.8
I 17 N	318	3.9	141	2.8	653.3	66	77	26	8.0	40	62	51	52	69	48	37	43	63	76	65	0.80	0.68	0.42	0.28	0.24	60.5
I 17 N	319	3.9	135	2.9	628.5	66	77	26	8.0	50	80	93	65	94	63	51	51	67	72	79	0.81	0.53	0.25	0.15	0.09	45.2
I 17 N	320	3.9	135	2.9	628.5	66	77	26	8.0	49	56	65	67	97	47	48	38	80	66	76	0.62	0.42	0.22	0.12	0.08	47.1
I 17 N	321	3.9	135	2.9	628.5	66	77	26	8.0	43	63	59	63	92	68	39	40	60	84	78	0.75	0.57	0.26	0.13	0.06	47.2
I 17 N	322	3.7	141	2.8	653.3	66	77	26	8.0	56	73	81	93	107	66	57	70	74	97	90	0.99	0.67	0.36	0.26	0.19	49.9
I 19 N	37	1.8	98	2.8	1087.6	53	76	12	2.0	219	185	207	283	51	46	55	53	56	80	83	0.89	0.44	0.24	0.18	0.08	41.1
I 19 N	38	1.8	98	2.8	1087.6	53	76	15	2.0	232	224	237	292	45	47	50	47	60	83	75	0.79	0.40	0.16	0.11	0.08	39.0
I 19 N	39	1.8	98	2.8	1087.6	53	76	15	2.0	191	164	213	230	50	45	50	45	55	99	71	1.17	0.62	0.31	0.21	0.16	42.2
I 40 E	259	1.7	428	2.9	1394.7	72	80	9	8.6	20	38	52	79	124	191	191	235	93	105	114	0.63	0.52	0.24	0.18	0.12	53.7
I 40 E	260	1.7	428	2.9	1394.7	72	80	9	8.6	40	64	72	104	163	183	169	98	50	81	83	2.03	1.42	0.80	0.63	0.43	52.3
I 40 E	261	1.7	428	2.9	1394.7	72	80	9	8.1	23	68	66	115	131	137	159	103	44	70	91	1.05	0.71	0.57	0.37	0.28	56.8
I 40 E	262	1.7	428	2.9	1394.7	72	80	9	8.6	29	56	62	103	146	156	193	103	55	96	93	2.04	1.40	0.77	0.61	0.44	51.6
I 40 E	263	1.7	428	2.9	1394.7	72	80	9	8.6	23	61	64	101	207	228	224	118	37	77	75	1.87	1.20	0.72	0.54	0.44	51.0
I 40 E	264	1.7	428	2.9	1394.7	72	80	15	8.6	15	35	41	82	105	133	133	126	61	63	65	0.95	0.53	0.28	0.14	0.06	41.3
I 40 E	265	1.7	428	2.9	1204.5	72	79	12	6.3	14	34	41	79	90	122	154	98	43	56	78	0.98	0.61	0.37	0.19	0.17	47.3
I 40 E	266	1.7	428	2.9	1204.5	72	79	12	6.3	21	58	112	135	179	209	168	82	72	58	103	0.84	0.50	0.24	0.18	0.13	45.0
I 40 E	267	1.7	428	2.9	1204.5	72	79	12	6.3	26	65	113	119	142	174	178	99	61	163	143	1.33	0.72	0.45	0.24	0.19	44.1
I 40 E	312	1.8	389	2.2	2293.9	60	74	4	4.0	197	250	38	36	58	124	89	104	114	138	112	0.99	0.80	0.62	0.42	0.29	63.0
I 40 E	313	1.8	373	2.3	2212.9	60	74	9	4.0	275	322	49	50	78	135	124	149	181	191	186	1.19	0.90	0.64	0.42	0.28	57.6
I 40 E	314	1.8	373	2.3	2212.9	60	74	6	4.0	187	266	38	47	64	123	98	122	132	112	116	1.19	0.91	0.59	0.36	0.22	55.0
I 40 E	315	1.8	373	2.3	2212.9	60	74	12	4.0	198	241	46	52	71	123	114	145	158	171	158	1.17	0.88	0.57	0.33	0.20	53.8
I 40 E	316	1.8	373	2.3	2212.9	60	74	4	4.0	198	266	55	52	73	118	89	114	117	139	144	1.37	1.02	0.68	0.45	0.30	55.8
I 40 E	317	1.8	373	2.3	2212.9	60	74	6	4.0	175	214	35	39	58	114	85	89	93	118	98	1.37	1.02	0.68	0.45	0.30	55.8
I 40 W	313	1.8	373	2.3	2212.9	60	74	4	8.0	216	268	47	56	78	145	117	152	157	217	228	1.50	0.95	0.53	0.33	0.22	47.1
I 40 W	314	1.8	373	2.3	2212.9	60	74	4	8.0	150	189	38	45	70	134	106	124	130	162	149	1.30	0.76	0.38	0.21	0.14	42.9
I 40 W	315	1.8	373	2.3	2212.9	60	74	7	8.0	190	230	47	48	72	155	143	150	146	190	167	1.57	0.93	0.52	0.28	0.19	44.5
I 40 W	316	1.8	373	2.3	2212.9	60	74	4	8.0	213	211	41	60	67	173	155	211	183	214	199	1.41	0.84	0.48	0.27	0.20	45.4
S 64 E	225	2.6	6	3.7	56.2	56	75	6	2.3	148	129	142	134	128	123	138	138	145	144	165	1.40	0.59	0.22	0.12	0.08	34.4
S 64 E	226	2.6	6	3.7	56.2	56	75	6	2.3	163	148	154	125	113	113	136	125	127	149	150	3.23	1.40	0.60	0.36	0.21	35.9
S 64 E	227	2.6	6	3.7	56.2	56	75	6	2.3	176	151	161	113	115	106	128	120	115	139	137	2.46	1.14	0.40	0.20	0.10	35.0

Before Overlay

ROUTE	MILE	R	AADL	GF	TSAEL	YEAR AS	YEAR OV	THICK BASE	THICK AC	MAYS ROUGHNESS BY YEAR 72	73	74	75	76	77	78	79	80	81	82	DYNAFLECT DEFLECTIONS D1	D2	D3	D4	D5	SPREAD
S 64	E 228	2.6	6	3.7	56.2	56	75	6	2.3	144	128	141	116	120	112	144	120	137	130	145	1.70	0.60	0.13	0.05	0.02	29.4
S 64	E 229	2.6	6	3.7	56.2	56	75	6	2.3	161	142	165	128	131	124	152	142	153	166	164	2.31	0.74	0.23	0.13	0.08	30.2
S 64	E 230	2.6	6	3.7	56.2	56	75	6	2.3	142	131	151	135	134	129	152	147	141	165	163	1.45	0.56	0.17	0.12	0.07	32.7
S 64	E 231	2.6	6	3.7	56.2	56	75	6	2.3	122	105	120	130	138	123	161	139	126	140	170	1.24	0.55	0.18	0.08	0.05	33.9
S 64	E 232	2.6	6	3.7	56.2	56	75	6	2.3	194	164	172	136	133	122	156	135	129	165	166	1.21	0.63	0.21	0.11	0.06	36.7
S 64	E 233	2.6	6	3.7	56.2	56	75	6	2.3	144	128	140	144	142	134	157	145	151	167	164	1.15	0.53	0.21	0.12	0.08	36.3
S 64	E 234	2.6	6	3.7	56.2	56	75	6	2.3	124	119	110	131	140	133	154	137	136	142	143	0.71	0.30	0.12	0.06	0.04	34.6
S 64	E 235	2.6	6	3.7	56.2	56	75	6	2.3	192	176	151	147	146	141	166	149	174	177	166	0.80	0.40	0.22	0.13	0.08	40.7
S 64	E 236	2.6	9	4.9	91.5	56	75	6	2.3	141	126	117	129	129	124	155	147	143	164	137	1.44	0.71	0.38	0.24	0.16	40.7
S 73	N 349	3.7	15	1.5	155.1	52	76	12	4.3	147	133	129	130	72	114	102	77	92	82	115	1.62	0.85	0.45	0.25	0.15	41.0
S 73	N 350	4.1	15	1.5	155.1	52	76	17	5.1	178	163	232	152	84	125	84	76	82	77	111	0.90	0.38	0.15	0.05	0.02	33.3
S 73	N 351	4.1	15	1.5	155.1	52	76	12	4.3	285	262	256	218	67	106	83	63	63	64	44	1.57	0.68	0.25	0.13	0.06	34.3
S 73	N 352	4.1	15	1.5	155.1	52	76	12	4.0	257	219	269	269	73	124	99	89	88	96	78	2.14	0.94	0.42	0.25	0.19	36.8
S 73	N 353	4.1	15	1.5	155.1	52	76	12	4.0	221	189	223	228	81	143	133	116	118	118	109	2.49	1.23	0.56	0.30	0.20	38.4
S 73	N 354	4.1	15	1.5	155.1	52	76	12	4.0	214	192	227	116	67	126	92	75	76	81	65	2.31	1.16	0.57	0.32	0.20	39.5
S 73	N 355	4.1	15	1.5	155.1	52	76	12	4.0	251	203	246	212	87	127	113	91	94	101	60	2.13	1.19	0.63	0.34	0.23	42.4
S 73	N 356	4.1	15	1.5	155.1	52	76	12	4.0	198	174	190	188	90	150	114	85	81	91	58	2.54	1.38	0.64	0.36	0.23	40.6
S 73	N 357	4.1	15	1.5	155.1	52	76	12	4.0	200	205	266	215	85	140	102	86	101	95	77	2.54	1.38	0.64	0.36	0.23	40.6
S 77	N 121	2.0	30	2.1	148.0	65	77	13	2.3	113	105	102	96	110	77	74	80	91	79	82	0.97	0.52	0.31	0.22	0.17	45.2
S 77	N 122	2.0	30	2.1	148.0	65	77	16	2.3	112	109	108	98	106	67	67	83	74	79	90	1.01	0.53	0.30	0.19	0.15	43.2
S 77	N 123	2.0	30	2.1	148.0	65	77	16	2.3	121	114	112	100	104	89	102	115	119	109	130	1.19	0.61	0.40	0.26	0.21	44.9
S 77	N 124	2.0	30	2.1	148.0	65	77	16	2.3	114	134	119	123	116	61	57	67	66	71	85	1.15	0.50	0.23	0.12	0.08	36.2
S 77	N 125	2.0	30	2.1	148.0	65	77	13	2.3	141	172	177	159	139	80	80	92	91	86	107	1.39	0.65	0.28	0.14	0.10	36.8
S 77	N 126	2.0	30	2.1	148.0	65	77	13	2.3	118	110	124	87	145	97	98	106	108	102	119	0.58	0.30	0.19	0.12	0.09	44.1
S 77	N 127	2.0	29	2.1	156.4	64	77	13	2.3	119	124	117	94	122	97	93	99	104	95	102	1.21	0.58	0.28	0.16	0.12	38.8
S 77	N 128	2.0	29	2.1	156.4	64	77	13	2.3	113	88	89	75	103	72	77	81	76	82	96	0.73	0.32	0.21	0.14	0.10	41.1
S 77	N 129	2.0	29	2.1	156.4	64	77	13	2.3	107	92	90	69	94	70	68	78	77	70	84	1.04	0.47	0.23	0.14	0.11	38.3
S 77	N 130	2.0	29	2.1	156.4	64	77	13	2.3	120	119	119	92	121	86	86	103	102	93	117	1.19	0.49	0.24	0.15	0.11	36.6
S 77	N 131	2.0	30	2.1	148.0	65	77	13	2.7	104	119	112	92	127	79	77	87	88	87	111	1.99	0.89	0.44	0.23	0.14	37.1
S 77	N 132	2.0	30	2.1	148.0	65	77	10	2.7	107	113	117	96	125	83	84	89	91	89	94	1.58	0.66	0.32	0.19	0.15	36.7
S 77	N 133	2.0	30	2.1	148.0	65	77	10	2.7	106	106	104	91	110	84	78	87	81	90	115	1.66	0.72	0.37	0.22	0.16	37.7
S 77	N 134	2.1	30	2.1	148.0	65	77	10	2.3	118	105	103	87	103	94	98	112	107	134	146	0.71	0.33	0.17	0.10	0.07	38.9
S 87	N 292	3.8	20	1.8	22.5	72	75	21	2.0	166	145	146	100	111	118	130	117	121	152	141	0.84	0.50	0.24	0.11	0.06	41.7
S 87	N 293	3.8	16	1.8	70.6	64	75	21	2.0	237	215	223	105	120	126	149	126	136	158	133	0.72	0.38	0.22	0.11	0.08	41.9
S 87	N 294	3.8	16	1.8	70.6	64	75	21	2.0	274	227	194	100	118	117	141	120	112	166	152	0.78	0.40	0.18	0.08	0.05	38.2
S 87	N 295	3.8	16	1.8	70.6	64	75	21	2.0	265	233	219	105	145	154	187	169	192	231	209	0.92	0.55	0.32	0.19	0.12	45.7
S 87	N 296	3.8	16	1.8	70.6	64	75	21	2.0	237	207	225	105	119	125	153	133	141	195	159	0.67	0.37	0.22	0.12	0.09	43.9
S 87	N 297	3.8	16	1.8	70.6	64	75	21	2.0	209	171	190	105	168	181	196	181	221	245	238	0.67	0.36	0.20	0.12	0.08	42.7
S 87	N 298	3.8	16	1.8	70.6	64	75	21	2.0	199	194	190	100	124	134	160	139	148	180	162	0.81	0.46	0.25	0.16	0.11	44.2
S 87	N 299	3.8	16	1.8	70.6	64	75	21	2.0	208	174	167	100	122	132	163	134	133	151	152	0.80	0.45	0.24	0.16	0.10	43.7
S 87	N 300	3.8	16	1.8	70.6	64	75	21	2.0	243	212	224	98	104	119	151	121	139	163	142	0.83	0.50	0.27	0.19	0.14	46.5
S 87	N 301	3.8	16	1.8	70.6	64	75	21	2.0	215	181	165	105	112	122	145	120	137	167	136	0.80	0.52	0.29	0.19	0.13	48.2
S 87	N 302	3.8	16	1.8	70.6	64	75	21	2.0	200	189	162	88	94	111	137	107	116	156	120	0.76	0.39	0.20	0.11	0.07	40.3
S 87	N 303	3.8	16	1.8	70.6	64	75	21	2.0	213	185	174	115	115	135	156	134	133	169	157	0.71	0.41	0.23	0.14	0.09	44.5
S 87	N 304	3.3	16	1.8	70.6	64	75	21	2.0	253	212	186	150	121	155	187	165	201	199	181	0.71	0.41	0.23	0.14	0.09	44.5
U 60	E 51	1.0	133	2.4	425.6	68	76	9	3.5	32	53	69	77	49	101	79	54	75	72	62	0.92	0.54	0.25	0.18	0.13	43.9
U 60	E 52	1.0	133	2.4	425.6	68	76	9	3.5	60	72	84	104	49	105	65	45	63	74	47	1.19	0.56	0.18	0.08	0.05	34.6
U 60	E 53	1.0	133	2.4	425.6	68	76	12	3.5	67	87	87	116	35	100	70	41	77	83	35	0.89	0.55	0.23	0.12	0.07	41.8
U 60	E 54	1.0	133	2.4	425.6	68	76	12	3.8	70	89	75	129	49	100	69	60	72	63	43	0.57	0.31	0.16	0.10	0.07	42.5
U 60	E 55	1.0	133	2.4	425.6	68	76	9	3.8	66	110	77	143	60	115	78	66	75	70	64	0.74	0.35	0.19	0.14	0.10	41.1
U 60	E 56	1.0	133	2.4	425.6	68	76	9	3.8	66	105	92	118	69	110	88	76	79	84	73	0.87	0.48	0.23	0.17	0.12	43.0
U 60	E 57	1.0	113	2.9	368.2	68	76	12	3.8	56	77	81	117	52	95	72	55	80	80	52	0.96	0.60	0.34	0.22	0.15	47.3
U 60	E 58	1.0	113	2.9	368.2	68	76	9	3.8	54	90	87	86	52	87	71	52	89	91	51	0.92	0.56	0.29	0.20	0.14	45.9
U 60	E 59	1.0	113	2.9	368.2	68	76	9	3.8	59	85	86	86	43	100	65	47	92	97	57	0.80	0.46	0.25	0.18	0.12	45.2
U 60	E 60	1.0	113	2.9	368.2	68	76	9	3.8	70	98	99	95	62	111	89	70	93	106	72	0.77	0.50	0.26	0.18	0.12	47.5
U 60	E 61	1.0	113	2.9	368.2	68	76	12	3.8	71	107	112	119	75	120	98	86	102	117	92	0.57	0.31	0.20	0.14	0.12	47.0
U 60	E 62	1.0	113	2.9	368.2	68	76	9	3.8	69	103	96	62	60	95	74	93	60	102	60	0.57	0.32	0.20	0.14	0.12	47.4

Before Overlay

ROUTE	MILE	R	AADL	GF	TSAEL	YEAR AS	YEAR OV	THICK BASE	THICK AC	MAYS ROUGHNESS BY YEAR 72	73	74	75	76	77	78	79	80	81	82	DYNAFLECT DEFLECTIONS D1	D2	D3	D4	D5	SPREAD
U 70	E 301	2.0	19	2.4	161.8	59	78	21	2.8	134	106	125	101	144	148	119	128	120	114	128	2.14	1.19	0.58	0.37	0.24	42.2
U 70	E 302	2.0	19	2.4	161.8	59	78	21	2.8	140	111	119	103	133	167	111	103	95	94	101	1.74	0.99	0.46	0.27	0.18	41.8
U 70	E 303	2.0	23	3.7	215.6	59	78	21	2.8	113	96	106	88	118	110	92	75	64	67	86	1.90	1.14	0.70	0.53	0.40	49.2
U 70	E 304	2.0	23	3.7	215.6	59	78	21	2.8	136	121	132	117	139	134	119	114	97	100	130	2.74	1.89	1.06	0.77	0.55	51.2
U 70	E 305	2.0	23	3.7	215.6	59	78	21	2.8	120	100	106	95	113	124	102	91	104	85	96	2.33	1.57	0.86	0.58	0.40	49.3
U 70	E 306	1.8	23	3.7	215.6	59	78	21	2.8	157	128	130	131	145	154	135	127	141	115	141	1.67	1.06	0.55	0.39	0.29	47.4
U 70	E 307	1.8	23	3.7	215.6	59	78	12	2.5	143	124	127	117	141	160	104	95	97	94	99	1.86	1.33	0.77	0.52	0.36	52.0
U 70	E 308	1.8	23	3.7	215.6	59	78	12	2.5	138	121	128	116	157	179	96	82	91	86	114	1.62	1.05	0.58	0.43	0.31	49.3
U 70	E 309	1.8	23	3.7	215.6	59	78	15	2.5	149	135	154	147	171	192	100	95	98	88	105	1.67	1.23	0.83	0.67	0.53	59.0
U 70	E 310	1.8	23	3.7	215.6	59	78	15	2.5	153	124	150	129	151	149	99	100	100	89	94	1.16	0.92	0.67	0.54	0.42	64.0
U 70	E 311	1.8	23	3.7	215.6	59	78	15	2.5	176	146	141	130	145	179	94	94	94	87	104	1.85	1.37	0.83	0.62	0.48	55.7
U 70	E 312	1.8	23	3.7	215.6	59	78	15	2.5	174	143	140	128	147	168	87	78	67	75	79	1.33	0.98	0.67	0.53	0.43	59.2
U 70	E 313	1.8	23	3.7	215.6	59	78	12	2.5	167	136	78	118	129	160	84	75	70	70	81	1.55	0.98	0.58	0.44	0.33	50.1
U 70	E 314	1.8	27	3.0	240.6	59	78	12	2.5	153	130	130	108	192	184	133	75	57	73	82	1.55	0.98	0.58	0.44	0.33	50.1
U 70	E 331	1.5	28	4.2	410.8	52	78	9	3.5	245	211	207	211	216	216	85	79	97	80	88	2.55	1.65	0.90	0.64	0.43	48.4
U 70	E 332	1.5	42	3.4	603.9	51	78	9	3.5	145	132	106	102	112	149	90	68	71	63	69	2.26	1.53	0.86	0.62	0.43	50.4
U 70	E 333	1.5	41	3.0	567.7	51	78	9	3.5	174	144	139	144	173	204	94	62	69	66	72	1.33	0.91	0.73	0.62	0.48	61.2
U 89	N 443	2.5	69	3.8	1710.0	37	76	12	2.0	188	167	186	65	78	58	80	75	96	110	78	1.95	1.02	0.53	0.29	0.19	40.8
U 89	N 444	2.5	69	3.8	1710.0	37	76	12	2.0	183	194	143	62	79	55	86	66	75	74	58	2.19	1.13	0.58	0.41	0.28	41.9
U 89	N 445	2.5	69	3.8	1710.0	37	76	12	2.0	147	136	130	156	165	168	145	153	96	92	75	0.97	0.60	0.32	0.21	0.14	46.2
U 89	N 446	2.5	69	3.8	1710.0	37	76	12	2.0	139	127	109	200	199	178	187	188	148	130	123	1.39	0.74	0.44	0.31	0.21	44.5
U 89	N 447	2.5	69	3.8	1710.0	37	76	12	2.0	186	225	154	85	89	81	96	88	123	70	71	1.49	0.89	0.57	0.34	0.23	47.2
U 89	N 448	2.5	69	3.8	1710.0	37	76	12	2.0	164	184	177	75	92	78	102	87	100	69	68	1.62	0.92	0.55	0.35	0.25	45.6
U 89	N 449	2.5	69	3.8	1710.0	37	76	12	2.0	157	182	212	132	132	135	135	121	116	92	93	2.19	1.15	0.60	0.33	0.19	40.7
U 89	N 450	1.8	69	3.8	1710.0	37	76	12	2.0	134	153	124	107	95	62	79	82	75	66	77	2.18	1.15	0.60	0.33	0.19	40.8
U 89	N 452	1.8	69	3.8	1710.0	37	76	12	2.0	125	132	136	162	108	55	75	68	89	59	72	1.57	0.97	0.58	0.37	0.23	47.4
U 89	N 453	1.8	69	3.8	1710.0	37	76	12	2.0	147	158	189	231	130	68	91	91	81	84	93	1.18	0.64	0.29	0.20	0.14	41.5
U 89	N 454	1.8	69	3.8	1710.0	37	76	12	2.0	164	164	174	214	133	71	91	86	76	89	96	1.63	1.00	0.51	0.29	0.20	44.5
U 89	N 455	1.8	69	3.8	1710.0	37	76	12	2.0	154	155	175	225	129	59	81	72	101	99	71	1.18	0.61	0.30	0.18	0.10	40.2
U 89	N 456	1.8	69	3.8	1710.0	37	76	12	2.0	155	160	161	230	61	65	79	72	101	109	78	1.92	0.91	0.34	0.15	0.06	35.2
U 89AN	357	2.5	17	2.7	369.4	38	77	8	2.8	140	166	169	204	164	75	112	97	140	103	118	1.43	0.81	0.45	0.22	0.12	42.4
U 89AN	358	2.5	17	2.7	369.4	38	77	8	2.8	180	221	198	245	209	90	123	110	122	90	102	1.40	0.85	0.50	0.30	0.21	46.6
U 89AN	359	2.5	17	2.7	369.4	38	77	8	2.8	170	192	195	216	197	79	111	99	119	96	87	1.18	0.68	0.34	0.22	0.14	43.4
U 89AN	360	2.5	17	2.7	369.4	38	77	8	2.8	150	176	196	201	176	89	104	97	116	109	95	1.05	0.64	0.36	0.24	0.16	46.7
U 89AN	361	2.5	17	2.7	369.4	38	77	8	2.8	150	171	195	199	186	85	112	102	123	118	102	1.19	0.58	0.30	0.19	0.12	40.0
U 89AN	362	2.5	17	2.7	382.2	37	77	8	2.8	160	186	186	179	188	78	111	104	119	115	114	1.66	0.81	0.30	0.14	0.09	36.1
U 89AN	363	2.5	17	2.7	382.2	37	77	8	2.8	190	219	208	252	215	88	121	100	127	105	108	2.26	1.34	0.57	0.23	0.13	40.1
U 89AN	364	2.5	14	3.0	327.0	37	77	8	2.8	190	211	222	238	209	69	109	85	121	92	101	1.84	0.90	0.43	0.24	0.15	38.7
U 89AN	365	2.5	14	3.0	327.0	37	77	8	2.8	160	177	199	210	181	76	108	82	109	86	89	2.10	1.20	0.60	0.31	0.18	41.8
U 89AN	366	2.5	14	3.0	327.0	37	77	8	2.8	150	193	176	212	192	91	120	100	126	115	118	0.77	0.34	0.16	0.09	0.05	36.6
U 89AN	367	2.5	14	3.0	327.0	37	77	8	2.8	150	173	187	321	180	81	110	87	114	93	93	1.04	0.50	0.18	0.08	0.03	35.2
U 89AN	368	2.5	14	3.0	327.0	37	77	8	2.8	210	247	236	267	211	101	120	107	130	131	120	1.65	0.82	0.30	0.12	0.06	35.8
U 89AN	369	2.5	14	3.0	327.0	37	77	8	2.8	220	241	270	315	266	99	120	126	137	144	118	1.03	0.60	0.26	0.14	0.08	41.0
U 89AN	370	2.7	14	3.0	327.0	37	77	8	2.8	225	242	281	287	272	175	130	133	139	148	135	1.03	0.60	0.26	0.13	0.08	40.8
U180	E 224	3.9	8	1.0	57.3	58	76	11	1.6	418	338	431	478	107	99	119	124	122	154	153	2.95	1.39	0.52	0.28	0.23	36.4
U180	E 225	3.9	8	1.0	57.3	58	76	11	1.6	418	348	461	515	108	96	146	151	147	178	174	3.23	1.40	0.32	0.07	0.05	31.4
U180	E 226	3.9	8	1.0	57.3	58	76	11	1.6	407	344	365	463	115	89	130	169	183	166	167	3.85	1.71	0.57	0.24	0.16	33.9
U180	E 227	3.9	8	1.0	57.3	58	76	11	1.6	416	348	436	480	106	102	121	122	131	136	134	3.37	1.29	0.34	0.16	0.10	31.2
U180	E 228	3.9	8	1.0	57.3	58	76	11	1.6	424	334	387	479	93	83	109	103	112	117	122	4.04	1.71	0.49	0.11	0.05	31.7
U180	E 229	3.9	8	1.0	57.3	58	76	11	1.6	340	277	319	381	80	76	94	99	128	127	131	2.63	0.97	0.42	0.18	0.08	32.5
U180	E 230	3.9	8	1.0	57.3	58	76	11	1.6	319	258	275	337	84	82	108	109	120	145	146	3.31	1.50	0.41	0.24	0.21	34.3
U180	E 231	3.9	8	1.0	57.3	58	76	11	1.6	360	299	327	388	96	88	125	103	131	124	138	4.78	1.20	0.40	0.14	0.13	27.8
U180	E 232	3.9	8	1.0	57.3	58	76	11	1.6	372	301	346	337	77	87	112	107	125	134	122	4.27	1.86	0.90	0.46	0.29	36.4
U180	E 233	3.9	8	1.0	57.3	58	76	14	1.6	384	314	326	410	86	78	102	98	121	118	113	4.04	1.91	1.23	0.76	0.60	42.3
U180	E 234	3.9	8	1.0	57.3	58	76	14	1.6	407	329	329	398	76	64	90	79	98	103	91	3.10	1.17	0.39	0.13	0.11	31.6
U180	E 235	4.0	8	1.0	53.9	59	76	9	2.8	138	112	120	131	95	99	120	115	128	124	111	2.47	0.79	0.26	0.07	0.04	29.4

After Overlay

ROUTE	MILE	R	AADL	GF	TSAEL	OV YR	THICK ACT	THICK DES	MAYS DES	MAYS ROUGHNESS BY YEAR 72	73	74	75	76	77	78	79	80	81	82	DYNAFLECT DEFLECTIONS D1	D2	D3	D4	D5	SPREAD
I 10 W	297	1.9	922	1.9	3685.0	77	1.8	3.3	53	44	49	52	55	47	36	32	20	52	58	38	0.65	0.47	0.27	0.22	0.16	54.5
I 10 W	298	1.9	988	1.4	3858.6	77	1.8	0.0	49	48	42	36	59	45	34	26	18	39	71	36	0.62	0.45	0.26	0.21	0.17	55.2
I 10 W	299	1.9	988	1.4	3858.6	77	1.8	5.8	60	60	50	59	76	47	37	37	26	56	82	51	0.73	0.46	0.22	0.19	0.12	47.1
I 10 W	300	1.9	852	2.0	3420.8	77	1.8	5.6	50	37	43	36	53	55	47	40	28	72	80	48	0.47	0.32	0.20	0.15	0.09	52.3
I 10 E	368	1.7	592	2.1	2387.7	75	1.8	6.0	96	80	45	147	40	58	52	53	54	83	109	63	0.67	0.44	0.22	0.17	0.10	47.8
I 10 E	369	1.7	592	2.1	2387.7	75	1.8	6.0	147	111	136	166	49	62	47	59	66	61	87	65	0.76	0.50	0.26	0.21	0.14	49.2
I 10 E	370	1.7	592	2.1	2387.7	75	1.8	6.0	151	87	141	190	51	58	46	49	43	62	58	63	0.65	0.43	0.24	0.15	0.09	48.0
I 10 E	371	1.7	592	2.1	2387.7	75	1.8	6.0	156	85	129	215	46	49	43	47	49	76	69	64	0.47	0.29	0.22	0.13	0.09	51.1
I 10 E	372	1.7	592	2.1	2387.7	75	1.8	6.0	134	63	114	192	37	52	44	43	47	64	89	68	0.66	0.51	0.30	0.19	0.12	53.9
I 10 E	373	1.7	592	2.1	2387.7	75	1.8	5.1	120	63	87	181	46	52	49	57	57	69	108	79	0.77	0.50	0.28	0.18	0.11	47.8
I 10 E	374	1.7	592	2.1	2387.7	75	1.8	4.5	131	69	91	200	53	59	53	61	62	84	102	81	0.60	0.40	0.26	0.19	0.13	52.7
I 10 E	375	1.7	592	2.1	2387.7	75	1.8	5.2	139	88	108	190	47	50	46	49	51	77	72	61	0.78	0.58	0.34	0.24	0.19	54.6
I 10 E	376	1.7	592	2.1	2387.7	75	1.8	6.0	127	68	84	182	40	51	46	47	50	66	90	78	0.88	0.55	0.27	0.20	0.15	46.6
I 10 E	377	1.7	592	2.1	2387.7	75	1.8	6.0	123	60	101	165	43	46	45	44	41	78	103	87	0.79	0.52	0.27	0.24	0.17	50.4
I 10 W	368	1.7	592	2.1	2387.7	75	1.8	6.0	103	61	82	145	32	46	39	53	45	58	60	77	0.69	0.40	0.26	0.15	0.10	46.4
I 10 W	369	1.7	592	2.1	2387.7	75	1.8	6.0	170	125	146	204	28	46	39	59	42	59	56	64	0.68	0.45	0.24	0.17	0.11	48.5
I 10 W	370	1.7	592	2.1	2387.7	75	1.8	6.0	182	192	101	219	39	52	39	49	44	70	80	56	0.48	0.32	0.25	0.16	0.10	54.6
I 10 W	371	1.7	592	2.1	2387.7	75	1.8	6.0	187	153	170	201	41	47	46	47	44	69	86	51	1.00	0.63	0.30	0.24	0.16	46.6
I 10 W	372	1.7	592	2.1	2387.7	75	1.8	6.0	126	77	105	169	41	46	43	43	42	72	70	55	0.95	0.61	0.29	0.23	0.15	46.9
I 10 W	373	1.7	592	2.1	2387.7	75	1.8	3.8	103	56	69	158	42	46	50	57	54	74	67	77	0.78	0.56	0.34	0.23	0.14	52.6
I 10 W	374	1.7	592	2.1	2387.7	75	1.8	5.6	120	54	85	190	44	62	53	61	63	69	79	87	0.86	0.62	0.33	0.26	0.17	52.1
I 10 W	375	1.7	592	2.1	2387.7	75	1.8	3.9	105	47	68	168	36	46	37	49	34	49	51	54	0.59	0.45	0.27	0.24	0.16	58.0
I 17 N	313	3.9	261	2.6	1076.5	77	2.3	0.0	80	60	72	81	74	80	60	64	72	87	115	87	0.85	0.66	0.39	0.21	0.11	52.2
I 17 N	314	3.9	261	2.6	1076.5	77	2.3	0.0	59	42	49	51	56	62	42	51	53	74	105	91	0.97	0.79	0.43	0.21	0.09	51.3
I 17 N	315	3.9	261	2.6	1076.5	77	2.3	0.0	70	34	39	61	61	88	46	44	45	65	62	64	0.77	0.61	0.35	0.19	0.10	52.5
I 17 N	316	3.9	261	2.6	1076.5	77	2.3	0.0	63	26	39	57	55	75	52	36	33	79	90	77	0.40	0.29	0.21	0.12	0.07	54.5
I 17 N	317	3.9	255	2.8	1061.1	77	2.3	0.0	69	35	52	63	70	71	52	49	37	71	104	94	0.38	0.28	0.17	0.13	0.09	55.3
I 17 N	318	3.9	255	2.8	1061.1	77	2.3	0.0	62	40	62	51	52	69	48	37	43	63	76	65	0.58	0.43	0.21	0.17	0.11	51.7
I 17 N	319	3.9	251	2.9	1049.0	77	2.3	5.1	85	50	80	93	65	94	63	51	51	67	72	79	0.70	0.43	0.23	0.12	0.07	44.3
I 17 N	320	3.9	251	2.9	1049.0	77	2.3	3.9	78	49	56	65	67	97	47	48	38	80	66	76	0.40	0.27	0.13	0.07	0.04	45.5
I 17 N	321	3.9	251	2.9	1049.0	77	2.3	4.0	75	43	63	59	63	92	68	39	40	60	84	78	0.37	0.21	0.11	0.06	0.04	42.7
I 17 N	322	3.7	255	2.8	1061.1	77	2.3	1.7	94	56	73	81	93	107	66	57	70	74	97	90	0.69	0.45	0.23	0.16	0.12	47.8
I 19 N	37	1.8	196	2.8	815.6	76	8.0	5.4	237	219	185	207	283	51	46	55	53	56	80	83	0.54	0.34	0.27	0.16	0.10	52.2
I 19 N	38	1.8	196	2.8	815.6	76	5.3	6.0	262	232	224	237	292	45	47	50	47	60	83	75	0.71	0.52	0.33	0.24	0.18	55.8
I 19 N	39	1.8	196	2.8	815.6	76	5.3	4.0	211	191	164	213	230	50	45	50	45	55	99	71	0.63	0.45	0.25	0.23	0.14	54.0
I 40 E	259	1.7	603	2.9	2520.1	80	6.8	1.9	228	20	38	52	79	124	191	191	235	93	105	114	0.52	0.36	0.20	0.19	0.13	53.8
I 40 E	260	1.7	603	2.9	2520.1	80	6.8	1.7	169	40	64	72	104	163	183	169	98	50	81	83	0.96	0.73	0.69	0.53	0.39	68.7
I 40 E	261	1.7	603	2.9	2520.1	80	6.8	0.0	155	23	68	66	115	131	137	159	103	44	70	91	0.79	0.63	0.52	0.41	0.32	67.6
I 40 E	262	1.7	603	2.9	2520.1	80	6.8	2.1	171	29	56	62	103	146	156	193	103	55	96	93	1.20	0.92	0.65	0.63	0.49	64.8
I 40 E	263	1.7	603	2.9	2520.1	80	6.8	2.5	217	23	61	64	101	207	228	224	118	37	77	75	0.90	0.71	0.61	0.56	0.46	72.0
I 40 E	264	1.7	603	2.9	2520.1	80	6.8	6.0	150	15	35	41	82	105	133	133	126	61	63	65	0.72	0.55	0.28	0.21	0.10	51.7
I 40 E	265	1.7	603	2.9	2520.1	79	6.5	4.9	145	14	34	41	79	90	122	154	98	43	56	78	0.71	0.56	0.35	0.23	0.18	57.2
I 40 E	266	1.7	603	2.9	2520.1	79	6.5	6.0	215	21	58	112	135	179	209	168	82	72	58	103	0.75	0.54	0.29	0.24	0.16	52.8
I 40 E	267	1.7	603	2.9	2520.1	79	6.5	6.0	194	26	65	113	119	142	174	178	99	61	163	143	0.93	0.68	0.54	0.35	0.24	58.9
I 40 E	312	1.8	754	2.2	3054.8	74	2.8	0.0	231	197	250	38	36	58	124	89	104	114	138	112	0.64	0.60	0.54	0.40	0.29	77.2
I 40 E	313	1.8	745	2.3	3032.0	74	2.8	0.6	309	275	322	49	50	78	135	124	149	181	191	186	1.04	0.70	0.55	0.34	0.24	55.2
I 40 E	314	1.8	745	2.3	3032.0	74	2.8	1.7	235	187	266	38	47	64	123	98	122	132	112	116	1.10	0.81	0.46	0.31	0.19	52.2
I 40 E	315	1.8	745	2.3	3032.0	74	2.8	2.3	227	198	241	46	52	71	123	114	145	158	171	158	0.81	0.67	0.47	0.27	0.21	60.0
I 40 E	316	1.8	745	2.3	3032.0	74	2.8	1.2	240	198	266	55	52	73	118	89	114	117	139	144	0.87	0.61	0.42	0.26	0.15	53.1
I 40 E	317	1.8	745	2.3	3032.0	74	2.8	1.1	201	175	214	35	39	58	114	85	89	93	118	98	0.87	0.61	0.42	0.26	0.15	53.1
I 40 W	313	1.8	745	2.3	3032.0	74	3.3	5.9	251	216	268	47	56	78	145	117	152	157	217	228	1.04	0.73	0.40	0.31	0.21	51.7
I 40 W	314	1.8	745	2.3	3032.0	74	3.3	6.0	175	150	189	38	45	70	134	106	124	130	162	149	1.10	0.63	0.32	0.14	0.12	42.0
I 40 W	315	1.8	745	2.3	3032.0	74	3.3	6.0	217	190	230	47	48	72	155	143	150	146	190	167	1.42	0.87	0.52	0.28	0.17	45.9
I 40 W	316	1.8	745	2.3	3032.0	74	3.3	6.0	218	213	211	41	60	67	173	155	211	183	214	199	0.86	0.53	0.26	0.19	0.13	45.8
S 64 E	225	2.6	11	3.7	47.6	75	3.3	0.0	145	148	129	142	134	128	123	138	138	145	144	165	0.65	0.32	0.17	0.09	0.06	39.7
S 64 E	226	2.6	11	3.7	47.6	75	3.0	0.0	161	163	148	154	125	113	113	136	125	127	149	150	1.02	0.60	0.42	0.20	0.14	46.7
S 64 E	227	2.6	11	3.7	47.6	75	3.0	0.0	169	176	151	161	113	115	106	128	120	115	139	137	0.62	0.31	0.18	0.06	0.04	39.0

After Overlay

ROUTE	MILE	R	AADL	GF	TSAEL	OV YR	THICK ACT	THICK DES	MAYS DES	72	73	74	MAYS ROUGHNESS BY YEAR 75	76	77	78	79	80	81	82	DYNAFLECT DEFLECTIONS D1	D2	D3	D4	D5	SPREAD
S 64	E 228	2.6	11	3.7	47.6	75	3.0	1.3	143	144	128	141	116	120	112	144	120	137	130	145	0.73	0.34	0.20	0.06	0.04	37.5
S 64	E 229	2.6	11	3.7	47.6	75	3.0	0.7	162	161	142	165	128	131	124	152	142	153	166	164	0.71	0.31	0.14	0.06	0.04	35.5
S 64	E 230	2.6	11	3.7	47.6	75	3.0	0.0	147	142	131	151	135	134	129	152	147	141	165	163	0.68	0.34	0.22	0.09	0.05	40.6
S 64	E 231	2.6	11	3.7	47.6	75	3.0	0.0	120	122	105	120	130	138	123	161	139	126	140	170	0.63	0.28	0.17	0.07	0.05	38.1
S 64	E 232	2.6	11	3.7	47.6	75	3.0	0.0	183	194	164	172	136	133	122	156	135	129	165	166	0.87	0.45	0.27	0.11	0.07	40.7
S 64	E 233	2.6	11	3.7	47.6	75	3.0	0.0	142	144	128	140	144	142	134	157	145	151	167	164	0.79	0.41	0.24	0.13	0.09	42.0
S 64	E 234	2.6	11	3.7	47.6	75	3.0	0.0	121	124	119	110	131	140	133	154	137	136	142	143	0.36	0.18	0.13	0.06	0.05	43.3
S 64	E 235	2.6	11	3.7	47.6	75	3.0	0.0	179	192	176	151	147	146	141	166	149	174	177	166	0.43	0.21	0.15	0.08	0.05	42.8
S 64	E 236	2.6	17	4.9	77.3	75	3.0	0.0	131	141	126	117	129	129	124	155	147	143	164	137	0.69	0.44	0.29	0.17	0.12	49.6
S 73	N 349	3.7	27	1.5	105.9	76	2.0	0.0	140	147	133	129	130	72	114	102	77	92	82	115	1.14	0.58	0.33	0.18	0.13	41.4
S 73	N 350	4.1	27	1.5	105.9	76	2.0	4.4	190	178	163	232	152	84	125	84	76	82	77	111	0.75	0.32	0.13	0.05	0.02	33.9
S 73	N 351	4.1	27	1.5	105.9	76	2.0	3.8	267	285	262	256	218	67	106	83	63	63	64	44	0.78	0.44	0.18	0.10	0.06	40.0
S 73	N 352	4.1	27	1.5	105.9	76	2.0	1.7	268	257	219	269	269	73	124	99	89	88	96	78	1.19	0.57	0.32	0.18	0.11	39.8
S 73	N 353	4.1	27	1.5	105.9	76	2.0	0.6	227	221	189	223	228	81	143	133	116	118	118	109	1.22	0.68	0.44	0.22	0.15	44.4
S 73	N 354	4.1	27	1.5	105.9	76	2.0	0.0	194	214	192	227	116	67	120	92	75	76	81	65	1.73	0.95	0.56	0.25	0.15	42.1
S 73	N 355	4.1	27	1.5	105.9	76	2.0	0.0	240	251	203	246	212	87	127	113	91	94	101	60	0.93	0.63	0.43	0.21	0.17	51.0
S 73	N 356	4.1	27	1.5	105.9	76	2.0	0.0	196	198	174	190	188	90	150	114	85	81	91	58	1.47	0.78	0.49	0.22	0.13	42.0
S 73	N 357	4.1	27	1.5	105.9	76	2.0	0.0	233	200	205	266	215	85	140	102	86	101	95	77	1.47	0.78	0.49	0.22	0.13	42.0
S 77	N 121	2.0	46	2.1	185.5	77	2.0	0.0	114	113	105	102	96	110	77	74	80	91	79	82	0.96	0.60	0.25	0.17	0.13	44.0
S 77	N 122	2.0	46	2.1	185.5	77	2.0	0.0	115	112	109	108	98	106	67	67	83	74	79	90	0.60	0.39	0.18	0.13	0.08	46.0
S 77	N 123	2.0	46	2.1	185.5	77	2.0	0.0	119	121	114	112	100	104	89	102	115	119	109	130	0.69	0.52	0.24	0.19	0.16	52.2
S 77	N 124	2.0	46	2.1	185.5	77	2.0	1.9	134	114	134	119	123	116	61	57	67	66	71	85	0.73	0.47	0.17	0.09	0.06	41.6
S 77	N 125	2.0	46	2.1	185.5	77	2.0	1.6	175	141	172	177	159	139	80	80	92	91	86	107	0.77	0.46	0.16	0.10	0.07	40.5
S 77	N 126	2.0	46	2.1	185.5	77	2.0	0.0	129	118	110	124	87	145	97	98	106	108	102	119	0.32	0.23	0.13	0.08	0.06	51.2
S 77	N 127	2.0	46	2.1	185.5	77	2.0	0.1	124	119	124	117	94	122	97	93	99	104	95	102	0.57	0.33	0.18	0.12	0.09	45.3
S 77	N 128	2.0	46	2.1	185.5	77	2.0	0.0	99	113	88	89	75	103	72	77	81	76	82	96	0.99	0.56	0.32	0.19	0.10	43.6
S 77	N 129	2.0	46	2.1	185.5	77	2.0	0.3	95	107	92	90	69	94	70	68	78	77	70	84	0.83	0.58	0.25	0.18	0.12	47.2
S 77	N 130	2.0	46	2.1	185.5	77	2.0	1.4	123	120	119	119	92	121	86	86	103	102	93	117	0.39	0.24	0.15	0.10	0.08	49.2
S 77	N 131	2.0	46	2.1	185.5	77	2.0	1.1	123	104	119	112	92	127	79	77	87	88	87	111	0.61	0.39	0.22	0.13	0.09	47.2
S 77	N 132	2.0	46	2.1	185.5	77	2.0	1.3	124	107	113	117	96	125	83	84	89	91	89	94	0.62	0.28	0.18	0.13	0.11	42.6
S 77	N 133	2.0	46	2.1	185.5	77	2.0	0.7	112	106	106	104	91	110	84	78	87	81	90	115	0.59	0.42	0.21	0.16	0.12	50.8
S 77	N 134	2.1	46	2.1	185.5	77	2.0	0.1	110	118	105	103	87	103	94	98	112	107	134	146	0.42	0.21	0.09	0.05	0.04	38.6
S 87	N 292	3.8	24	1.8	95.5	75	2.0	0.0	153	166	145	146	100	111	118	130	117	121	152	141	1.04	0.70	0.21	0.13	0.06	41.2
S 87	N 293	3.8	24	1.8	95.5	75	2.3	0.0	242	237	215	223	105	120	126	149	126	136	158	133	1.11	0.64	0.21	0.15	0.07	39.3
S 87	N 294	3.8	24	1.8	95.5	75	2.3	0.2	246	274	227	194	100	118	117	141	120	112	166	152	1.01	0.47	0.17	0.07	0.04	34.9
S 87	N 295	3.8	24	1.8	95.5	75	2.3	0.0	256	265	233	219	105	145	154	187	169	192	231	209	1.03	0.63	0.25	0.18	0.11	42.7
S 87	N 296	3.8	24	1.8	95.5	75	2.3	0.0	240	237	207	225	105	119	125	153	133	141	195	159	0.88	0.48	0.17	0.11	0.07	38.9
S 87	N 297	3.8	24	1.8	95.5	75	2.3	0.0	203	209	171	190	105	168	181	196	181	221	245	238	0.79	0.47	0.21	0.14	0.09	43.0
S 87	N 298	3.8	24	1.8	95.5	75	2.3	0.0	208	199	194	190	100	124	134	160	139	148	180	162	1.04	0.57	0.21	0.15	0.11	40.0
S 87	N 299	3.8	24	1.8	95.5	75	2.3	0.0	194	208	174	167	100	122	132	163	134	133	151	152	0.82	0.51	0.20	0.12	0.07	42.0
S 87	N 300	3.8	24	1.8	95.5	75	2.3	0.0	243	243	212	224	98	104	119	151	121	139	163	142	1.02	0.63	0.25	0.19	0.11	43.1
S 87	N 301	3.8	24	1.8	95.5	75	2.3	0.0	198	215	181	165	105	112	122	145	120	137	167	136	0.79	0.47	0.21	0.14	0.09	43.0
S 87	N 302	3.8	24	1.8	95.5	75	2.3	0.0	195	200	189	162	88	94	111	137	107	116	156	120	0.87	0.51	0.21	0.13	0.08	41.4
S 87	N 303	3.8	24	1.8	95.5	75	2.3	0.0	203	213	185	174	115	115	135	156	134	133	169	157	1.00	0.57	0.21	0.15	0.08	40.2
S 87	N 304	3.3	24	1.8	95.5	75	2.3	0.0	230	253	212	186	150	121	155	187	165	201	199	181	1.01	0.58	0.21	0.15	0.08	40.2
U 60	E 51	1.0	201	2.4	821.7	76	1.7	1.7	71	32	53	69	77	49	101	79	54	75	72	62	0.24	0.19	0.13	0.10	0.08	61.7
U 60	E 52	1.0	201	2.4	821.7	76	1.7	6.0	92	60	72	84	104	49	105	65	45	63	74	47	0.35	0.21	0.10	0.05	0.04	42.9
U 60	E 53	1.0	201	2.4	821.7	76	1.7	3.5	103	67	87	87	116	35	100	70	41	77	83	35	0.61	0.37	0.18	0.11	0.07	43.9
U 60	E 54	1.0	201	2.4	821.7	76	1.7	3.1	105	70	89	75	129	49	100	69	60	72	63	43	0.62	0.35	0.16	0.09	0.06	41.3
U 60	E 55	1.0	201	2.4	821.7	76	1.7	3.8	117	66	110	77	143	60	115	78	66	75	70	64	0.63	0.36	0.16	0.12	0.09	43.2
U 60	E 56	1.0	201	2.4	821.7	76	1.7	2.5	110	66	105	92	118	69	110	88	76	79	84	73	0.54	0.36	0.20	0.15	0.11	50.4
U 60	E 57	1.0	191	2.9	798.2	76	1.7	0.0	97	56	77	81	117	52	95	72	55	80	80	52	0.60	0.49	0.28	0.20	0.16	57.7
U 60	E 58	1.0	191	2.9	798.2	76	1.7	0.6	89	54	90	87	86	52	87	71	52	89	91	51	0.69	0.48	0.26	0.18	0.14	50.7
U 60	E 59	1.0	191	2.9	798.2	76	1.7	0.9	88	59	85	86	86	43	100	65	47	92	97	57	0.73	0.51	0.27	0.19	0.14	50.4
U 60	E 60	1.0	191	2.9	798.2	76	1.7	0.0	101	70	98	99	95	62	111	89	70	93	106	72	0.50	0.36	0.22	0.17	0.12	54.8
U 60	E 61	1.0	191	2.9	798.2	76	1.7	0.0	119	71	107	112	119	75	120	98	86	102	117	92	0.59	0.36	0.25	0.15	0.12	49.8
U 60	E 62	1.0	191	2.9	798.2	76	1.7	0.0	87	69	103	96	62	60	95	74	93	60	102	60	0.59	0.36	0.25	0.15	0.12	49.8

After Overlay

ROUTE	MILE	R	AADL	GF	TSAEL	OV YR	THICK ACT	THICK DES	MAYS DES	MAYS ROUGHNESS BY YEAR 72	73	74	75	76	77	78	79	80	81	82	DYNAFLECT DEFLECTIONS D1	D2	D3	D4	D5	SPREAD
U 70 E	301	2.0	37	2.4	151.3	78	1.8	0.0	138	134	106	125	101	144	148	119	128	120	114	128	1.10	0.64	0.37	0.25	0.16	45.8
U 70 E	302	2.0	37	2.4	151.3	78	1.8	0.0	142	140	111	119	103	133	167	111	103	95	94	101	1.18	0.83	0.42	0.29	0.15	48.6
U 70 E	303	2.0	46	3.7	199.0	78	1.8	0.0	113	113	96	106	88	118	110	92	75	64	67	86	0.98	0.77	0.46	0.40	0.30	59.4
U 70 E	304	2.0	46	3.7	199.0	78	1.8	0.0	141	136	121	132	117	139	134	119	114	97	100	130	1.31	1.01	0.60	0.44	0.34	56.5
U 70 E	305	2.0	46	3.7	199.0	78	1.8	0.0	119	120	100	106	95	113	124	102	91	104	85	96	1.34	0.91	0.56	0.47	0.28	53.1
U 70 E	306	1.8	46	3.7	199.0	78	2.1	0.0	154	157	128	130	131	145	154	135	127	141	115	141	0.86	0.64	0.23	0.22	0.22	50.5
U 70 E	307	1.8	46	3.7	199.0	78	1.8	0.0	149	143	124	127	117	141	160	104	95	97	94	99	1.17	0.68	0.53	0.44	0.27	52.8
U 70 E	308	1.8	46	3.7	199.0	78	1.8	0.0	155	138	121	128	116	157	179	96	82	91	86	114	1.14	0.72	0.48	0.34	0.25	51.4
U 70 E	309	1.8	46	3.7	199.0	78	1.8	0.0	176	149	135	154	147	171	192	100	95	98	88	105	1.02	0.72	0.61	0.54	0.42	64.9
U 70 E	310	1.8	46	3.7	199.0	78	1.8	0.0	155	153	124	150	129	151	149	99	100	100	89	94	0.79	0.65	0.46	0.39	0.31	65.8
U 70 E	311	1.8	46	3.7	199.0	78	1.8	0.0	167	176	146	141	130	145	179	94	94	94	87	104	1.31	0.99	0.63	0.57	0.43	60.0
U 70 E	312	1.8	46	3.7	199.0	78	1.8	0.0	164	174	143	140	128	147	168	87	78	67	75	79	1.09	0.77	0.57	0.45	0.36	59.4
U 70 E	313	1.8	46	3.7	199.0	78	1.8	0.0	142	167	136	78	118	129	160	84	75	70	70	81	0.86	0.60	0.38	0.31	0.25	55.8
U 70 E	314	1.8	54	3.0	226.7	78	1.5	0.0	167	153	130	130	108	192	184	133	75	57	73	82	0.86	0.60	0.38	0.31	0.25	55.8
U 70 E	331	1.5	55	4.2	242.9	78	3.3	0.0	234	245	211	207	211	216	216	85	79	97	80	88	1.19	0.84	0.48	0.41	0.29	53.9
U 70 E	332	1.5	84	3.4	358.7	78	3.3	0.0	131	145	132	106	102	112	149	90	68	71	63	69	0.97	0.66	0.51	0.39	0.27	57.7
U 70 E	333	1.5	81	3.0	340.0	78	3.3	0.0	176	174	144	139	144	173	204	94	62	69	66	72	1.32	0.89	0.57	0.50	0.38	55.5
U 89 N	443	2.5	137	3.8	595.1	76	3.8	3.8	154	188	167	186	65	78	58	80	75	96	110	78	0.92	0.66	0.40	0.23	0.13	50.9
U 89 N	444	2.5	137	3.8	595.1	76	3.8	2.9	148	183	194	143	62	79	55	86	66	75	74	58	0.78	0.57	0.37	0.23	0.16	54.1
U 89 N	445	2.5	137	3.8	595.1	76	3.8	0.9	147	147	136	130	156	165	168	145	153	96	92	75	0.66	0.40	0.24	0.15	0.10	47.0
U 89 N	446	2.5	137	3.8	595.1	76	3.8	1.8	148	139	127	109	200	199	178	187	188	148	130	123	0.65	0.40	0.24	0.15	0.10	47.4
U 89 N	447	2.5	137	3.8	595.1	76	3.8	0.4	166	186	225	154	85	89	81	96	88	123	70	71	0.63	0.40	0.25	0.17	0.11	49.5
U 89 N	448	2.5	137	3.8	595.1	76	3.8	1.2	153	164	184	177	75	92	78	102	87	100	69	68	0.56	0.40	0.28	0.20	0.13	56.1
U 89 N	449	2.5	137	3.8	595.1	76	3.8	4.0	176	157	182	212	132	132	135	135	121	116	92	93	0.78	0.52	0.32	0.18	0.10	48.7
U 89 N	450	1.8	137	3.8	595.1	76	3.8	3.1	133	134	153	124	107	95	62	79	82	75	66	77	0.78	0.52	0.32	0.18	0.10	48.7
U 89 N	452	1.8	137	3.8	595.1	76	2.3	0.0	142	125	132	136	162	108	55	75	68	89	59	72	0.56	0.33	0.25	0.14	0.10	49.3
U 89 N	453	1.8	137	3.8	595.1	76	2.3	3.2	188	147	158	189	231	130	68	91	91	81	84	93	0.58	0.28	0.15	0.09	0.07	40.3
U 89 N	454	1.8	137	3.8	595.1	76	2.3	1.3	185	164	164	174	214	133	71	91	86	76	89	96	0.87	0.49	0.28	0.16	0.10	43.7
U 89 N	455	1.8	137	3.8	595.1	76	2.3	4.2	184	154	155	175	225	129	59	81	72	101	99	71	0.89	0.40	0.19	0.08	0.05	36.2
U 89 N	456	1.8	137	3.8	595.1	76	2.3	6.0	183	155	160	161	230	61	65	79	72	101	109	78	0.81	0.37	0.19	0.11	0.07	38.3
U 89AN	357	2.5	34	2.7	140.9	77	2.1	0.0	175	140	166	169	204	164	75	112	97	140	103	118	1.02	0.64	0.48	0.25	0.17	50.2
U 89AN	358	2.5	34	2.7	140.9	77	2.1	0.0	220	180	221	198	245	209	90	123	110	122	90	102	0.67	0.48	0.31	0.20	0.15	54.0
U 89AN	359	2.5	34	2.7	140.9	77	2.1	0.0	202	170	192	195	216	197	79	111	99	119	96	87	1.34	0.45	0.24	0.15	0.10	34.0
U 89AN	360	2.5	34	2.7	140.9	77	2.1	0.0	187	150	176	196	201	176	89	104	97	116	109	95	0.42	0.29	0.22	0.14	0.09	55.2
U 89AN	361	2.5	34	2.7	140.9	77	2.1	0.0	189	150	171	195	199	186	85	112	102	123	118	102	0.50	0.36	0.20	0.14	0.08	51.2
U 89AN	362	2.5	34	2.7	140.9	77	2.1	1.5	187	160	186	186	179	188	78	111	104	119	115	114	0.57	0.42	0.16	0.12	0.06	46.7
U 89AN	363	2.5	34	2.7	140.9	77	2.1	0.0	226	190	219	208	252	215	88	121	100	127	105	108	1.24	0.64	0.34	0.19	0.08	40.2
U 89AN	364	2.5	27	3.0	113.3	77	2.1	0.0	223	190	211	222	238	209	69	109	85	121	92	101	0.64	0.52	0.24	0.15	0.08	50.9
U 89AN	365	2.5	27	3.0	113.3	77	2.1	0.0	193	160	177	199	210	181	76	108	82	109	86	89	1.13	0.61	0.38	0.21	0.14	43.7
U 89AN	366	2.5	27	3.0	113.3	77	2.1	0.4	193	150	193	176	212	192	91	120	100	126	115	118	0.68	0.39	0.19	0.11	0.06	42.1
U 89AN	367	2.5	27	3.0	113.3	77	2.1	1.5	211	150	173	187	321	180	81	110	87	114	93	93	0.50	0.27	0.09	0.04	0.02	36.8
U 89AN	368	2.5	27	3.0	113.3	77	2.1	1.2	244	210	247	236	267	211	101	120	107	130	131	120	0.74	0.50	0.19	0.10	0.06	43.0
U 89AN	369	2.5	27	3.0	113.3	77	1.8	0.0	274	220	241	270	315	266	99	120	126	137	144	118	0.82	0.48	0.24	0.12	0.05	41.7
U 89AN	370	2.7	27	3.0	113.3	77	2.1	0.0	273	225	242	281	287	272	175	130	133	139	148	135	0.82	0.48	0.24	0.12	0.05	41.7
U180 E	224	3.9	11	1.0	42.2	76	3.6	0.0	452	418	338	431	478	107	99	119	124	122	154	153	1.53	0.87	0.39	0.21	0.07	40.1
U180 E	225	3.9	11	1.0	42.2	76	3.6	2.7	475	418	348	461	515	108	96	146	151	147	178	174	1.40	0.72	0.24	0.09	0.02	35.3
U180 E	226	3.9	11	1.0	42.2	76	3.6	0.5	428	407	344	365	463	115	89	130	169	183	166	167	1.54	0.88	0.38	0.19	0.07	39.7
U180 E	227	3.9	11	1.0	42.2	76	3.6	2.4	457	416	348	436	480	106	102	121	122	131	136	134	1.33	0.76	0.31	0.16	0.06	39.4
U180 E	228	3.9	11	1.0	42.2	76	3.6	2.3	440	424	334	387	479	93	83	109	103	112	117	122	1.31	0.87	0.38	0.18	0.04	42.4
U180 E	229	3.9	11	1.0	42.2	76	3.6	1.1	356	340	277	319	381	80	76	94	99	128	127	131	0.79	0.55	0.25	0.14	0.06	45.3
U180 E	230	3.9	11	1.0	42.2	76	3.6	0.0	320	319	258	275	337	84	82	108	109	120	145	146	1.21	0.71	0.34	0.23	0.12	43.1
U180 E	231	3.9	11	1.0	42.2	76	3.6	3.9	371	360	299	327	388	96	88	125	103	131	124	138	0.80	0.43	0.15	0.08	0.03	37.2
U180 E	232	3.9	11	1.0	42.2	76	3.6	0.0	364	372	301	346	337	77	87	112	107	125	134	122	2.06	1.15	0.58	0.39	0.20	42.5
U180 E	233	3.9	11	1.0	42.2	76	3.6	0.0	387	384	314	326	410	86	78	102	98	121	118	113	1.64	1.07	0.59	0.45	0.26	48.9
U180 E	234	3.9	11	1.0	42.2	76	3.6	1.8	393	407	329	329	398	76	64	90	79	98	103	91	1.08	0.60	0.32	0.25	0.14	44.3
U180 E	235	4.0	11	1.0	42.2	76	3.6	2.1	132	138	112	120	131	95	99	120	115	128	124	111	1.01	0.55	0.22	0.10	0.04	38.0

APPENDIX B
ESTIMATION OF FUNDAMENTAL PAVEMENT MATERIALS PROPERTIES FROM DYNAFLECT DEFLECTIONS

The ADOT and other have invested considerable resources toward the determination of the fundamental properties of pavement materials (Refs. 1 through 15). The preponderance of the effort at ADOT was a continuation of studies begun at the Florida DOT using deflections obtained from the Falling Weight Deflectometer (FWD) (Reference 9). Although the results of these early experimentations were encouraging, the emphasis of the work at ADOT was shifted to other pavement management and design areas because:

1. The matching of theoretical deflection basins to measured deflection basins required excessive computer resources.
2. ADOT has never implemented pavement design procedures that involved the use of layered theory. Laboratory testing of pavement materials to determine fundamental stiffness (modulus) characteristics has been verly limited. The present ADOT specification would not provide a reasonable degree of certainty that as-constructed pavements would have the stiffness (modulus) developed in the laboratory during the AC mix design process.
3. The Dynaflect deflection test data was more difficult to evaluate and analyze. Some of the problems associated with using the Dynaflect for the determination of pavement layer stiffness are:
   a. The load is dynamic.
   b. The effective load magnitude is low.
   c. The load is fixed; stress sensitivity of materials cannot be determined.
   d. The deflection at the center of the load is not measureable; for some pavements, the law of superposition does not (apparently) hold, leading to unreasonable pavement layer stiffnesses.

The problem of matching a theoretical deflection basin to the measured Dynaflect deflecton basin was investigated as a part of this project. The basin-matching procedures that were available were somewhat inefficient requiring excessive computer execution time. An attempt was made to simplify the solution to the determination of surface deflections as a function of elastic modulus. The most commonly used computer programs available at ADOT to solve the layered pavement system problems were:

1. ELSYM5 (Ref. 19)
2. CHEVRON N-LAYER (Ref. 17, 18)
3. Various finite-element programs

A search of the literture for simplified alternate solutions disclosed an interesting approach by Jenffroy and Bachelez (Ref 16). The simplifying aspects of their solution included:

1. Limited to three layers.
2. The interface between the surface layer (AC layer) and the second layer (base) was assumed to be free of shear stresses (no friction).

   The integral equation for the vertical deflection of the pavement surface at a distance r from the load axis is:

$$w(r) = \frac{1.5 \times q \times a}{E2} \int_{0}^{+\text{infinity}} \frac{J1(X) \times J0(X \times r/a)}{X \times (T(X) + B^3 \times X^3)} \, dx$$

Where

a = load radius; for the Dynaflect = $2.0^{0.5}$
q = vertical load pressure; for the Dynaflect = 159 psi
w(r) = surface deflection at radius r
J1 = Bessel function of the first kind, order 1
J0 = Bessel function of the first kind, order 0
B = H 1/2 x $((E1/(6 \times E2))^{0.333})$

$$T(X) = \frac{1-2 \times N \times (1+2 \times (A \times X) \times EXP(-2 \times A \times X) + N^2 \times EXP(-4 \times A \times X)}{1+4 \times N \times A \times X \times EXP(-2 \times A \times X) - N^2 EXP(-4 \times A \times X)}$$

N = (E2 - E3) / (E2 + E3)
A = H2/a
EXP = Napierian (natural) antilogarithm
Poisson's Ratio = 0.5
E1 = modulus of elasticity of the AC surface layer
E2 = modulus of elasticity of the unbound base layer
E3 = modulus of elasticity of the subgrade
H1 = thickness of the AC surface layer
H2 = thickness of the unbound base layer

It was necessary to evaluate the improper integral by numerical mehtods. The limit of the integral as x approaches zero is E1/(2 x E2); the upper limit of the integral as x approaches positive infinity is zero. Fortunately the value of the integral approximates its zero limit at a conveniently low value; for all practical purposes at x = 10. The IBM Scientific Subroutine, QSF was used to perform the integration calculations using Simpson's Rule. The efficienty of the integration calculation could be improved by developing a routine that is specially designed and programmed to solve this particular integral. The efficiency of the solution method for the Bessel Functions could also be improved.

A comparison of the deflections calculated by this simplified method with deflections calculated by the CHEVRON program did not exhibit significant differences at the radii of the normal Dynaflect geophone configuration (10.0, 15.6, 26.0, 37.4, 49.0 inches). There were significant differences in the calculated deflections at r = 0. The CHEVRON program consistently produced a larger deflection than the simplified method. While this presented no difficulty while working on Dynaflect deflection basin-mathcing problems, many other deflection basin configurations (e.g., FWD) include a measured deflection at r = 0. Other authors (Ref 6) have suggested that the ELSYM5 and CHEVRON programs calculate unrealistic deflections near the load. In the referenced paper, ELSYM5 deflections were compared with the BISAR deflections; ELSYM5 predicted significantly higher deflections in the vicinity of the applied load. Comparison of ELSYM5 and CHEVRON N-LAYER deflections during this project showed excellent agreement between the outputs of these two programs. Further inquiry into comparison of the simplified equation with CHEVRON-type layer theory programs may be undertaken; unfortunately, the BISAR program is not presently available at ADOT.

A more productive area to improve the efficienty of matching theoretical and measured deflection basins proved to be in improving the logic used to iteratively adjust the layer moduli to efficiently converge or match deflection basins. The current steps are:

1. Estimate an initial subgrade (E3) modulus from:

$$E3(psi) = \frac{q \times a^2 \times (1-Nu^2)}{w(r)}$$

Where

q = vertical load pressure; for Dynaflect = 159.16 psi
a = load radius; for Dnyaflect = $2^{0.5}$ = 1.414 inches
Nu = Poisson's ratio; assumed to be $0.2^{0.5}$ = 0.447
r = distance from the load; for the fifth Dynaflect sensors r = 49.0 inches
w(r) = Dynaflect deflection (inch) at r = 49.0 inches

Based on the findings of this project, the initial subgrade modulus should now be estimated from:

$E3(ksi) = (0.013+0.16 \times w(r))^{-1}$

2. Estimate the initial base (E2) modulus from:

   $E2(psi) = E3 \times F2$

Where

$F2 = 0.2 \times (25.4 \times H2)^{0.45}$

H2 = base thickness, inches:

F2 GE 2
F2 LE 4

GE, greater than or equal to
LE, less than or equal to

3. Estimate the initial AC surfacing (E1) modulus:

   E1 = 200000 psi
   DIFMIN = 100000
   N = 0

4. N = N + 1

   Calcullate five Dynaflect deflections at radii 10.0, 15.6, 26.0, 37.4, 49.0 inches.

5. Calculate the effective thickness of the AC surfacing and the unbound base as a function of the estimated subgrade modulus, E3.

   $HE1 = 0.9 \times H1 \times E1^{0.333} \div E3$

   $HE2 = 0.9 \times H2 \times E2^{0.333} \div E3$

   HE1 = effective thickness of the AC surface layer, inches
   HE2 = effective thickness of the unbound base layer,
   HE = HE1 + HE 2

6. Calculate the AC surfacing modulus adjustment factor, F1

   F1 = (MDEF(1) + CDEF(1)) x 0.5 x MDEF(1)

   Calculate the unbound base modulus adjustment factor, F2

   F2 = (SMDEF + SCDEF) x 0.5 x SMDEF

   Calculate the subgrade modulus adjustment factor, F3

   F3 = (SGMDEF + SGCDEF) x 0.5 x SGMDEF

Where

MDEF (1,2,3,4,5) = measured Dynaflect sensor deflection, 1 through 5
CDEF (1,2,3,4,5) = calculated Dynaflect sensor deflections, 1 through 5
SGMDEF = the sum of the measured deflections of those Dynaflect sensors located at distances from the load greater than HE (MDEF(5) is used if HE is greater than 49.0)
SGCDEF = the sum of the calculated deflections of those Dynaflect sensors used to calculate SGMDEF.
SGMDEF = the sum of the measured deflections of those Dynaflect sensors located at distances from the load less than or equal to HE.
SCDEF = sum of the calculated deflections at the same sensors used to calculate SMDEF.

7. E1, E2, E3 Adjustment Logic

   A. If ABS (F3-1.00) LT 0.02, E3 is not adjusted but E1 = F1 x E1: then go to Step D

   B. If ABS (F3-1.00) GT 0.02, and if F2 LT 1.0 and F1 LT 1.0, go to Step C

      If F2 GT 1.0 and F1 GT 1.0 go to Step C
      Otherwide, E1 = F1 x E1
      then go to Step C.

   C. If F3 GT 1.0 and F2 GT 1.0 go to Step E
      If F3 LT 1.0 and F2 LT 1.0 go to Step E
      Otherwise E2 = F2 x E2
      then go to Step D

   D. E2 = F2 x E2
      go to Step E

   E. If E1 GT 1500000, E1 = 1500000
      If E2 GT 500000, E2 = 500000
      If E3 GT 60000, E3 = 60000
      If E2 LT 15000, E2 = 15000
      If E3 LT 3000, E3 = 3000
      If E1 LT E2, E 1 = E2

   F. DIFI = ABS (F1 - 1.0)
      DIF2 = ABS (F2 - 1.0)
      DiDIF 3 = ABS (F3 - 1.0)
      TOTDIF = DIFI + DIF2 + DIF3
      If TOTDIF GT DIFMIN go to G
      E1SAVE = E1
      E2SAVE = E2
      E3SAVE = E3
      DIFMIN = TOTDIF
      go to G

   G. If (DIF1 LT 0.03 and
         DIF2 LT 0. 01 and
         DIF3 LT 0. 01) go to H
      If N GT 30 go to H
      Otherwise go to #4

   H. E1 = E1SAVE
      E2 = E2SAVE
      E3 = E3SAVE

END OF DEFLECTION BASIN FITTING ROUTINE

8. The modulus values of E1, E2, E3 and the thicknesses H1 and H2 are then input into the CHEVRON N-LAYER program. The other parameters used for input were: a 91.27 psi load uniformly distributed on a circular plate with a radius of 5.91 inches. Poisson's ratio of 0.35, 0.40, and 0.045 for the surfacing, base and subgrade layers, respectively. The load parameters are similar to that imposed by the FWD and also one-half of a legally-loaded heavy truck axle. The radial (tensile) strain at the interface of the existing AC pavement with the underlying base and the vertical strain at the top of the subgrade were the values used in the multiple regression analysis performed in this study.

   This matching of the theoretical deflection basin with the measured Dynaflect deflection basin generally produced subgrade (E3) modulus values which were greater than expected; the AC surfacing (E1) modulus values which were lower than anticipated. No attempt was made to apply any adjustment factors to either of these values as a part of this study.

APPENDIX B
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Appendix C

```
 10 REM AC OVERLAY DESIGN USING DYNAFLECT DEFLECTIONS, FEB 1983, EISENBERG
 20 DIM A$79,M$(20),M(20),S(20),W(20,5),O(20)
 30 LET W$ = 'Y'
 40 PRINT
 50 PRINT USING 60,DAT
 60 :AC OVERLAY DESIGN USING DYNAFLECT DEFLECTIONS    ##########
 70 PRINT
 80 PRINT 'TYPE A LINE OF RELEVANT INFORMATION, SUCH AS PROJECT NUMBER, PROJECT
NAME, ETC'
 90 PRINT 'USE ANY CHARACTERS EXCEPT COMMAS, SEMICOLONS, SLASHES, SINGLE OR DOUB
LE QUOTES'
 100 INPUT A$
 110 PRINT
 120 PRINT 'THE PROJECT REGIONAL FACTOR IS =';
 130 INPUT R
 140 IF R < 5 GOTO 170
 150 PRINT 'THE REGIONAL FACTOR IS TOO LARGE, TRY AGAIN'
 160 GOTO 120
 170 PRINT
 180 PRINT 'INPUT THE TRAFFIC GROWTH FACTOR (PERCENT) OR THE TOTAL 18000 POUND S
INGLE-AXLE'
 190 PRINT 'EQUIVALENT LOADS (18 KIP SAEL) EXPECTED DURING THE DESIGN PERIOD'
 200 REM G = GROWTH FACTOR
 210 INPUT G
 220 L1 = G
 230 REM IF G <= 20, INPUT MUST BE GROWTH FACTOR, ELSE TOTAL 18 KIP SAEL
 240 PRINT
 250 PRINT 'INPUT THE YEAR THE OVERLAY CONSTRUCTION WILL BE COMPLETED - 19XX';
 260 INPUT Y1
 270 IF Y1 > 60 & Y1 < 90 GOTO 300
 280 PRINT 'ERROR - OVERLAY YEAR IS NOT REASONABLE, TRY AGAIN'
 290 GOTO 250
 300 PRINT
 310 REM TRAFFIC IS ASSUMED TO BE FOR 1982 - CHANGE EACH YEAR OR INPUT???
 320 Y2 = 82
 330 IF G > 20 GOTO 380
 340 PRINT USING 350,Y2
 350 :INPUT THE 18 KIP SAEL FOR THE YEAR 19## =
 360 INPUT T
 370 PRINT
 380 PRINT 'THE OVERLAY DESIGN PERIOD =';
 390 INPUT Y3
 400 IF Y3 > 5 & Y3 < 31 GOTO 430
 410 PRINT 'THE DESIGN PERIOD IS NOT REASONABLE, TRY AGAIN'
 420 GOTO 380
```

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```
430 IF G > 20 GOTO 540
440 D1 = Y1 - Y2
450 D2 = 0.01 * G * T
460 REM D1 IS THE TRAFFIC ADJUSTMENT YEARS
470 REM D2 IS THE CHANGE IN 18 KIP SAEL PER YEAR
480 REM T IS THE 18 KIP SAEL ADJUSTED FOR THE DIFFERENCE BETWEEN THE TRAFFIC
490 REM DATA YEAR AND THE YEAR THE OVERLAY WILL BE CONSTRUCTED
500 T = D1 * D2 + T
510 L1 = T * Y3 * (200. + Y3 * G) * 0.005
520 L1 = INT(L1 + 0.5)
530 GOTO 570
540 IF G > 10000 GOTO 570
550 PRINT 'ERROR - THE 18 KIP SAEL IS NOT REASONABLE - TRY AGAIN'
560 GOTO 170
570 L2 = LGT(L1 * 0.001)
580 PRINT
590 I = 0
600 I = I + 1
610 PRINT 'INPUT THE LOCATION(S) THE DEFLECTIONS REPRESENT, SUCH AS MILEPOSTS O
R'
620 PRINT 'STATIONS, IN ANY FORMAT (MAXIMUM OF 18 CHARACTERS)'
630 INPUT M$(I)
640 PRINT 'INPUT THE INCHES OF MAYS RIDEMETER ROUGHNESS';
650 INPUT M(I)
660 IF M(I) > 10 & M(I) < 1000 GOTO 690
670 PRINT 'THE MAYS RIDEMETER ROUGHNESS IS NOT REASONABLE, TRY AGAIN'
680 GOTO 640
690 PRINT 'INPUT THE DYNAFLECT SENSOR DEFLECTIONS (MILS) 1 THRU 5, SEPARATED BY
COMMAS';
700 INPUT W(I,1),W(I,2),W(I,3),W(I,4),W(I,5)
710 S(I) = (W(I,1)+W(I,2)+W(I,3)+W(I,4)+W(I,5)) * 20. / W(I,1)
720 REM S(I) IS THE SPREADABILITY INDEX ACCORDING TO VASWANI
730 O(I) = (L2 + 0.104 * R + 0.000578 * M(I) - 0.0653 * S(I)) / (0.0587 * (2.6
+ 32. * W(I,5))**0.333333)
740 REM OVERLAY THICKNESS IS CONSTRAINED BY THE LIMITS OF 0 TO 6 INCHES
750 IF O(I) < 0. THEN O(I) = 0.
760 IF O(I) > 6. THEN O(I) = 6.
770 PRINT
780 PRINT USING 790,O(I)
790 :OVERLAY THICKNESS = #.## INCHES
800 PRINT
810 PRINT 'DO YOU WISH TO CALCULATE ANOTHER OVERLAY THICKNESS FOR THIS PROJECT
(Y OR N)'
820 INPUT Y$
830 IF Y$ = W$ GOTO 600
840 PRINT 'FOR A SUMMARY REPORT, PRESS THE CLEAR KEY, PRESS Y, THEN PRESS ENTER
```

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```
 850 INPUT Y$
 860 IF Y$ <> W$ GOTO 1010
 870 PRINT USING 880,A$
 880 :##################################################################################################
#####
 890 PRINT USING 900,R,Y1,Y3
 900 :REGIONAL FACTOR = #.#   OVERLAY YEAR = 19##   DESIGN PERIOD = ## YEARS
 910 PRINT USING 920,L1
 920 :TOTAL 18 KIP SAEL =##########
 930 PRINT
 940 PRINT TAB(25) 'DYNAFLECT DEFLECTIONS - MILS' TAB(63) 'OVERLAY'
 950 PRINT '  LOCATION          ROUGH   #1     #2     #3     #4     #5   SPREAD  THICK

 960 PRINT
 970 :#################### ###  #.### #.### #.### #.### #.###  ###.#    #.##
 980 FOR N = 1 TO I
 990 PRINT USING 970,M$(N),M(N),W(N,1),W(N,2),W(N,3),W(N,4),W(N,5),S(N),O(N)
 1000 NEXT N
 1010 PRINT
 1020 PRINT 'DO YOU WISH TO CALCULATE OVERLAY THICKNESSES FOR A NEW PROJECT (Y O
R N)'
 1030 INPUT Y$
 1040 IF Y$ = W$ GOTO 40
 1050 END
 END OF DATA
```

```
Y
 EXAMPLE PROBLEM FOR REPORT
 REGIONAL FACTOR = 3.0   OVERLAY YEAR = 1983   DESIGN PERIOD = 10 YEARS
 TOTAL 18 KIP SAEL =  1000000

                          DYNAFLECT DEFLECTIONS - MILS          OVERLAY
   LOCATION          ROUGH   #1     #2     #3     #4     #5   SPREAD  THICK

 MP 1 - MP 3          200  3.520 2.170 1.060  .650  .490   44.8    3.24
 MP 4 - MP 5          100  1.510 1.140  .630  .390  .280   52.3    0.00
 MP 6 - MP 8          300  2.280 1.690  .930  .520  .360   50.7    1.23

 DO YOU WISH TO CALCULATE OVERLAY THICKNESSES FOR A NEW PROJECT (Y OR N)
 ?
N
 DATE: 83-076; TIME: 10:46:41.2; CPU TIME: 0000.2 SEC
```

APPENDIX D

A "satellite" study was done to investigate the effect of temperature and season. Temperature and/or seasonal effects are of concern to the users of non-destructive test (NDT) data because they could result in "incorrect" answers.

To study this effect, 20 sites that had monthly dynaflect and temperature measurements were analyzed.The analysis consisted of calculating the spreadability for each test date and plotting the spreadability versus month. Most projects had about two years of monthly data providing "double" coverage of the month axis. These spreadability versus month plots were then reviewed and categorized into three categories; 1-Low seasonal effect, 2-Medium seasonal effect, and 3-High seasonal effect. A project with low effect had a virtually unchanged spreadability from month to month whereas a high effect had obvious high and low spreadability points.

In looking through the individual spreadability versus month plots is was apparent that there were substantial differences in seasonal effect. A plot of "Seasonal" category (1,2,or3) versus asphaltic concrete thickness suggests that thicker AC has a more pronounced seasonal effect. (See Figure D1). This might suggest a temperature effect since the warmer months generally had lower spreadability for the thicker AC pavements. Attempts to compare temperature versus spreadability as well as cracking versus spreadability were not successful.

Some of the more interesting individual plots include Figure D2. This section of highway had monthly tests both before and after being overlaid. Prior to overlay, the seasonal effect was low whereas after overlay the effect was moderately high. It is also interesting to note that while the overlay was providing an apparent increase in strength during months 1 thru 5 and 8 thru 12, the strength, as measured by spreadability, was practically unchanged during months 5 thru 8.

Figure D3 is interesting because of the small but consistent effect caused by the ½ "finishing" course that was placed. Figure D4 is typical of a thin AC and low seasonal effect.

These preliminary findings would suggest that AC pavements under 5" can be tested at almost any time of year in Arizona with the results being usable, representative spreadability values. For pavements with AC over 5" thick, tests for worst case values should be during months 4 thru 10.

FIGURE D1

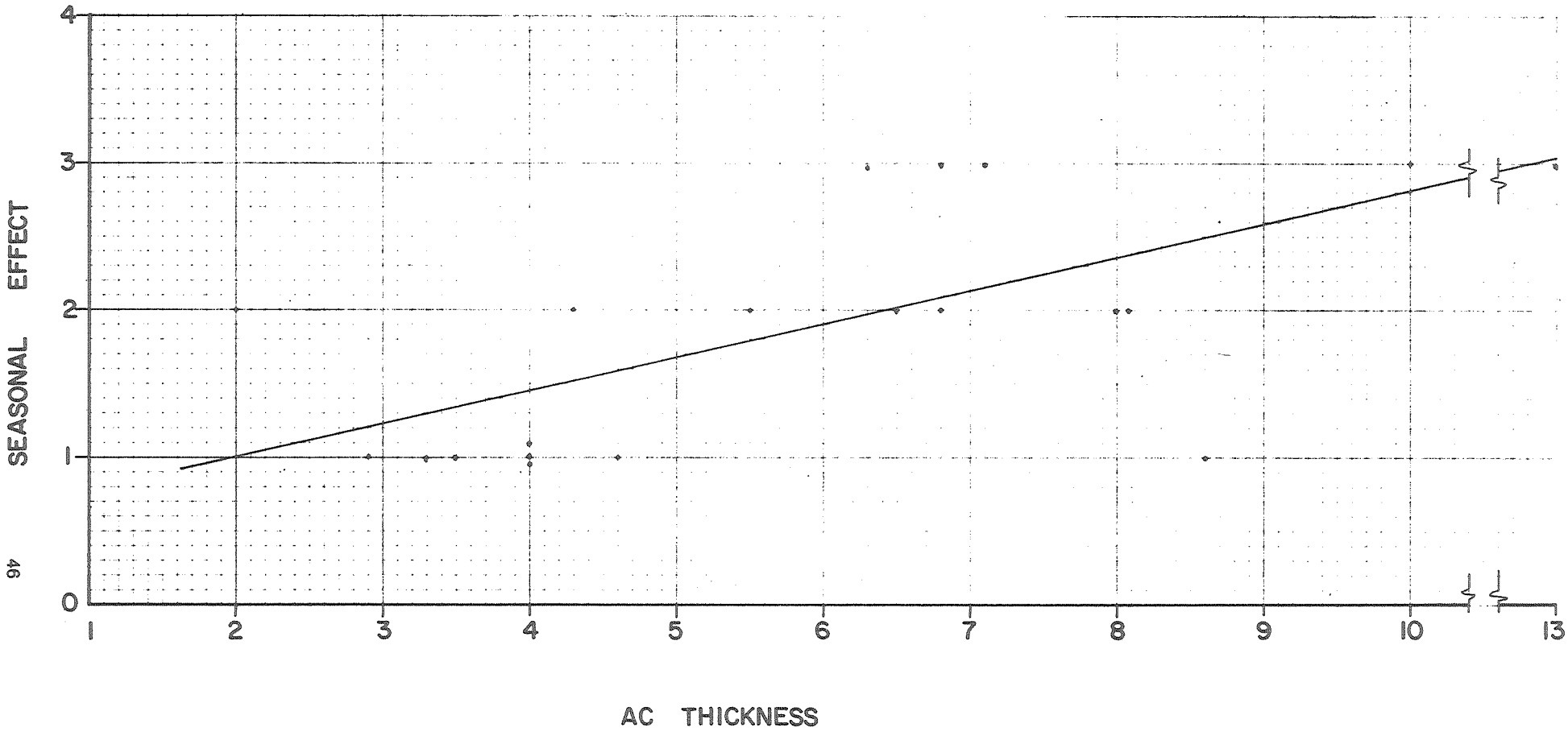


FIGURE D2

SYBIL RD. NO. 2 110 W.B. M.P. 311

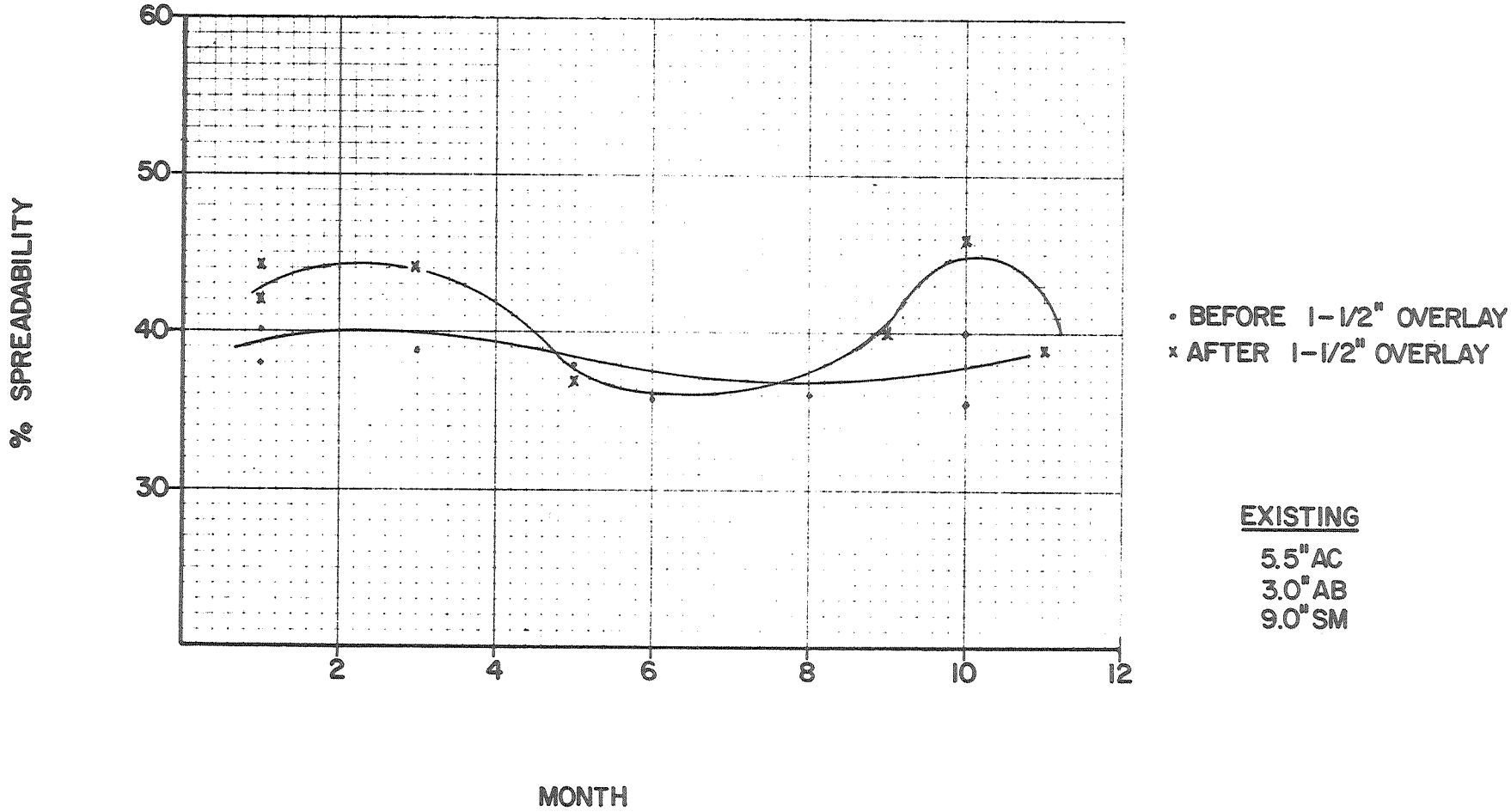


FIGURE D3

GILA BEND, #6 I8 E.B. M.P. 113

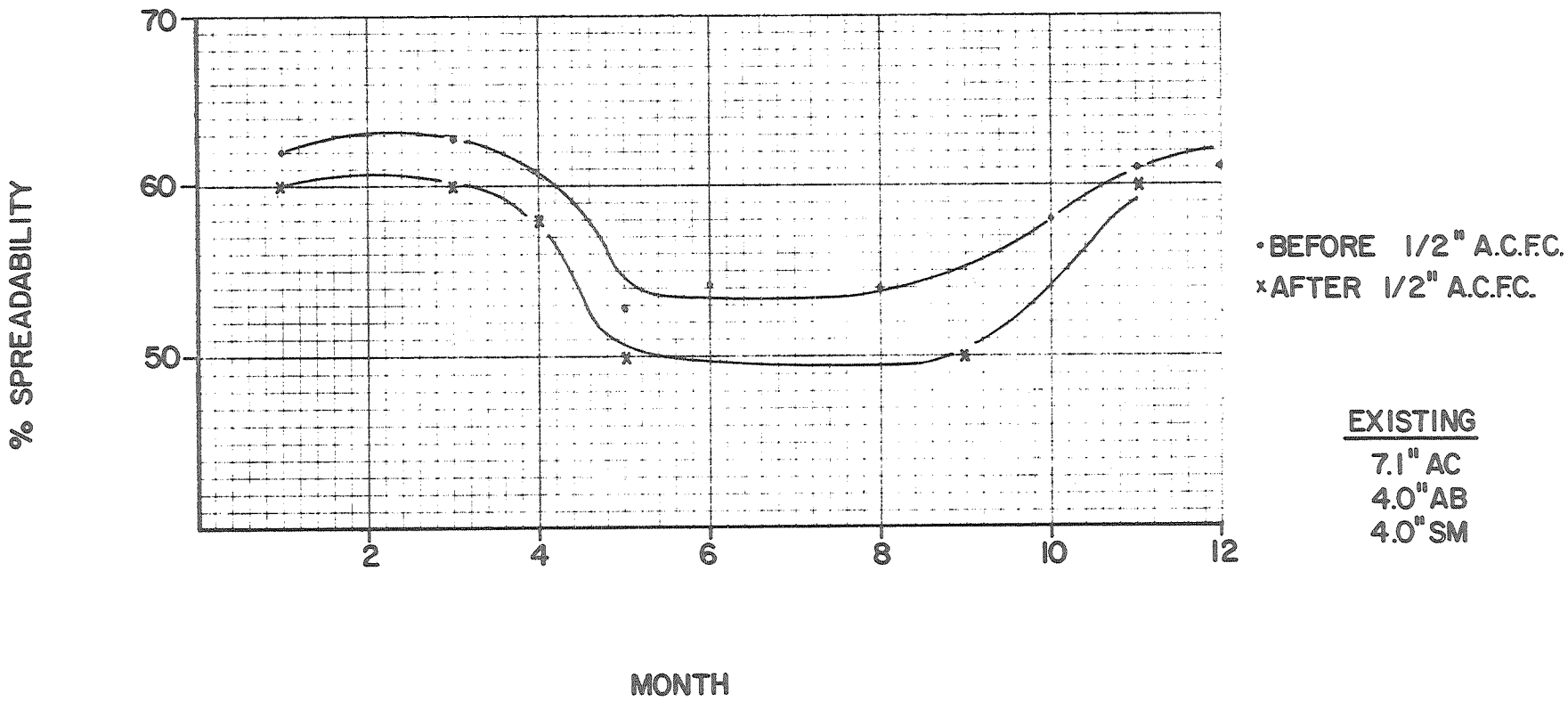
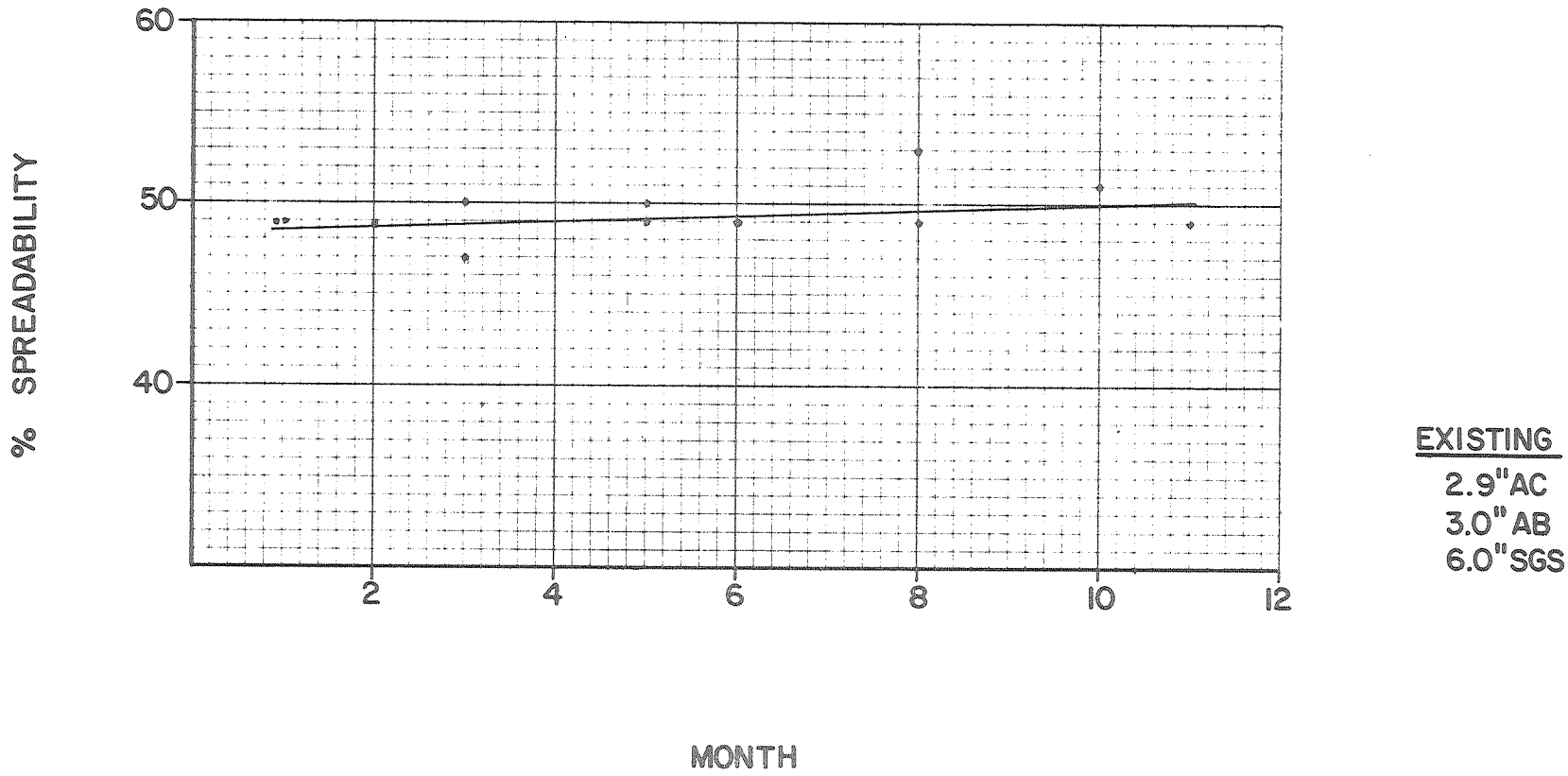


FIGURE D4

CUTTER, # 3 U.S. 70 M.P. 259