ARIZONA DEPARTMENT OF TRANSPORTATION

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# EVALUATION OF CONCRETE PAVEMENTS IN THE PHOENIX URBAN CORRIDOR

## Volume II
## Appendices

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**16. Abstract**

Arizona has been building portland cement concrete (PCC) pavements since the 1950's and now has approximately 400 lane miles of PCC pavements. Overall, these pavements have performed exceptionally well and have carried large traffic volumes. However, these pavements have experienced a range of distresses, including faulting, cracking, spalling, and, consequently, roughness. Since ADOT is considering the construction of approximately 230 lane miles of PCC in the next 20 years, a comprehensive evaluation of the 36 concrete pavements in the Phoenix Urban Corridor was conducted to identify the performance trends of the different designs and to aid in the recommendation of appropriate rehabilitation strategies. The field testing and evaluation consisted of condition surveys, drainage survey, nondestructive deflection testing, coring and subsurface boring investigations, a roughness survey, and Weigh-in-Motion (WIM) studies on selected sites.

This volume provides project documentation to the main report. The appendices of this volume summarize the performance data for the sections; provide strip maps taken from the distress surveys; describe the creation and use of the project data base; summarize the results from the WIM studies, furnish rehabilitation selection guidelines; and provide an overview of rehabilitation methods.

This volume is the second in a series of two. Volume I provides a general performance summary of the sections, evaluates pertinent concrete design models, and provides recommended design and rehabilitation alternatives.

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# SI* (MODERN METRIC) CONVERSION FACTORS

## APPROXIMATE CONVERSIONS TO SI UNITS

### LENGTH

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| in | inches | 25.4 | millimetres | mm |
| ft | feet | 0.305 | metres | m |
| yd | yards | 0.914 | metres | m |
| mi | miles | 1.61 | kilometres | km |

### AREA

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| $in^2$ | square inches | 645.2 | millimetres squared | $mm^2$ |
| $ft^2$ | square feet | 0.093 | metres squared | $m^2$ |
| $yd^2$ | square yards | 0.836 | metres squared | $m^2$ |
| ac | acres | 0.405 | hectares | ha |
| $mi^2$ | square miles | 2.59 | kilometres squared | $km^2$ |

### VOLUME

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| fl oz | fluid ounces | 29.57 | millilitres | mL |
| gal | gallons | 3.785 | litres | L |
| $ft^3$ | cubic feet | 0.028 | metres cubed | $m^3$ |
| $yd^3$ | cubic yards | 0.765 | metres cubed | $m^3$ |

NOTE: Volumes greater than 1000 L shall be shown in $m^3$.

### MASS

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| oz | ounces | 28.35 | grams | g |
| lb | pounds | 0.454 | kilograms | kg |
| T | short tons (2000 lb) | 0.907 | megagrams | Mg |

### TEMPERATURE (exact)

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| °F | Fahrenheit temperature | 5(F-32)/9 | Celcius temperature | °C |

## APPROXIMATE CONVERSIONS FROM SI UNITS

### LENGTH

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| mm | millimetres | 0.039 | inches | in |
| m | metres | 3.28 | feet | ft |
| m | metres | 1.09 | yards | yd |
| km | kilometres | 0.621 | miles | mi |

### AREA

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| $mm^2$ | millimetres squared | 0.0016 | square inches | $in^2$ |
| $m^2$ | metres squared | 10.764 | square feet | $ft^2$ |
| ha | hectares | 2.47 | acres | ac |
| $km^2$ | kilometres squared | 0.386 | square miles | $mi^2$ |

### VOLUME

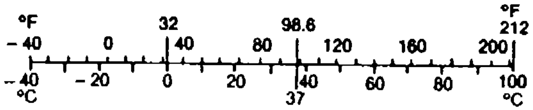
| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| mL | millilitres | 0.034 | fluid ounces | fl oz |
| L | litres | 0.264 | gallons | gal |
| $m^3$ | metres cubed | 35.315 | cubic feet | $ft^3$ |
| $m^3$ | metres cubed | 1.308 | cubic yards | $yd^3$ |

### MASS

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.205 | pounds | lb |
| Mg | megagrams | 1.102 | short tons (2000 lb) | T |

### TEMPERATURE (exact)

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| °C | Celcius temperature | 1.8C + 32 | Fahrenheit temperature | °F |




* SI is the symbol for the International System of Measurement

(Revised April 1989)

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# APPENDIX A

# PROJECT SUMMARY TABLES

# APPENDIX A PROJECT SUMMARY TABLES

This appendix provides the summary tables that contain all of the design, construction, maintenance, rehabilitation, traffic, drainage, and performance data for the sections included in the study. A key to those summary tables follows to assist in their interpretation. Each category and columnar heading is described, a key to the abbreviations used in the tables are presented, and, where appropriate, sources of information used to complete the tables are provided. The tables themselves are presented at the end of this appendix.

## 1. DESIGN DATA

The following is an explanation of the headings for the design tables. This includes the slab design data (table A-1); base and subbase design data (table A-2); subgrade and outer shoulder design data (table A-3); and the pavement joint information (table A-4).

### SLAB DESIGN DATA

**HIGHWAY NUMBER.** Projects representing the three major thoroughfares of Phoenix were included in study. The highway number of each section is given in this column (either S.R. 360, I-10, or I-17).

**PROJECT SECTION ID.** To aid in the overall organization of this project, each individual section was marked with a section identification. Those sections originally included in this study begin with an indicator of the highway number and then a sequential number assigned to a specific section (e.g., 17-01 indicates section 1 on I-17). Those Arizona sections included from the FHWA study are characterized by the State's abbreviation and a number. Each different design within that project was further identified by a number sequentially assigned as a suffix, thereby differentiating between sections.

**YEAR BUILT.** This heading provides the year that each individual pavement was constructed and opened to traffic.

**SURVEY DIRECTION.** The direction of the surveyed section is provided in this column—either WB (westbound), EB (eastbound), SB (southbound), or NB (northbound).

**NUMBER OF LANES IN SURVEY DIRECTION.** The total number of lanes in the survey direction only (one direction) is provided in this column. This value ranges from 2 to 4.

**PRIMARY LANE IN SURVEY.** The primary lane that was surveyed is given in this column. ADOT convention is that lane 3 is the outer (truck) lane, lane 2 is the center lane, and lane 1 is the innermost lane.

**START MP.** The starting milepost of each section is provided in this column.

**SECTION LENGTH, FT.** The total length of the surveyed section, in feet, is provided in this column. The length was typically 1000 ft, although this may be more or less depending upon the characteristics of the pavement.

**PAVEMENT TYPE.** Three types of pavements are included in this study. Most of the sections are of the Jointed Plain Concrete Pavement (JPCP) variety, although there were several Continuously Reinforced Concrete Pavement (CRCP) sections and several prestressed (PRES) sections. There were no Jointed Reinforced Concrete Pavement (JRCP) sections.

**PCC SURFACE**

Thickness, in

The plans thickness is obtained from plans, drawings, or reports provided by the State or reporting agency. Field thicknesses come from the coring performed as part of the field survey. The core thickness reported represents one to two center slab cores. This is not a valid sample size and it is not intended to suggest that the actual thickness of the slab is that obtained from the cores. The design thickness has been used in backcalculation procedures and ESAL calculations. for some projects, the core thickness was unavailable and an entry of N/A is made.

Pavement Slab Length, ft

The transverse joint spacing of the section is entered in this column. Joint spacings are either uniform or random. Random joint spacings are a sequence of four slab lengths that are repeated in a consistent pattern. All slab lengths are reported to the nearest foot.

% Steel

The CRCP and the prestressed sections contain a certain amount of steel whose purpose is to keep transverse shrinkage cracks tight. The percent steel is calculated as follows:

$$\% \text{ STEEL} = \frac{A_s * n}{t * 12} \qquad \text{(A-1)}$$

where:

$A_s$ = cross-sectional area of the longitudinal steel, in
n = number of pieces of longitudinal steel per foot
t = thickness of the slab, in

This actually gives a value of percent steel/foot, which is very close to the percent steel calculated on the slab's entire cross section.

Skewed Joints, Yes/No

Skewed joints are transverse joints which are not constructed perpendicular to the longitudinal centerline. The standard practice is to have an offset of 2 ft in 12 and to construct the skew counterclockwise. Sections with skewed joints are identified by a "Y".

Load Transfer Devices (LTD's)

The most commonly encountered LTD's are dowels. If dowels are used, the dowel diameter, in inches, is shown. If no LTD is used, a diameter of 0.0 is entered. Dowels are often placed with a coating to inhibit corrosion and to facilitate movement. The coatings most commonly used include paint and/or grease (P/G), epoxy, a plastic coating, stainless steel (ST STL), and liquid asphalt (LA). If there was no dowel, a series of three dashes is entered.

E, ksi

Young's modulus of elasticity (E) is estimated using backcalculation procedures. The FWD deflection basin and radius of relative stiffness are used to characterize the strength of the surface in terms of the dynamic modulus of elasticity. This figure is rounded to the nearest 10 ksi. The dynamic E is not the same as the E calculated with other correlations.

$M_r$, psi

The modulus of rupture reported here is an estimate of the value obtained from third point loading. It is calculated from the correlation $M_r = 1.02 * F_t + 210$, where $F_t$ is the split tensile strength from the cores collected during the field survey. This correlation is developed in work by Foxworthy.[A-1]

## BASE AND SUBBASE DESIGN DATA

The first nine columns are repeats of categories discussed above and are included on each table for clarity of presentation. The base data begins in column 10.

### BASE

Type

The base layer is the layer in the pavement system directly beneath the surface. Many different materials are used in the construction of base layers. The following list includes the abbreviations used for both base and subbase materials:

| | |
|---|---|
| AGG: | gravel or crushed stone |
| CTB: | cement-treated base |
| LCB: | Lean concrete base (also econocrete) |
| NONE: | no base; slab is constructed directly on the subgrade |

Thickness

The plans thickness is obtained from plans, drawings, or reports provided by the State or reporting agency. Field thicknesses are measured from the coring performed as part of the field survey. The values represent one to two center slab cores. As with the slab core measurements, this is not a valid sample size and its inclusion here is not intended to imply that the actual thickness of the base is that obtained from the cores.

If there is not base layer, the design and core thicknesses are entered as three dashes. As is noted above, some core thicknesses were not available and are noted as N/A.

E, ksi

Young's modulus of elasticity (E) is estimated using backcalculation procedures. The FWD deflection basin and radius of relative stiffness are used to characterize the strength of the surface in terms of the dynamic modulus of elasticity. This figure is rounded to the nearest 10 ksi. The dynamic E is not the same as the E calculated with other correlations.

Estimated Permeability

The coefficient of permeability, k, is reported in units of ft/hr. The procedure used in this study to estimate the permeability of porous base and subbase layers follows that outlined in reference A-2. The permeability equation in that reference has been worked into a computerized solution, DRAINIT.[A-3] The inputs to this solution include the effective grain size, $D_{10}$, the specific gravity, $G_s$, and the percent passing the No. 200 sieve. The types of fines and the general material type are also needed. All of the material properties were obtained from the coring and boring performed as part of the field surveys, with the exception of $G_s$. In some cases, that is available from project records. Where it is not available it is estimated. The estimated permeability of stabilized, nondraining layers is assumed to be zero. If there is no base, the estimated permeability is recorded as three dashes. If insufficient material was obtained to estimate the permeability, an entry of N/A is made.

$K_{eff}$ (Dynamic)

The effective dynamic modulus of subgrade reaction on the base is backcalculated using a closed-form numerical procedure which evaluates the stiffness of the surface and subsurface layers in terms of dynamic loading. The FWD deflection basin and radius of relative stiffness are used to determine the dynamic k-value on top of the base. The dynamic k-value is approximately 50 percent higher than the static k-value due to the stress state induced by the dynamic load.

### SUBBASE

The subbase is the layer of the pavement system located beneath the base. The descriptions of the categories and the entries are identical to those used in the section on bases.

## SUBGRADE AND SHOULDER DESIGN DATA

There is some repetition of data for clarity. The subgrade information begins in column 10.

### SUBGRADE

AASHTO Subgrade Soil Type

The subgrade is the lowest layer of the pavement system. It is the existing material upon which the pavement system is constructed. The pavement may be constructed on the existing soil or it may rest on fill material. The AASHTO soil type is determined in accordance with AASHTO M-145. Results were obtained from the boring operations, construction reports, or county soil surveys.

% Passing # 200

The percent of the subgrade material passing the number 200 sieve is listed in this column.

Plasticity Index

The plasticity index is provided in this column. The plasticity index is defined as the difference between the liquid limit and the plastic limit, and therefore indicates the range of moisture content over which the soil is in a plastic condition.

E, ksi

Young's modulus of elasticity (E) is estimated using backcalculation procedures. The FWD deflection basin and radius of relative stiffness are used to characterize the strength of the surface in terms of the dynamic modulus of elasticity. This figure is rounded to the nearest 10 ksi. The dynamic E is not the same as the E calculated with other correlations.

Estimated Permeability

The coefficient of permeability, k, is reported in units of ft/hr. Typically, however, this value was not available for the subgrade material.

## SHOULDER

Shoulder Included in Survey

Along with the condition survey, a survey of the shoulder was also conducted. The lane that was being surveyed determined which shoulder was included in the survey for that section. This will typically be the outer shoulder, but in some instances was the inner shoulder.

Type

Two surface types were observed on the outer shoulders in this project. They are asphalt concrete (AC) and portland cement concrete (PCC). In most cases, the PCC shoulders are tied to the mainline pavement with regularly spaced rebar.

Thickness

The thickness of the surface and base courses are provided for the outer shoulder. In certain cases, the cross section of the surface layer tapers from the pavement edge to the outer edge of the shoulder. Then the thickness provided is an average of the thickest and thinnest part of the cross section and is noted by an asterisk.

## PAVEMENT JOINT DATA

Again there is some repetition of column headings for sake of clarity. These have been described elsewhere.

### TRANSVERSE JOINT.

Dowel Diameter, in

This category has been previously described elsewhere.

Calculated Average Joint Opening, in

Joint movement is a function of slab length, temperature change, the thermal coefficient of expansion of the slab material, and the friction between the slab and the base. The calculated mean joint opening can be estimated from the following equation:

$$\Delta L = C * L * \alpha * \Delta T \qquad \text{(A-2)}$$

where:

$\Delta L$ = mean joint opening, inches
$C$ = an adjustment factor for base friction; 0.80 for granular material and 0.65 for stabilized material
$L$ = slab length, inches
$\alpha$ = thermal coefficient of expansion of PCC, $5.5 * 10^{-6}$ in/in/°F
$\Delta T$ = design temperature change

Skewed Joints, Y/N

This category has been previously described.

Joint Sealant Shape Factor

The joint shape factor is the ratio of the joint reservoir width to the joint reservoir depth. This is based on the design and not on actual field measurements. If the joint was not sealed at construction and remained unsealed, the shape factor is 0.0. Note that the joint reservoir may be different than the initial sawcut of the transverse joint.

Joint Sealant

Type

The types of sealants used in the transverse joints and their abbreviations are presented below:

| | |
|---|---|
| PREF: | preformed elastomeric compound |
| HP: | hot-poured bituminous material |
| AC: | asphalt cement |
| SIL: | silicone sealant |
| RA: | rubberized asphalt |

Age

The age of the sealant at the time of the survey is recorded. This is not always the same as the age of the pavement, as some sections have been resealed.

Condition

The joint sealant condition was evaluated by severity during the field survey. The condition reported is the average condition, or the condition of the sealant in the majority of the joints. Only the outer lane is included in this rating. The following rating scheme is used:

| SEVERITY LEVEL | CONDITION |
|---|---|
| NONE | EXCELLENT |
| LOW | GOOD |
| MODERATE | FAIR |
| HIGH | POOR |

**DEPTH OF LONGITUDINAL JOINT, IN.** The depth of the longitudinal joint between lanes is obtained from construction records. It was not measured in the field. If the lanes were placed at separate times and no joint was sawed or formed by an insert, this is recorded as N/A.

## 2. MONITORING DATA

This section describes selected monitoring information. Such items as deflection data (table A-5), shoulder information (table A-6), drainage information (table A-7), and traffic information (table A-8) are included here.

### DEFLECTION DATA — OUTER LANE

#### DEFLECTION, MILS.

Mid-Slab Deflections

A Falling Weight Deflectometer (FWD) was used to measure pavement deflections under a dynamic load. A series of four loads in a range from 7 kips to 17 kips were applied to the center of the slab and the resultant deflections were recorded by a set of sensors in thousandths of an inch. The deflections at the load closest to 9 kips were then "normalized" to 9 kips by plotting load vs. deflection and obtaining a deflection for each test. The results presented here for each section are the normalized high and low deflections recorded from the load plate sensor ($D_0$), and the average of all of the mid-slab deflections for the section. The area of the deflection basin is also given.

Loaded Corner

FWD testing was performed at the corners of the slabs. Data collected at this location is used to determine load transfer at the joint and to determine the existence of voids under the slab corners. The loaded corner deflection is the deflection recorded by the sensor directly under the load plate ($D_0$). The value presented here is an average of all of the loaded corner deflections from the section.

Unloaded Corner

When deflection testing is performed in the corner of the slab, a sensor is placed opposite the loaded corner, on the unloaded corner. The deflections recorded from this sensor ($D_1$ or $D_6$) represent the unloaded corner deflections. This value is also an average of all of the unloaded corner deflections from the section.

**ADJUSTED PERCENT LOAD TRANSFER EFFICIENCY.** The general definition of load transfer (percent) is the deflection of the unloaded corner divided by the deflection of the loaded corner multiplied by 100. The adjusted load transfer is a corrected value to take into account the fact that the slab deflects under loading; the natural bending of the slab under load must be accounted for to more accurately model the deflection of the corner. The correction factor used is the average of $D_o/D_1$ for the section. The load transfer is multiplied by the correction factor to obtain the adjusted load transfer efficiency.

**PERCENT LOAD TRANSFER ACROSS SHOULDER.** The load transfer across the shoulder can be calculated from deflections measured across this joint, if the shoulder is PCC. The method of calculation is the same as that described above. If the shoulder is AC or AGG, the entry in this column is N/A.

**AVERAGE NDT TEST TEMPERATURE, °F.** FWD test results are somewhat sensitive to the temperature of the slab being tested. The average ambient temperature over the course of the testing is presented here.

**PERCENT CORNERS WITH VOIDS.** Using procedures developed under NCHRP 1-21, deflection measurements obtained at the slab corners can be used to identify the presence of voids under those corners.[A-4] The percent of the corners tested which had voids is presented here.

## SHOULDER INFORMATION

Again, there is a repeat of the first 9 columnar headings. The shoulder information begins in column 10.

**SHOULDER INCLUDED IN SURVEY.** The shoulder included in the field survey of that section (outer or inner) is listed in this column.

**TYPE-THICKNESS, IN.**

Surface

The layer type and its thickness are given for the surface. This information is obtained from plans, specifications or other sources made available by the States. The surface types are asphalt concrete (AC) and portland cement concrete (PCC). Shoulder types preceded by a plus sign (+) indicate an average thickness.

Base

The base type and its thickness are given. The base types are the same as previously described. An average is given when the shoulder thickness changes from the pavement edge to the outer edge.

**OVERALL SHOULDER CONDITION.** The shoulder condition rating is a subjective evaluation made at the time of the field survey. The ratings used were excellent, good, fair, and poor. They are based on the amount of distress recorded on the shoulder.

**SHOULDER JOINT SEAL CONDITION.** As part of the drainage survey, the condition of the lane-shoulder joint sealant was evaluated for each section. The severity levels for the observed sealant distress were NONE, LOW, MODERATE, and HIGH. These correspond to an overall shoulder joint seal condition of excellent, good, fair, and poor.

## DRAINAGE INFORMATION

Drainage information begins in column 10.

**PERMEABILITY, FT/HR.**

Base

The calculation of the estimated permeability, k, of the base has been previously described.

Subbase

The calculation of the estimated permeability, k, of the subbase has been previously described.

Subgrade

The determination of the estimated permeability, k, of the subgrade is presented when made available from other sources.

**$C_d$.** This parameter, the AASHTO drainage coefficient, is an overall estimate of the drainability of the entire section or its ability to remove water from the pavement structure. It is based on a number of factors, including environment, layer permeabilities, time of saturation, longitudinal and transverse slopes, and material characteristics. For rigid pavements, $C_d$ ranges from 0.7 (indicating very poor drainage) to 1.25 (indicating very good drainage).

**DOWELS, Y/N.** This is the same as information presented earlier. It is included again as an aid to understanding the other data on this page.

**DEPTH TO DITCH, FT.** The depth from the pavement edge to the bottom of the ditch line was estimated during the field survey. This number is only an estimate. If a value of 0 is entered, there is no drainage curbs and gutters or storm drains.

### PRIMARY LANE, AVERAGE

Average Transverse Slope, Percent.
The average transverse slope of the outer lane of the pavement was measured at the beginning, middle, and end of the section, using a bubble level with a slope indicator. The three values are averaged and converted from in/ft to a percentage. A negative value indicates that the outer lane sloped down toward the outer shoulder when facing in the direction of traffic.

Average Longitudinal Grade, Percent.
The average longitudinal grade was also measured three times and the readings were averaged. A negative slope indicates that the pavement slopes down in the direction of the survey. In some cases the slope changed signs during the section. In those instances, the three readings are still averaged.

## TRAFFIC INFORMATION

### ORIGINAL DESIGN TRAFFIC

Very little original design traffic was available. The design traffic that was available is presented here.

ESAL's
This is the number of 18-kip Equivalent Single-Axle Load (ESAL) applications used for the design of the pavement.

Average Daily Traffic (ADT)
This is the two-way ADT used for the design of the pavement.

Percent Trucks
This is the percent of heavy trucks used for the design of the pavement.

Age at Survey. The age of the pavement at the time of the survey is the number of years passed from the time of construction through 1988.

### 1988 ESTIMATED.

ADT
This is the 1988 two-way ADT obtained for each section.

Percent Trucks

This is the 1988 truck percentage (excluding panels and pickups) obtained for each section.

**LANE #3**

Lane #3 is the outermost traffic lane.

1988 ESAL Estimated From ADT and Percent Trucks

Using ADT, percent truck information, and truck weight information, the ESAL applications for 1988 were calculated and entered here.

Estimated ESAL's To Date

Using historical ADT, percent truck information, and truck weight information, the cumulative ESAL applications (from the date of opening to traffic through 1988) were calculated and entered here.

**LANE #2**

Lane #2 is the lane adjacent to the outer lane.

1988 ESAL Estimated From ADT and Percent Trucks

This is the same as described above.

Estimated ESAL's To Date

This is the same as described above.

**LANE #1**

Lane #1 is the innermost (median-side) traffic lane.

1988 ESAL Estimated From ADT and Percent Trucks

This is the same as described above.

Estimated ESAL's To Date

This is the same as described above.

## 3. PERFORMANCE DATA

Key elements of each pavement section's performance are summarized for the outer lane (lane 3), the middle or center lane (lane 2), and the inner lane (lane 1). This information is presented in tables A-9 through A-11, respectively. This data was collected during the field surveys conducted during the spring of 1988. It is not possible to include all of the performance data in these tables; that information is available in the computerized database. Instead, key performance indicators are provided. The distress identification, rating of severity levels, and recording of quantities were all performed in accordance with guidelines presented in reference A-5. Sections with more than two lanes in the direction of the survey were only visually surveyed for condition and distress in all lanes other than the outer lane due to safety considerations, unless that other lane was the one of primary interest.

**PERFORMANCE DATA - LANE 3**

**DOWEL DIAMETER, IN.** This category of data is described elsewhere and is included here for reference only.

**AVERAGE PRESENT SERVICEABILITY RATING.** The PSR was recorded by two people while running the Mays Roughness survey. The PSR is a rating assigned to the pavement by the survey crew after driving over the pavement at the posted speed limit. The rating scale ranges from 0 (considered an "impassable" pavement) to 5 (considered a "perfect" pavement). The PSR is a highly subjective rating given the small sample size and is included for reference purposes only.

**MAYS ROUGHNESS, IN/MI.** A 1985 Buick Le Sabre equipped with a Mays Roughness Meter was used to perform a roughness survey on every section of the project. The vehicle, loaded to a fairly constant weight, made two passes over each section at 50 mi/hr. The roughness readings from both passes were averaged to obtain the value presented in this table.

**AVERAGE TRANSVERSE FAULTING, IN.** Hand measurements of the faulting of each transverse joint were recorded in the outer wheel path of each lane, for sections with fewer than three lanes in the direction of the survey, and in the outer lane only, for sections with three or more lanes in the direction of the survey. The average of the faulting measurements is given in this column.

**DETERIORATED TRANSVERSE CRACKS/MI.** The occurrence of transverse cracks and their severity was recorded during the field survey. For JPCP pavements, transverse cracks of low, moderate, and high severity are counted together and summed as deteriorated cracks per mile.

**LONGITUDINAL CRACKING, LINEAR FT/MI.** Longitudinal cracks of all severities were measured and recorded. The totals are summarized as a number of linear feet of longitudinal cracking per mile of pavement.

**PUMPING.** The entire section is given a rating for pumping based on the presence of the highest severity level of pumping noted during the field survey.

**PERCENT OF TRANSVERSE JOINTS SPALLED.** Three severity levels of transverse joint spalling are recognized and were recorded. The percentage of joints falling in the low-, medium-, and high-severity joint spalling are shown here.

**SPALL REPAIR AT JOINTS.** A good deal of partial-depth spall repairs had been performed at the transverse joints. This column summarizes the type of repair material placed within each sections and the percentage of joints to which the repair material had been applied.

### PERFORMANCE DATA - LANE 2

The column headings for this table are the same as the ones described above.

### PERFORMANCE DATA - LANE 1

The column headings for this table are the same as the ones described above.

## 4. SUMMARY TABLES

The tables summarizing all of the design and construction data for the study sections follow the list of references.

## 5. REFERENCES

A-1. Foxworthy, P. T., "Concepts for the Development of a Nondestructive Testing and Evaluation System for Rigid Airfield Pavements," Ph.D. Dissertation, University of Illinois, June 1985.

A-2. Moulton, L. K, "Highway Subdrainage Design," FHWA-TS-80-224, Federal Highway Administration, August 1980.

A-3. "DRAINIT—Subdrainage Design By Microcomputer," Computer Program prepared under FHWA Contract DTFH61-88-C-00070, Federal Highway Administration, 1988.

A-4. Crovetti, J. A. and M. I. Darter, "Appendix C—Void Detection Procedures," NCHRP Project 1-21, March 1985.

A-5. Smith, K. D., M. I. Darter, J. B. Rauhut, and K. T. Hall, "Distress Identification Manual for the Long-Term Pavement Performance Studies," Report Prepared for the Strategic Highway Research Program, December 1987.

Table A-1. Slab design data for study sections.

| Highway Number | Project Section ID | Year Built | Survey Dim. | Number of Lanes Survey Dim. | Primary Lane in Survey | Start MP | Section Length, FT | Pvt. Type | PCC SURFACE THICKNESS, IN Plans | Field | Pavement Slab Length, FT | % Steel | Skewed Joints Y/N | LTD's Dia, IN | Coating | E, KSI from FWD | Mr,PSI from cores |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RT 360 | AZ 1-1 | 1972 | WB | 3 | 3 | 1.19 | 1063 | JPCP | 9.0 | N/A | 13-15-17-15 | --- | Y | 0.00 | --- | 3140 | 687 |
| | AZ 1-2 | 1975 | WB | 3 | 3 | 4.34 | 1061 | JPCP | 13.0 | N/A | 13-15-17-15 | --- | Y | 0.00 | --- | 3440 | 649 |
| | AZ 1-4 | 1979 | WB | 3 | 3 | 7.42 | 1051 | JPCP | 13.0 | 13.0 | 13-15-17-15 | --- | Y | 0.00 | --- | 3490 | 702 |
| | AZ 1-5 | 1979 | WB | 3 | 3 | 6.50 | 1059 | JPCP | 11.0 | 11.0 | 13-15-17-15 | --- | Y | 0.00 | --- | 3290 | 761 |
| | AZ 1-6 | 1981 | WB | 2 | 3 | 9.40 | 1059 | JPCP | 9.0 | N/A | 13-15-17-15 | --- | Y | 0.00 | --- | 3090 | 853 |
| | AZ 1-7 | 1981 | WB | 2 | 3 | 10.38 | 1058 | JPCP | 9.0 | N/A | 13-15-17-15 | --- | Y | 0.00 | --- | 3090 | 868 |
| | 360-01 | 1985 | EB | 2 | 3 | 15.34 | 1065 | JPCP | 9.0 | 8.9 | 13-15-17-15 | --- | Y | 0.00 | --- | 6730 | 863 |
| | 360-02 | 1985 | EB | 2 | 3 | 13.50 | 1069 | JPCP | 9.0 | 9.2 | 13-15-17-15 | --- | Y | 0.00 | --- | 5490 | 899 |
| | 360-03 | 1983 | EB | 2 | 3 | 11.80 | 1054 | JPCP | 9.0 | 9.5 | 13-15-17-15 | --- | Y | 0.00 | --- | 5930 | 950 |
| | 360-04 | 1979 | WB | 3 | 3 | 6.31 | 868 | JPCP | 11.0 | 10.9 | 13-15-17-15 | --- | Y | 0.00 | --- | 3590 | 878 |
| | 360-05 | 1977 | EB | 3 | 3, 2 | 4.27 | 3508 | PRES | 6.0 | N/A | 402 | 0.11 | N/A | 0.00 | --- | 5500 | N/A |
| | 360-06 | 1977 | EB | 3 | 3, 2 | 4.85 | 1426 | PRES | 6.0 | N/A | 402 | 0.11 | N/A | 0.00 | --- | 5390 | N/A |
| | 360-07 | 1984 | EB | 3 | 1 | 4.31 | 1200 | CRCP | 9.0 | N/A | N/A | 0.65 | N/A | 0.00 | --- | 4890 | N/A |
| | 360-08 | 1984 | EB | 3 | 1 | 4.70 | 1200 | CRCP | 9.0 | N/A | N/A | 0.65 | N/A | 0.00 | --- | 4590 | N/A |
| | 360-09 | 1975 | WB | 3 | 3 | 3.54 | 904 | JPCP | 13.0 | 11.7 | 13-15-17-15 | --- | Y | 0.00 | --- | 3010 | 868 |
| | 360-10A | 1977 | EB | 3 | 3, 2 | 5.01 | 207 | PRES | 6.0 | N/A | 207 | 0.11 | N/A | 0.00 | --- | 5810 | N/A |
| | 360-10B | 1977 | EB | 3 | 3, 2 | 5.07 | 829 | PRES | 6.0 | N/A | 502 | 0.11 | N/A | 0.00 | --- | 5660 | N/A |
| I-10 | AZ 2 | 1985 | EB | 4 | 3 | 141.19 | 1041 | JPCP | 10.0 | N/A | 13-15-17-15 | --- | Y | 1.25 | EPOXY | 5560 | 725 |
| | 10-01 | 1968 | EB | 3 | 1 | 152.82 | 1059 | JPCP | 9.0 | 9.6 | 13-15-17-15 | --- | Y | 0.00 | --- | 5560 | 899 |
| | 10-02 | 1968 | EB | 4 | 1 | 153.14 | 1006 | JPCP | 9.0 | 8.7 | 13-15-17-15 | --- | Y | 0.00 | --- | 3910 | 878 |
| | 10-03 | 1968 | WB | 3 | 3 | 153.87 | 1048 | JPCP | 9.0 | 9.0 | 13-15-17-15 | --- | Y | 0.00 | --- | 4930 | 965 |
| | 10-04 | 1986 | WB | 4 | 3 | 140.34 | 1065 | JPCP | 10.0 | 11.9 | 13-15-17-15 | --- | Y | 1.25 | EPOXY | 6360 | 776 |
| | 10-05 | 1985 | EB | 4 | 3 | 136.68 | 1054 | JPCP | 10.0 | 9.0 | 13-15-17-15 | --- | Y | 1.25 | EPOXY | 4360 | N/A |
| | 10-06 | 1984 | WB | 3 | 3 | 130.88 | 1065 | JPCP | 10.0 | 9.7 | 13-15-17-15 | --- | Y | 1.25 | EPOXY | 5690 | 837 |
| | 10-07 | 1984 | WB | 3 | 3 | 130.50 | 1065 | JPCP | 10.0 | 9.7 | 13-15-17-15 | --- | Y | 1.25 | EPOXY | 4040 | 776 |
| I-17 | 17-01 | 1961 | SB | 3 | 1 | 205.50 | 1065 | JPCP | 9.0 | 9.3 | 15.0 | --- | N | 0.00 | --- | 5080 | 797 |
| | 17-02 | 1961 | NB | 3 | 1 | 201.65 | 1055 | JPCP | 9.0 | 6.9 | 15.0 | --- | N | 0.00 | --- | 5450 | 842 |
| | 17-03 | 1965 | SB | 3 | 3 | 211.89 | 1061 | JPCP | 9.0 | 9.1 | 15.0 | --- | Y | 0.00 | --- | 6010 | 934 |
| | 17-04 | 1965 | SB | 3 | 3 | 208.20 | 1070 | JPCP | 9.0 | 9.3 | 15.0 | --- | Y | 0.00 | --- | 6110 | 1103 |
| | 17-05 | 1965 | NB | 3 | 3 | 210.40 | 871 | JPCP | 9.0 | 9.7 | 15.0 | --- | Y | 0.00 | --- | 6890 | 995 |
| | 17-06 | 1963 | NB | 3 | 3 | 198.70 | 1065 | JPCP | 9.0 | 9.1 | 15.0 | --- | N | 0.00 | --- | 5690 | 848 |
| | 17-10 | 1961 | NB | 3 | 3 | 205.20 | 886 | JPCP | 9.0 | 9.8 | 15.0 | --- | N | 0.00 | --- | 3740 | 638 |
| | 17-11 | 1965 | NB | 3 | 3 | 208.70 | 1065 | JPCP | 9.0 | 9.1 | 15.0 | --- | Y | 0.00 | --- | 6530 | 904 |

Table A-2. Base and subbase design data for study sections.

| Highway Number | Project Section ID | Year Built | Survey Dir. | Number of Lanes Survey Dir. | Primary Lane in Survey | Start MP | Section Length, FT | Pvt. Type | BASE Type | BASE THICKNESS, IN Plans | BASE THICKNESS, IN Field | BASE E, KSI from FWD | BASE Estimated Perm., FT/HR | Keff, (Dyn.) PCI | SUBBASE Type | SUBBASE THICKNESS, IN Plans | SUBBASE THICKNESS, IN Field | SUBBASE E, KSI from FWD | SUBBASE Estimated Perm., FT/HR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RT 360 | AZ 1-1 | 1972 | WB | 3 | 3 | 1.19 | 1063 | JPCP | CTB | 6.0 | N/A | --- | --- | 546 | AGG | 4.0 | N/A | --- | .06 |
| | AZ 1-2 | 1975 | WB | 3 | 3 | 4.34 | 1061 | JPCP | NONE | --- | --- | --- | --- | 492 | NONE | --- | --- | --- | --- |
| | AZ 1-4 | 1979 | WB | 3 | 3 | 7.42 | 1051 | JPCP | NONE | --- | --- | --- | --- | 344 | NONE | --- | --- | --- | --- |
| | AZ 1-5 | 1979 | WB | 3 | 3 | 6.50 | 1059 | JPCP | NONE | --- | --- | --- | --- | 439 | NONE | --- | --- | --- | --- |
| | AZ 1-6 | 1981 | WB | 2 | 3 | 9.40 | 1059 | JPCP | LCB | 4.0 | N/A | --- | --- | 621 | NONE | --- | --- | --- | --- |
| | AZ 1-7 | 1981 | WB | 2 | 3 | 10.38 | 1058 | JPCP | LCB | 4.0 | N/A | --- | --- | 584 | NONE | --- | --- | --- | --- |
| | 360-01 | 1985 | EB | 2 | 3 | 15.34 | 1065 | JPCP | LCB | 4.0 | 4.5 | --- | --- | 278 | NONE | --- | --- | --- | --- |
| | 360-02 | 1985 | EB | 2 | 3 | 13.50 | 1069 | JPCP | LCB | 4.0 | 4.2 | --- | --- | 390 | NONE | --- | --- | --- | --- |
| | 360-03 | 1983 | EB | 2 | 3 | 11.80 | 1054 | JPCP | LCB | 4.0 | 3.6 | --- | --- | 251 | NONE | --- | --- | --- | --- |
| | 360-04 | 1979 | WB | 3 | 3 | 6.31 | 868 | JPCP | NONE | --- | --- | --- | --- | 448 | NONE | --- | --- | --- | --- |
| | 360-05 | 1977 | EB | 3 | 3, 2 | 4.27 | 3508 | PRES | LCB | 4.0 | N/A | --- | --- | 271 | NONE | --- | --- | --- | --- |
| | 360-06 | 1977 | EB | 3 | 3, 2 | 4.85 | 1426 | PRES | LCB | 4.0 | N/A | --- | --- | 211 | NONE | --- | --- | --- | --- |
| | 360-07 | 1984 | EB | 3 | 1 | 4.31 | 1200 | CRCP | AGG | 4.0 | N/A | --- | --- | 311 | NONE | --- | --- | --- | --- |
| | 360-08 | 1984 | EB | 3 | 1 | 4.70 | 1200 | CRCP | AGG | 4.0 | N/A | --- | --- | 335 | NONE | --- | --- | --- | --- |
| | 360-09 | 1975 | WB | 3 | 3 | 3.54 | 904 | JPCP | NONE | --- | --- | --- | --- | 408 | NONE | --- | --- | --- | --- |
| | 360-10A | 1977 | EB | 3 | 3, 2 | 5.01 | 207 | PRES | LCB | 4.0 | N/A | --- | --- | 252 | NONE | --- | --- | --- | --- |
| | 360-10B | 1977 | EB | 3 | 3, 2 | 5.07 | 829 | PRES | LCB | 4.0 | N/A | --- | --- | 261 | NONE | --- | --- | --- | --- |
| I-10 | AZ 2 | 1985 | EB | 4 | 3 | 141.19 | 1041 | JPCP | LCB | 5.0 | N/A | --- | --- | 174 | NONE | --- | --- | --- | --- |
| | 10-01 | 1968 | EB | 3 | 1 | 152.82 | 1059 | JPCP | AGG | 4.0 | 4.4 | --- | .16 | 189 | AGG | 5.0 | N/A | --- | .24 |
| | 10-02 | 1968 | EB | 4 | 1 | 153.14 | 1006 | JPCP | AGG | 4.0 | 4.5 | --- | .19 | 207 | AGG | 5.0 | 4.5 | --- | .27 |
| | 10-03 | 1968 | WB | 3 | 3 | 153.87 | 1048 | JPCP | AGG | 4.0 | 5.0 | --- | .16 | 312 | AGG | 5.0 | 4.0 | --- | .17 |
| | 10-04 | 1986 | WB | 4 | 3 | 140.34 | 1065 | JPCP | LCB | 5.0 | 5.3 | --- | --- | 217 | NONE | --- | --- | --- | --- |
| | 10-05 | 1985 | EB | 4 | 3 | 136.68 | 1054 | JPCP | LCB | 5.0 | 5.7 | --- | --- | 284 | NONE | --- | --- | --- | --- |
| | 10-06 | 1984 | WB | 3 | 3 | 130.88 | 1065 | JPCP | LCB | 5.0 | 5.3 | --- | --- | 258 | NONE | --- | --- | --- | --- |
| | 10-07 | 1984 | WB | 3 | 3 | 130.50 | 1065 | JPCP | LCB | 5.0 | 4.3 | --- | --- | 261 | NONE | --- | --- | --- | --- |
| I-17 | 17-01 | 1961 | SB | 3 | 1 | 205.50 | 1065 | JPCP | AGG | 3.0 | 3.0 | --- | .08 | 215 | AGG | 6.0 | ??? | --- | --- |
| | 17-02 | 1961 | NB | 3 | 1 | 201.65 | 1055 | JPCP | AGG | 3.0 | 3.0 | --- | .68 | 174 | AGG | 6.0 | 2.4 | --- | 1.0 |
| | 17-03 | 1965 | SB | 3 | 3 | 211.89 | 1061 | JPCP | AGG | 3.0 | 3.0 | --- | .04 | 123 | AGG | 6.0 | 4.0 | --- | .03 |
| | 17-04 | 1965 | SB | 3 | 3 | 208.20 | 1070 | JPCP | AGG | 4.0 | 4.0 | --- | .06 | 205 | AGG | 6.0 | 1.9 | --- | .09 |
| | 17-05 | 1965 | NB | 3 | 3 | 210.40 | 871 | JPCP | AGG | 4.0 | 4.0 | --- | .03 | 141 | AGG | 6.0 | 5.5 | --- | .03 |
| | 17-06 | 1963 | NB | 3 | 3 | 198.70 | 1065 | JPCP | AGG | 3.0 | 3.0 | --- | .05 | 359 | AGG | 6.0 | 2.5 | --- | --- |
| | 17-10 | 1961 | NB | 3 | 3 | 205.20 | 886 | JPCP | AGG | 4.0 | 4.0 | --- | .19 | 260 | AGG | 6.0 | 1.5 | --- | .13 |
| | 17-11 | 1965 | NB | 3 | 3 | 208.70 | 1065 | JPCP | AGG | 4.0 | 4.4 | --- | .16 | 105 | AGG | 6.0 | N/A | --- | .11 |

Table A-3. Subgrade and outer shoulder design data for study sections.

| | | | | | | | | | SUBGRADE | | | | | SHOULDER | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Highway Number | Project Section ID | Year Built | Survey Dim. | Number of Lanes Survey Dim. | Primary Lane in Survey | Start MP | Section Length, FT | Pvt. Type | AASHTO Soil Type | % Pass # 200 | Plast. Index | E, PSI from FWD | Estimated Perm., FT/HR | Shoulder Included in Survey | Type | THICKNESS, IN Surface | Base |
| RT 360 | AZ 1-1 | 1972 | WB | 3 | 3 | 1.19 | 1063 | JPCP | A-6 | N/A | N/A | --- | .11 | OUTER | AC | 3.0 | 6.0 |
| | AZ 1-2 | 1975 | WB | 3 | 3 | 4.34 | 1061 | JPCP | A-6 | 5 | 21 | --- | .11 | OUTER | PCC | 9.0 | 0.0 |
| | AZ 1-4 | 1979 | WB | 3 | 3 | 7.42 | 1051 | JPCP | A-6 | 1 | 0 | --- | .11 | OUTER | PCC | 13.0 | 0.0 |
| | AZ 1-5 | 1979 | WB | 3 | 3 | 6.50 | 1059 | JPCP | A-6 | 4 | 16 | --- | .11 | OUTER | PCC | 11.0 | 0.0 |
| | AZ 1-6 | 1981 | WB | 2 | 3 | 9.40 | 1059 | JPCP | A-6 | 3 | 0 | --- | .03 | OUTER | PCC | 9.0 | 4.0 |
| | AZ 1-7 | 1981 | WB | 2 | 3 | 10.38 | 1058 | JPCP | A-6 | 8 | 33 | --- | .03 | OUTER | PCC | 9.0 | 4.0 |
| | 360-01 | 1985 | EB | 2 | 3 | 15.34 | 1065 | JPCP | A-7-5 | 69 | 35 | --- | .28 | OUTER | PCC | 9.0 | 4.0 |
| | 360-02 | 1985 | EB | 2 | 3 | 13.50 | 1069 | JPCP | A-7-5 | 69 | 35 | --- | .11 | OUTER | PCC | 9.0 | 4.0 |
| | 360-03 | 1983 | EB | 2 | 3 | 11.80 | 1054 | JPCP | A-7-6 | 59 | 31 | --- | .11 | OUTER | PCC | 9.0 | 4.0 |
| | 360-04 | 1979 | WB | 3 | 3 | 6.31 | 868 | JPCP | A-7-5 | 46 | 19 | --- | .11 | OUTER | PCC | 11.0 | 0.0 |
| | 360-05 | 1977 | EB | 3 | 3, 2 | 4.27 | 3508 | PRES | A-7-5 | 64 | 17 | --- | .11 | OUTER | PRES | 6.0 | 4.0 |
| | 360-06 | 1977 | EB | 3 | 3, 2 | 4.85 | 1426 | PRES | A-7-5 | 66 | 30 | --- | .11 | OUTER | PRES | 6.0 | 4.0 |
| | 360-07 | 1984 | EB | 3 | 1 | 4.31 | 1200 | CRCP | A-2 | 31 | 20 | --- | .11 | INNER | CRCP | 9.0 | 4.0 |
| | 360-08 | 1984 | EB | 3 | 1 | 4.70 | 1200 | CRCP | A-2 | 31 | 20 | --- | .11 | INNER | CRCP | 9.0 | 4.0 |
| | 360-09 | 1975 | WB | 3 | 3 | 3.54 | 904 | JPCP | A-7-6 | 64 | 22 | --- | .11 | OUTER | PCC | 13.0 | 0.0 |
| | 360-10A | 1977 | EB | 3 | 3, 2 | 5.01 | 207 | PRES | A-7-5 | 66 | 24 | --- | .11 | OUTER | PRES | 6.0 | 4.0 |
| | 360-10B | 1977 | EB | 3 | 3, 2 | 5.07 | 829 | PRES | A-7-5 | 66 | 24 | --- | .11 | OUTER | PRES | 6.0 | 4.0 |
| I-10 | AZ 2 | 1985 | EB | 4 | 3 | 141.19 | 1041 | JPCP | A-6 | 27 | 12 | --- | .03 | OUTER | PCC | 10.0 | 5.0 |
| | 10-01 | 1968 | EB | 3 | 1 | 152.82 | 1059 | JPCP | A-7-6 | 44 | 27 | --- | --- | INNER | AC | 3.0 | 10.0 |
| | 10-02 | 1968 | EB | 4 | 1 | 153.14 | 1006 | JPCP | A-7-6 | 44 | 27 | --- | --- | INNER | AC | 3.0 | 10.0 |
| | 10-03 | 1968 | WB | 3 | 3 | 153.87 | 1048 | JPCP | A-7-6 | 44 | 27 | --- | .11 | OUTER | AC | 3.0 | 10.0 |
| | 10-04 | 1986 | WB | 4 | 3 | 140.34 | 1065 | JPCP | N/A | N/A | N/A | --- | .03 | OUTER | PCC | 10.0 | 5.0 |
| | 10-05 | 1985 | EB | 4 | 3 | 136.68 | 1054 | JPCP | A-7 | 69 | 14 | --- | .24 | OUTER | PCC | 10.0 | 5.0 |
| | 10-06 | 1984 | WB | 3 | 3 | 130.88 | 1065 | JPCP | A-2-4 | 27 | NP | --- | .05 | OUTER | PCC | 10.0 | 5.0 |
| | 10-07 | 1984 | WB | 3 | 3 | 130.50 | 1065 | JPCP | A-5 | 58 | 7 | --- | --- | OUTER | PCC | 10.0 | 5.0 |
| I-17 | 17-01 | 1961 | SB | 3 | 1 | 205.50 | 1065 | JPCP | A-7-6 | 49 | 13 | --- | .11 | INNER | PCC | N/A | N/A |
| | 17-02 | 1961 | NB | 3 | 1 | 201.65 | 1055 | JPCP | A-7-6 | 53 | 21 | --- | .11 | INNER | PCC | N/A | N/A |
| | 17-03 | 1965 | SB | 3 | 3 | 211.89 | 1061 | JPCP | A-4(3) | 50 | 6 | --- | .11 | OUTER | AC | 3.0 | 6.0 |
| | 17-04 | 1965 | SB | 3 | 3 | 208.20 | 1070 | JPCP | A-1-b | 7 | NP | --- | .06 | OUTER | AC | 3.0 | 12.0 |
| | 17-05 | 1965 | NB | 3 | 3 | 210.40 | 871 | JPCP | A-4(3) | 50 | 6 | --- | .11 | OUTER | AC | 3.0 | 6.0 |
| | 17-06 | 1963 | NB | 3 | 3 | 198.70 | 1065 | JPCP | N/A | N/A | NP | --- | .11 | OUTER | AC | 3.0 | 4.0 |
| | 17-10 | 1961 | NB | 3 | 3 | 205.20 | 886 | JPCP | A-6 | 39 | 17 | --- | .07 | OUTER | AC | 3.0 | 15.0 |
| | 17-11 | 1965 | NB | 3 | 3 | 208.70 | 1065 | JPCP | A-1-b | 7 | NP | --- | .09 | OUTER | AC | 3.0 | 4.0 |

Table A-4. Pavement joint data for study sections.

| Highway Number | Project Section ID | Year Built | Slab T, IN | Pavement Slab Length, FT | Pvt. Type | Base Type | TRANSVERSE JOINT Dowel Dia., IN | Calc Avg Jt Open IN | Skewed Joints Y/N | Sealant Shape Factor | SEALANT Type | SEALANT Age | SEALANT Cond | Depth of Long. Joint Sawcut, IN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RT 360 | AZ 1-1 | 1972 | 9.0 | 13-15-17-15 | JPCP | CTB | 0.00 | 0.05 | Y | 0.67 | RA | 1 | GOOD | --- |
| | AZ 1-2 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 0.06 | Y | 0.67 | RA | 1 | EXC | --- |
| | AZ 1-4 | 1979 | 13.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 0.06 | Y | 0.67 | RA | 1 | GOOD | --- |
| | AZ 1-5 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 0.06 | Y | 0.67 | RA | 1 | FAIR | --- |
| | AZ 1-6 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 0.05 | Y | 0.67 | RA | 1 | GOOD | --- |
| | AZ 1-7 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 0.05 | Y | 0.67 | RA | 1 | FAIR | --- |
| | 360-01* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 0.05 | Y | 0.67 | ELAS | 3 | POOR | --- |
| | 360-02* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 0.05 | Y | 0.67 | ELAS | 3 | POOR | --- |
| | 360-03* | 1983 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 0.05 | Y | 0.67 | ELAS | 5 | POOR | --- |
| | 360-04 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 0.06 | Y | 0.67 | ELAS | 9 | POOR | --- |
| | 360-05 | 1977 | 6.0 | 402 | PRES | LCB | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A | --- |
| | 360-06 | 1977 | 6.0 | 402 | PRES | LCB | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A | --- |
| | 360-07 | 1984 | 9.0 | N/A | CRCP | AGG | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A | --- |
| | 360-08 | 1984 | 9.0 | N/A | CRCP | AGG | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A | --- |
| | 360-09 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 0.05 | Y | ? | ELAS | 13 | POOR | --- |
| | 360-10A | 1977 | 6.0 | 207 | PRES | LCB | 0.00 | 0.61 | N/A | N/A | N/A | N/A | N/A | --- |
| | 360-10B | 1977 | 6.0 | 502 | PRES | LCB | 0.00 | 1.49 | N/A | N/A | N/A | N/A | N/A | --- |
| I-10 | AZ 2 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 0.05 | Y | 0.67 | RA | 4 | GOOD | --- |
| | 10-01 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 0.06 | Y | 0.27 | ASPH | 20? | POOR | --- |
| | 10-02 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 0.06 | Y | 0.27 | ASPH | 20? | POOR | --- |
| | 10-03 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 0.06 | Y | 0.27 | ASPH | 20? | POOR | --- |
| | 10-04 | 1986 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 0.05 | Y | 0.4 | ELAS | 2 | POOR | --- |
| | 10-05 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 0.05 | Y | 0.4 | ELAS | 3 | POOR | --- |
| | 10-06 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 0.05 | Y | 0.4 | ELAS | 4 | FAIR | --- |
| | 10-07 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 0.05 | Y | 0.4 | ELAS | 4 | FAIR | --- |
| I-17 | 17-01** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 0.05 | N | 0.09 | RA | 7 | POOR | --- |
| | 17-02** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 0.05 | N | 0.09 | RA | 8 | POOR | --- |
| | 17-03** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 0.05 | Y | 0.09 | SIL | 1 | EXC | --- |
| | 17-04** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 0.05 | Y | 0.09 | RA | 7 | POOR | --- |
| | 17-05** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 0.05 | Y | 0.09 | SIL | 1 | EXC | --- |
| | 17-06 | 1963 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 0.05 | N | 0.09 | RA | ??? | POOR | --- |
| | 17-10** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 0.05 | N | 0.09 | RA | 8 | POOR | --- |
| | 17-11** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 0.05 | Y | 0.09 | RA | 8 | FAIR | --- |

*Inner lane (#1) paved 16' wide.

**These sections have been diamond ground.

Table A-5. Deflection data for outer lane of study sections.

| Highway Number | Project Section ID | Year Built | Slab T, IN | Pavement Slab Length, FT | Pvt. Type | Base Type | DEFLECTION, mils: Mid-Slab High | Mid-Slab Low | Mid-Slab Ave. | Mid-Slab AREA | Loaded Corner | Unloaded Corner | Adjusted Percent LTE | Percent LT Across Shldr | Avg. NDT Test Temp, F | Percent Corners with Voids |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RT 360 | AZ 1-1 | 1972 | 9.0 | 13-15-17-15 | JPCP | CTB | 3.9 | 2.5 | 3.3 | 37.3 | 8.6 | 6.3 | 94 | N/A | 73 | 37 |
| | AZ 1-2 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | 3.2 | 2.0 | 2.7 | 39.7 | 4.6 | 4.0 | 100 | 86 | 68 | 0 |
| | AZ 1-4 | 1979 | 13.0 | 13-15-17-15 | JPCP | NONE | 3.0 | 1.8 | 2.3 | 39 | 6.3 | 5.5 | 100 | 79 | 74 | 0 |
| | AZ 1-5 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | 3.6 | 2.5 | 3.2 | 39.5 | 12.5 | 9.9 | 100 | 72 | 71 | 57 |
| | AZ 1-6 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 2.4 | 1.8 | 2.1 | 40.9 | 5.0 | 4.4 | 100 | 100 | 68 | 0 |
| | AZ 1-7 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 3.2 | 2.5 | 2.8 | 36.3 | 6.9 | 5.1 | 94 | 95 | 74 | 4 |
| | 360-01* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | 3.7 | 2.5 | 3.2 | 45.7 | 21.4 | 5.1 | 27 | 92 | 58 | 90 |
| | 360-02* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | 3.4 | 2.3 | 2.9 | 45.2 | 14.3 | 5.3 | 42 | 85 | 61 | 60 |
| | 360-03* | 1983 | 9.0 | 13-15-17-15 | JPCP | LCB | 5.4 | 2.2 | 3.9 | 45.7 | 15.5 | 7.2 | 51 | 89 | 65 | 37 |
| | 360-04 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | 3.1 | 2.0 | 2.6 | 41.6 | 11.5 | 9.8 | 98 | 25 | 65 | 35 |
| | 360-05 | 1977 | 6.0 | 402 | PRES | LCB | 8.1 | 5.4 | 6.7 | 36 | N/A | N/A | N/A | 76 | 82 | N/A |
| | 360-06 | 1977 | 6.0 | 402 | PRES | LCB | 8.9 | 6.0 | 7.5 | 37.4 | N/A | N/A | N/A | 93 | 73 | N/A |
| | 360-07 | 1984 | 9.0 | N/A | CRCP | AGG | 4.5 | 2.5 | 3.4 | 37.2 | N/A | N/A | N/A | 100 | 71 | N/A |
| | 360-08 | 1984 | 9.0 | N/A | CRCP | AGG | 4.8 | 3.0 | 3.6 | 40.9 | N/A | N/A | N/A | 100 | 67 | N/A |
| | 360-09 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | 3.3 | 2.1 | 2.6 | 41.8 | 4.1 | 3.7 | 100 | 77 | 66 | 0 |
| | 360-10A | 1977 | 6.0 | 207 | PRES | LCB | 8.7 | 6.8 | 7.7 | 39.2 | N/A | N/A | N/A | N/A | 69 | N/A |
| | 360-10B | 1977 | 6.0 | 502 | PRES | LCB | 13.8 | 5.0 | 8.7 | 37.2 | N/A | N/A | N/A | N/A | 68 | N/A |
| I-10 | AZ 2 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 3.3 | 2.1 | 2.6 | 39.1 | 11.1 | 6.1 | 72 | 100 | 80 | 31 |
| | 10-01 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 4.9 | 4.4 | 4.7 | 44.2 | 19.3 | 18.3 | 100 | N/A | 64 | 81 |
| | 10-02 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 5.3 | 3.6 | 4.7 | 43.5 | 27.6 | 26.5 | 100 | N/A | 59 | 100 |
| | 10-03 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 4.1 | 2.7 | 3.5 | 42.5 | 22.0 | 18.4 | 94 | N/A | 59 | 100 |
| | 10-04 | 1986 | 10.0 | 13-15-17-15 | JPCP | LCB | 4.1 | 2.2 | 3.4 | 43.4 | 14.1 | 6.2 | 49 | 73 | 76 | 71 |
| | 10-05 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 4.0 | 3.0 | 3.4 | 42.8 | 11.9 | 9.0 | 85 | 84 | 68 | 64 |
| | 10-06 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 3.7 | 2.5 | 3.2 | 44.9 | 8.7 | 7.1 | 91 | 78 | 70 | 15 |
| | 10-07 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 4.1 | 3.3 | 3.7 | 43.1 | 6.7 | 6.2 | 100 | 88 | 67 | 10 |
| I-17 | 17-01** | 1961 | 9.0 | 15.0 | JPCP | AGG | 5.0 | 3.4 | 4.1 | 42.8 | 12.7 | 12.1 | 100 | 78 | 82 | 20 |
| | 17-02** | 1961 | 9.0 | 15.0 | JPCP | AGG | 8.5 | 4.0 | 5.3 | 43.1 | 10.9 | 10.1 | 100 | 62 | 79 | 15 |
| | 17-03** | 1965 | 9.0 | 15.0 | JPCP | AGG | 6.2 | 4.8 | 5.3 | 45.4 | 9.7 | 8.8 | 97 | N/A | 78 | 0 |
| | 17-04** | 1965 | 9.0 | 15.0 | JPCP | AGG | 7.1 | 2.6 | 4.4 | 44.2 | 12.3 | 11.4 | 100 | N/A | 85 | 21 |
| | 17-05** | 1965 | 9.0 | 15.0 | JPCP | AGG | 6.0 | 3.7 | 4.7 | 45.2 | 8.7 | 8.0 | 99 | N/A | 74 | 11 |
| | 17-06 | 1963 | 9.0 | 15.0 | JPCP | AGG | 3.9 | 2.7 | 3.2 | 42.2 | 13.0 | 12.3 | 100 | N/A | 79 | 77 |
| | 17-10** | 1961 | 9.0 | 15.0 | JPCP | AGG | 5.2 | 3.4 | 4.6 | 41.3 | 13.4 | 12.5 | 100 | N/A | 77 | 63 |
| | 17-11** | 1965 | 9.0 | 15.0 | JPCP | AGG | 5.8 | 4.6 | 5.3 | 47.1 | 13.6 | 11.4 | 89 | N/A | 78 | 15 |

*Inner lane (#1) paved 16' wide.

**These sections have been diamond ground.

Table A-6. Outer shoulder information for study sections.

| Highway Number | Project Section ID | Year Built | Slab T, IN | Pavement Slab Length, FT | Pvt. Type | Base Type | Shoulder Included in Survey | TYPE-THICKNESS, IN Surface | TYPE-THICKNESS, IN Base | Overall Shoulder Condition | Shoulder Jt Seal Condition |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RT 360 | AZ 1-1 | 1972 | 9.0 | 13-15-17-15 | JPCP | CTB | OUTER | AC-3 | AGG-6 | FAIR | GOOD |
| | AZ 1-2 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | OUTER | +PCC-9 | NONE | EXC | FAIR |
| | AZ 1-4 | 1979 | 13.0 | 13-15-17-15 | JPCP | NONE | OUTER | PCC-13 | NONE | EXC | FAIR |
| | AZ 1-5 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | OUTER | PCC-11 | NONE | EXC | POOR |
| | AZ 1-6 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | OUTER | PCC-9 | LCB-4 | EXC | FAIR |
| | AZ 1-7 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | OUTER | PCC-9 | LCB-4 | EXC | POOR |
| | 360-01* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | OUTER | PCC-9 | LCB-4 | EXC | POOR |
| | 360-02* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | OUTER | PCC-9 | LCB-4 | EXC | POOR |
| | 360-03* | 1983 | 9.0 | 13-15-17-15 | JPCP | LCB | OUTER | PCC-9 | LCB-4 | EXC | POOR |
| | 360-04 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | OUTER | PCC-11 | NONE | EXC | POOR |
| | 360-05 | 1977 | 6.0 | 402 | PRES | LCB | OUTER | PRES-6 | LCB-4 | EXC | N/A |
| | 360-06 | 1977 | 6.0 | 402 | PRES | LCB | OUTER | PRES-6 | LCB-4 | EXC | N/A |
| | 360-07 | 1984 | 9.0 | N/A | CRCP | AGG | INNER | CRCP-9 | LCB-4 | EXC | POOR |
| | 360-08 | 1984 | 9.0 | N/A | CRCP | AGG | INNER | CRCP-9 | LCB-4 | EXC | POOR |
| | 360-09 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | OUTER | PCC-13 | NONE | EXC | POOR |
| | 360-10A | 1977 | 6.0 | 207 | PRES | LCB | OUTER | PRES-6 | LCB-4 | EXC | N/A |
| | 360-10B | 1977 | 6.0 | 502 | PRES | LCB | OUTER | PRES-6 | LCB-4 | EXC | N/A |
| I-10 | AZ 2 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | OUTER | PCC-10 | LCB-5 | EXC | GOOD |
| | 10-01 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | INNER | AC-3 | AGG-10 | GOOD | POOR |
| | 10-02 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | INNER | AC-3 | AGG-10 | FAIR | POOR |
| | 10-03 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | OUTER | AC-3 | AGG-10 | FAIR | POOR |
| | 10-04 | 1986 | 10.0 | 13-15-17-15 | JPCP | LCB | OUTER | PCC-10 | LCB-5 | EXC | POOR |
| | 10-05 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | OUTER | PCC-10 | LCB-5 | EXC | POOR |
| | 10-06 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | OUTER | PCC-10 | LCB-5 | EXC | POOR |
| | 10-07 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | OUTER | PCC-10 | LCB-5 | EXC | N/A |
| I-17 | 17-01** | 1961 | 9.0 | 15.0 | JPCP | AGG | INNER | PCC- | --- | GOOD | POOR |
| | 17-02** | 1961 | 9.0 | 15.0 | JPCP | AGG | INNER | PCC- | --- | GOOD | POOR |
| | 17-03** | 1965 | 9.0 | 15.0 | JPCP | AGG | OUTER | AC-3 | AGG-6 | GOOD | EXC |
| | 17-04** | 1965 | 9.0 | 15.0 | JPCP | AGG | OUTER | AC-3 | AGG-12 | FAIR | POOR |
| | 17-05** | 1965 | 9.0 | 15.0 | JPCP | AGG | OUTER | AC-3 | AGG-6 | GOOD | EXC |
| | 17-06 | 1963 | 9.0 | 15.0 | JPCP | AGG | OUTER | AC-3 | AGG-4 | GOOD | POOR |
| | 17-10** | 1961 | 9.0 | 15.0 | JPCP | AGG | OUTER | AC-3 | AGG-15 | GOOD | POOR |
| | 17-11** | 1965 | 9.0 | 15.0 | JPCP | AGG | OUTER | AC-3 | AGG-4 | GOOD | GOOD |

*Inner lane (#1) paved 16' wide. + Average.

**These sections have been diamond ground.

Table A-7. Drainage information for study sections.

| Highway Number | Project Section ID | Year Built | Slab T, IN | Pavement Slab Length, FT | Pvt. Type | Base Type | PERMEABILITY, FT/HR Base | Subbase | Subgrade | Cd | Dowels Y/N | Depth to Ditch, FT | PRIMARY LANE, AVG Trans. Slope, % | Longit. Grade, % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RT 360 | AZ 1-1 | 1972 | 9.0 | 13-15-17-15 | JPCP | CTB | 0 | .06 | .11 | 1.00 | N | 2.0 | -0.52 | 0.78 |
| | AZ 1-2 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | N/A | N/A | .11 | 1.10 | N | 2.0 | -1.04 | 0.87 |
| | AZ 1-4 | 1979 | 13.0 | 13-15-17-15 | JPCP | NONE | N/A | N/A | .11 | 1.10 | N | 2.0 | -2.08 | 0.00 |
| | AZ 1-5 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | N/A | N/A | .11 | 1.10 | N | 2.0 | -2.08 | 1.39 |
| | AZ 1-6 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 0 | N/A | .03 | 1.10 | N | 2.0 | -2.08 | 0.00 |
| | AZ 1-7 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 0 | N/A | .03 | 1.15 | N | 2.0 | -2.08 | 0.00 |
| | 360-01* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | 0 | N/A | .28 | 1.15 | N | N/A | -1.39 | -1.04 |
| | 360-02* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | 0 | N/A | .11 | 1.15 | N | 25.0 | -1.73 | -1.91 |
| | 360-03* | 1983 | 9.0 | 13-15-17-15 | JPCP | LCB | 0 | N/A | .11 | 1.15 | N | 10.0 | -1.56 | -1.39 |
| | 360-04 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | N/A | N/A | .11 | 1.10 | N | N/A | -2.60 | 0.00 |
| | 360-05 | 1977 | 6.0 | 402 | PRES | LCB | 0 | N/A | .11 | 1.15 | N | N/A | -1.04 | -1.04 |
| | 360-06 | 1977 | 6.0 | 402 | PRES | LCB | 0 | N/A | .11 | 1.15 | N | N/A | -1.73 | 0.35 |
| | 360-07 | 1984 | 9.0 | N/A | CRCP | AGG | 0 | N/A | .11 | N/A | N | N/A | -1.56 | -1.39 |
| | 360-08 | 1984 | 9.0 | N/A | CRCP | AGG | 0 | N/A | .11 | N/A | N | N/A | 1.39 | 0.69 |
| | 360-09 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | N/A | N/A | .11 | 1.10 | N | N/A | -1.04 | -1.04 |
| | 360-10A | 1977 | 6.0 | 207 | PRES | LCB | 0 | N/A | .11 | 1.15 | N | 2.0 | -0.13 | 0.00 |
| | 360-10B | 1977 | 6.0 | 502 | PRES | LCB | 0 | N/A | .11 | 1.15 | N | 2.0 | -0.13 | -0.03 |
| I-10 | AZ 2 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 0 | N/A | .03 | 1.05 | Y | 2.0 | -3.39 | 1.04 |
| | 10-01 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | .16 | .24 | N/A | 0.95 | N | 5.0 | 1.04 | 0.00 |
| | 10-02 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | .19 | .27 | N/A | 0.95 | N | 4.0 | 0.52 | 0.35 |
| | 10-03 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | .16 | .17 | .11 | 1.00 | N | 4.0 | -1.73 | 0.17 |
| | 10-04 | 1986 | 10.0 | 13-15-17-15 | JPCP | LCB | 0 | N/A | .03 | 1.15 | Y | N/A | -1.39 | 0.00 |
| | 10-05 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 0 | N/A | .24 | 1.15 | Y | N/A | -2.77 | 0.35 |
| | 10-06 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 0 | N/A | .05 | 1.15 | Y | 5.0 | -1.73 | 0.52 |
| | 10-07 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 0 | N/A | N/A | 1.15 | Y | 5.0 | -1.56 | 0.00 |
| I-17 | 17-01** | 1961 | 9.0 | 15.0 | JPCP | AGG | .08 | N/A | .11 | 1.00 | N | N/A | 1.04 | 0.52 |
| | 17-02** | 1961 | 9.0 | 15.0 | JPCP | AGG | .68 | 1.0 | .11 | 1.15 | N | N/A | 0.52 | 0.69 |
| | 17-03** | 1965 | 9.0 | 15.0 | JPCP | AGG | .04 | .03 | .11 | 0.95 | N | N/A | -0.87 | 0.00 |
| | 17-04** | 1965 | 9.0 | 15.0 | JPCP | AGG | .06 | .09 | .06 | 1.00 | N | N/A | -1.04 | -2.00 |
| | 17-05** | 1965 | 9.0 | 15.0 | JPCP | AGG | .03 | .03 | .11 | 0.90 | N | 3.0 | -0.34 | 0.00 |
| | 17-06 | 1963 | 9.0 | 15.0 | JPCP | AGG | .05 | N/A | .11 | 1.00 | N | N/A | -1.04 | 0.52 |
| | 17-10** | 1961 | 9.0 | 15.0 | JPCP | AGG | .19 | .13 | .07 | 1.05 | N | N/A | -1.21 | -0.43 |
| | 17-11** | 1965 | 9.0 | 15.0 | JPCP | AGG | .16 | .11 | .09 | 1.05 | N | 3.0 | -0.52 | 0.17 |

*Inner lane (#1) paved 16' wide.

**These sections have been diamond ground.

Table A-8. Traffic information for study sections.

| Highway Number | Project Section ID | Year Built | Slab T, IN | Pavement Slab Length, FT | Pvt. Type | Base Type | ORIGINAL DESIGN TRAFFIC ESALs, (million) | 2-way ADT (thous.) | % Trucks | Age at Survey | 1988 ESTIMATED 2-way ADT, (thous.) | % Trks | LANE # 3 *** 1988 ESALs (millions) | Est. ESALs to Date (millions) | LANE # 2 *** 1988 ESALs (millions) | Est. ESALs to Date (millions) | LANE # 1 *** 1988 ESALs (millions) | Est. ESALs to Date (millions) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RT 360 | AZ 1-1 | 1972 | 9.0 | 13-15-17-15 | JPCP | CTB | | 74 | | 15 | 110.4 | 3.1 | 0.43 | 3.31 | 0.03 | 1.65 | 0.06 | 0.17 |
| | AZ 1-2 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | | 74 | | 12 | 118.6 | 3.1 | 0.46 | 2.85 | 0.33 | 1.54 | 0.07 | 0.21 |
| | AZ 1-4 | 1979 | 13.0 | 13-15-17-15 | JPCP | NONE | | | | 8 | 93.7 | 3.1 | 0.38 | 1.99 | 0.25 | 0.99 | 0.05 | 0.13 |
| | AZ 1-5 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | | | | 8 | 106.4 | 3.1 | 0.42 | 2.33 | 0.29 | 1.23 | 0.06 | 0.16 |
| | AZ 1-6 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | | | | 6 | 97.8 | 3.1 | 0.48 | 1.68 | 0.23 | 0.67 | N/A | N/A |
| | AZ 1-7 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | | | | 6 | 75.4 | 3.1 | 0.38 | 1.27 | 0.16 | 0.45 | N/A | N/A |
| | 360-01* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | | | | 3 | 46.5 | 3.5 | 0.28 | 0.77 | 0.10 | 0.25 | N/A | N/A |
| | 360-02* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | | | | 3 | 46.5 | 3.5 | 0.28 | 0.78 | 0.10 | 0.26 | N/A | N/A |
| | 360-03* | 1983 | 9.0 | 13-15-17-15 | JPCP | LCB | | | | 5 | 46.5 | 3.5 | 0.28 | 1.09 | 0.10 | 0.36 | N/A | N/A |
| | 360-04 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | | | | 9 | 108.8 | 3.5 | 0.49 | 2.64 | 0.34 | 1.58 | 0.07 | 0.29 |
| | 360-05 | 1977 | 6.0 | 402 | PRES | LCB | | | | 11 | 110.8 | 3.5 | 0.50 | 3.13 | 0.35 | 1.72 | 0.07 | 0.21 |
| | 360-06 | 1977 | 6.0 | 402 | PRES | LCB | | | | 11 | 110.8 | 3.5 | 0.50 | 3.13 | 0.35 | 1.72 | 0.07 | 0.21 |
| | 360-07 | 1984 | 9.0 | N/A | CRCP | AGG | | | | 4 | 110.8 | 3.5 | — | — | — | — | 0.07 | 0.21 |
| | 360-08 | 1984 | 9.0 | N/A | CRCP | AGG | | | | 4 | 110.8 | 3.5 | — | — | — | — | 0.07 | 0.21 |
| | 360-09 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | | | | 13 | 120.2 | 3.5 | 0.66 | 3.82 | 0.34 | 1.75 | N/A | N/A |
| | 360-10A | 1977 | 6.0 | 207 | PRES | LCB | | | | 11 | 110.8 | 3.5 | 0.50 | 3.13 | 0.35 | 1.72 | 0.07 | 0.21 |
| | 360-10B | 1977 | 6.0 | 502 | PRES | LCB | | | | 11 | 110.8 | 3.5 | 0.50 | 3.13 | 0.35 | 1.72 | 0.07 | 0.21 |
| I-10 | AZ 2 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | | 40.5 | | 2 | 50.0 | 9.0 | 0.96 | 1.68 | 0.50 | 0.84 | 0.12 | 0.20 |
| | 10-01 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | | | | 20 | 124.9 | 9.7 | 2.30 | 23.14 | 1.68 | 14.93 | 0.35 | 3.22 |
| | 10-02 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | | | | 20 | 141.1 | 9.7 | 2.54 | 23.76 | 1.94 | 15.59 | 0.39 | 3.34 |
| | 10-03 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | | | | 20 | 142.8 | 9.7 | 2.57 | 23.76 | 1.97 | 15.63 | 0.40 | 3.35 |
| | 10-04 | 1986 | 10.0 | 13-15-17-15 | JPCP | LCB | | | | 2 | 51.0 | 9.0 | 0.99 | 2.82 | 0.52 | 1.49 | 0.06 | 0.17 |
| | 10-05 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | | | | 3 | 47.0 | 9.0 | 0.92 | 2.37 | 0.47 | 1.22 | 0.06 | 0.14 |
| | 10-06 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | | | | 4 | 31.2 | 3.2 | 2.26 | 6.85 | 0.99 | 2.75 | 0.25 | 0.07 |
| | 10-07 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | | | | 4 | 31.2 | 3.2 | 2.26 | 6.85 | 0.99 | 2.75 | 0.25 | 0.07 |
| I-17 | 17-01** | 1961 | 9.0 | 15.0 | JPCP | AGG | | | | 27 | 132.1 | 9.5 | 1.57 | 20.27(9.84) | 1.17 | 13.45(7.10) | 0.24 | 2.87(1.47) |
| | 17-02** | 1961 | 9.0 | 15.0 | JPCP | AGG | | | | 27 | 125.9 | 9.5 | 1.51 | 19.41(10.54) | 1.10 | 12.90(7.51) | 0.23 | 2.75(1.56) |
| | 17-03** | 1965 | 9.0 | 15.0 | JPCP | AGG | | | | 23 | 112.3 | 9.5 | 1.37 | 14.47(2.01) | 0.96 | 6.57(1.41) | 0.20 | 0.39 |
| | 17-04** | 1965 | 9.0 | 15.0 | JPCP | AGG | | | | 23 | 126.2 | 9.5 | 1.51 | 17.96(9.54) | 1.12 | 11.84(6.80) | 0.23 | 2.53(1.41) |
| | 17-05** | 1965 | 9.0 | 15.0 | JPCP | AGG | | | | 23 | 117.2 | 9.5 | 1.42 | 14.66(2.08) | 1.01 | 6.71(1.49) | 0.21 | 0.41 |
| | 17-06 | 1963 | 9.0 | 15.0 | JPCP | AGG | | | | 25 | 124.6 | 9.7 | 1.52 | 19.18 | 1.11 | 12.36 | 0.23 | 2.67 |
| | 17-10** | 1961 | 9.0 | 15.0 | JPCP | AGG | | | | 27 | 132.1 | 9.5 | 1.57 | 19.26(10.81) | 1.17 | 12.74(7.78) | 0.24 | 2.72(1.61) |
| | 17-11** | 1965 | 9.0 | 15.0 | JPCP | AGG | | | | 23 | 126.2 | 9.5 | 1.51 | 15.61(3.61) | 1.11 | 9.80(2.64) | 0.23 | 2.14(0.54) |

*Inner lane (#1) paved 16' wide.

**These sections have been diamond ground.

*** 1987 data listed for AZ 1-1, 1-2, 1-4, 1-5, 1-6, 1-7, 2.
For the I-17 sections, the number in parentheses represents ESALs to date since grinding.

Table A-9. Performance data for lane 3 of study sections.

| Highway Number | Project Section ID | Year Built | Slab T, IN | Pavement Slab Length, FT | Pvt. Type | Base Type | Dowel Dia IN | Ave. PSR | May's Rough., IN/MI | Average Trans. Faulting IN | Trans. Cracks/ Mile | Longit. Cracking, LIN FT/MI | Pumping, N/L/M/H | PERCENT JOINTS SPALLED | | | SPALL REPAIR AT JOINTS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | L | M | H | Type | % Jts |
| RT 360 | AZ 1-1 | 1972 | 9.0 | 13-15-17-15 | JPCP | CTB | 0.00 | 3.4 | 114 | 0.08 | 0.0 | 0.0 | N | 0 | 22 | 0 | CEM | 21 |
| | AZ 1-2 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 3.8 | 65 | 0.01 | 0.0 | 0.0 | N | 1 | 1 | 0 | BIT | 4 |
| | AZ 1-4 | 1979 | 13.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 3.6 | 102 | 0.01 | 0.0 | 0.0 | N | 0 | 1 | 0 | --- | 0 |
| | AZ 1-5 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 3.8 | 85 | 0.03 | 0.0 | 0.0 | N | 1 | 0 | 0 | --- | 0 |
| | AZ 1-6 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 3.5 | 97 | 0.01 | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | AZ 1-7 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 3.8 | 91 | 0.02 | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | 360-01* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 4.4 | 62 | 0.05 | 0.0 | 0.0 | N | 17 | 0 | 0 | --- | 0 |
| | 360-02* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 4.2 | 80 | 0.02 | 0.0 | 0.0 | N | 5 | 0 | 0 | --- | 0 |
| | 360-03* | 1983 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 4.1 | 86 | 0.02 | 0.0 | 0.0 | N | 4 | 0 | 0 | --- | 0 |
| | 360-04 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 4.3 | 55 | 0.04 | 0.0 | 18.0 | N | 2 | 2 | 0 | --- | 0 |
| | 360-05 | 1977 | 6.0 | 402 | PRES | LCB | N/A | 3.9 | 88 | N/A | --- | --- | N | N/A | N/A | N/A | EPX/BIT | 62 |
| | 360-06 | 1977 | 6.0 | 402 | PRES | LCB | N/A | 3.3 | 131 | N/A | --- | --- | N | N/A | N/A | N/A | BIT | 63 |
| | 360-07 | 1984 | 9.0 | N/A | CRCP | AGG | N/A | --- | --- | --- | --- | --- | N | --- | --- | --- | --- | --- |
| | 360-08 | 1984 | 9.0 | N/A | CRCP | AGG | N/A | --- | --- | --- | --- | --- | N | --- | --- | --- | --- | --- |
| | 360-09 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | 0 | 4.8 | 64 | 0.02 | 35.0 | 35.0 | N | 5 | 0 | 0 | --- | 0 |
| | 360-10A | 1977 | 6.0 | 207 | PRES | LCB | N/A | 4.0 | --- | N/A | --- | --- | N | N/A | N/A | N/A | N/A | N/A |
| | 360-10B | 1977 | 6.0 | 502 | PRES | LCB | N/A | 4.0 | --- | N/A | --- | --- | N | N/A | N/A | N/A | --- | 0 |
| I-10 | AZ 2 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 3.6 | 71 | 0.01 | 0.0 | 0.0 | N | 3 | 0 | 0 | BIT | 1 |
| | 10-01 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 3.2 | 143 | N/A | 0.0 | 0.0 | N | 10 | 35 | 0 | UPM | 32 |
| | 10-02 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 3.2 | 155 | N/A | 0.0 | 0.0 | N | 16 | 22 | 0 | UPM | 22 |
| | 10-03 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 3.8 | 144 | 0.03 | 0.0 | 0.0 | N | 27 | 39 | 0 | UPM | 25 |
| | 10-04 | 1986 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 4.1 | 88 | 0.03 | 0.0 | 0.0 | N | 25 | 1 | 0 | --- | 0 |
| | 10-05 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 4.2 | 80 | 0.01 | 0.0 | 0.0 | N | 71 | 1 | 0 | --- | 0 |
| | 10-06 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 4.2 | 64 | 0.02 | 0.0 | 560.0 | N | 3 | 0 | 0 | --- | 0 |
| | 10-07 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 4.1 | 54 | 0.02 | 0.0 | 20.0 | N | 4 | 1 | 0 | --- | 0 |
| I-17 | 17-01** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 3.9 | 106.0 | N/A | 0 | 0 | N | 3 | 58 | 1 | UPM/CEM | 61 |
| | 17-02** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 3.9 | 60.0 | N/A | 0 | 0 | N | 17 | 43 | 0 | UPM | 36 |
| | 17-03** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 3.9 | 91.0 | 0.05 | 5 | 134 | N | 6 | 64 | 0 | CEM | 60 |
| | 17-04** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 3.7 | 50.0 | 0.02 | 0 | 15 | N | 7 | 17 | 17 | UPM | 31 |
| | 17-05** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 4.1 | 77.0 | 0.06 | 0 | 0 | N | 2 | 5 | 0 | CEM | 28 |
| | 17-06 | 1963 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 2.9 | N/A | 0.09 | 0 | 0 | N | 14 | 15 | 6 | UPM | 24 |
| | 17-10** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 4.1 | 103.0 | 0.03 | 0 | 18 | N | 10 | 13 | 5 | UPM | 30 |
| | 17-11** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 4.1 | 83.0 | 0.01 | 0 | 200 | N | 10 | 57 | 33 | CEM | 54 |

*Inner lane (#1) paved 16' wide.

**These sections have been diamond ground.

Table A-10. Performance data for lane 2 of study sections.

| Highway Number | Project Section ID | Year Built | Slab T, IN | Pavement Slab Length, FT | Pvt. Type | Base Type | Dowel Dia IN | PSR | Mays Rough. IN/MI | Average Trans. Faulting IN | Trans. Cracks/ Mile | Longit. Cracking, LIN FT/MI | Pumping, N/L/M/H | PERCENT JOINTS SPALLED | | | SPALL REPAIR AT JOINTS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | L | M | H | Type | % Jts |
| RT 360 | AZ 1-1 | 1972 | 9.0 | 13-15-17-15 | JPCP | CTB | 0.00 | 3.4 | 102 | N/A | 0.0 | 0.0 | N | 0 | 23 | 0 | CEM | 29 |
| | AZ 1-2 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 3.8 | 76 | N/A | 0.0 | 0.0 | N | 16 | 8 | 0 | BIT | 1 |
| | AZ 1-4 | 1979 | 13.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 3.4 | 100 | N/A | 0.0 | 0.0 | N | 0 | 1 | 0 | --- | 0 |
| | AZ 1-5 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 3.8 | 83 | N/A | 0.0 | 0.0 | N | 1 | 0 | 0 | --- | 0 |
| | AZ 1-6 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 3.8 | 83 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | AZ 1-7 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 3.8 | 74 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | 360-01* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 4.5 | 70 | N/A | 0.0 | 0.0 | N | 13 | 0 | 0 | --- | 0 |
| | 360-02* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 4.3 | 83 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | 360-03* | 1983 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 4.2 | 75 | N/A | 0.0 | 55.0 | N | 3 | 0 | 0 | --- | 0 |
| | 360-04 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 4.1 | 58 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | 360-05 | 1977 | 6.0 | 402 | PRES | LCB | N/A | 4.1 | 87 | N/A | --- | --- | N | N/A | N/A | N/A | EPX/BIT | 67 |
| | 360-06 | 1977 | 6.0 | 402 | PRES | LCB | N/A | 4.0 | 102 | N/A | --- | --- | N | N/A | N/A | N/A | AC | 63 |
| | 360-07 | 1984 | 9.0 | N/A | CRCP | AGG | N/A | --- | --- | --- | --- | --- | N | --- | --- | --- | --- | N/A |
| | 360-08 | 1984 | 9.0 | N/A | CRCP | AGG | N/A | --- | --- | --- | --- | --- | N | --- | --- | --- | --- | N/A |
| | 360-09 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 4.3 | 74 | N/A | 6.0 | 0.0 | N | 5 | 0 | 0 | --- | 0 |
| | 360-10A | 1977 | 6.0 | 207 | PRES | LCB | N/A | 3.9 | N/A | N/A | 0.0 | --- | N | N/A | N/A | N/A | --- | N/A |
| | 360-10B | 1977 | 6.0 | 502 | PRES | LCB | N/A | 3.9 | N/A | N/A | 0.0 | --- | N | N/A | N/A | N/A | --- | 0 |
| I-10 | AZ 2 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | N/A | N/A | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | 10-01 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 3.2 | 182 | N/A | 0.0 | 0.0 | N | 17 | 39 | 0 | UPM | 37 |
| | 10-02 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 3.2 | 174 | N/A | 0.0 | 0.0 | N | 16 | 25 | 0 | UPM | 26 |
| | 10-03 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 3.8 | 122 | N/A | 0.0 | 0.0 | N | 15 | 55 | 0 | UPM | 45 |
| | 10-04 | 1986 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 4.5 | 61 | N/A | 0.0 | 0.0 | N | 0 | 3 | 0 | UPM? | 1 |
| | 10-05 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 3.8 | 87 | N/A | 0.0 | 0.0 | N | 0 | 1 | 0 | --- | 0 |
| | 10-06 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 4.5 | 65 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | 10-07 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 4.5 | 51 | N/A | 0.0 | 0.0 | N | 1 | 0 | 0 | --- | 0 |
| I-17 | 17-01** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 3.9 | 111 | N/A | 0 | 0.0 | N | 15 | 42 | 1 | UPM/CEM | 47 |
| | 17-02** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 3.6 | 99 | N/A | 0 | 30.0 | N | 13 | 42 | 0 | UPM | 63 |
| | 17-03** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 3.9 | 92 | N/A | 5 | 0.0 | N | 8 | 64 | 0 | CEM | 67 |
| | 17-04** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 4.1 | 90 | N/A | 0 | 0.0 | N | 4 | 28 | 14 | UPM | 33 |
| | 17-05** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 4.2 | 72 | N/A | 0 | 0.0 | N | 0 | 0 | 0 | CEM | 19 |
| | 17-06 | 1963 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 2.9 | 232 | N/A | 0 | 0.0 | N | 11 | 28 | 10 | UPM | 35 |
| | 17-10** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 4.1 | 101 | N/A | 0 | 0.0 | N | 8 | 8 | 12 | UPM | 23 |
| | 17-11** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 4.3 | 87 | N/A | 0 | 0.0 | N | 3 | 46 | 0 | CEM | 47 |

*Inner lane (#1) paved 16' wide.

**These sections have been diamond ground.

Table A-11. Performance data for lane 1 of study sections.

| Highway Number | Project Section ID | Year Built | Slab T, IN | Pavement Slab Length, FT | Pvt. Type | Base Type | Dowel Dia IN | PSR | May's Rough., IN/MI | Average Trans. Faulting IN | Trans. Cracks/ Mile | Longit. Cracking, LIN FT/MI | Pumping N/L/M/H | PERCENT JOINTS SPALLED L | M | H | SPALL REPAIR AT JOINTS Type | % Jts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RT 360 | AZ 1-1 | 1972 | 9.0 | 13-15-17-15 | JPCP | CTB | 0.00 | 3.4 | 102 | N/A | 15.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | AZ 1-2 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 3.8 | 76 | N/A | 0.0 | 0.0 | N | 0 | 3 | 0 | --- | 0 |
| | AZ 1-4 | 1979 | 13.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 3.4 | 100 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | AZ 1-5 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 3.8 | 83 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | AZ 1-6 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 3.8 | 83 | N/A | 0.0 | 0.0 | N | N/A | N/A | N/A | N/A | N/A |
| | AZ 1-7 | 1981 | 9.0 | 13-15-17-15 | JPCP | LCB | 0.00 | 3.8 | 74 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | N/A | N/A |
| | 360-01* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | --- | --- | --- | --- | --- | --- | N | --- | --- | --- | --- | --- |
| | 360-02* | 1985 | 9.0 | 13-15-17-15 | JPCP | LCB | --- | --- | --- | --- | --- | --- | N | --- | --- | --- | --- | --- |
| | 360-03* | 1983 | 9.0 | 13-15-17-15 | JPCP | LCB | --- | --- | --- | --- | --- | --- | N | --- | --- | --- | --- | --- |
| | 360-04 | 1979 | 11.0 | 13-15-17-15 | JPCP | NONE | 0.00 | 4.1 | 93 | N/A | 0.0 | 0.0 | N | 2 | 0 | 0 | --- | 0 |
| | 360-05 | 1977 | 6.0 | 402 | PRES | LCB | --- | --- | --- | --- | --- | --- | N | --- | --- | --- | --- | --- |
| | 360-06 | 1977 | 6.0 | 402 | PRES | LCB | --- | --- | --- | --- | --- | --- | N | --- | --- | --- | --- | --- |
| | 360-07 | 1984 | 9.0 | N/A | CRCP | AGG | N/A | 3.9 | 86 | N/A | --- | --- | N | N/A | N/A | N/A | N/A | N/A |
| | 360-08 | 1984 | 9.0 | N/A | CRCP | AGG | N/A | 4.0 | 80 | N/A | --- | --- | N | N/A | N/A | N/A | N/A | N/A |
| | 360-09 | 1975 | 13.0 | 13-15-17-15 | JPCP | NONE | 0 | 4.6 | 80 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | 360-10A | 1977 | 6.0 | 207 | PRES | LCB | --- | --- | --- | --- | --- | --- | N | --- | --- | --- | --- | --- |
| | 360-10B | 1977 | 6.0 | 502 | PRES | LCB | --- | --- | --- | --- | --- | --- | N | --- | --- | --- | --- | --- |
| I-10 | AZ 2 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | --- | --- | --- | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | 10-01 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 3.8 | 159 | 0.03 | 0.0 | 0.0 | N | 21 | 42 | 0 | UPM | 33 |
| | 10-02 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 3.7 | 170 | 0.06 | 0.0 | 0.0 | N | 23 | 29 | 0 | UPM | 25 |
| | 10-03 | 1968 | 9.0 | 13-15-17-15 | JPCP | AGG | 0.00 | 3.4 | 153 | N/A | 0.0 | 0.0 | N | 20 | 31 | 0 | UPM | 21 |
| | 10-04 | 1986 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 4.3 | 59 | N/A | 0.0 | 0.0 | N | 1 | 0 | 0 | --- | 0 |
| | 10-05 | 1985 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 4.1 | 108 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | 10-06 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 4.1 | 64 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | 10-07 | 1984 | 10.0 | 13-15-17-15 | JPCP | LCB | 1.25 | 4.1 | 65 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| I-17 | 17-01** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 3.6 | 95 | 0.01 | 0.0 | 0.0 | N | 14 | 17 | 1 | UPM/CEM | 24 |
| | 17-02** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 3.7 | 95 | 0.01 | 0.0 | 30.0 | N | 13 | 42 | 0 | UPM | 35 |
| | 17-03** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 4.2 | 71 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | --- | 0 |
| | 17-04** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 3.9 | 61 | N/A | 0.0 | 0.0 | N | 10 | 21 | 15 | UPM | 33 |
| | 17-05** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 4.3 | 50 | N/A | 0.0 | 0.0 | N | 0 | 0 | 0 | CEM | 1 |
| | 17-06 | 1963 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 3.1 | 185 | N/A | 0.0 | 0.0 | N | 4 | 11 | 0 | UPM | 13 |
| | 17-10** | 1961 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 4.3 | 85 | N/A | 0.0 | 0.0 | N | 2 | 32 | 0 | UPM | 33 |
| | 17-11** | 1965 | 9.0 | 15.0 | JPCP | AGG | 0.00 | 4.5 | 44 | N/A | 0.0 | 0.0 | N | 13 | 32 | 0 | CEM | 44 |

*Inner lane (#1) paved 16' wide.

**These sections have been diamond ground.

# APPENDIX B

# PROJECT STRIP MAPS

# APPENDIX B PROJECT STRIP MAPS

Strip maps of the various projects are included in this appendix. These maps, shown in figures B-1 through B-28, were taken from the original distress survey sheets and are very useful in providing a general indication of the performance of each pavement section. The strip maps were prepared only for those sections that were included in the ADOT study, and not for those that were surveyed as part of the parallel FHWA study. It should be noted that the distress, traffic, and deflection data summarized on the strip maps are for the primary lane of survey for that particular section.

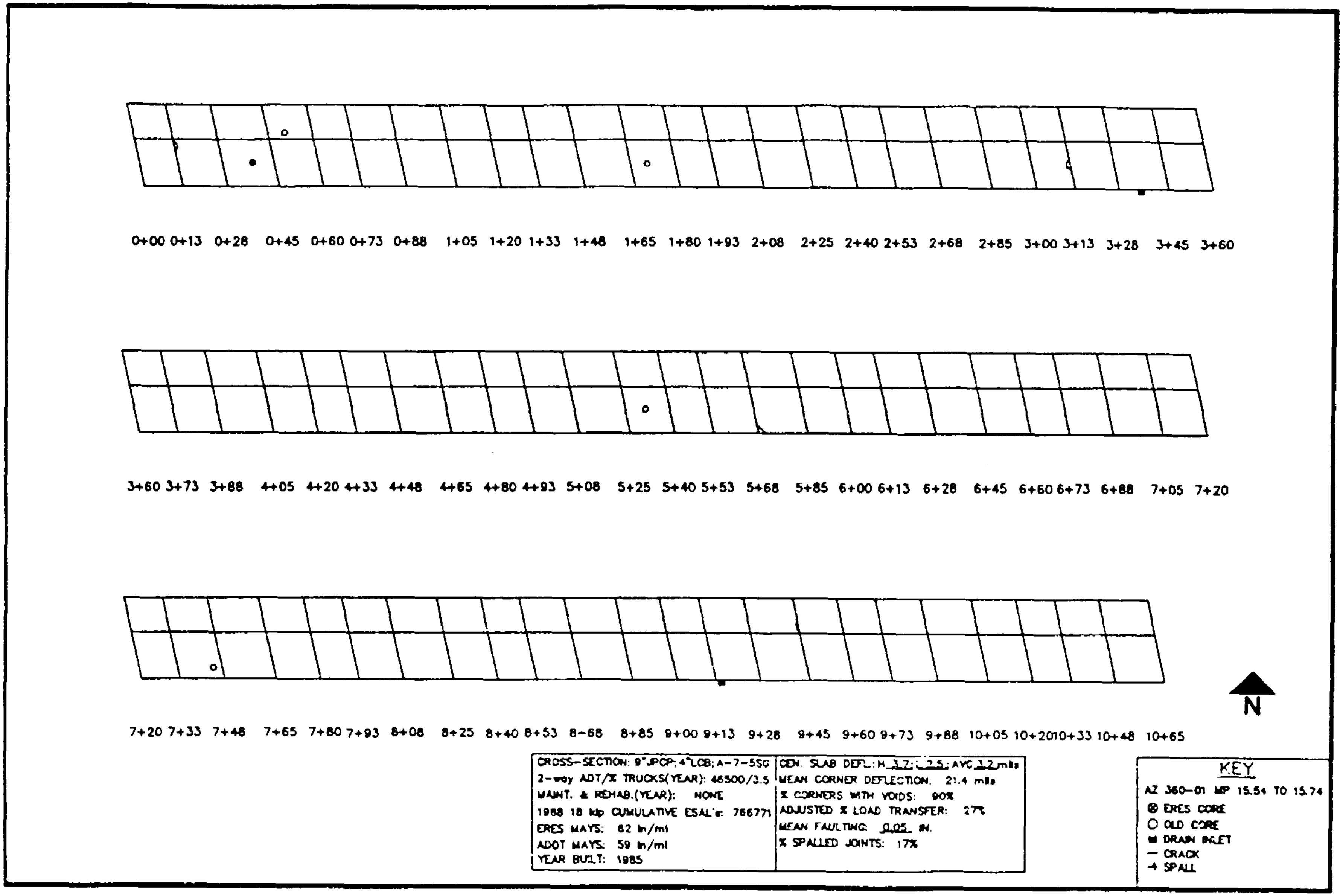



Figure B-1. Project strip map for AZ 360-01.

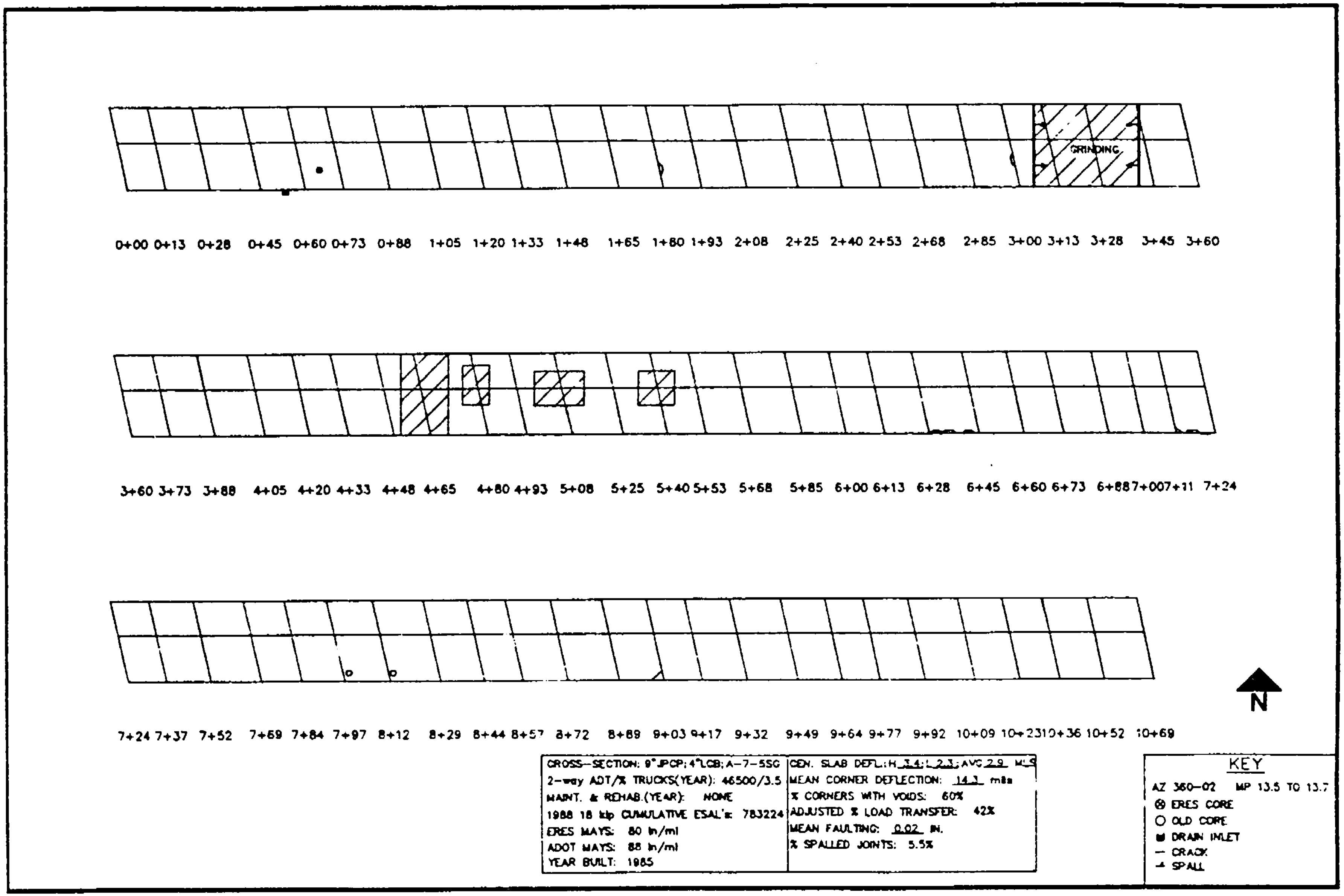



Figure B-2. Project strip map for AZ 360-02.

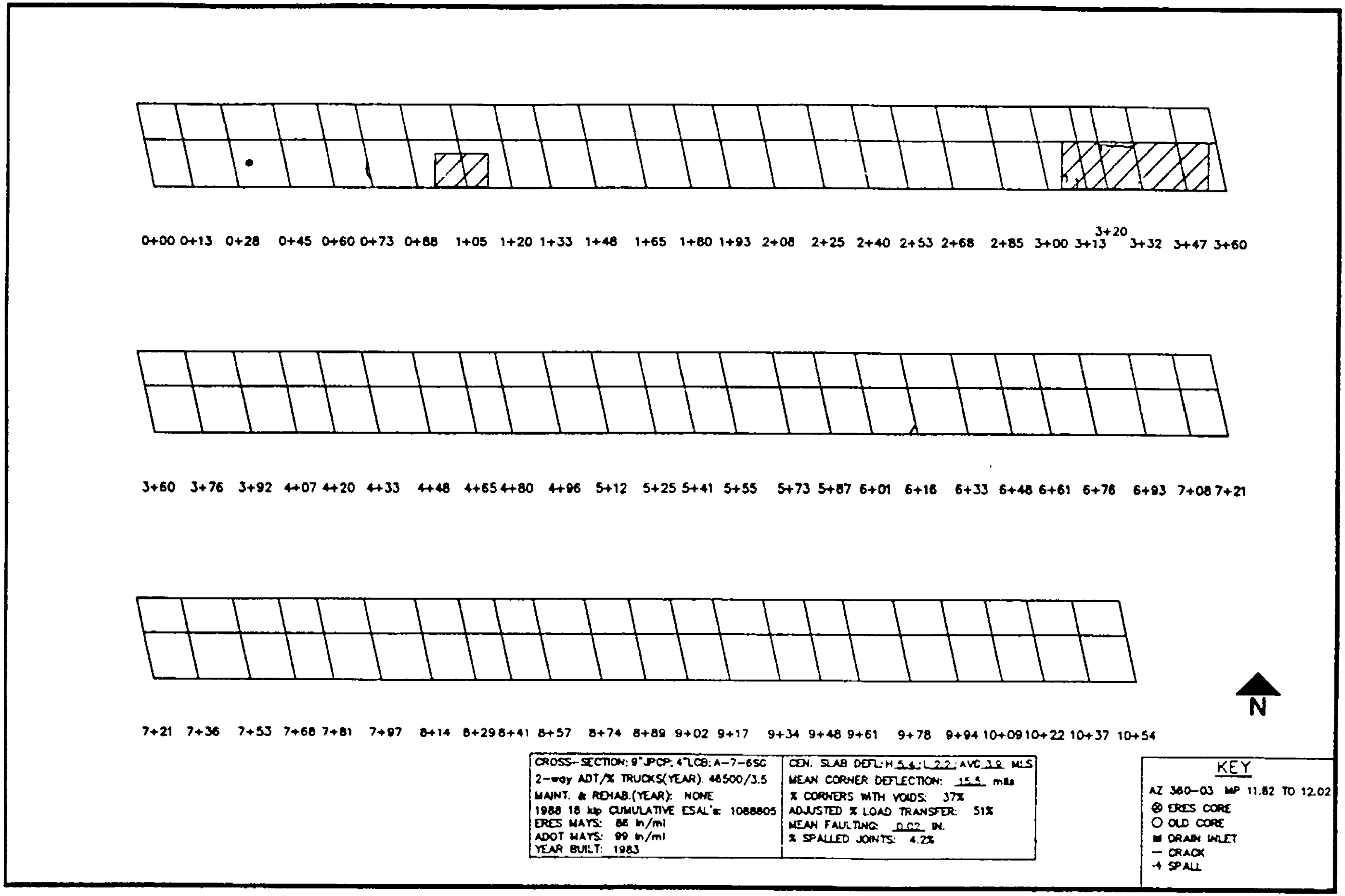



Figure B-3. Project strip map for AZ 360-03.

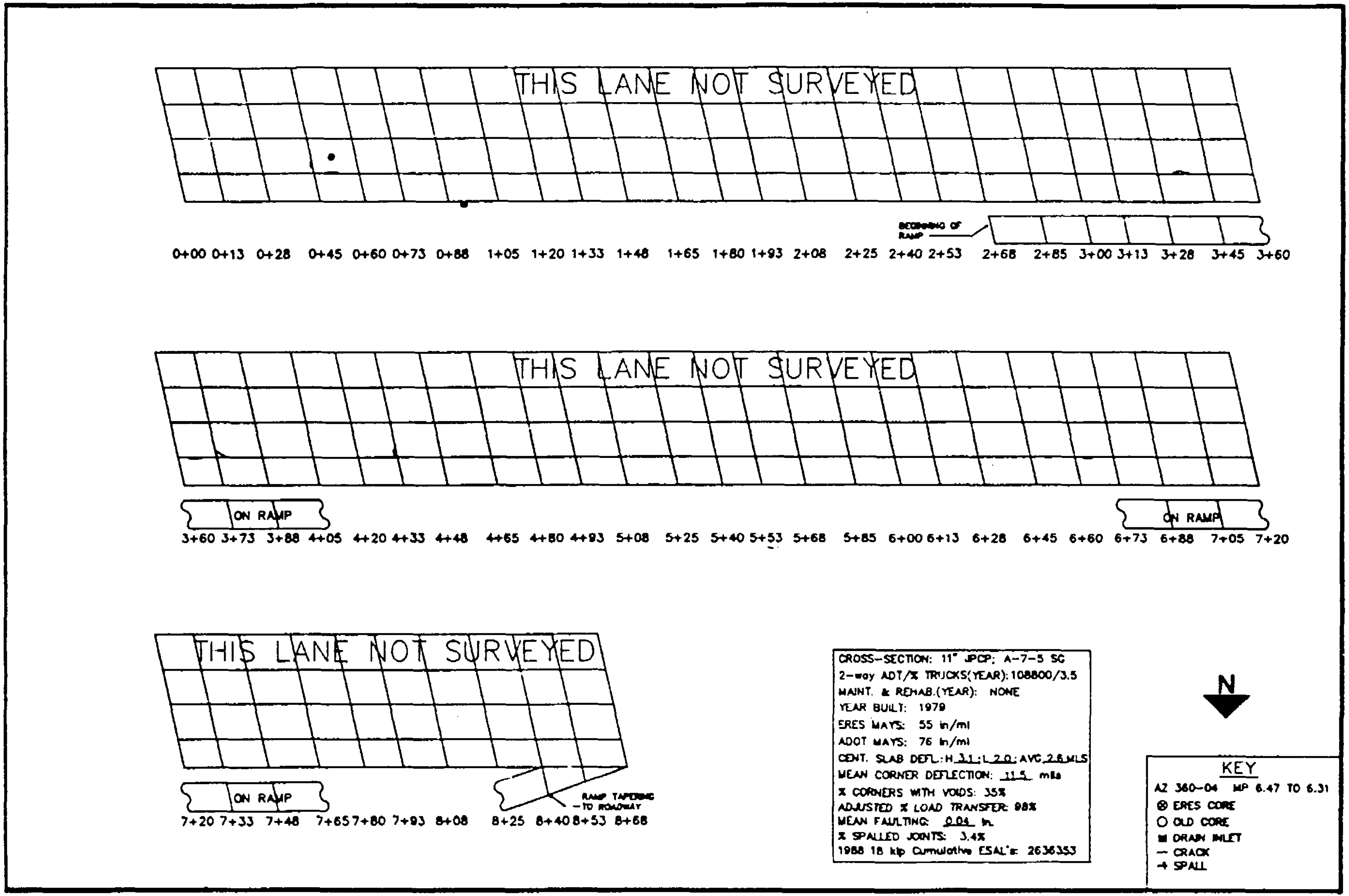



Figure B-4. Project strip map for AZ 360-04.

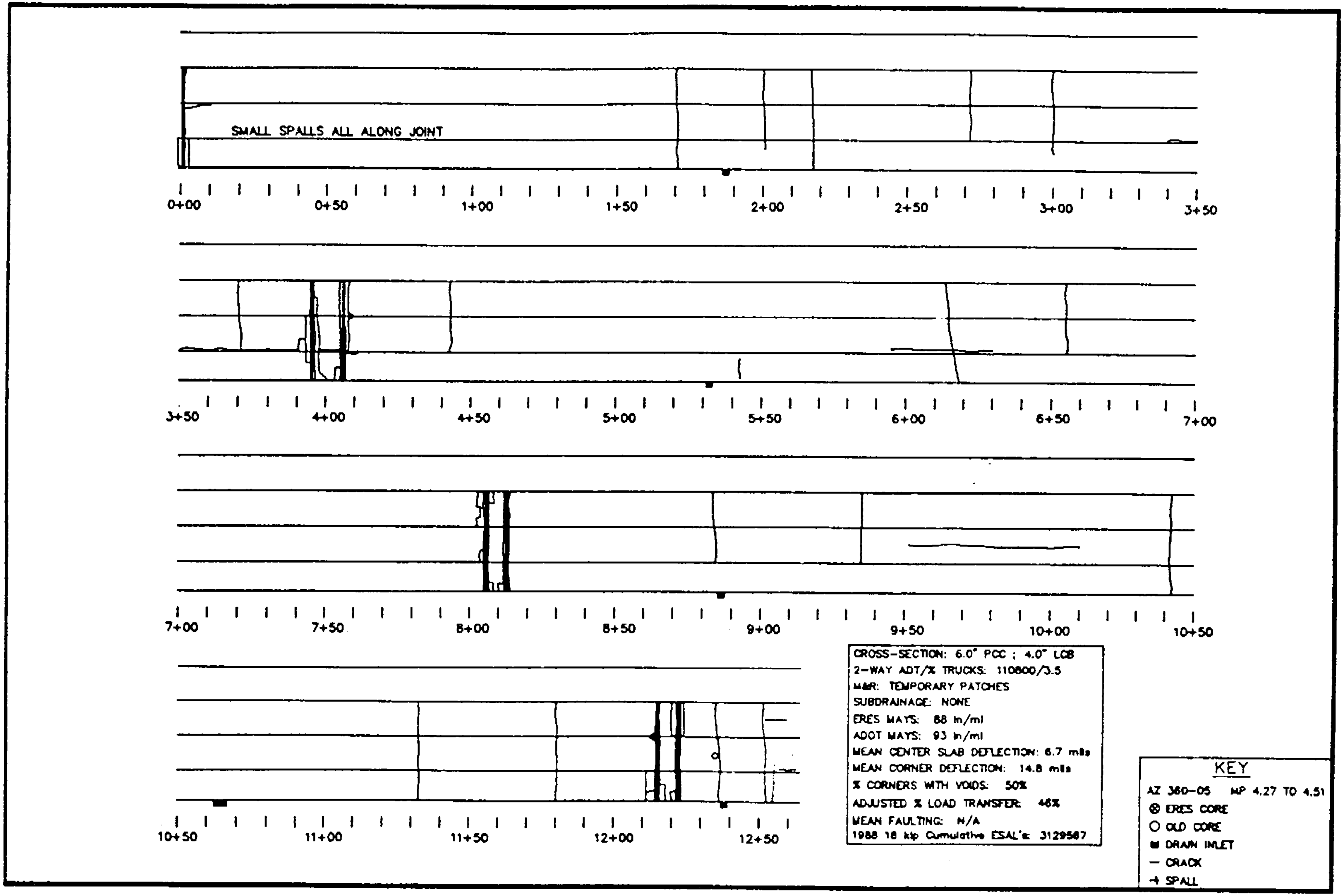



Figure B-5. Project strip map for AZ 360-05.

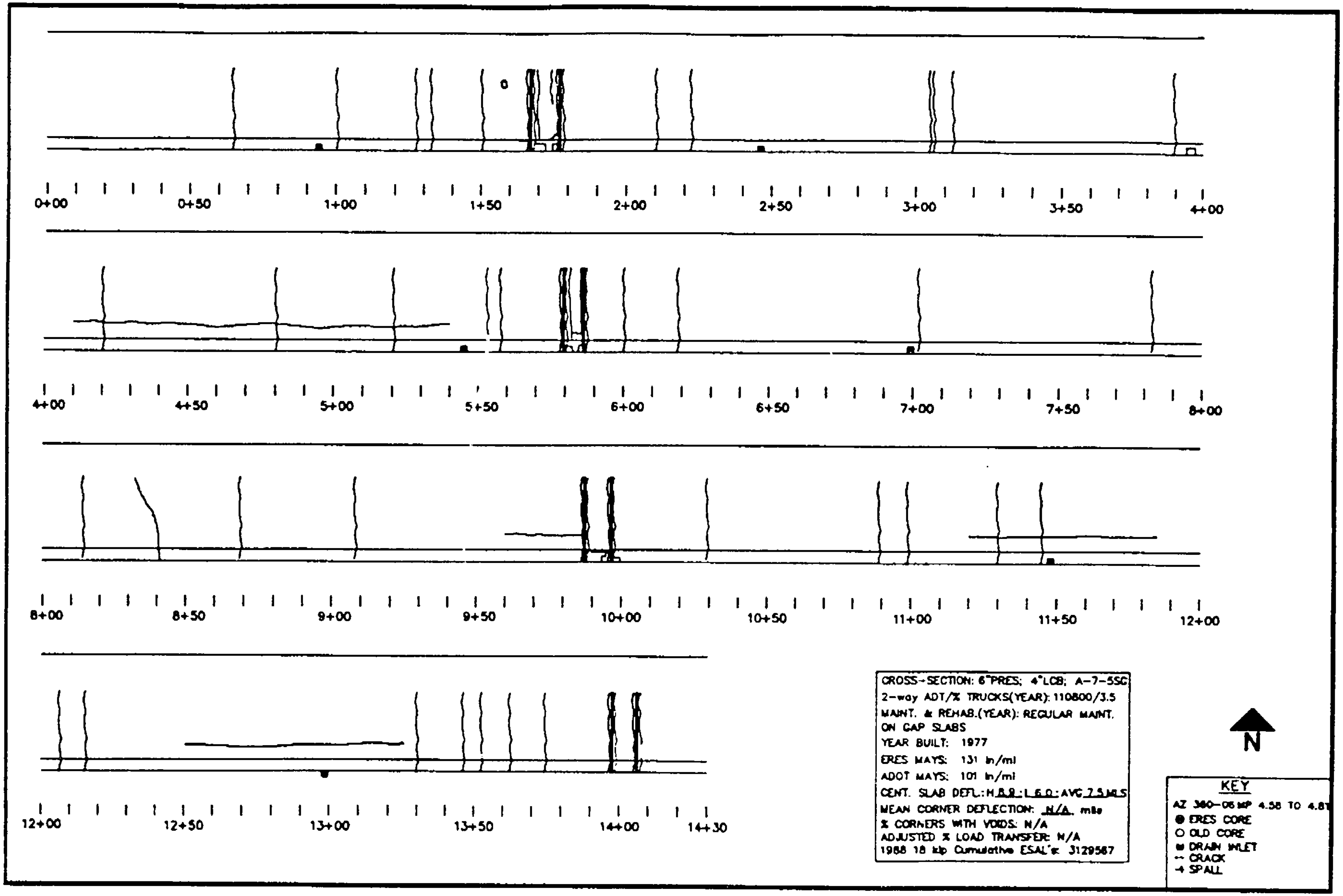



Figure B-6. Project strip map for AZ 360-06.

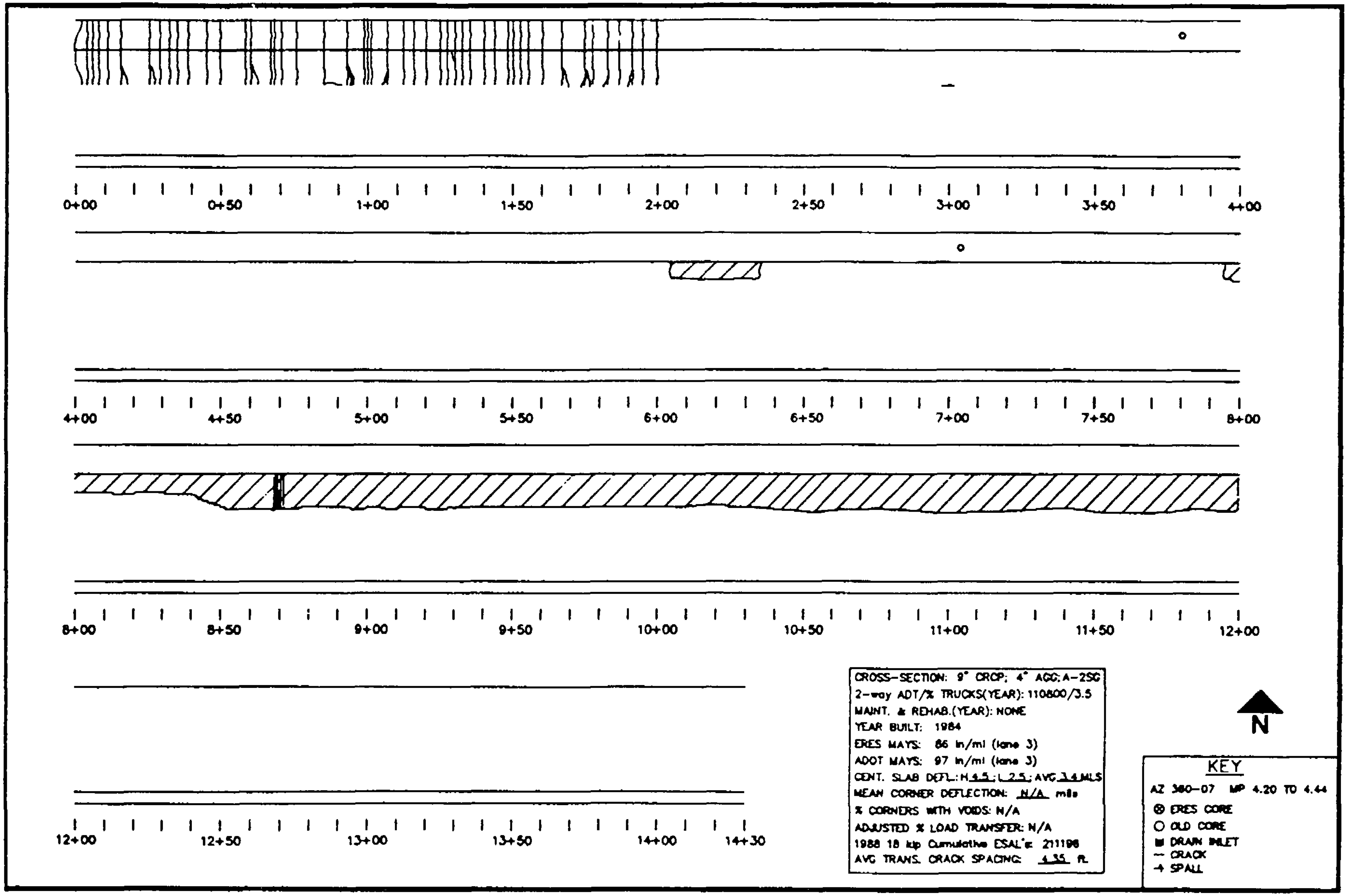



Figure B-7. Project strip map for AZ 360-07.

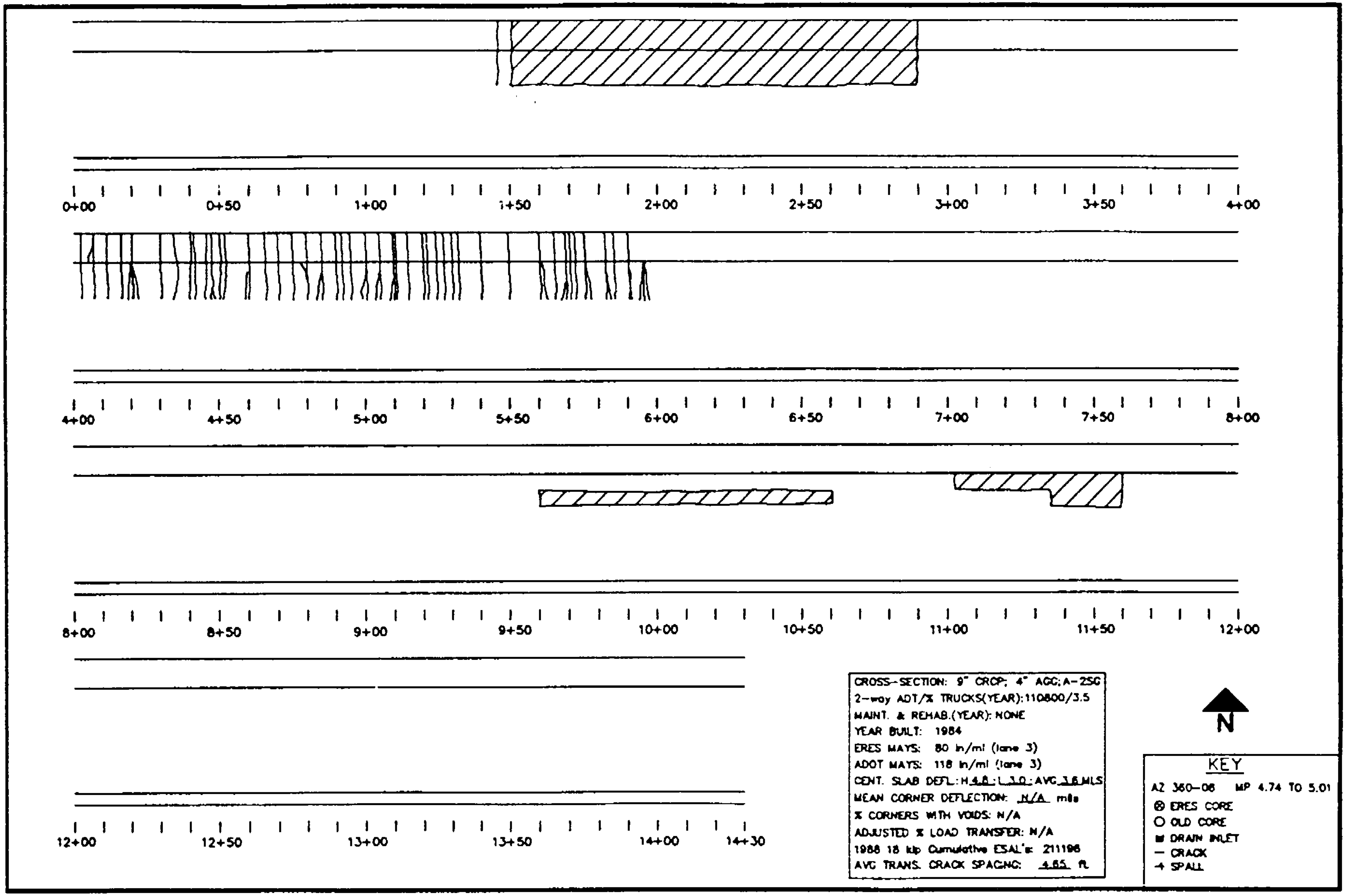



Figure B-8. Project strip map for AZ 360-08.

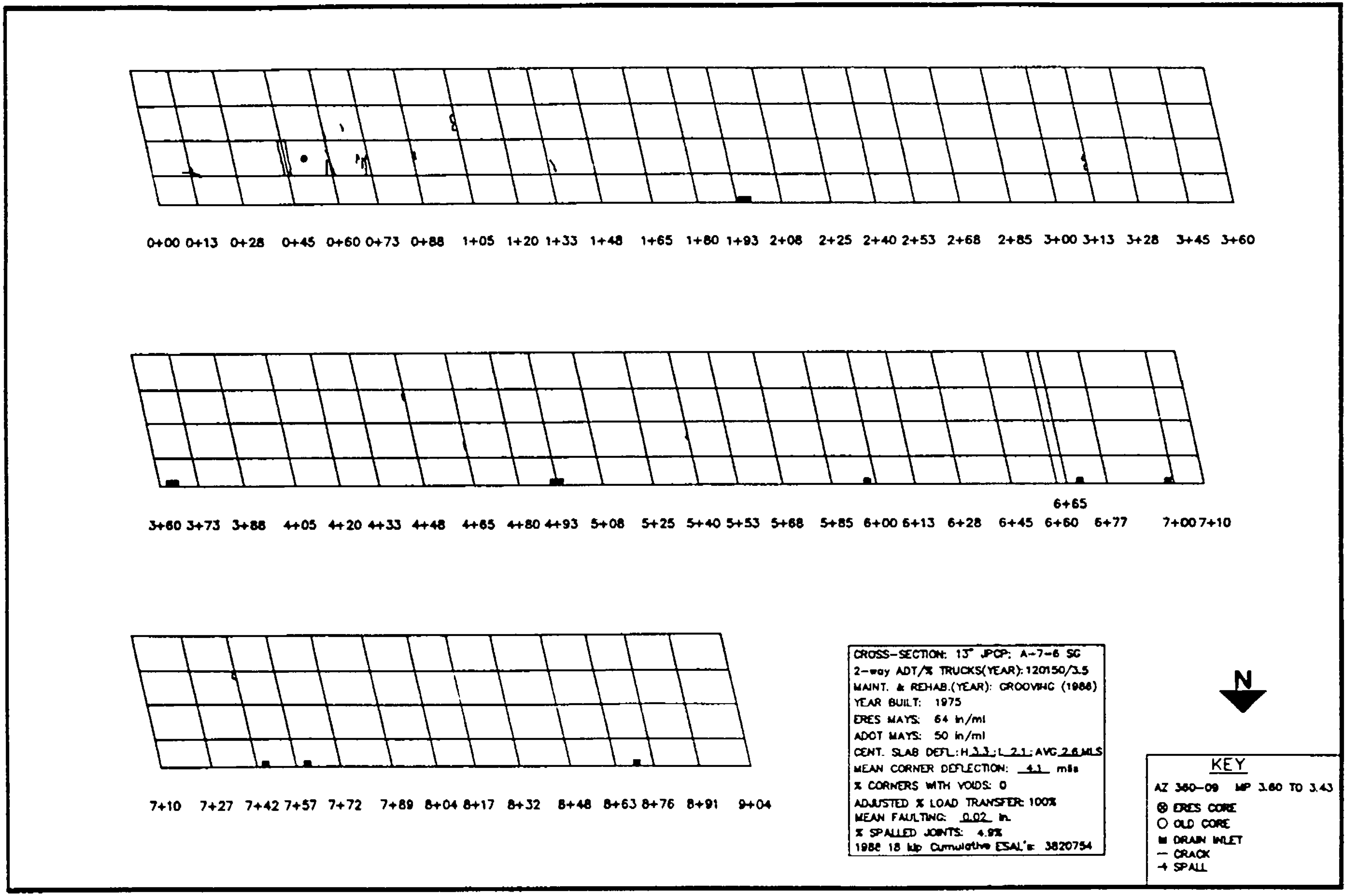



Figure B-9. Project strip map for AZ 360-09.

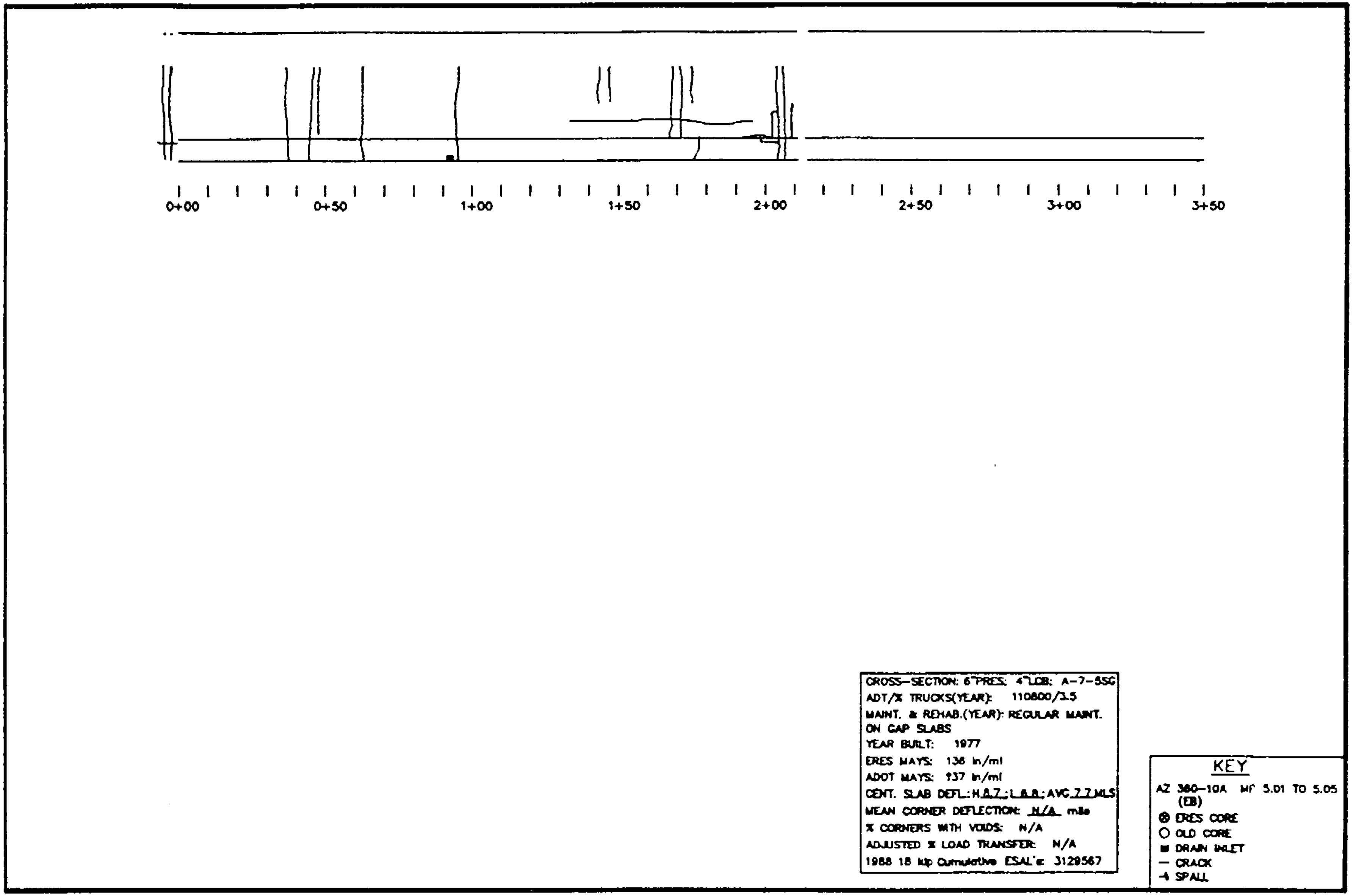



Figure B-10. Project strip map for AZ 360-10A.

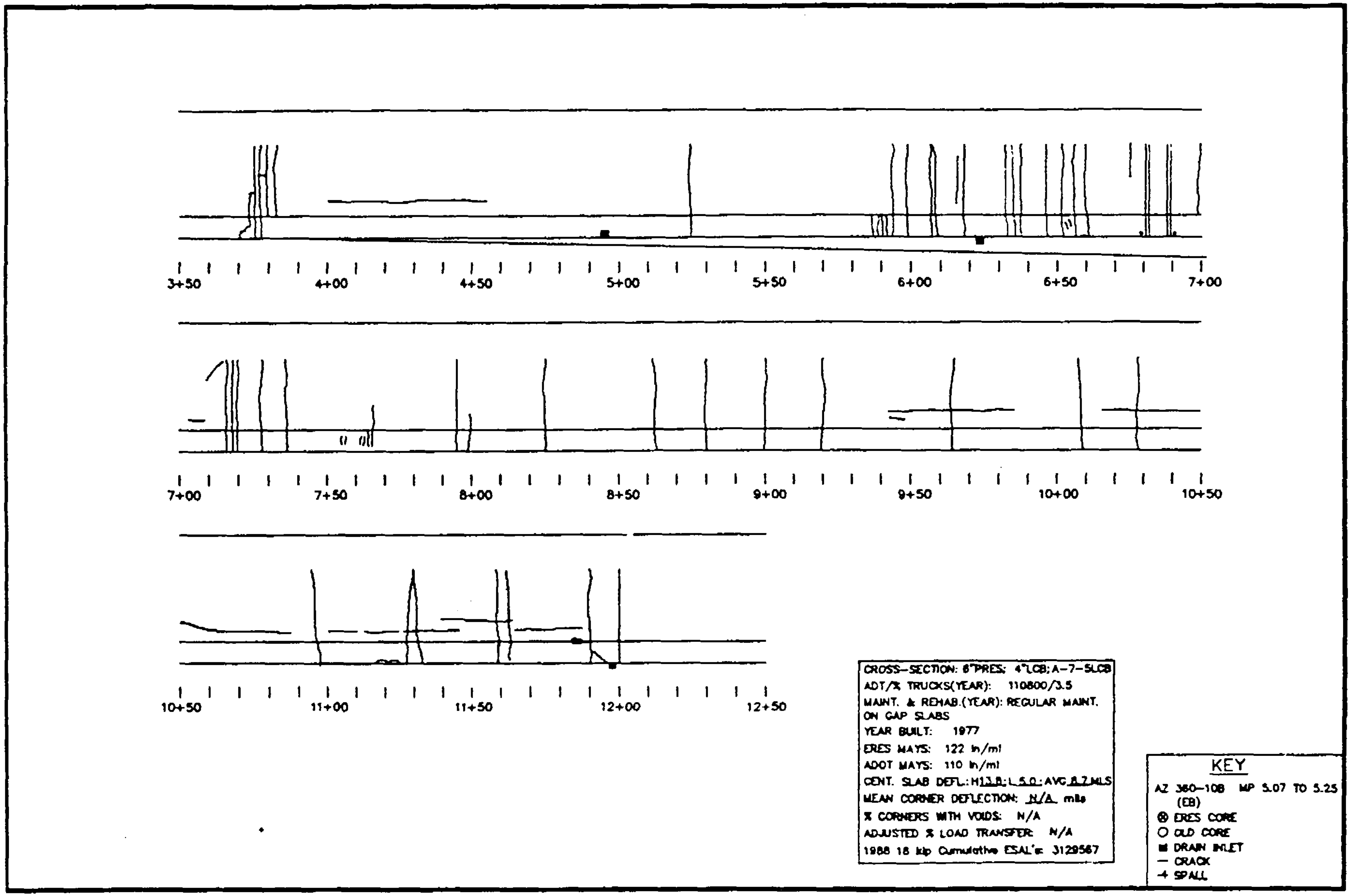



Figure B-11. Project strip map for AZ 360-10B.

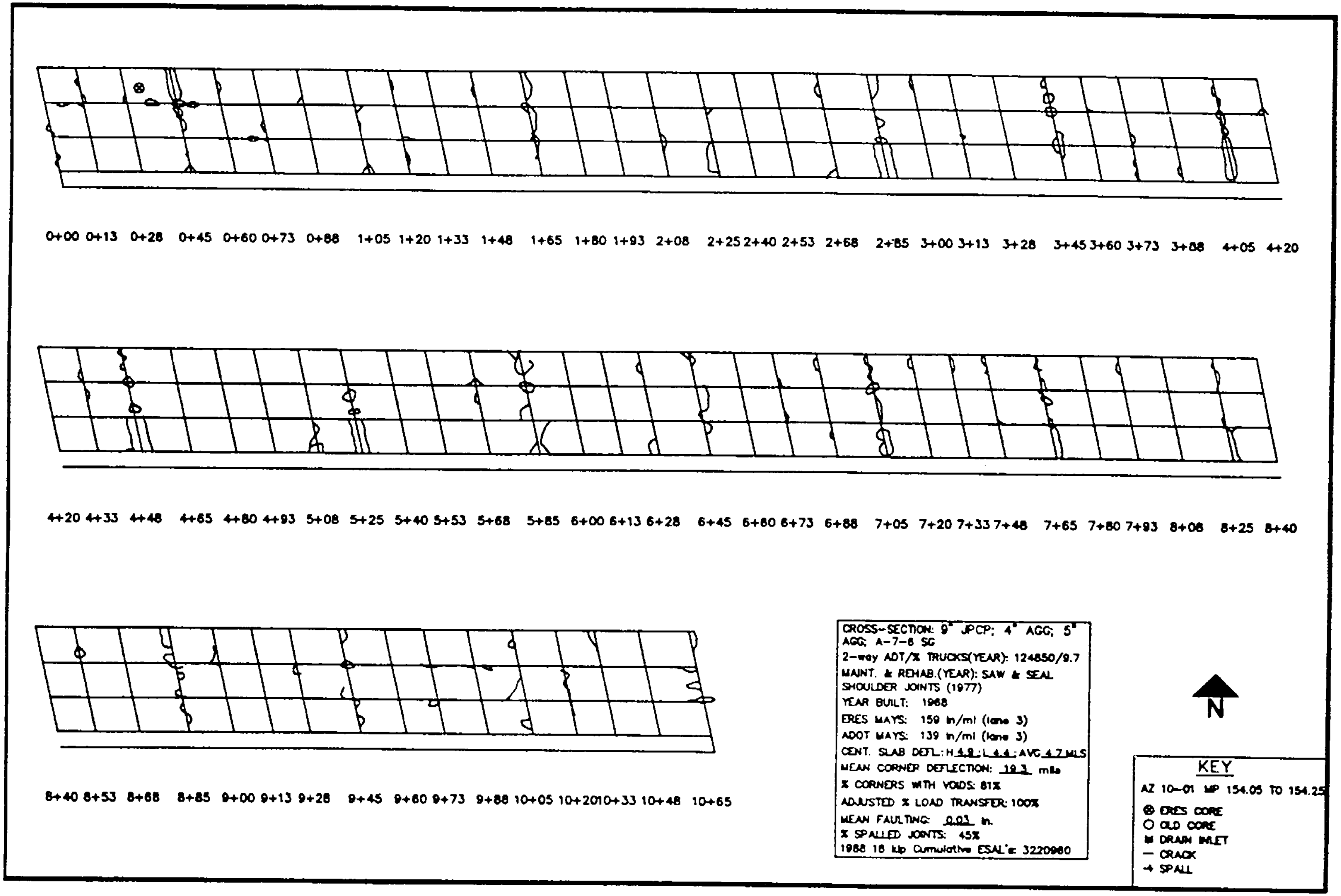



Figure B-12. Project strip map for AZ 10-01.

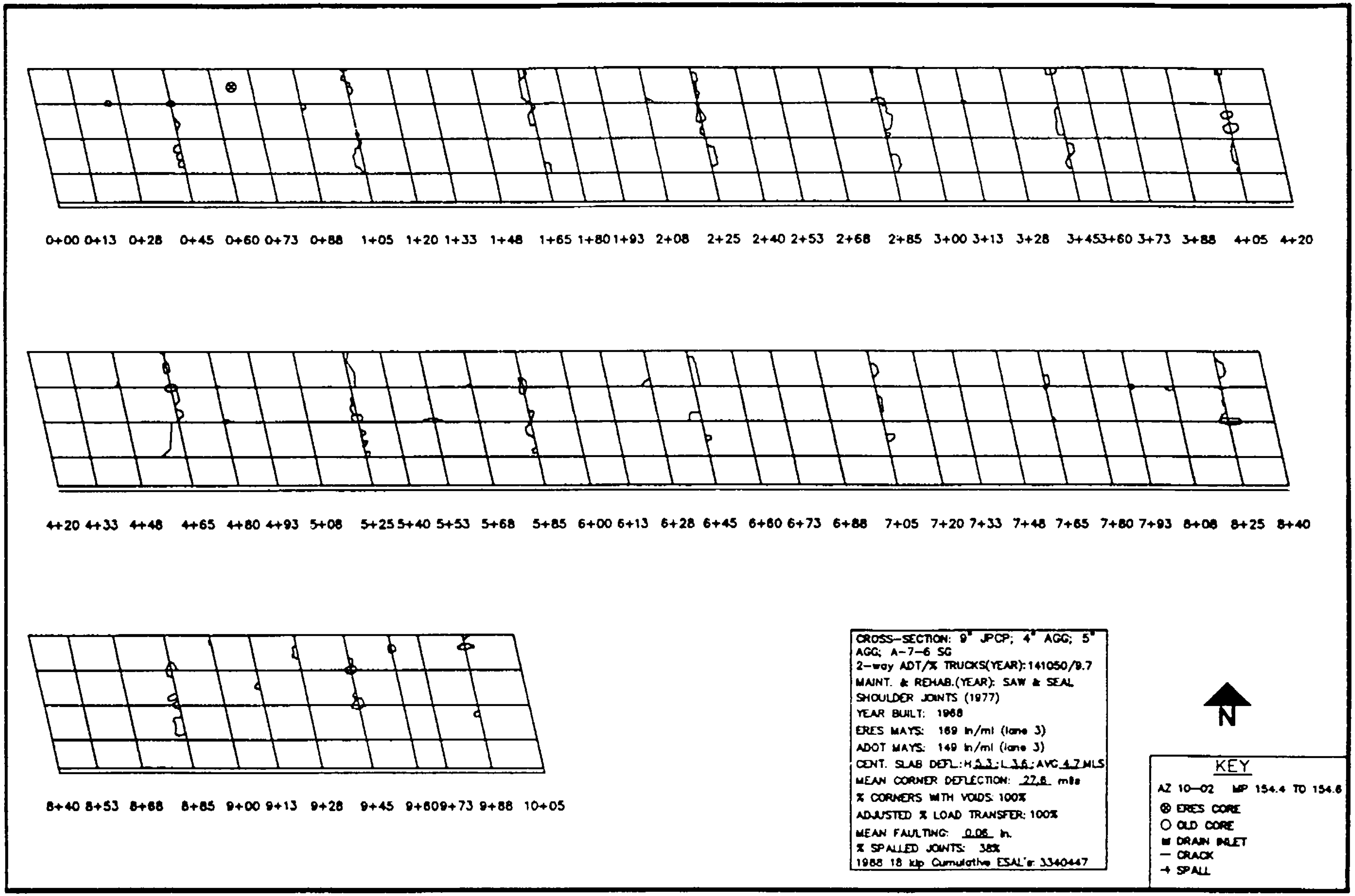



Figure B-13. Project strip map for AZ 10-02.

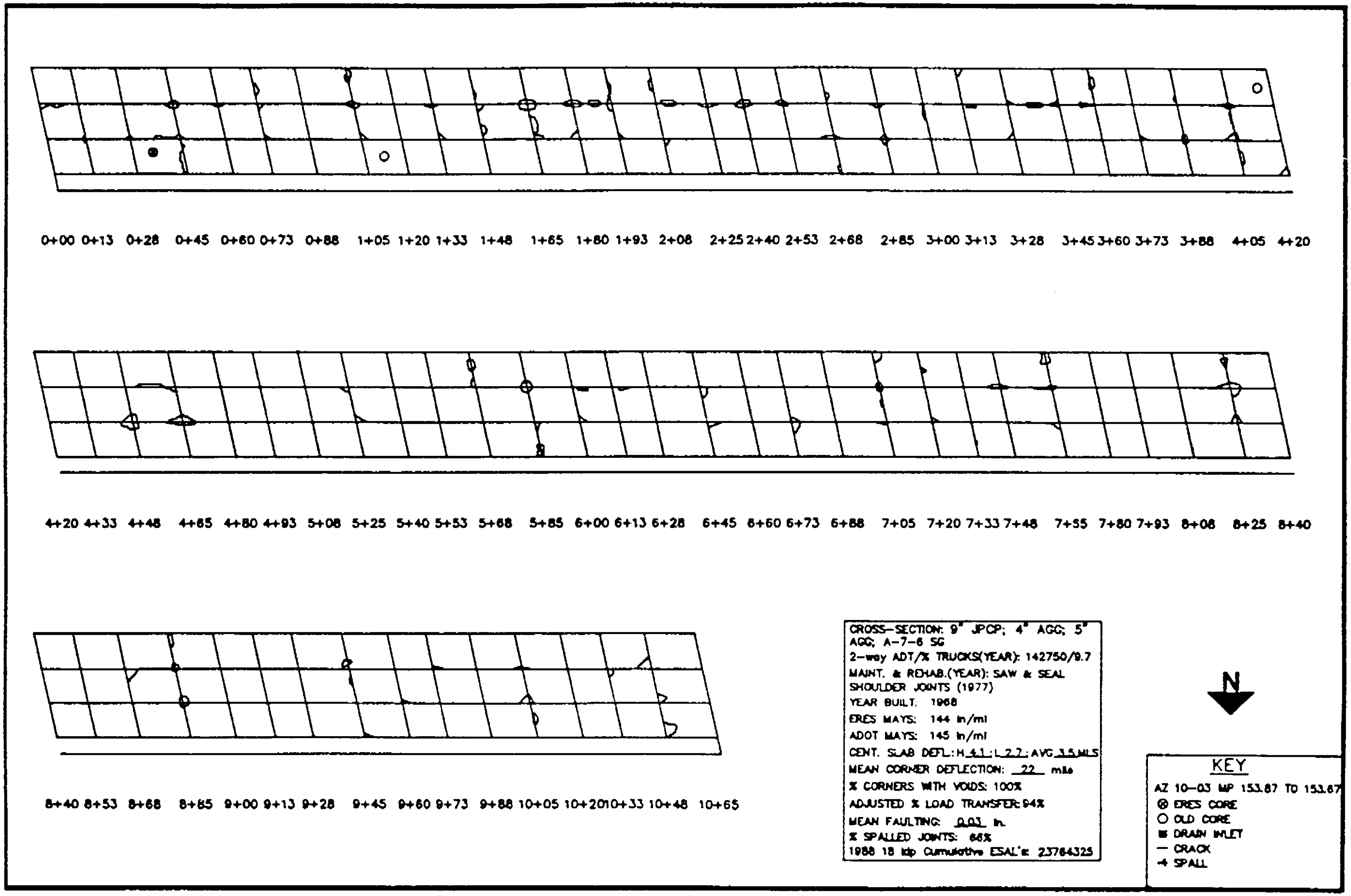



Figure B-14. Project strip map for AZ 10-03.

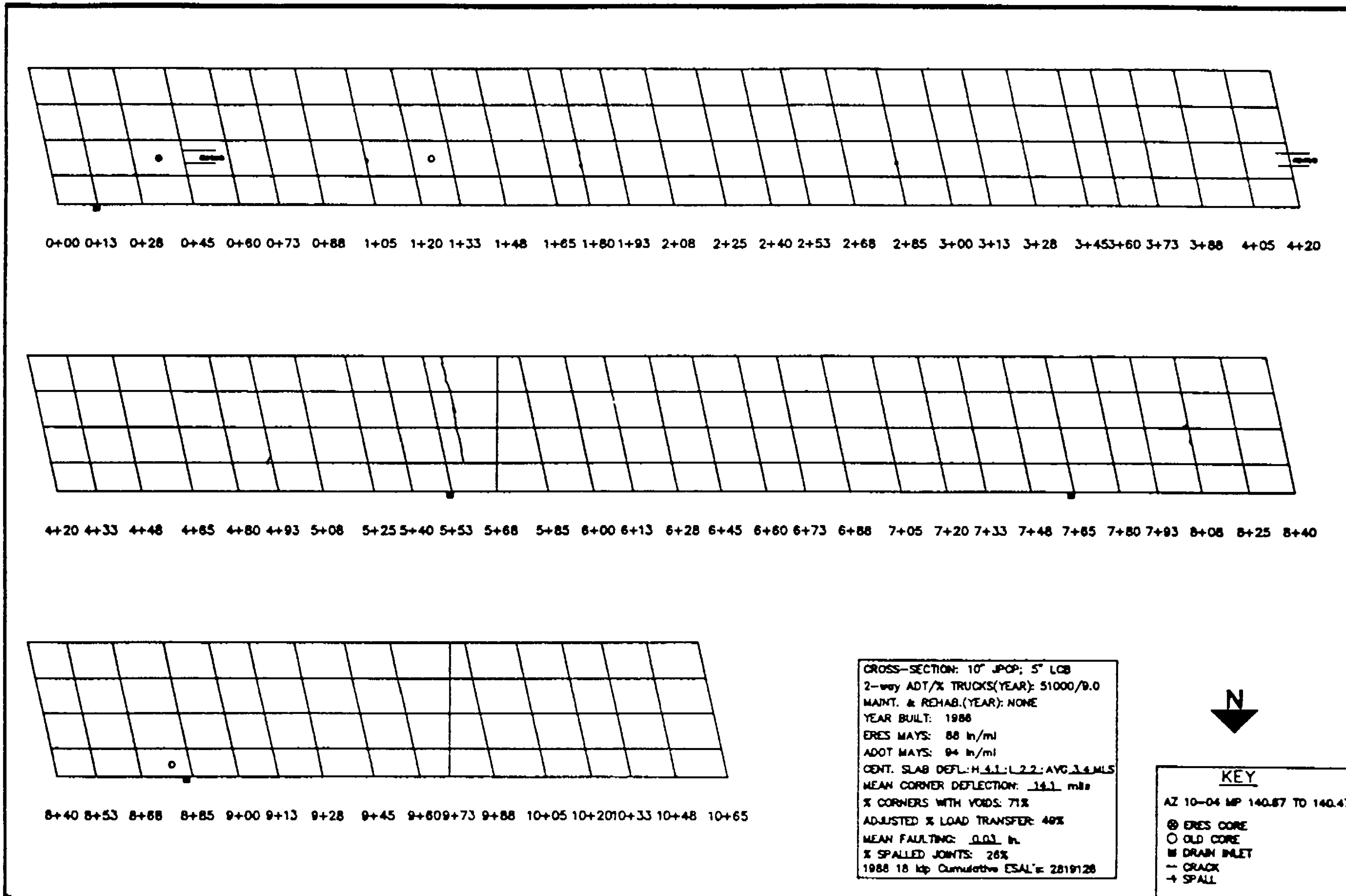



Figure B-15. Project strip map for AZ 10-04.

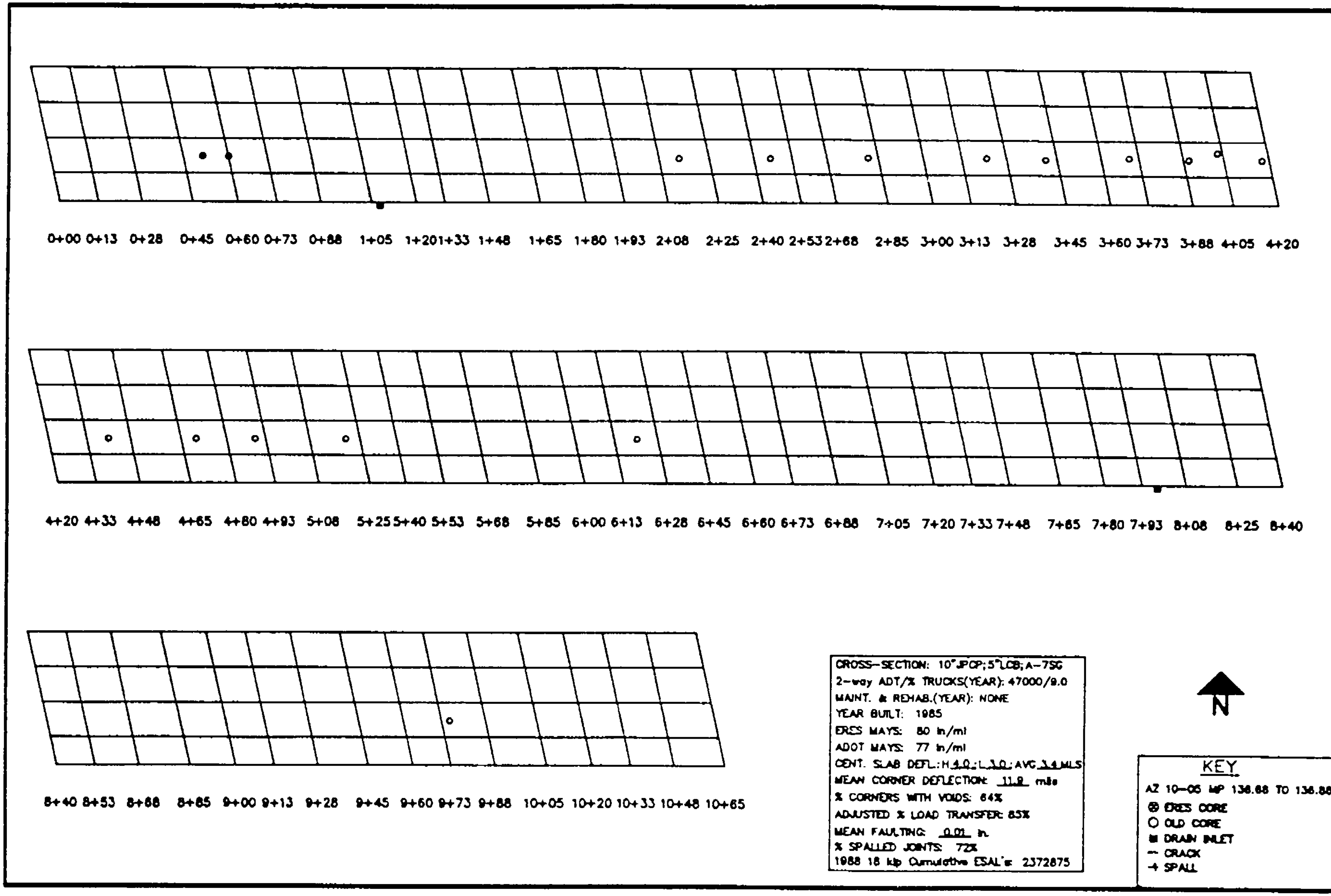



Figure B-16. Project strip map for AZ 10-05.

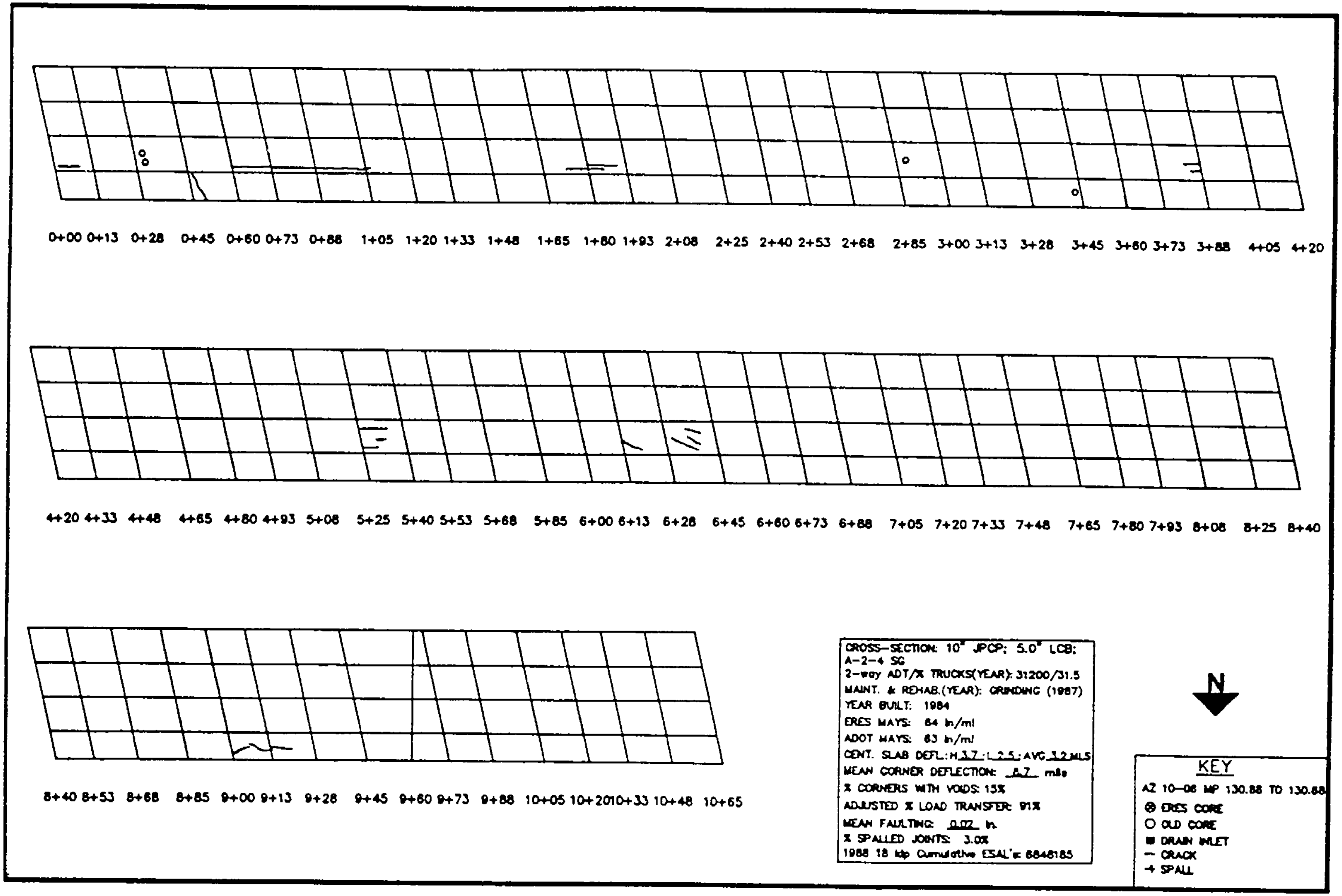



Figure B-17. Project strip map for AZ 10-06.

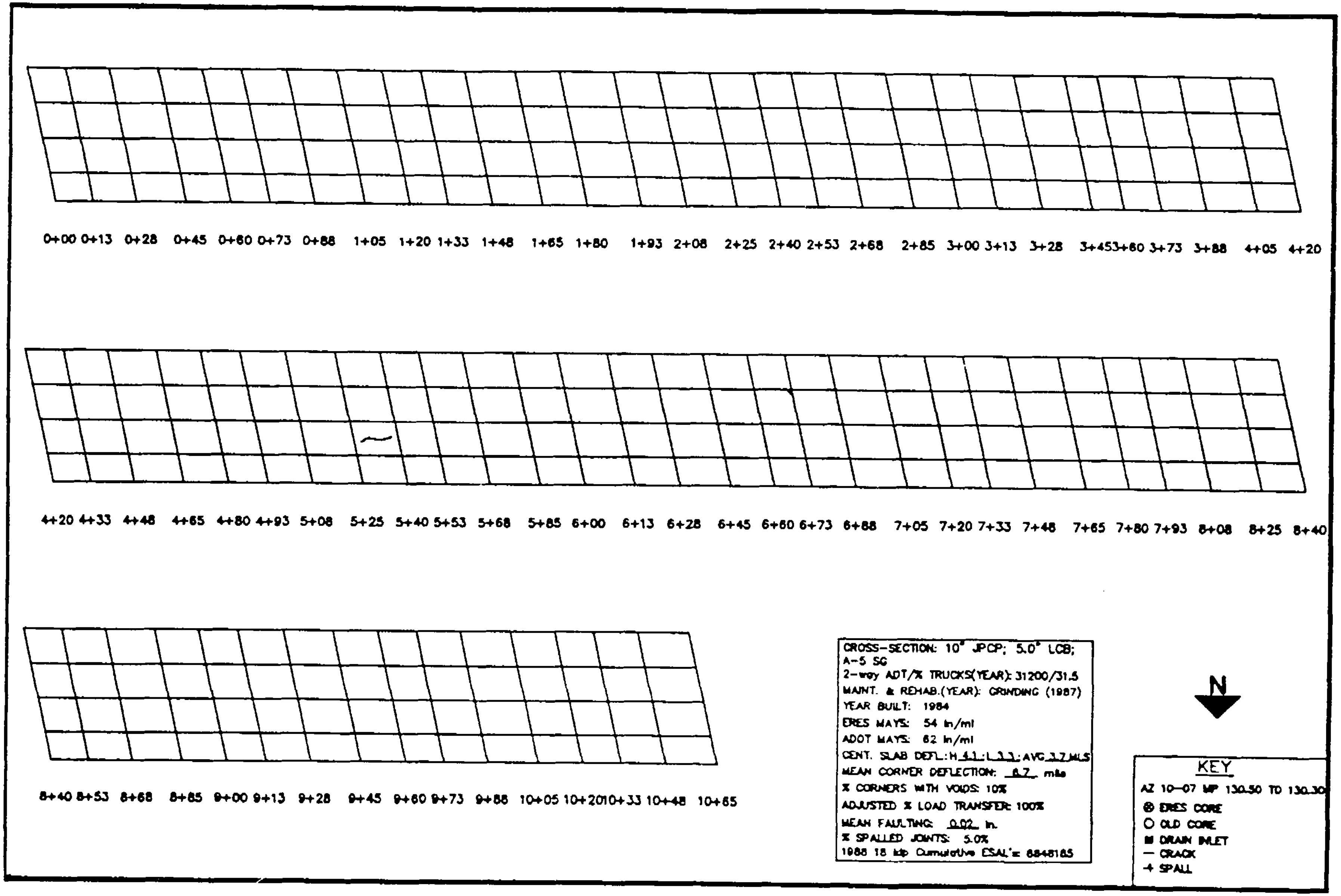



Figure B-18. Project strip map for AZ 10-07.

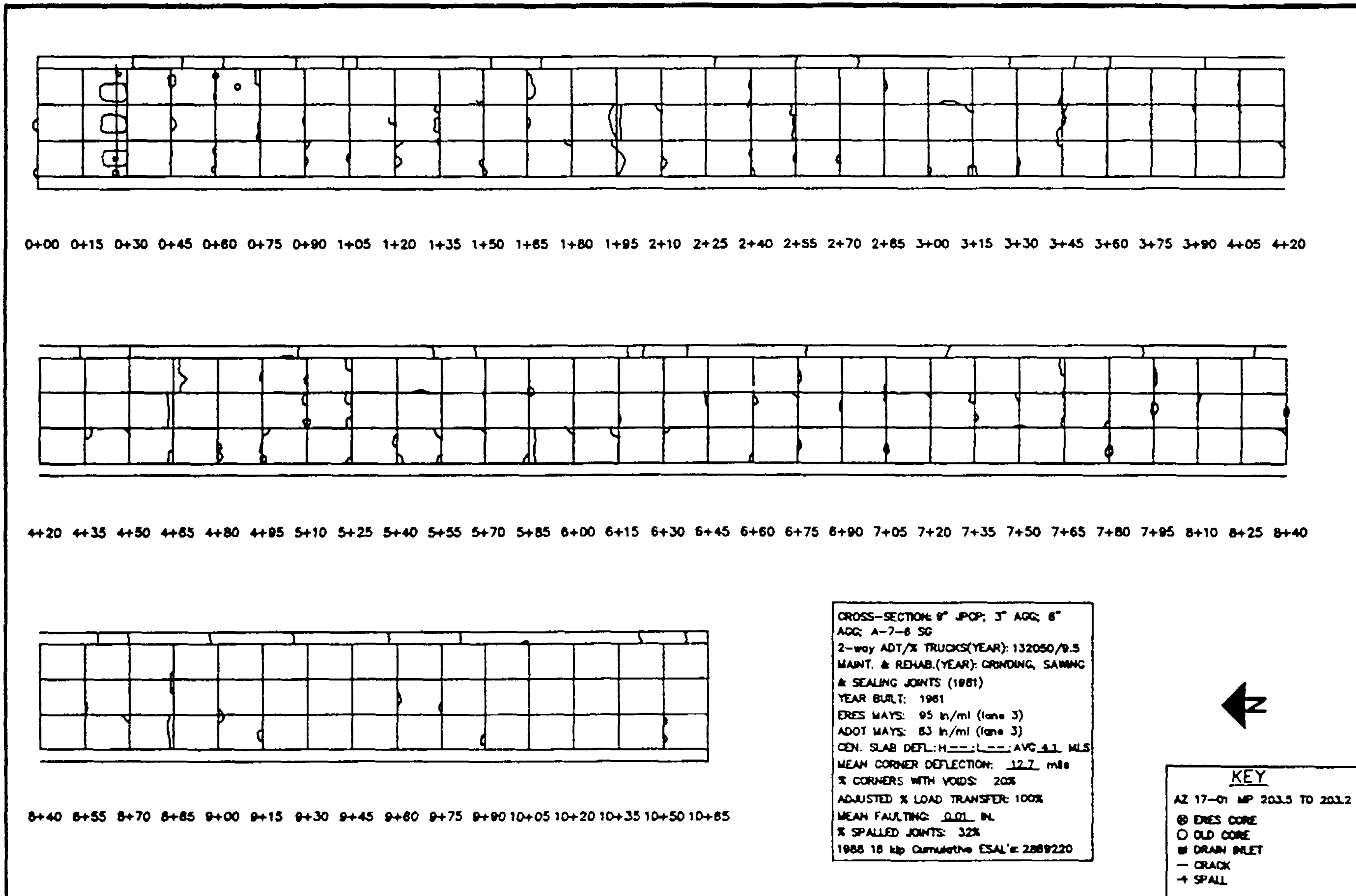



Figure B-19. Project strip map for AZ 17-01.

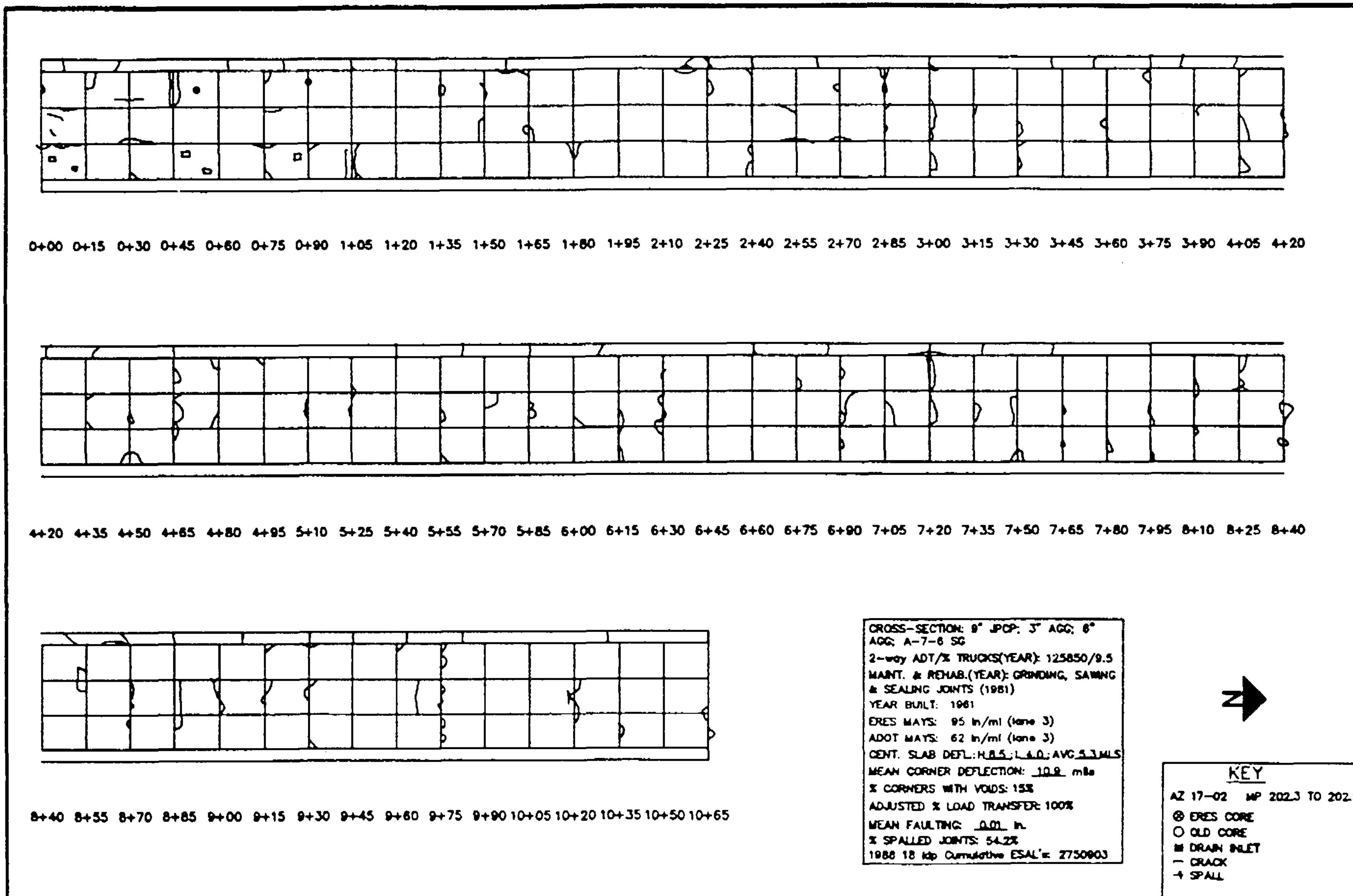



Figure B-20. Project strip map for AZ 17-02.

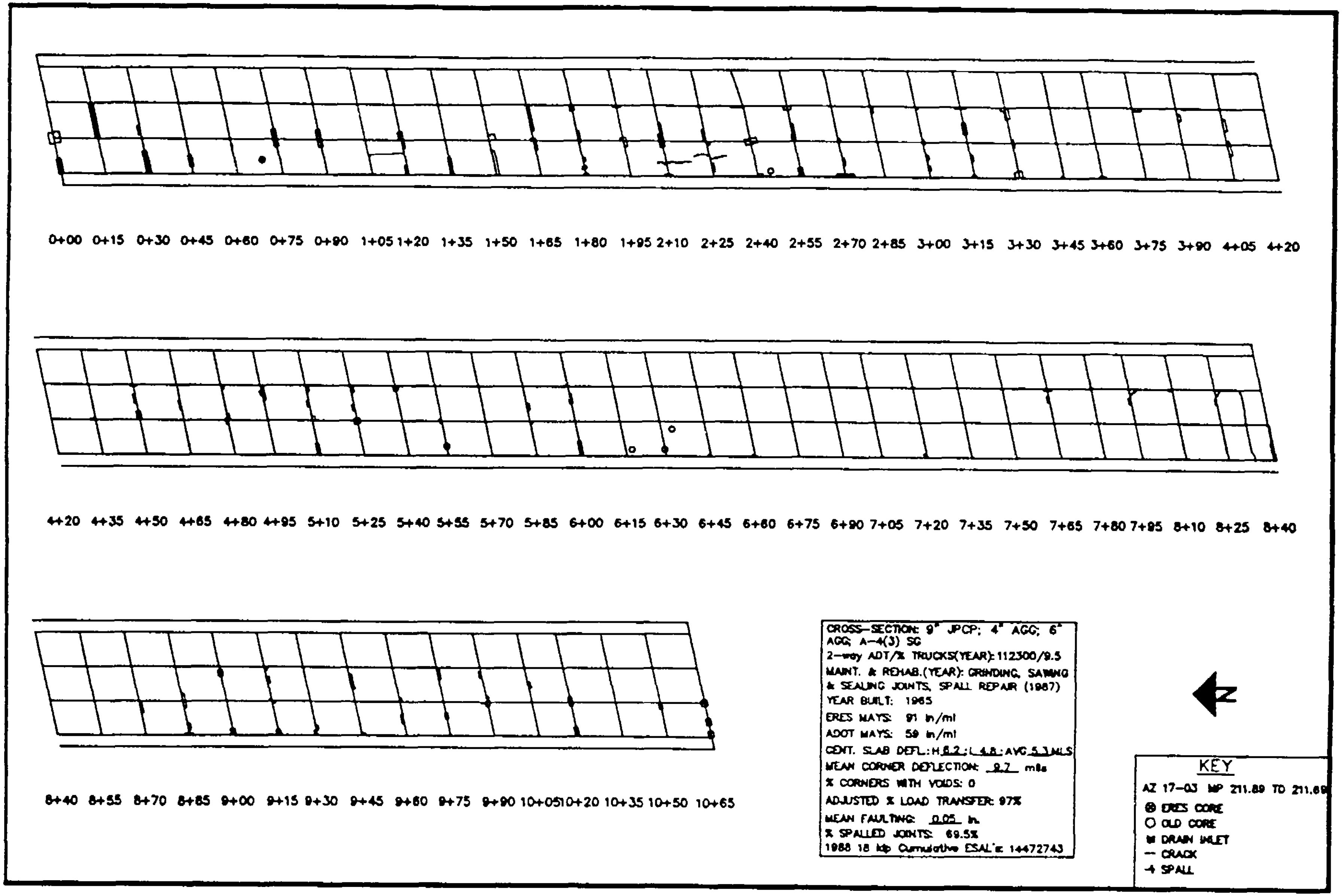



Figure B-21. Project strip map for AZ 17-03.

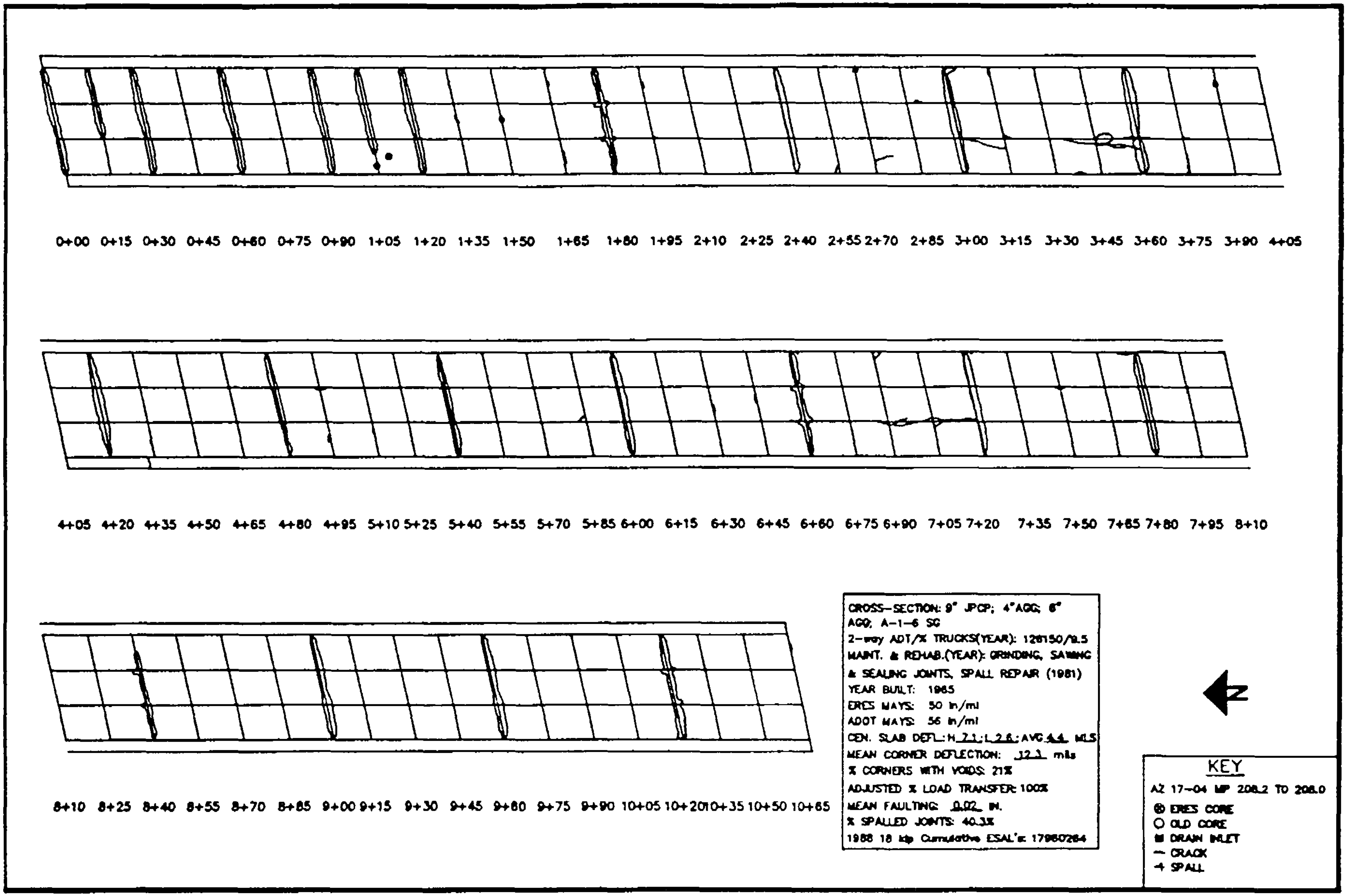



Figure B-22. Project strip map for AZ 17-04.

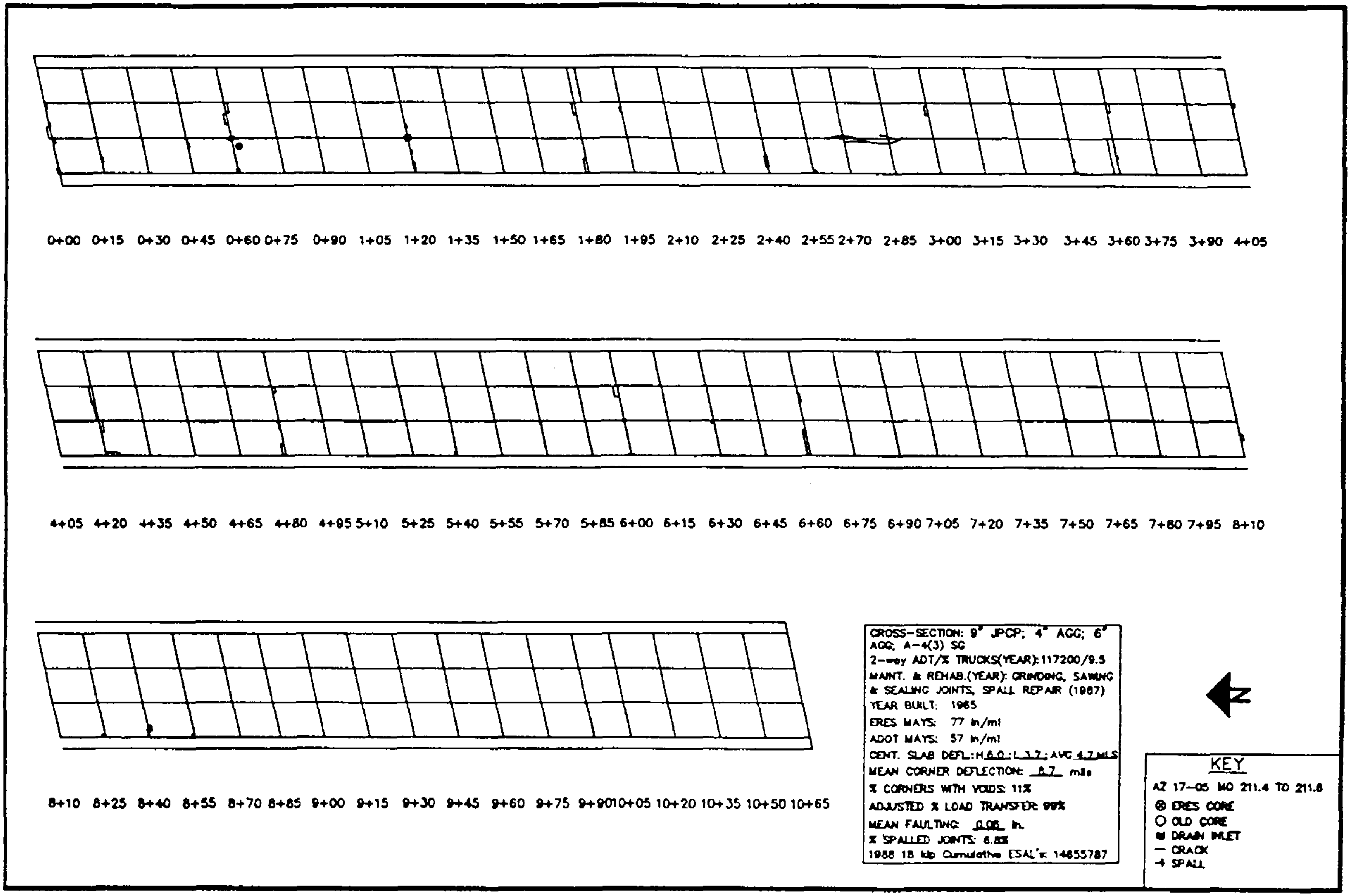



Figure B-23. Project strip map for AZ 17-05.

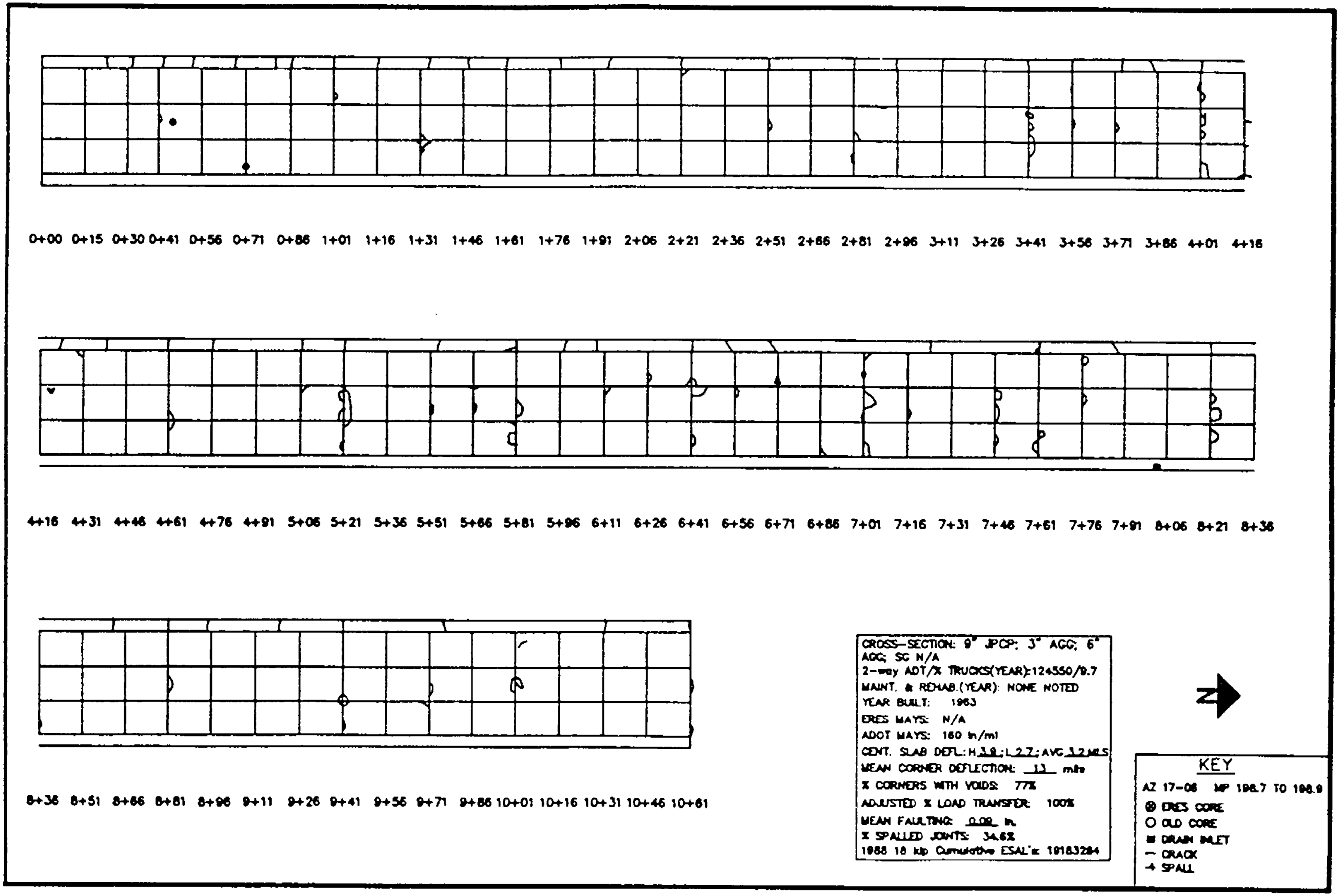



Figure B-24. Project strip map for AZ 17-06.

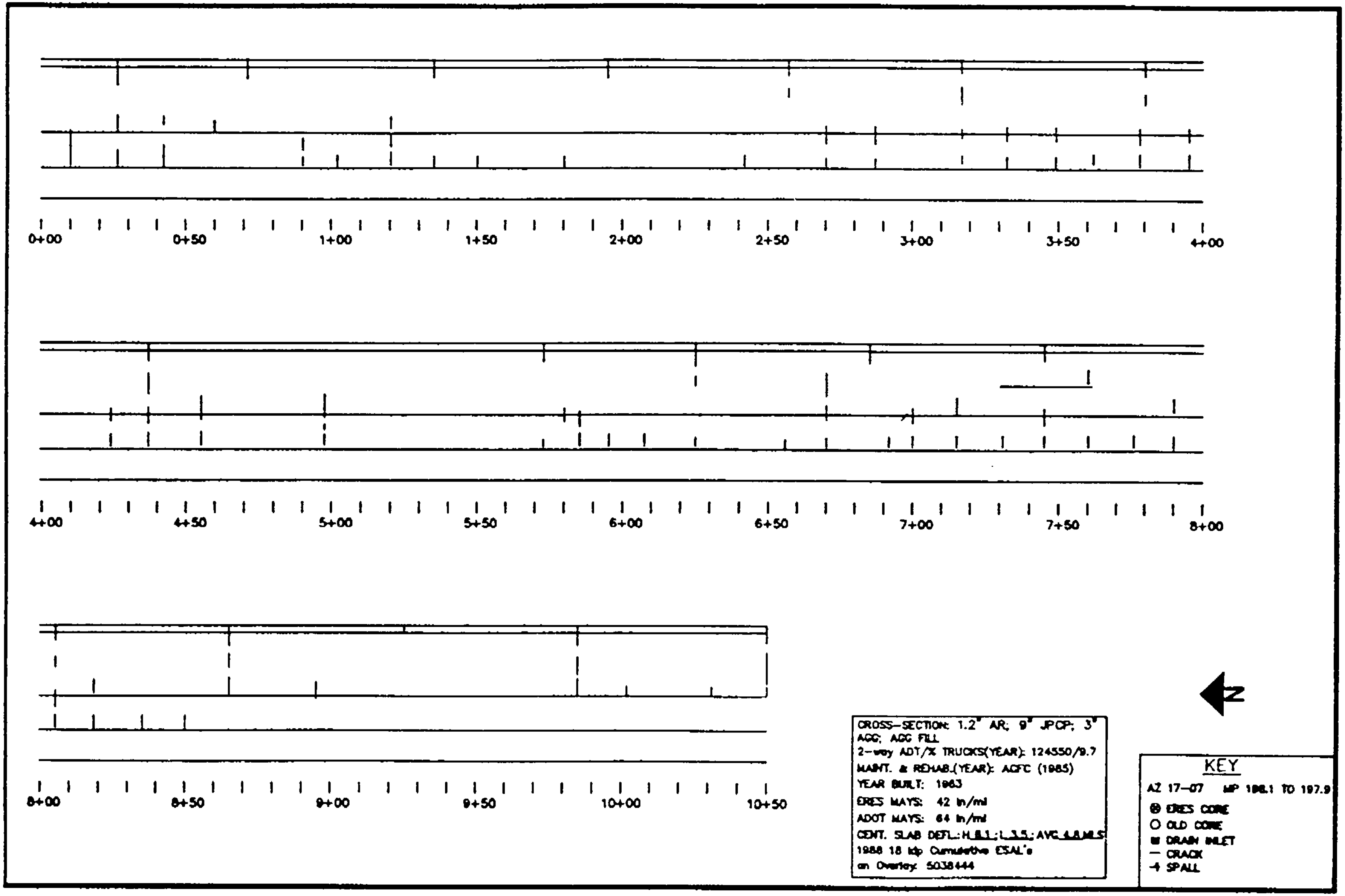



Figure B-25. Project strip map for AZ 17-07.

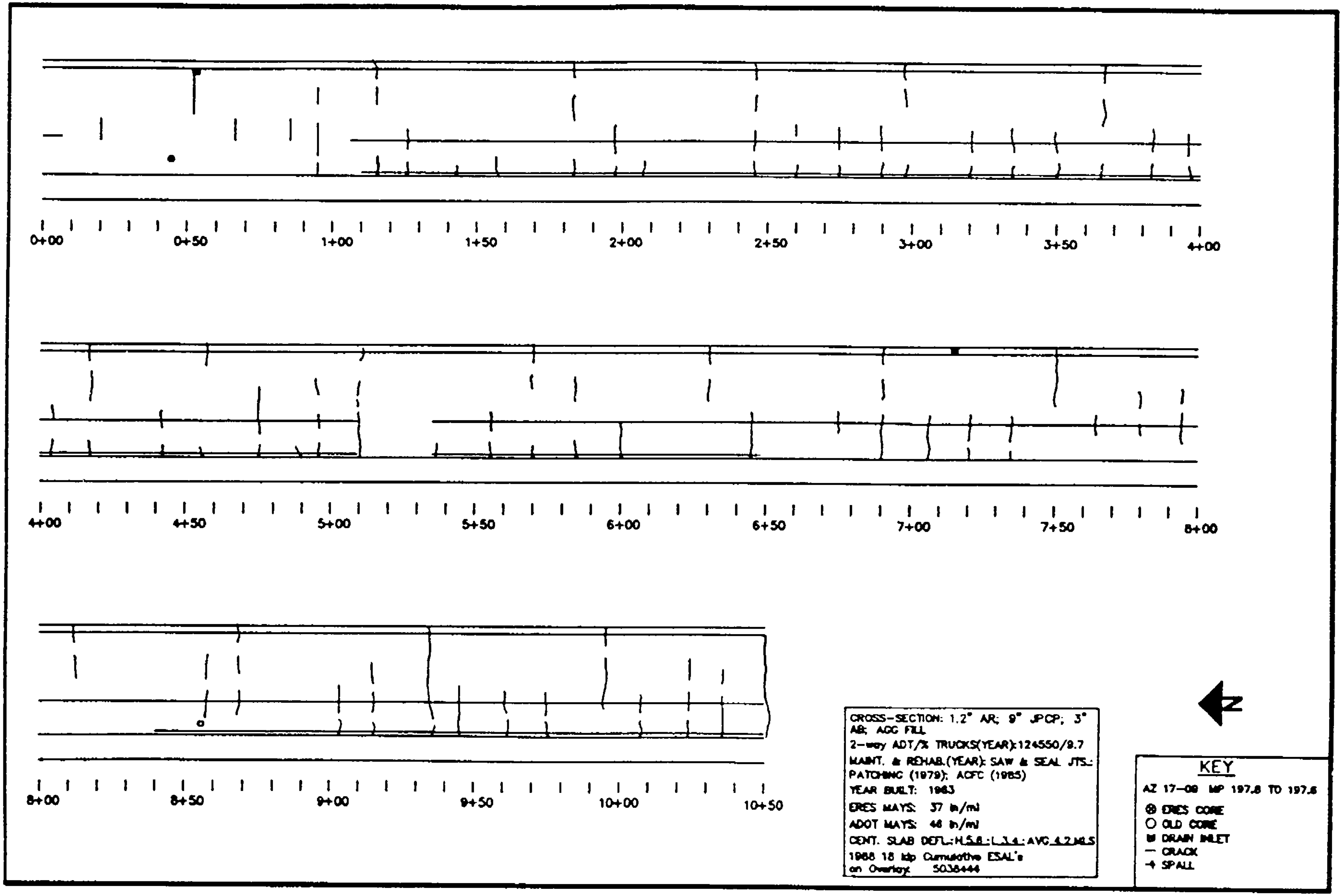



Figure B-26. Project strip map for AZ 17-09.

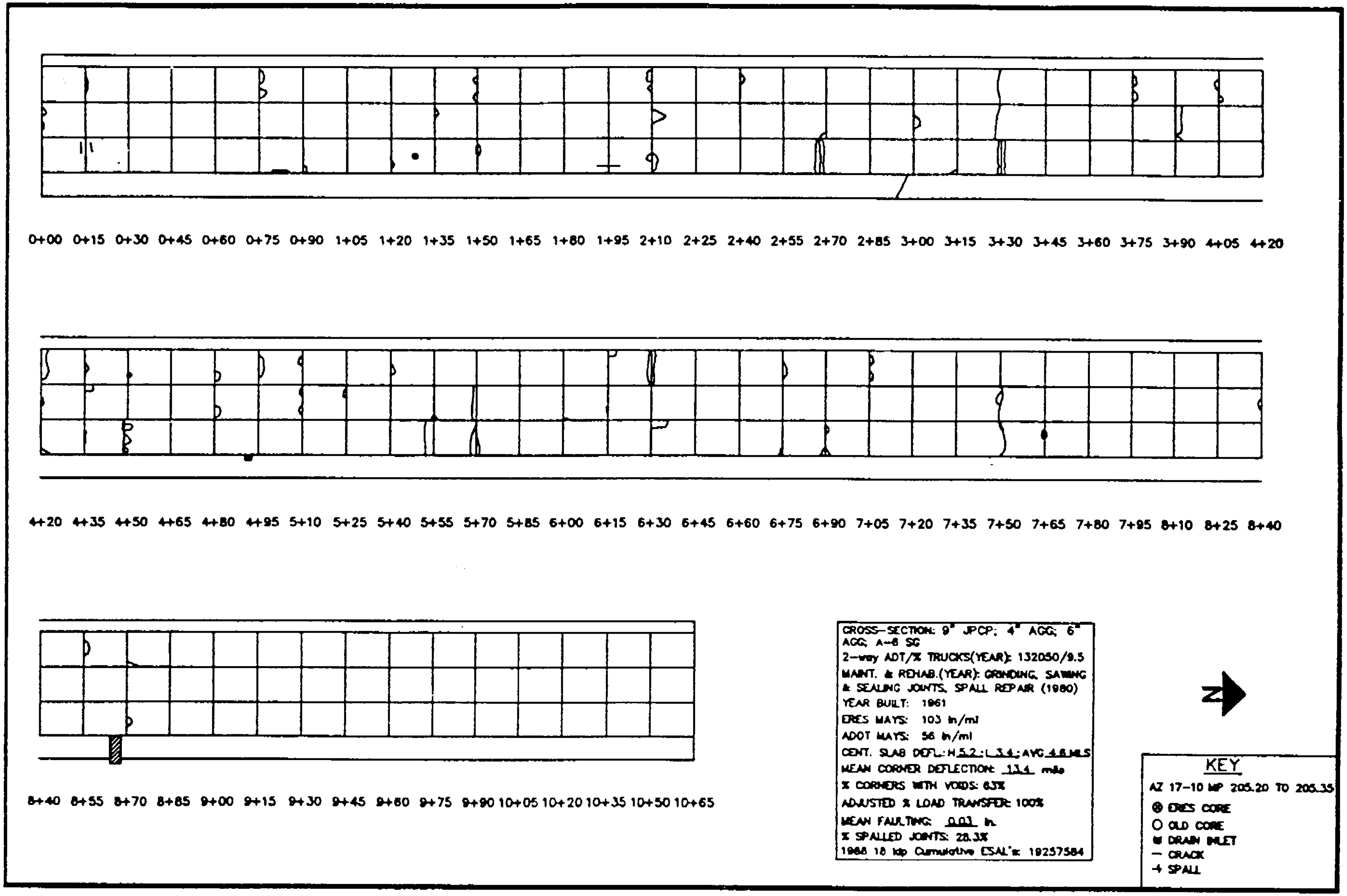



Figure B-27. Project strip map for AZ 17-10.

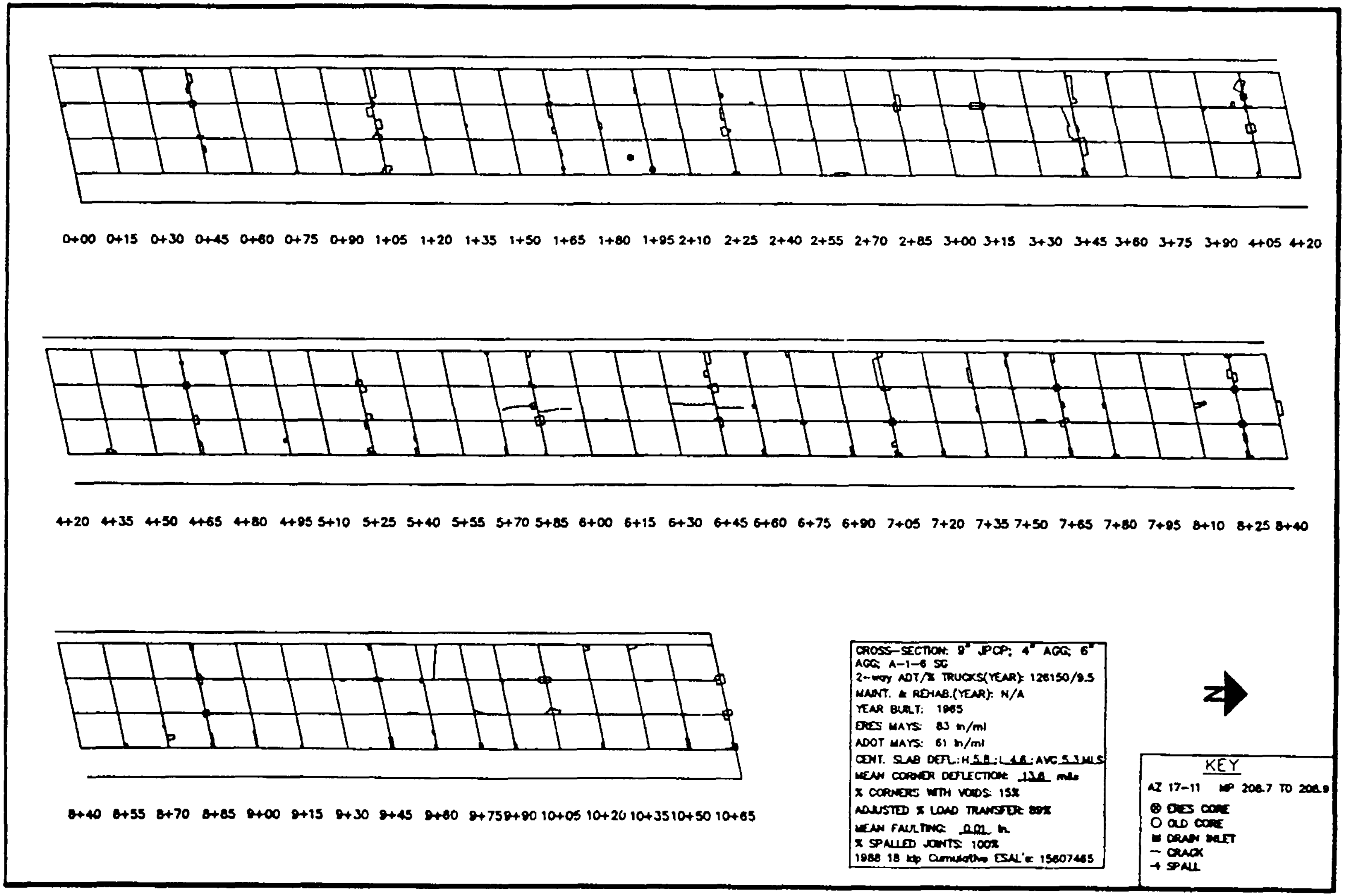



Figure B-28. Project strip map for AZ 17-11.

# APPENDIX C

# DATA BASE USERS MANUAL

# APPENDIX C DATA BASE USERS MANUAL

## 1. INTRODUCTION

A comprehensive data base has been created that contains pavement design and construction data, climatic information, traffic data, and condition data for over 48 pavement sections. The data base includes projects from jointed concrete pavements (40 sections), prestressed concrete pavements (4 sections), continuously reinforced concrete pavements (2 sections), and 3-layer structural rehabilitation pavements (2 sections).

The data base used was the UNIFY Relational Data Base System. The system resides on an IBM PC-AT with 640K RAM and a 30-Mb hard disk. The project data base, termed the ADOT data base, occupies approximately 8-Mb of hard disk space.

## 2. DATA BASE SET-UP

Note that the UNIFY system must be properly installed and the path must include the UNIFY BIN directory before using UNIFY. The following describes the procedure to set up the ADOT data base from diskettes provided by ERES.

For this discussion, all references to words or letters in quotes (such as "adot" or "P") indicate that those words or letters should be typed in. The references to <RETURN> or <ENTER> indicate that the return or enter key is to be hit. Symbols such as <^U>, <^X>, and so on, indicate that while the Control key is depressed, the U or X key is hit.

While the directory names to be entered are arbitrary, the following terms were assigned:

1. ***Monitor Data Base.*** The monitoring data is expected to reside in the directory ADOT\DBASE\DBMON. This directory must first be created by typing "md" and then the directory title. Once this directory has been created, enter the directory by typing "cd\adot\dbase\dbmon", and insert the *Monitor Data Base Disk* #1 in drive "A". Type the command SPLICE A: [destination filename] - e.g. C:\ADOT\DBASE\DBMON. After disk #1 has been copied to the hard drive, the user will be prompted to enter disk #2, and then disk #3. This will copy the rest of file MON.EXE, onto the hard drive. Execute the files by typing the file name. Once the files have been loaded into the directory, erase the .EXE file from the directory.

2. *Inventory Data Base.* The inventory data is expected to reside in the directory ADOT\DBASE\DBINVEN. As before, this directory must first be created by typing "md\adot\dbase\dbinven" and then the directory title. Once this directory has been created, enter the directory by typing "cd\adot\dbase\dbinven", and insert the *Inventory Data Base Disk* in drive A:. To load this data, copy the INV.EXE files into the ADOT\DBASE\DBINVEN directory; then execute the files by typing the file name. Once the files have been loaded into the directory, erase the .EXE file from the directory.

This procedure will install both data bases onto the hard disk. To use either data base, simply enter the appropriate directory and type "unify".

There are two directories (Monitor and Inventory) set up for this complete data base. To enter these directories from the main drive enter the following information:

"CD\ADOT\DBASE\DBMON"
"CD\ADOT\DBASE\DBINVEN"

Once this information is typed in, the user needs to enter "UNIFY" to enter the data base directory.

The *Monitor Data Base* (DBMON) contains screens for all Monitoring and Traffic Data. The *Inventory Data Base* (DBINVEN) contains screens for all Inventory, Maintenance, Environmental, and Rehabilitation Data.

The first menu screen to come up in each of these data bases is the screen in figure C-1. This is the UNIFY Main Menu. Before any data can be entered, the word "adot" must be typed in by the SELECTION command. The command "adot" must be typed in lower case letters, as the UNIFY system in case sensitive. This is true for both directories.

Failure to type in "adot" at the SELECTION prompt and directly entering any of the categories on the UNIFY Main Menu will enter the user into the programming menus for the data base. If this is inadvertently done, <^U> will return the user to the chosen menu. <F3> will then return the user to the Main Menu where "adot" can then be typed in to enter the menus for data entry.

The following figures show the layout of the menus and sub-menus for each Directory. Figures C-2a to C-2h are *Inventory Data Base Screens* and figures C-3a to C-3h are *Monitoring Data Base Screens.*

For selection of a sub-menu, the <RETURN> key can be used to toggle down to the desired sub-menu. Then the sub-menu is selected by hitting the <F1> key. The number designating the sub-menu can also be typed in, followed by the <RETURN> key.

A listing and description of the function and input keys is provided in the Function and Input Keys section.

```
[mainmenu]                 UNIFY Release 3.2          2 MAY 1990 - 12:42
                            UNIFY Main Menu

              1. Design and Create a New Data Base
              2. Create or Modify Screen Forms
              3. SQL - Query/DML Language
              4. Edit SQL or RPT Command Files
              5. Add, Modify or Delete Menus
              6. Data Base Design Utilities
              7. System Administration

SELECTION: adot
F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-1. UNIFY Main Menu.

```
[adot]                    UNIFY Release 3.2              2 MAY 1990 - 02:57
                     ADOT Inventory Data - Main Menu

              1. ADOT Required Information

              2. ADOT Inventory Data

              3. ADOT Maintenance Data

              4. ADOT Environmental Data

              5. ADOT Error Checking Routines

              6. ADOT Data Listing Procedure

              7. ADOT Rehabilitation Information

 SELECTION:

F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-2a. ADOT Inventory Data - Main Menu.

```
[reqinfo]                  UNIFY Release 3.2           2 MAY 1990 - 02:57
                        ADOT Required Information

                1. ERES Identification

                2. State Identification

                3. ADOT Inventory Data

                4. ADOT Maintenance Data

                5. ADOT Environmental Data

                6. ADOT Data Sheet Comments

 SELECTION:

F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-2b. ADOT Required Information.

```
[inv]                         UNIFY Release 3.2               2 MAY 1990 - 02:57
                             ADOT Inventory Data

 1. Inventory Data - Sheets 1 & 2      10. Inventory Data - Sheet 11
 2. Inventory Data - Sheet 3           11. Inventory Data - Sheet 12
 3. Inventory Data - Sheet 4           12. Inventory Data - Sheet 13
 4. Inventory Data - Sheet 5           13. Inventory Data - Sheet 14
 5. Inventory Data - Sheet 6           14. Inventory Data - Sheet 15
 6. Inventory Data - Sheet 7           15. Inventory Data - Sheet 16
 7. Inventory Data - Sheet 8
 8. Inventory Data - Sheet 9
 9. Inventory Data - Sheet 10
 SELECTION:

F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-2c. ADOT Inventory Data.

```
[main]                    UNIFY Release 3.2             2 MAY 1990 - 02:58
                       ADOT Maintenance Data

                  1. Maintenance Data - Sheet 1

                  2. Maintenance Data - Sheet 2

SELECTION:
F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-2d. ADOT Maintenance Data.

```
[env]                    UNIFY Release 3.2              2 MAY 1990 - 02:58
                      ADOT Environmental Data

              1. Environmental Data - Sheet 1
              2. Environmental Data - Sheet 2
              3. Environmental Data - Sheet 3

SELECTION:
F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-2e. ADOT Environmental Data.

```
[errorchk]                UNIFY Release 3.2              2 MAY 1990 - 02:58
                     ADOT Error Checking Routines

                    1. Inventory Error Checking

                    2. Maintenance Error Checking

                    3. Envrionmental Error Checking

                    4. Rehabilitation Error Checking

 SELECTION:
F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-2f. ADOT Error Checking Routines.

[dumpdata] UNIFY Release 3.2 2 MAY 1990 - 02:58

ADOT Data Listing Procedure

ADOT Data Base Data Dump

Enter ERES ID you wish to print data for :

Accept entries [CTRL E], Clear field [CTRL Z], Exit [CTRL X]

Figure C-2g. ADOT Data Listing Procedure.

```
[rehab]                    UNIFY Release 3.2              2 MAY 1990 - 02:58
                    ADOT Rehabilitation Information

                1. 3-Layer System Data - Sheet 5a

 SELECTION:
F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-2h. ADOT Rehabilitation Information.

```
[reqinfo]                  UNIFY Release 3.2              2 MAY 1990 - 12:42
                      Required ADOT Data Base Information

                      1. ERES Identification

                      2. State Code Maintenance

                      3. ADOT Traffic Menu

                      4. ADOT Monitoring Data - Sheet 1

                      5. ADOT Monitoring Data - Sheets 2-11

                      6. Monitoring Data Comment Sheets

 SELECTION:
F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-3a. Required ADOT Data Base Information.

```
[adot]                     UNIFY Release 3.2            2 MAY 1990 - 12:42
                      ADOT Monitoring Data  - Main Menu

                   1. Required ADOT Data Base Information

                   2. ADOT Monitoring Data - Sheet 1

                   3. ADOT Monitoring Data - Sheets 2-11

                   4. ADOT Monitoring Data - Sheets 8a-13a

                   5. ADOT Traffic Menu

                   6. ADOT Monitor Error Checking

                   7. ADOT Report Generation

                   8. Redux and Repetative Data Entry

 SELECTION:

F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-3b. ADOT Monitoring Data - Main Menu.

```
[monitor]                    UNIFY Release 3.2           2 MAY 1990 - 12:42
                      ADOT Monitoring Data - Sheets 2-11

 1. Monitoring Data - Sheet 2 (req)    10. Monitoring Data - Sheet 7 (data)
 2. Monitoring Data - Sheet 2 (data)
 3. Monitoring Data - Sheet 3
 4. Monitoring Data - Sheet 4
 5. Monitoring Data - Sheet 5 (req)
 6. Monitoring Data - Sheet 5 (data)
 7. Monitoring Data - Sheet 6 (req)
 8. Monitoring Data - Sheet 6 (data)
 9. Monitoring Data - Sheet 7 (req)
 SELECTION:

F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-3c. ADOT Monitoring Data - Sheets 2-11.

```
[monitor3]                    UNIFY Release 3.2              2 MAY 1990 - 12:42
                    ADOT Monitoring Data - Sheets 8a-13a

                    1. Monitoring Data - Sheet 8a
                    2. Monitoring Data - Sheet 9a
                    3. Monitoring Data - Sheet 8b
                    4. Monitoring Data - Sheet 9b
                    5. Monitoring Data - Sheet 10a
                    6. Monitoring Data - Sheet 11a
                    7. Monitoring Data - Sheet 12a
                    8. Monitoring Data - Sheet 13a
SELECTION:
F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-3d. ADOT Monitoring Data - Sheets 8a-13a.

```
[traffic]                    UNIFY Release 3.2            2 MAY 1990 - 12:43
                             ADOT Traffic Menu

                 1. Traffic Data - Sheet 1

                 2. Traffic Data - Sheet 1 Additional

                 3. WIM Vehicle Class

                 4. Axle Load Distributions

 SELECTION:

F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-3e. ADOT Traffic Menu.

[monerror] UNIFY Release 3.2 2 MAY 1990 - 12:43

ADOT Monitor Error Checking

ADOT Data Base Error Checking

This routines checks for any data errors in the Monitoring Data relations.

Proceed ?

Figure C-3f. ADOT Monitor Error Checking.

```
[dumpmenu]                 UNIFY Release 3.2            2 MAY 1990 - 12:43
                          ADOT Report Generation

                   1. ADOT Data Listing Procedure

                   2. FWD Data

                   3. Vehicle Classification

                   4. WIM Data

                   5. Traffic Data

 SELECTION:
F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-3g. ADOT Report Generation.

```
[convert]                UNIFY Release 3.2           2 MAY 1990 - 12:43
                    Redux and Repetative Data Entry

               1. Convert Redux Data to Input Format

               2. Repetative Data Entry

 SELECTION:
F1-select ^U-up RET-down F2-home F3-previous F4-clear F5-exit F6-help /-more
```

Figure C-3h. Redux and Repetative Data Entry.

## 3. ADDING FILES

The initial information to be input into both directories (for all sections) should be the Required ADOT Data Base Information. This is the first selection on the Main Menu, then the first selection on the first sub-menu. This category is ERES Identification. This screen contains the ERES ID, state code, and project ID. All other input data is referenced from this information.

Every screen will come up first with the following prompt at the bottom of the screen: (I)nquire, (A)dd, (M)odify, (D)elete. Type in "A" and then hit <RETURN> to add data for an individual section.

After data is input, <^U> will save the screen and call up another blank screen for more data entry. If no more data input is needed, then <^U> will again call up the same (I), (A), (M), (D) prompts for any Inquiries, Additions, Modifications, or Deletions of data for that particular screen. Hitting <^U> again will send the user back to the previous menu. To add another screen of data, the user just needs to continue entering another section after the first <^U> has cleared the previous screen and saved the data.

The user should keep in mind that once a data input screen has been saved by hitting <^U>, any additional information that needs to be added to that screen in that particular file will have to be added in the (M)odify mode. If the user tries to add more data in that same file, the following message will appear at the bottom of the screen: *This record already exists.*

The user can continue to enter data as mentioned above for each of the sheets (screens) on each of the sub-menus. Once the user has entered all of the data in a particular sub-menu, the user can then hit the <F3> key to go back to the previous main menu and toggle through the sub-menus until all data has been entered for all menus and sub-menus.

While in the *Monitoring* or *Inventory Data Bases,* the following sheets of distress information have to be entered in a special way:

- Monitoring Data sheets 5 (data), 6 (data), 7 (data)
- Traffic Data sheet 1a
- Traffic Data sheet 1b
- Inventory Data sheet 8

These sheets contain repetitive data that has to be input with only one line of data per screen in the following manner:

1. Enter ERES ID.
2. Enter lane number (if applicable).
3. Enter first line of information on sheet.
4. <^U> to save screen and call up blank screen.
5. Repeat steps 1 and 2.
6. Enter second line of information on sheet.
7. <^U> to save this screen and call up blank screen.
8. Continue this process for every line of data.

All data for all screens in both directories can be entered by following the instructions described above.

An alternate means of entering data for monitoring sheets 5, 6, and 7 is through the use of the Repetitive Data Entry Program listed in the "adot" sub-menu. Before entering any data through this program, the required data for sheets 5, 6, and 7 must be entered first. This is accomplished by going to the "adot" sub-menu and entering REDUX and Repetitive Data Entry. In this menu, enter the Repetitive Data Entry function and choose the number which corresponds to the data sheet that is being entered. Enter the data in the following way:

1. Enter ERES ID.
2. Enter Date of Survey.
3. Enter Lane Number.
4. Enter rest of required data on screen.
5. <^U> to save this screen.

After step 5, the ERES ID, data of survey and lane number will remain the same and does not have to be input again until the ERES ID, date of survey, or lane number changes.

When all of the data is input for a specific ID, date, or lane, entering a zero (0) in the fourth line down will send the user back to the Repetitive Date Entry Menu. The user can then choose another data sheet for input or type <E> to exit program.

The first selection of the Repetitive Data Entry menu, *Convert REDUX Data to Input Format,* was specifically designed for the input of ERES' reduced FWD data and this program is only applicable for use with FWD data that ERES has reduced.

## 4. MODIFYING FILES

To modify any screen, go through the menu to the screen that needs modification. Type "M" then <RETURN>. The user can hit <^E>, which will call up all input files. The user can then scan every file to find the necessary file(s) for modification. If the user chooses to scan all files in this manner, after <^E> is hit the following prompt will come up on the bottom of the screen: (N)ew, (P)revious, (S)top. By entering "N" then <RETURN>, the next file in the program will be called up to the screen. By entering "P" then <RETURN>, the program will call up the previous file to the screen. Entering "S" then <RETURN> will stop the Modification process and return the user to the prompt: (I)nquire, (A)dd, (M)odify, (D)elete. All files can also be scanned in this mode by hitting the <RETURN> key. Doing this will advance the screens of input one at a time in the same manner as hitting "N". The user can also just type in the name of file (ERES ID) to be modified. This hit <RETURN> and <^E> for the program to search for that particular file.

Data can then be modified by toggling with the <RETURN> key to the correct data entry point. After modification, <^U> will save the modified screen and allow for additional search of data input with the prompt <^E> for additional search. Hitting <^X> will exit to the menu. <^U> can also be hit to exit back to the (I), (A), (M), (D) prompt, then <^U ^U> to go back to the previous menu.

An alternative method for scanning particular files can be done in the following ways:

1. "*" <^E> - Calls up all files.
2. "AZ*" <^E> - Calls up all files with the first letters of the ERES ID beginning "AZ".
3. "AZ 1-*" <^E> - Calls up all files with the ERES ID beginning "AZ 1-".
4. "AZ 1-1" <^E> - Calls up the file AZ 1-1.
5. Any field on any record can be searched by entering either "*", text values, or numerical values in that field followed by <^E>. All entries that match the user's query will be called up to the screen.

## 5. DELETING FILES

To delete any complete screen or any portion of a screen, go through the menu to the screen that has the file to delete. When the prompt (I)nquire, (A)dd, (M)odify, (D)elete comes up, type in "D" and <RETURN>. The prompt ^E, ^Z, ^X will appear at the bottom of the screen. By entering <^E>, the program will begin searching all files. The user can also type in the ID of the section desired to be deleted. Then, by entering <^E>, that particular section will be brought up on the screen for complete or partial deletion.

Once the file is identified, the prompt (N)ew, (P)revious, (D)elete, (S)top comes up at the bottom of the screen. The (N), (P), and (S) commands will function the same as stated before in the instructions for Modifying Files. By hitting "D" and <RETURN>, that entire screen of input data will be deleted. If only a portion of the data needs to be deleted, the user can toggle the cursor down the screen by hitting <RETURN> and then by hitting <^Z> or <F4>. If only a part of the file is deleted, the Modification Program can be used to re-enter the new data for the file. The user can return to the menu in the same manner as mentioned before in the section on Modifying Files.

*Note:* If deleting only a reference file that has no data input into it, the prompt -Delete?- will come up at the bottom of the screen. Replying with the response "Y" and then <RETURN> will delete the reference file. Replying with an "N" and then <RETURN> will cancel the (D) command for that file.

## 6. INQUIRING INTO FILES

The Inquire command allows the user to view any or all files of data for any screen that has information input into it.

While in the Inquire mode, the user can search all files by hitting <^E> and then toggling through using the <RETURN> key or by using the (N)ew, or (P)revious commands. Typing "S" and then the <RETURN> key will send the user back to the ^E, ^Z, or ^X mode. These commands in this mode perform the same as in the Modify or Delete mode. The user also has the option to search for a particular file by typing in that file name, then <^E> for the program to search for that file.

## 7. ERROR CHECKING

The error checking routine checks for values that are either out of range or invalid. To utilize this command, go to "ADOT Error Checking Routines" on either directory Main Menu. Whereas in the *Monitoring Data Base,* all categories of screens are checked together with one command. In the *Inventory Data Base,* there are four separate categories of screens for error checking: Inventory, Maintenance, Environmental, and Rehabilitation. In the *Inventory Data Base,* go to the desired category for error checking. The screen will indicate that this routine will check for any data errors in the category the user has chosen. Type in "Y" to proceed with the error checking, or "N" to return to the previous menu. In the *Monitoring Data Base,* the program will automatically check all categories for errors.

Regardless of which data base the user is in, this Error Checking Routine will check for <u>all</u> errors in <u>all</u> files that have been input. There is no way of singling out a single file or screen for error checking.

The next screen that comes up for this routine will be Method of Output for Error Checking. Enter report "1", then toggle using the <RETURN> key to the method of output you have chosen: SCREEN, PRINT, or FILE. Type an "X" in the appropriate blank. Toggle the <RETURN> key back to SCREEN and hit <^U>. The prompt (F)oreground, (D)ebug, (Cancel) will then come up at the bottom of the screen. Type in "F" and <RETURN> to proceed with the chosen method of output.

The program will run internally first, then continue with output. By typing "C" and <RETURN>, this program will be canceled and the user returned to the previous menu.

After data has been output, <^U> can be hit until the user is back at the previous menu.

## 8. DATA LISTING

The data listing command provides a report of all data for a section or sections that are specified by the user. To utilize this command, go to "ADOT Data Listing Procedure" in the *Inventory Data Base* and "Report Generation" in the *Monitoring Data Base*. In the *Inventory Data Base,* all of the data that has been input will be given in the method of output chosen by the operator.

In the *Monitoring Data Base,* the user has the option of listing the FWD data, vehicle classification data, weigh-in-motion (WIM) data, historical traffic data, or all other monitored data. The exact ID file name can be input after the prompt, or a certain category of sections can be entered. For example: "CA*" <^E> would search and list all data in all of the sections with "CA" as the beginning letters for the ERES ID, whereas "CA 1-1" <^E>, which is an exact section ID, would search and list all data for this particular section. By entering "*" <^E>, the program will search for all data entries and will list all entries.

The Method of Output for Data Listing Procedure and Report Generation is the same as described above in the method for Error Checking Routines.

## 9. ADDITIONAL NOTES

- A default value of -99 was selected to indicate that a specific field of information on the screens was either unavailable or not applicable to a particular section.

- A "Comments Sheet" has been added to both directories for the input of any additional information that is not required to be input anywhere else in the data bases. This information consists of any information gathered in the field surveys or through research that is unique to the section or may be useful in the analysis of that section.

- When adding data to the individual screens in either directory, the ERES ID is the first information to be entered. This gives the program a reference under which to save the files. If the correct ID is not entered to each individual screen, a message will appear at the bottom of the screen: *"Reference not Found."* The cursor will then return to the first line of the screen for the correct ID to be entered. Remember that the UNIFY System is upper and lower case type sensitive. If the ERES Identification was originally entered in upper case, it must continue to be entered that way.

- The location codes for FWD testing are as follows:

  Code 0 - Wheelpath
  Code 1 - Midslab
  Code 2 - Same slab as Code 1, but adjacent joint at outside corner
  Code 3 - Next slab, but adjacent to same joint

  If sensor "-1" is perpendicular to the other sensors, the prefix 1 is used with the above codes, i.e. 11, 12, 13.

  Code 4 - Sensor $D_0$ load in wheelpath at approach to crack (prestressed).
  Code 22 - Sensor $D_0$ load in wheelpath at approach to anchor joint (prestressed).
  Code 23 - Sensor $D_0$ load in wheelpath on opposite side of approach to anchor joint (prestressed).
  Code 32 - Sensor $D_0$ load on corner at approach to anchor joint (prestressed).
  Code 33 - Sensor $D_0$ load on corner on opposite side of approach to anchor joint (prestressed).
  Code 42 - Sensor $D_0$ load in center of slab at approach to crack (CRCP).
  Code 43 - Sensor $D_0$ load in center of slab on opposite side of approach to crack (CRCP).

- Traffic sheets 2 and 3 - 9 are the monitored vehicle classification and weigh-in-motion data. Because of the substantial amount of information for this record, the following section ID's were used and these ID's reflect project wide information:

  <u>AZI10EB</u> - AZI10-01, AZI10-02, AZI10-05, AZ 2

  <u>AZI10WB</u> - AZI10-03, AZI10-04, AZI10-06, AZI10-07

  <u>AZI17NB</u> - AZI17-01, AZI17-02, AZI17-03, AZI17-04, AZI17-05, AZI17-06, AZI17-07, AZI17-09, AZI17-10, AZI17-11

  <u>AZ360</u> - AZ360-01, AZ360-02, AZ360-03, AZ360-04. AZ360-05, AZ360-06, AZ360-07, AZ360-08, AZ360-09, AZ36010A,

AZ36010B, AZ 1-1, AZ 1-2, AZ 1-4, AZ 1-5, AZ 1-6, AZ 1-7

There were no WIM studies done for any of the California sections.

On each of these screens there is always one more axle load than axle spacings. Load 1 and 2 correspond with spacing 1; load 2 and 3 correspond with spacing 2; and so on.

```
  |               |               |
  |    Spacing    |    Spacing    |
  |       1       |       2       |
  |               |               |
Load 1          Load 2          Load 3
```

- On sheet 9 in the *Inventory Data Base,* the field for dowel spacing is coded as a string of XX characters so that numbers (e.g., 6, 18, 30, etc.) as well as letters (e.g., No Dowels) could be listed.

- The table and figure numbers of standard codes correspond directly with table and figure numbers referred to on data sheets. These table and figure numbers are in no way referenced to any other table or figure than those that appear in appendix C.

## 10. SUPPLEMENTARY INFORMATION

Following is supplementary information provided in support of this users manual. The "Tables and Figures of Standards Codes" section provides tables and figures listing all standard codes contained in the data base. These standard codes are taken directly from the original Strategic Highway Research Program (SHRP) <u>Data Collection Guide for Long Term Pavement Performance Studies</u>, and, therefore, have table and figure references that do not follow the sequence used in this report. The "Function and Input Keys" section provides a description of the functional input keys for manipulation of the data base. The "FHWA Vehicle Classifications with Definitions" section lists standard FHWA vehicle classifications with definitions of each class. The "Data Sheets" section contains the data sheets for all pavement sections. The following sub-sections of data sheets are attached: Inventory Data Sheets, Traffic Data Sheets, Maintenance Data Sheets, Monitored Data Sheets, Environmental Data Sheets, General Comments Sheets, Prestressed Pavements Data Sheets, Continuously Reinforced Pavements Data Sheets, 3-Layer System Data Sheets, and Rehabilitation Data Sheets.

# TABLES AND FIGURES

# OF

# STANDARD CODES

Table A.1 Table of Standard Codes for States, District of Columbia, Puerto Rico, American Protectorates and Canadian Provinces.

| State | Code | State | Code |
|---|---|---|---|
| Alabama | 01 | New York | 36 |
| Alaska | 02 | North Carolina | 37 |
| Arizona | 04 | North Dakota | 38 |
| Arkansas | 05 | Ohio | 39 |
| California | 06 | Oklahoma | 40 |
| Colorado | 08 | Oregon | 41 |
| Connecticut | 09 | Pennsylvania | 42 |
| Delaware | 10 | Rhode Island | 44 |
| District of Columbia | 11 | South Carolina | 45 |
| Florida | 12 | South Dakota | 46 |
| Georgia | 13 | Tennessee | 47 |
| Hawaii | 15 | Texas | 48 |
| Idaho | 16 | Utah | 49 |
| Illinois | 17 | Vermont | 50 |
| Indiana | 18 | Virginia | 51 |
| Iowa | 19 | Washington | 53 |
| Kansas | 20 | West Virginia | 54 |
| Kentucky | 21 | Wisconsin | 55 |
| Louisiana | 22 | Wyoming | 56 |
| Maine | 23 | American Samoa | 60 |
| Maryland | 24 | Guam | 66 |
| Massachusetts | 25 | Puerto Rico | 72 |
| Michigan | 26 | Virgin Islands | 78 |
| Minnesota | 27 | Alberta | 81 |
| Mississippi | 28 | British Columbia | 82 |
| Missouri | 29 | Manitoba | 83 |
| Montana | 30 | New Brunswick | 84 |
| Nebraska | 31 | Newfoundland | 85 |
| Nevada | 32 | Nova Scotia | 86 |
| New Hampshire | 33 | Ontario | 87 |
| New Jersey | 34 | Prince Edward Island | 88 |
| New Mexico | 35 | Quebec | 89 |
| | | Saskatchewan | 90 |

Note: The U.S. codes are consistent with the Federal Information Processing Standards (FIPS) and HPMS.

Table A.2 Functional Class Codes.

| Functional Class | Code |
|---|---|
| Rural: | |
| Principal Arterial- Interstate | 01 |
| Principal Arterial - Other | 02 |
| Minor Arterial | 06 |
| Major Collector | 07 |
| Minor Collector | 08 |
| Local Collector | 09 |
| Urban: | |
| Principal Arterial - Interstate | 11 |
| Principal Arterial - Other Freeways or Expressways | 12 |
| Other Principal Arterial | 14 |
| Minor Arterial | 16 |
| Collector | 17 |
| Local | 19 |

Note: These codes are consistent with the HPMS system.

Table A.4 Pavement Type Codes.

| Type of Pavement | Code |
| --- | --- |
| Flexible Pavements: | |
| Asphalt Concrete With Granular Base | 01 |
| Asphalt Concrete With Stabilized Base | 02 |
| Asphalt Concrete Pavement With Asphalt Concrete Overlay | 03 |
| Asphalt Concrete Pavement With JPCP Overlay | 04 |
| Asphalt Concrete Pavement With JRCP Overlay | 05 |
| Asphalt Concrete Pavement With CRCP Overlay | 06 |
| Rigid Pavements: | |
| JPCP - Original Construction | 11 |
| JRCP - Original Construction | 12 |
| CRCP - Original Construction | 13 |
| JPCP With Asphalt Concrete Overlay | 14 |
| JRCP With Asphalt Concrete Overlay | 15 |
| CRCP With Asphalt Concrete Overlay | 16 |
| JPCP With JPCP Overlay | 17 |
| JPCP With JRCP Overlay | 18 |
| JRCP With JPCP Overlay | 19 |
| JRCP With JRCP Overlay | 20 |
| CRCP With JPCP Overlay | 21 |
| CRCP With JRCP Overlay | 22 |
| CRCP With CRCP Overlay | 23 |
| JPCP With CRCP Overlay | 24 |
| JRCP With CRCP Overlay | 25 |
| Prestressed Concrete | 52 |
| Composite Pavements (Overlay Included in Initial Construction): | |
| CRCP With Asphalt Concrete Overlay | 31 |
| CRCP Over Asphalt Concrete Base | 32 |
| JPCP Over Asphalt Concrete Base | 33 |
| JRCP Over Asphalt Concrete Base | 34 |
| CRCP Over Lean Concrete Base | 35 |
| JPCP Over Lean Concrete Base | 36 |
| JRCP Over Lean Concrete Base | 37 |

Definitions:

JPCP - Jointed Plain Concrete Pavement
JRCP - Jointed Reinforced Concrete Pavement
CRCP - Continuously Reinforced Concrete Pavement
Flexible Pavement - Asphalt Concrete Pavement
Rigid Pavement - Portland Cement Concrete Pavement

Table A.5 Pavement Surface Material Type Codes.

| Material Type | Code |
|---|---|
| Asphalt Concrete, Dense Graded | 01 |
| Asphalt Concrete, Open Graded (Porous Friction Course) | 02 |
| Sand Asphalt. | 03 |
| Portland Cement Concrete (JPCP) | 04 |
| Portland Cement Concrete (JRCP) | 05 |
| Portland Cement Concrete (CRCP) | 06 |
| Portland Cement Concrete (Prestressed) | 07 |
| Portland Cement Concrete (Fibrous) | 08 |
| Plant Mix Material (Emulsified Asphalt), Cold Laid | 09 |
| Plant Mix Material (Cutback Asphalt), Cold Laid | 10 |
| Single Surface Treatment | 11 |
| Double Surface Treatment | 12 |
| Recycled Asphalt Concrete | |
| Hot, Central Plant Mix | 13 |
| Cold Laid, Central Plant Mix | 14 |
| Cold Laid, Mix-In-Place | 15 |
| Heater Scarification/Recompaction | 16 |
| Recycled Portland Cement Concrete | |
| JPCP. | 17 |
| JRCP. | 18 |
| CRCP. | 19 |

Table A.6 Base and Subbase Material Type Codes.

| | Code |
|---|---|
| No Base (Pavement Placed Directly on Subgrade) | 21 |
| Gravel (Uncrushed) | 22 |
| Crushed Stone, Gravel, or Slag | 23 |
| Sand. | 24 |
| Soil/Aggregate Mixture (Predominantly Fine-Grained Soil) | 25 |
| Soil/Aggregate Mixture (Predominantly Course-Grained Soil) | 26 |
| Soil Cement (Cement Treated Sand) | 27 |
| Asphalt Bound Base or Subbase Materials | |
| Dense Graded, Hot Laid, Central Plant Mix | 28 |
| Dense Graded, Cold Laid, Central Plant Mix | 29 |
| Dense Graded, Cold Laid, Mixed-In-Place | 30 |
| Open Graded, Hot Laid, Central Plant Mix | 31 |
| Open Graded, Cold Laid, Central Plant Mix | 32 |
| Open Graded, Cold Laid, Mixed-In-Place | 33 |
| Recycled Asphalt Concrete, Plant Mix, Hot Laid | 34 |
| Recycled Asphalt Concrete, Plant MIx, Cold Laid | 35 |
| Recycled Asphalt Concrete, Mixed-In-Place | 36 |
| Cement-Aggregate Mixture (Gravel and Crushed Stone) | 37 |
| Lean Concrete Mixture | 38 |
| Recycled Concrete Mixture | 39 |
| Sand-Shell Mixture | 40 |
| Limerock | 41 |
| Lime-Treated Subgrade Soil | 42 |
| Cement-Treated Subgrade Soil | 43 |
| Pozzolanic-Aggregate Mixture | 44 |
| Cracked and Seated PCC Layer | 45 |
| Open Graded Aggregate Layer | 46 |
| Other | 49 |

Table A.7 Subgrade Soil Description Codes.

| Soil Description | Code |
| --- | --- |
| **Fine-Grained Subgrade Soils:** | |
| Clay (Liquid Limit >50) | 51 |
| Sandy Clay | 52 |
| Silty Clay | 53 |
| Silt | 54 |
| Sandy Silt | 55 |
| Clayey Silt | 56 |
| **Coarse-Grained Subgrade Soils:** | |
| Sand | 57 |
| Poorly Graded Sand | 58 |
| Silty Sand | 59 |
| Clayey Sand | 60 |
| Gravel | 61 |
| Poorly Graded Gravel | 62 |
| Clayey Gravel | 63 |
| Shale | 64 |
| Rock | 65 |

Table A.8 Material Type Codes for Thin Seals and Interlayers.

| | Code |
|---|---|
| Chip Seal Coat | 71 |
| Slurry Seal Coat | 72 |
| Fog Seal Coat | 73 |
| Woven Fabric | 74 |
| Nonwoven Fabric | 75 |
| Stress Absorbing Membrane Interlayer | 77 |
| Thin Asphalt Concrete Interlayer | 78 |
| Gravel Interlayer | 79 |
| Open-Graded Asphalt Interlayer | 80 |
| Chip Seal with Special Binder | 81 |
| Sand Seal | 82 |
| Asphalt Rubber | 83 |
| Sand Asphalt | 84 |

Table A.10 Soil Type Codes, AASHTO Soil Classification.

| | Code |
|---|---|
| A-1-a | 01 |
| A-1-b | 02 |
| A-3 | 03 |
| A-2-4 | 04 |
| A-2-5 | 05 |
| A-2-6 | 06 |
| A-2-7 | 07 |
| A-4 | 08 |
| A-5 | 09 |
| A-6 | 10 |
| A-7-5 | 11 |
| A-7-6 | 12 |

Table A.11 Portland Cement Type Codes.

| | Code |
|---|---|
| Type I | 41 |
| Type II | 42 |
| Type III | 43 |
| Type VI | 44 |
| Type V | 45 |
| Type IS | 46 |
| Type ISA | 47 |
| Type IA | 48 |
| Type IIA | 49 |
| Type IIIA | 50 |
| Type IP | 51 |
| Type IPA | 52 |
| Type N | 53 |
| Type NA | 54 |
| Other | 55 |

Table A.16 Grades of Asphalt, Emulsified Asphalt, and Cutback Asphalt Codes.

| | Code |
|---|---|
| **Asphalt Cements** | |
| AC-2.5 | 01 |
| AC-5 | 02 |
| AC-10 | 03 |
| AC-20 | 04 |
| AC-30 | 05 |
| AC-40 | 06 |
| AR-1000 (AR-10 by AASHTO Designation) | 07 |
| AC-2000 (AR-20 by AASHTO Designation) | 08 |
| AC-4000 (AR-40 by AASHTO Designation) | 09 |
| AC-8000 (AR-80 by AASHTO Designation) | 10 |
| AC-16000 (AR-160 by AASHTO Designation) | 11 |
| 200-300 pen | 12 |
| 120-150 pen | 13 |
| 85-100 pen | 14 |
| 60-70 pen | 15 |
| 40-50 pen | 16 |
| **Emulsified Asphalts** | |
| RS-1 | 17 |
| RS-2 | 18 |
| MS-1 | 19 |
| MS-2 | 20 |
| MS-2h | 21 |
| HFMS-1 | 22 |
| HFMS-2 | 23 |
| HFMS-2h | 24 |
| HFMS-2s | 25 |
| SS-1 | 26 |
| SS-1h | 27 |
| CRS-1 | 28 |
| CRS-2 | 29 |
| CMS-2 | 30 |
| CMS-2h | 31 |
| CSS-1 | 32 |
| CSS-1h | 33 |

Table A.16 Grades of Asphalt, Emulsified Asphalt, and Cutback Asphalt Codes (Continued).

| | Code |
|---|---|
| **Cutback Asphalts (RC, MC, SC)** | |
| 30 (MC Only) | 34 |
| 70 | 35 |
| 250 | 36 |
| 800 | 37 |
| 3000 | 38 |

Taken from MS-5, "A Brief Introduction to Asphalt," and Specification Series No. 2 (SS-2), "Specifications for Paving and Industrial Asphalts," both publications by the Asphalt Institute.

Table A.17 Maintenance and Rehabilitation Work Type Codes.

| | Code |
|---|---|
| Crack Sealing (linear ft.) | 01 |
| Transverse Joint Sealing (linear ft.) | 02 |
| Lane/Shoulder Longitudinal Joint Sealing (linear ft.) | 03 |
| Full Depth Transverse Joint Repair Patch (sq. yds.) | 04 |
| Full Depth Patching of PCC PAvement Other Than at a Joint (sq. yds.) | 05 |
| Partial Depth Patching of PCC Pavement (sq. yds.) | 06 |
| PCC Slab Replacement (sq. yds.) | 07 |
| PCC Shoulder Restoration (sq. yds.) | 08 |
| PCC Shoulder Replacement (sq. yds.) | 09 |
| AC Shoulder Restoration (sq. yds.) | 10 |
| AC Shoulder Replacement (sq. yds.) | 11 |
| Grinding Surface (sq. yds.) | 12 |
| Grooving Surface (sq. yds.) | 13 |
| Pressure Grout Subsealing (no. of holes) | 14 |
| Slab Jacking Depressions (no. of depressions) | 15 |
| Asphalt Subsealing (no. of holes) | 16 |
| Spreading of Sand or Aggregate (sq. yds.) | 17 |
| Reconstruction (Removal and Replacement - sq. yds.) | 18 |
| Asphalt Concrete Overlay (sq. yds.) | 19 |
| Portland Cement Concrete Overlay (sq. yds.) | 20 |
| Mechanical Premix Patch (using motor grader and roller - sq. yds.) | 21 |
| Manual Premix Spot Patch (hand spreading and compacting with roller - sq. yds.) | 22 |
| Machine Premix Patch (placing premix with paver roller - sq. yds.) | 23 |
| Full Depth Patch of AC Pavement (removing damaged material, repairing supporting, material, repairing - sq. yds.) | 24 |
| Patch Pot Holes (hand spread and compacted with truck - no. of holes) | 25 |
| Skin Patching (hand tools/hot pour to apply liquid asphalt and aggregate - sq. yds.) | 26 |
| Strip Patching (using spreader and distributor to apply hot liquid asphalt and aggregate - sq. yds.) | 27 |
| Surface Treatment, Single Layer (sq. yds.) | 28 |
| Surface Treatment, Double Layer (sq. yds.) | 29 |
| Surface Treatment, Three or More Layers (sq. yds.) | 30 |

Table A.17 Maintenance and Rehabilitation Work Type Codes (Continued).

| | Code |
|---|---|
| Aggregate Seal Coat (sq. yds.) | 31 |
| Sand Seal Coat (sq. yds.) | 32 |
| Slurry Seal Coat (sq. yds.) | 33 |
| Fog Seal Coat (sq. yds.) | 34 |
| Prime Coat (sq. yds.) | 35 |
| Tack Coat (sq. yds.) | 36 |
| Dust Layering (sq. yds.) | 37 |
| Longitudinal Subdrains (linear ft.) | 38 |
| Transverse Subdrains (linear ft.) | 39 |
| Drainage Blankets (sq. yds.) | 40 |
| Well System | 41 |
| Drainage Blankets with Longitudinal Drains | 42 |
| Hot Mix Recycled Asphalt Concrete (sq. yds.) | 43 |
| Cold Mix Recycled Asphalt Concrete (sq. yds.) | 44 |
| Heater Scarification, Surface Recycled Asphalt Concrete (sq. yds.) | 45 |
| Crack and Seat PCC Pavement as a Base for New AC Surface (sq. yds.) | 46 |
| Crack and Seat PCC Pavement as a Base for New PCC Surface (sq. yds.) | 47 |
| Recycled Portland Cement Concrete (sq. yds.) | 48 |
| Pressure Relief Joints in PCC Pavements (linear ft.) | 49 |
| Joint Load Transfer Restoration in PCC Pavements (linear ft.) | 50 |
| Mill Off AC and Overlay with AC (sq. yds.) | 51 |
| Mill Off AC and Overlay with PCC (sq. yds.) | 52 |
| Other | 53 |

Table A.18 Location on Pavement Codes.

| | Code |
|---|---|
| Outside Lane (Number 1) | 01 |
| Inside Lane (Number 2) | 02 |
| Inside Lane (Number 3) | 03 |
| Shoulder | 04 |
| Curb and Gutter | 05 |
| Side Ditch | 06 |
| Culvert | 07 |
| Other | 08 |
| All Lanes, Both Directions | 09 |

Note: SHRP LTPP only studies outside lanes.

Table A.19 Maintenance Materials Type Codes.

| | Code |
|---|---|
| Preformed Joint Fillers | 01 |
| Hot Poured Joint and Crack Sealer | 02 |
| Cold Poured Joint and Crack Sealer | 03 |
| Open Graded Asphalt Concrete | 04 |
| Hot Mix Asphalt Concrete Laid Hot | 05 |
| Hot Mix Asphalt Concrete Laid Cold | 06 |
| Sand Asphalt | 07 |
| Portland Cement Concrete (Overlay or Replacement) | |
| Jointed Plain (JPCP) | 08 |
| Jointed Reinforced (JRCP) | 09 |
| Continuously Reinforced (CRCP) | 10 |
| Portland Cement Concrete (Patches) | 11 |
| Hot Liquid Asphalt and Aggregate (Seal Coat) | 12 |
| Hot Liquid Asphalt and Mineral Aggregate | 13 |
| Hot Liquid Asphalt and Sand | 14 |
| Emulsified Asphalt and Aggregate (Seal Coat) | 15 |
| Emulsified Asphalt and Mineral Aggregate | 16 |
| Emulsified Asphalt and Sand | 17 |
| Hot Liquid Asphalt | 18 |
| Emulsified Asphalt | 19 |
| Sand Cement (Using Portland Cement) | 20 |
| Lime Treated or Stabilized Materials | 21 |
| Cement Treated or Stabilized Materials | 22 |
| Cement Grout | 23 |
| Aggregate (Gravel, Crushed Stone, or Slag) | 24 |
| Sand | 25 |
| Mineral Dust | 26 |
| Mineral Filler | 27 |
| Other | 28 |

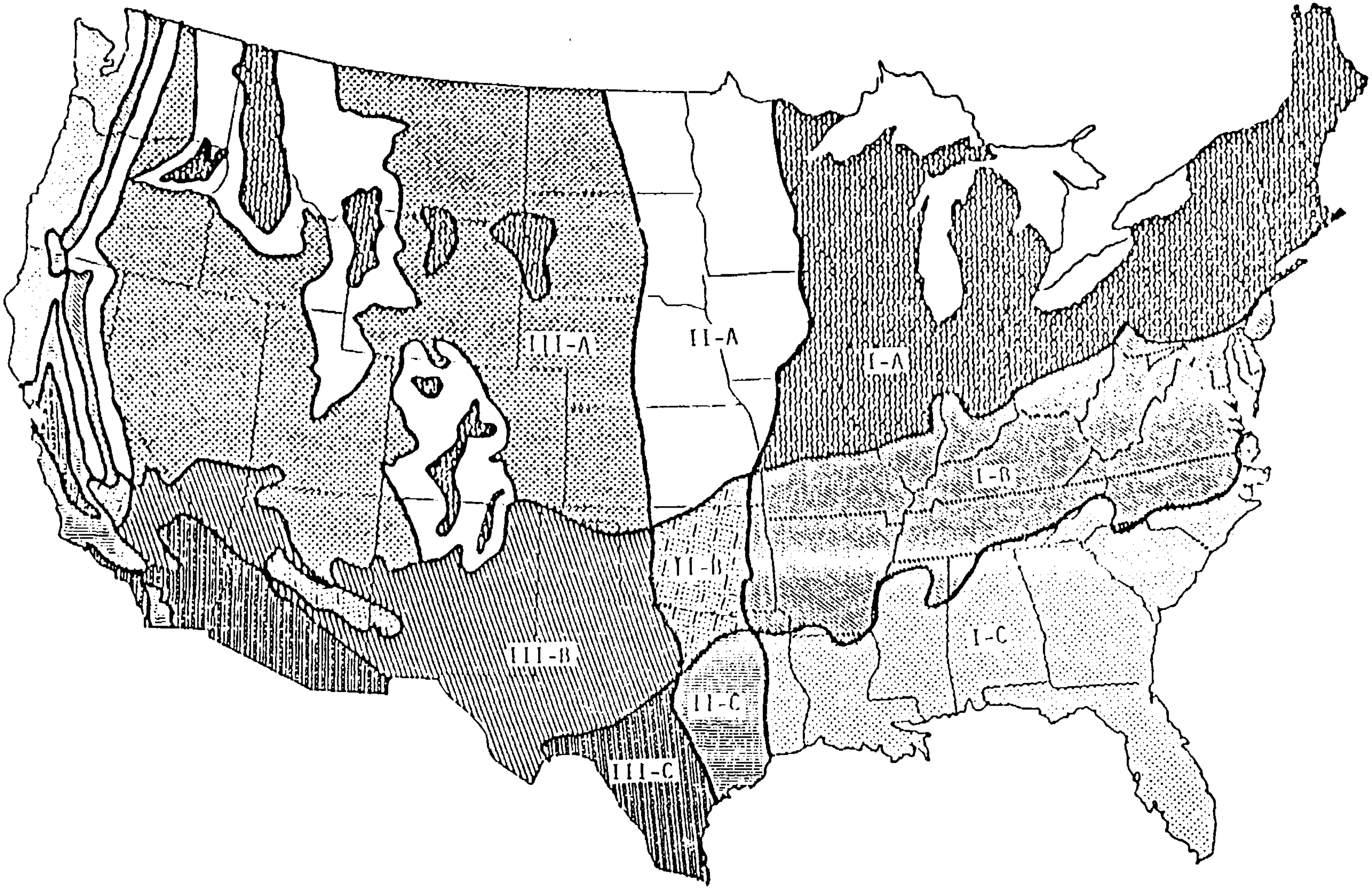



Figure C-4. Climatic zones for the United States.
(See following table for explanation of codes)

## CLIMATIC ZONES FOR THE UNITED STATES WITH CORRESPONDING PRRP DATA BASE CODES

| CLIMATIC ZONES | | PRRP ENVIRONMENTAL ZONES |
|---|---|---|
| I-A, | Wet-Freeze | Wet-Freeze (2) |
| I-B, | Wet-Freeze-Thaw | Wet-Freeze (2) |
| I-C, | Wet-No Freeze | Wet-No Freeze (1) |
| II-A, | Intermediate-Freeze | Dry-Freeze (4) |
| II-B, | Intermediate-Freeze-Thaw | Dry-Freeze (4) |
| II-C, | Intermediate-No Freeze | Dry-Freeze (4) |
| III-A, | Dry-Freeze | Dry-Freeze (4) |
| III-B, | Dry-Freeze-Thaw | Dry-Freeze (4) |
| III-C, | Dry-No Freeze | Dry-No Freeze (3) |

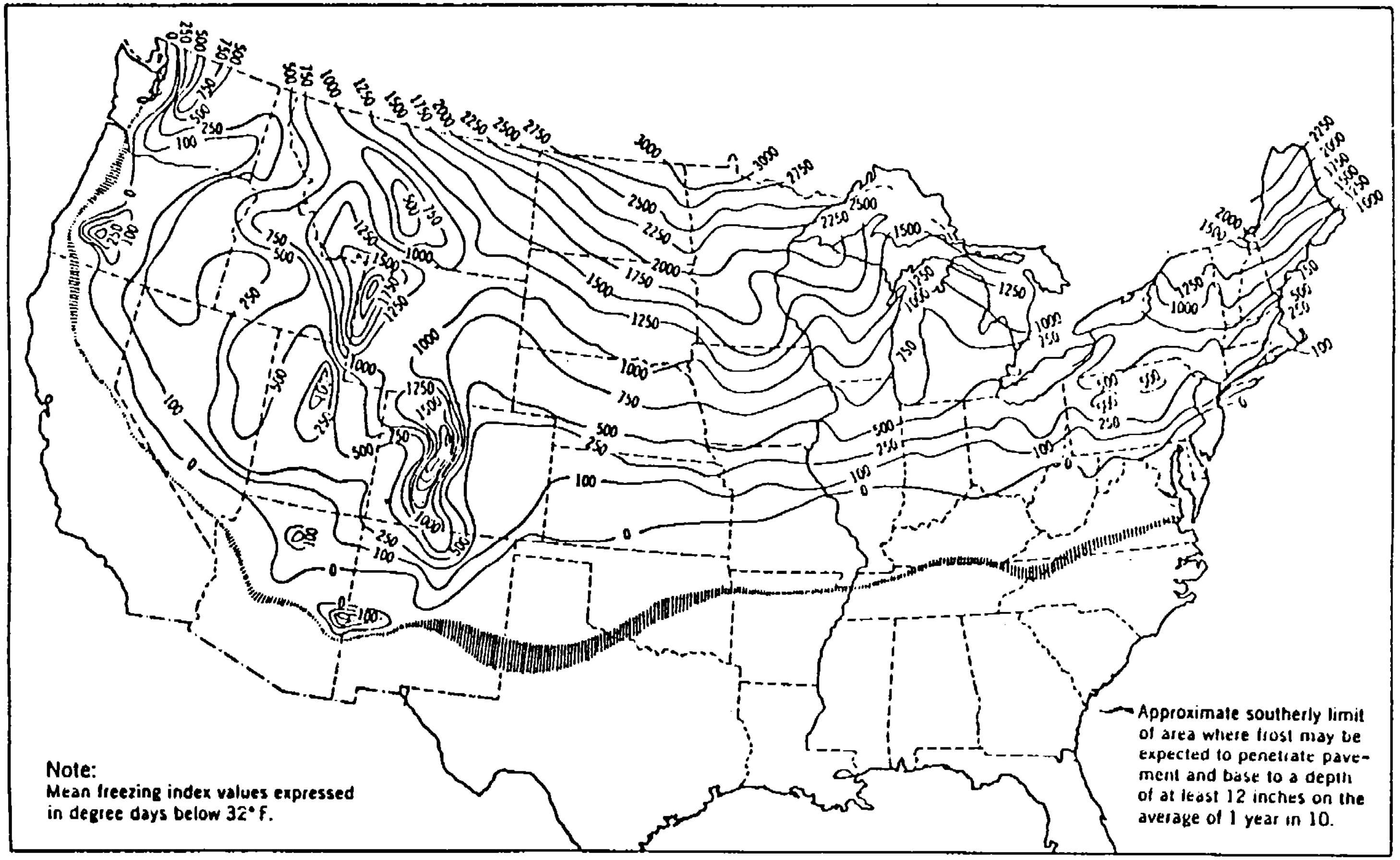



Figure C-5. Distribution of mean freezing-index values in the continental United States. (From Corps of Engineers EM 1110-345-306.)

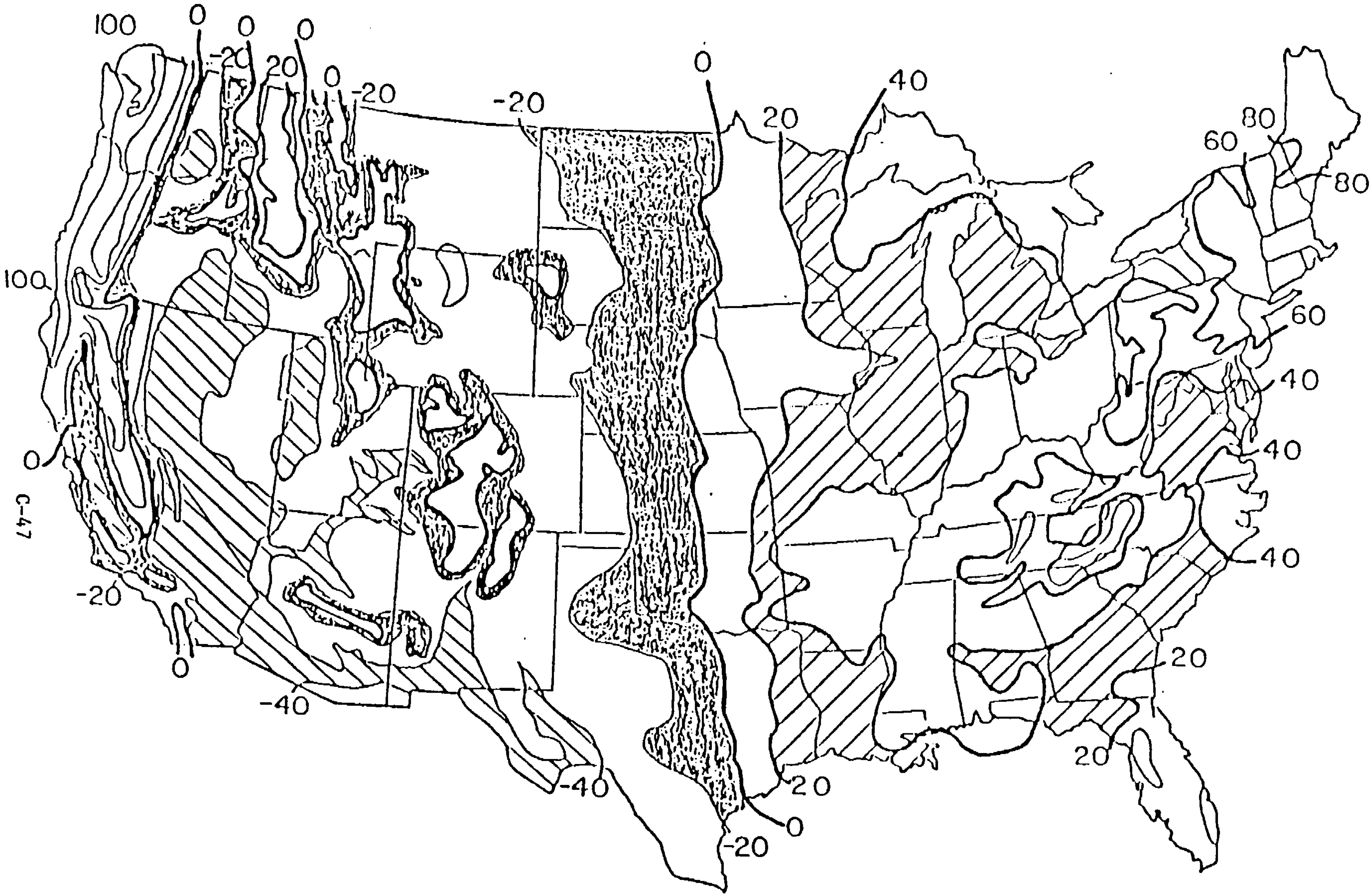



Figure C-6. Distribution of Thornthwaite Moisture Index in the United States (After Thornthwaite)

# FUNCTION AND INPUT KEYS

# FUNCTION AND INPUT KEYS

Following is a list of the various function and input keys for use with the data base:

F1 - Select
F2 - Home Menu
F3 - Previous Menu
F4 - Clears field or line cursor is on
F5 - Exit to DOS
F6 - Help key
F9 - Toggles Function Key Menu off and on

^U - While inputting data, this command will move the cursor up one line. After screen input is complete, <^U> will save the screen and then call up the same blank screen for more input. Hitting <^U> again will call up the (I)nquire, (A)dd, (M)odify, (D)elete menu at bottom of screen. Hitting <^U> again will send the user back to the menu. After data input, the cursor must be on the first line of data for user to be able to hit <^U> and save the screen.

^E - This command will search all records by hitting <^E>, or will search for a particular record if that record's ID is already input.

^X - While in any mode, this command will exit the user to the previous menu.

^Z - This command will clear the field that the cursor is on for deletion or modification.

I - Inquire - While in a data input screen, type in ID of section and this mode will bring that screen information up for viewing on the monitor. The user can also search all records for inquiry by hitting <^E>.

A - Add - This mode is used for initial input of all data to any screen.

M - Modify - This mode is used to modify data or add more data to a screen that already exists.

D - Delete - This mode can be used to delete entire screens of input data or can be used to delete specific lines of data by using the <F4> key or <^Z>.

While in (I)nquire, (M)odify, and (D)elete modes, and while searching all fields of data input for any screen, hitting either the <RETURN> key or "N" and <RETURN> will call up the next screen of input data, "P" and <RETURN> will toggle back to previous screen of input, and "S" then <RETURN> will stop the search and go back into ^E, ^Z, or ^X mode. While in this mode, <^U> must be hit four times to get back to the previous menu if <^X> is not used.

# FHWA VEHICLE CLASSIFICATIONS WITH DEFINITIONS

## FHWA VEHICLE CLASSIFICATIONS WITH DEFINITIONS

Type Name and Description

1. Motorcycles (Optional) - All two- or three-wheeled motorized vehicles. Typical vehicles in this category have saddle type seats and are steered by handle bars rather than a wheel. This category includes motorcycles, motor scooters, mopeds, motor-powered bicycles, and three-wheeled motorcycles. This vehicle type may be reported at the option of the State.

2. Passenger Cars - All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and including those passenger cars pulling recreational or other light trailers.

3. Other Two-Axle, Four-Tire Single Unit Vehicles - All two-axle, four-tire vehicles, other than passenger cars. Included in this classification are pickups, vans, and other vehicles such as campers, motor homes, ambulances, hearses, and carryalls. Other two-axle, four-tire single unit vehicles pulling recreational or other light trailers are included in this classification.

4. Buses - All vehicles manufactured as traditional passenger-carrying buses with two axles and six tires or three or more axles. This category includes only traditional buses (including school buses) functioning as passenger-carrying vehicles. All two-axle, four-tire minibuses should be classified as other two-axle, four-tire single unit vehicles. Modified buses should be considered to be a truck and be appropriately classified.

NOTE: In reporting information on trucks, the following criteria should be used:

a. Truck tractor units traveling without a trailer will be considered single unit trucks.
b. A truck tractor unit pulling other such units in a "saddle mount" configuration will be considered as one single unit truck and will be defined only by the axles on the pulling unit.
c. Vehicles shall be defined by the number of axles in contact with the roadway. Therefore, "floating" axles are counted only when in the down position.
d. The term "trailer" includes both semi- and full trailers.

5. Two-Axle, Six-Tire, Single Unit Trucks - All vehicles on a single frame including trucks, camping and recreation vehicles, motor homes, etc., having two axles and dual rear wheels.

6. Three-Axle Single Unit Trucks - All vehicles on a single frame including trucks, camping and recreation vehicles, motor homes, etc., having three axles.

7. Four or More Axle Single Unit Trucks - All trucks on a single frame with four or more axles.

8. Four or Less Axle Single Trailer Trucks - All vehicles with four or less axles consisting of two units, one of which is a tractor or straight truck power unit.

9. Five-Axle Single Trailer Trucks - All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power unit.

10. Six or More Axle Single Trailer Trucks - All vehicles with six or more axles consisting of two units, one of which is a tractor or straight truck power unit.

11. Five or Less Axle Multi-Trailer Trucks - All vehicles with five or less axles consisting of three or more units, one of which is a tractor or straight truck power unit.

12. Six-Axle Multi-Trailer Trucks - All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power unit.

13. Seven or More Axle Multi-Trailer Trucks - All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power unit.

14. All Other Vehicle Types - Any and all vehicles which do not fit into one of the above-mentioned categories.

# DATA SHEETS

# INVENTORY

# DATA SHEETS

SHEET 1
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

GEOMETRIC, SHOULDER, AND DRAINAGE INFORMATION

1. TYPE OF PAVEMENT (SEE CODES, TABLE A.4) ___ ___

2. NUMBER OF THROUGH LANES IN DIRECTION OF SURVEY ___

3. LANE WIDTH (FEET) ___ ___

4. LANES (BY NUMBER) INCLUDED IN MONITORING SECTION ___,___,___

(LANE 1 IS OUTSIDE LANE,
LANE 2 IS NEXT TO LANE 1, ETC.)

5. OUTSIDE SHOULDER WIDTH (FEET) ___.___

6. INSIDE SHOULDER WIDTH (FEET) ___.___

7. SHOULDER SURFACE TYPE:

| | | | |
|---|---|---|---|
| Turf . . . . . . . . . | 1 | Concrete . . . . . . . . . | 4 |
| Granular . . . . . . . | 2 | Surface Treatment . . . | 5 |
| Asphalt Concrete . . | 3 | Other ___________________ | 6 |

a) OUTSIDE SHOULDER ___
b) INSIDE SHOULDER ___

8. OUTSIDE SHOULDER:

a) BASE TYPE (SEE BASE TYPE CODE, TABLE A.6) ___

b) SURFACE THICKNESS (INCHES) ___ ___.___

c) MAXIMUM ___ ___.___

d) MINIMUM ___ ___.___

e) CONTINUOUS SLOPE Y / N

f) BASE THICKNESS (INCHES) ___ ___.___

g) JOINT SPACING (FEET) ___ ___ - ___ ___ - ___ ___ - ___ ___

h) TRANSVERSE JOINTS IN SHOULDER MATCH JOINTS IN MAINLINE PAVEMENT Y / N

i) TRANSVERSE JOINT SKEWNESS Y / N

SHEET 2
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

GEOMETRIC, SHOULDER, AND DRAINAGE INFORMATION (CONTINUED)

SUBSURFACE DRAINAGE TYPE ___

- No subsurface drainage . . . . . . . . . . . . . . . . . . . 1
- Longitudinal drains . . . . . . . . . . . . . . . . . . . 2
- Transverse drains . . . . . . . . . . . . . . . . . . . 3
- Drainage blanket . . . . . . . . . . . . . . . . . . . 4
- Well system . . . . . . . . . . . . . . . . . . . . . 5
- Drainage blanket with longitudinal drains . . . . . . 6
- Other (Specify) . . . . . . . . . . . . . . . . . . . 7

DIAMETER OF LONGITUDINAL DRAINPIPES (INCHES) ___.___

SUBSURFACE DRAINAGE LOCATION ___

- Continuous along Project . . . . . . . . . . . . . . . 1
- Intermittent . . . . . . . . . . . . . . . . . . . . . 2

SPACING OF LATERAL OUTLETS (FEET) ___ ___ ___

COEFFICIENT OF DRAINAGE ($C_d$) ___.___ ___

SHEET 3
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

FIELD SURVEY: GENERAL INFORMATION

DATE OF FIELD SURVEY (MONTH/DAY/YR) ___ ___/___ ___/___ ___
SURVEYORS' INITIALS ______/ ______/ ______
FUNCTIONAL CLASSIFICATION (See Table A.2, Appendix A) ___ ___

TEST SECTION LOCATION:

START POINT MILEMARK ___ ___ ___.___ ___
END POINT MILEMARK ___ ___ ___.___ ___

START POINT STATION NUMBER ___ ___ ___ ___+ ___ ___.___ ___
END POINT STATION NUMBER ___ ___ ___ ___+ ___ ___.___ ___

LENGTH OF SECTION (FEET) ___ ___ ___ ___

IF NO MP OR STN, DISTANCE FROM NEAREST STRUCTURE/
INTERCHANGE/CROSSROAD (FEET) ___ ___ ___ ___

TYPE/NAME OF STRUCTURE/INTERCHANGE/CROSSROAD ______________________

AVERAGE CONTRACTION JOINT SPACING (FEET) ___ ___ ___.___
RANDOM JOINT SPACING (IF APPLICABLE) ___ ___-___ ___-___ ___-___ ___
TRANSVERSE JOINT SKEWNESS Y / N
FT/LANE ___

SHEET 4
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

FIELD SURVEY: DRAINAGE INFORMATION

| | STATION | SLOPE SIGN | INNER LANE | SLOPE SIGN | OUTER LANE |
|---|---|---|---|---|---|
| LONGITUDINAL SLOPE[1] (Percent) (3 MEASUREMENTS, EQUALLY SPACED ALONG PROJECT) | ___ ___ ___ ___+___ ___ | ___ | ___.___ ___ | ___ | ___.___ ___ |
| | ___ ___ ___ ___+___ ___ | ___ | ___.___ ___ | ___ | ___.___ ___ |
| | ___ ___ ___ ___+___ ___ | ___ | ___.___ ___ | ___ | ___.___ ___ |
| TRANSVERSE SLOPE[2] (Percent) (3 MEASUREMENTS, EQUALLY SPACED ALONG PROJECT) | ___ ___ ___ ___+___ ___ | ___ | ___.___ ___ | ___ | ___.___ ___ |
| | ___ ___ ___ ___+___ ___ | ___ | ___.___ ___ | ___ | ___.___ ___ |
| | ___ ___ ___ ___+___ ___ | ___ | ___.___ ___ | ___ | ___.___ ___ |
| SHOULDER SLOPE[2] (Percent) (3 MEASUREMENTS, EQUALLY SPACED ALONG PROJECT | ___ ___ ___ ___+___ ___ | ___ | ___.___ ___ | ___ | ___.___ ___ |
| | ___ ___ ___ ___+___ ___ | ___ | ___.___ ___ | ___ | ___.___ ___ |
| | ___ ___ ___ ___+___ ___ | ___ | ___.___ ___ | ___ | ___.___ ___ |

CUT OR FILL DEPTH (GROUND LEVEL TO PAVEMENT SURFACE ELEVATION) ___

Fill > 40 FT . . . . . . . . . . . 1
Fill 16 - 40 FT . . . . . . . . . 2
Fill 6 - 15 FT . . . . . . . . . . 3
At Grade (5 FT Fill to 5 FT Cut) . 4
Cut 6 - 15 FT . . . . . . . . . . 5
Cut 16 - 40 FT . . . . . . . . . . 6
Cut > 40 FT . . . . . . . . . . . 7
Other ________________________ 8

DEPTH OF DITCH LINE (FROM PAVEMENT SURFACE, FEET) ___ ___

NOTES:

[1] Longitudinal slope is positive when elevation increases in the direction of the survey.

[2] Transverse slope is negative when the elevation of the center-line side of the lane is greater than the elevation of the shoulder side of the lane in the direction of the survey.

SHEET 5
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

FIELD SURVEY: DRAINAGE INFORMATION (CONTINUED)

LANE/SHOULDER JOINT INTEGRITY:

| | OUTER SHOULDER | INNER SHOULDER |
|---|---|---|
| SEALANT DAMAGE[1] | N L M H | N L M H |
| BLOWHOLES | N L M H | N L M H |

INDICATORS OF POOR DRAINAGE:

| | |
|---|---|
| Cattails or willows growing in ditch | Y / N |
| Drainage outlets clogged | Y / N |
| Drainage outlets below ditchline | Y / N |
| Non-continuous cross section, crown to drainage ditch | Y / N |
| Pumping | N L M H |
| Other ________________________________ | Y / N |

NOTE:[1] If not applicable, leave blank.

SHEET 6
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

## PHYSICAL PROPERTIES OF THE BASE COURSE

| | |
|---|---|
| THICKNESS (INCHES) | ___ ___.___ |
| LIQUID LIMIT | ___.___ |
| PLASTIC LIMIT | ___.___ |
| PLASTICITY INDEX | ___.___ |

GRADATION:

| SIEVE | PERCENT PASSING |
|---|---|
| 1-1/2" | ___.___ |
| 3/4" | ___.___ |
| 3/8" | ___.___ |
| # 4 | ___.___ |
| # 10 | ___.___ |
| # 30 | ___.___ |
| # 40 | ___.___ |
| # 60 | ___.___ |
| # 80 | ___.___ |
| # 100 | ___.___ |
| # 200 | ___.___ |

SHEET 7
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

## AGE AND MAJOR PAVEMENT IMPROVEMENTS

DATE CONSTRUCTED (MONTH/YEAR) ___ ___/___ ___

OPENED TO TRAFFIC (MONTH/YEAR) ___ ___/___ ___

YEARS WHEN MAJOR IMPROVEMENTS OCCURRED AND TYPES OF IMPROVEMENTS

| IMPROVEMENT TYPE CODES | | YEAR | TYPE |
|---|---|---|---|
| OVERLAY . . . . . . . . . . . | 01 | ___ ___ | ___ ___ |
| SLAB JACKING . . . . . . . . | 02 | ___ ___ | ___ ___ |
| JOINT REPAIR . . . . . . . . | 03 | ___ ___ | ___ ___ |
| IMPROVED SHOULDER . . . . . | 04 | ___ ___ | ___ ___ |
| RECYCLED . . . . . . . . . . | 05 | ___ ___ | ___ ___ |
| UNDERDRAINS . . . . . . . . . | 06 | ___ ___ | ___ ___ |
| REMOVED AND RECONSTRUCTED . | 07 | | |
| OTHER, SPECIFY ____________ | 08 | | |

YEAR WHEN ROADWAY WIDENED ___ ___

ORIGINAL NUMBER OF LANES (ONE DIRECTION) ___

FINAL NUMBER OF LANES (ONE DIRECTION) ___

LANE NUMBER OF LANE ADDED ___

NOTES: [1] A lane created by roadway widening should not be used for SHRP-LTPP unless the pavement structure under the entire lane was constructed at the same time and is uniform.

[2] Major improvements to pavements only. Does not include bridges.

SHEET 8
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

LAYER DESCRIPTIONS

| LAYER[1] NUMBER | LAYER[2] DESCRIPTION | THICKNESS (INCHES) FROM PLANS | THICKNESS (INCHES) FROM CORES/BORING | MATERIAL[3] TYPE CLASSIFICATION |
|---|---|---|---|---|
| 1 | SUBGRADE (7) | ___ ___.___ | ___ ___.___ | ___ ___ |
| 2 | ___ | ___ ___.___ | ___ ___.___ | ___ ___ |
| 3 | ___ | ___ ___.___ | ___ ___.___ | ___ ___ |
| 4 | ___ | ___ ___.___ | ___ ___.___ | ___ ___ |
| 5 | ___ | ___ ___.___ | ___ ___.___ | ___ ___ |
| 6 | ___ | ___ ___.___ | ___ ___.___ | ___ ___ |
| 7 | ___ | ___ ___.___ | ___ ___.___ | ___ ___ |
| 8 | ___ | ___ ___.___ | ___ ___.___ | ___ ___ |
| 9 | ___ | ___ ___.___ | ___ ___.___ | ___ ___ |

DEPTH (FEET) BELOW SURFACE TO "RIGID" LAYER
SUCH AS ROCK, STONE, OR DENSE SHALE ___ ___

NOTES:

1 Layer 1 is subgrade soil; the last layer is the existing surface.

2 LAYER DESCRIPTION CODES:

| | | | |
|---|---|---|---|
| Overlay | 1 | Subbase Layer | 6 |
| Seal Coat | 2 | Subgrade | 7 |
| Original Surface | 3 | Interlayer | 8 |
| HMAC Layer (Below Surface Layer) | 4 | Porous Friction Course | 9 |
| Base Layer | 5 | Surface Treatment | 10 |

3 The material type classification codes for surface, base or subbase, subgrade, and seal coat or interlayer materials appear in Tables A.5, A.6, A.7, and A.8 respectively.

SHEET 9
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

RIGID PAVEMENT LAYERS,[1]JOINT DATA

LAYER NUMBER (FROM SHEET 8) ___

AVERAGE CONTRACTION JOINT SPACING (FEET) ___ ___ ___.___

RANDOM JOINT SPACING, IF ANY: ___-___-___-___

BUILT-IN EXPANSION JOINT SPACING (FEET) ___ ___ ___ ___

SKEWNESS OF JOINT (FT/LANE) ___.___

TRANSVERSE CONTRACTION JOINT LOAD TRANSFER SYSTEM ___

- Dowels . . . . . . . . . . . . . . . . . . . . 1
- Aggregate Interlock. . . . . . . . . . . . . . 2
- I-Beams . . . . . . . . . . . . . . . . . . . 3
- Star Lugs . . . . . . . . . . . . . . . . . . 4
- Other (Specify) ________________________ 5

DOWEL DIAMETER (INCHES) ___.___ ___

DOWEL LOCATION, DISTANCE FROM LANE/SHOULDER EDGE, INCHES

DOWEL NUMBER[2]

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OUTER LANE | | | | | | | | | | | | |
| INNER LANE | | | | | | | | | | | | |

DOWEL LENGTH (INCHES) .___ ___

DOWEL COATING ___

- Paint and/or Grease . . . . . . . . . . . . . 1
- Plastic . . . . . . . . . . . . . . . . . . . 2
- Monel . . . . . . . . . . . . . . . . . . . . 3
- Stainless Steel . . . . . . . . . . . . . . . 4
- Epoxy . . . . . . . . . . . . . . . . . . . . 5
- Other (Specify) ________________________ 6

METHOD USED TO INSTALL DOWELS ___

- Preplaced on baskets . . . . . . . . . . . 1
- Mechanically installed . . . . . . . . . . 2
- Other (Specify) ________________________ 3

JOINT LOAD TRANSFER (PERCENT) ___ ___

NOTES: [1] Use a separate sheet for each rigid pavement layer.
[2] For each lane, Dowel Number 1 is nearest the lane/shoulder joint, Number 2 is next to Number 1, and so on.

SHEET 10
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

RIGID PAVEMENT LAYERS, JOINT DATA[1] (CONTINUED)

LAYER NUMBER (FROM SHEET 8) ___

METHOD USED TO FORM TRANSVERSE JOINTS ___
- Sawed . . . . . . . . . . . . . . 1
- Plastic Insert . . . . . . . . . 2
- Metal Insert (i.e., Uni-Tube) . 3
- Other (Specify) ____________ 4

TRANSVERSE JOINT SEALANT TYPE (AS BUILT) ___
- Preformed (open web) . . . . . 1
- Asphalt . . . . . . . . . . . . . 2
- Rubberized Asphalt . . . . . . 3
- Low-Modulus Silicone . . . . . 4
- Other (i.e., closed neoprene or specify) ____________ 5

TRANSVERSE JOINT SEALANT RESERVOIR (AS BUILT)
- WIDTH, (IN.) ___.___ ___
- DEPTH, (IN.) ___.___

TYPE OF LONGITUDINAL JOINT (BETWEEN LANES) ___
- Butt . . . . . . . . . . . 1
- Keyed . . . . . . . . . . 2
- Sawed Weakened Plane . . 3
- Insert Weakened Plane . . . 4
- Other ____________ (Specify) 5

TIE BAR DIAMETER (INCHES) ___.___ ___

TIE BAR LENGTH (INCHES) ___ ___.

TIE BAR SPACING (INCHES) ___ ___.___

TYPE OF SHOULDER-OUTER LANE JOINT ___
- Butt . . . . . . . . . . . 1
- Keyed . . . . . . . . . . 2
- Sawed Weakened Plane . . 3
- Insert Weakened Plane . . . 4
- Tied Concrete Curb . . . . 5
- Other ____________ (Specify) 6

SHOULDER-TRAFFIC LANE JOINT TIE BAR (FOR CONCRETE SHOULDER)

- DIAMETER (INCHES) ___.___ ___
- LENGTH (INCHES) ___ ___
- SPACING (INCHES) ___ ___

DEPTH OF LONGITUDINAL JOINT CUT (IN.) ___.___

NOTE: [1] Use a separate sheet for each rigid pavement layer.

SHEET 11
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

RIGID PAVEMENT LAYERS,
REINFORCING STEEL DATA[1]

LAYER NUMBER (FROM SHEET 8) ___

TYPE OF REINFORCEMENT ___
- Deformed Bars . . . . . . . . . . . . . 1
- Welded Wire Fabric . . . . . . . . . 2
- Other (Specify) ___________________ 3

TRANSVERSE BAR DIAMETER (INCHES) ___.___ ___

TRANSVERSE BAR SPACING (INCHES) ___ ___.___

LONGITUDINAL BAR DIAMETER (INCHES) ___.___ ___

LONGITUDINAL BAR SPACING (INCHES) ___ ___.___

YIELD STRENGTH OF REINFORCEMENT (KSI) ___ ___.___

DEPTH TO REINFORCEMENT FROM SLAB SURFACE (INCHES) ___.___

NOTE: [1] Use a separate sheet for each rigid pavement layer.

SHEET 12
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

RIGID PAVEMENT LAYERS, CONCRETE MIXTURE DATA[1]

LAYER NUMBER (FROM SHEET 8) ___

MIX DESIGN (LB/YD$^3$ - OVEN DRIED WEIGHT)
- (A) Coarse Aggregate . . . . . . . . . ___ ___ ___ ___.
- (B) Fine Aggregate . . . . . . . . . . ___ ___ ___ ___.
- (C) Cement . . . . . . . . . . . . . . ___ ___ ___ ___.
- (D) Water . . . . . . . . . . . . . . ___ ___ ___ ___.

STRENGTH (28-day Modulus of Rupture - AASHTO T97 OR ASTM C78)
(psi) (based on 3rd point loading)
- (A) Mean . . . . . . . . . . . . . . . ___ ___ ___ ___.
- (B) Range:
  - Maximum Value . . . . . . . ___ ___ ___ ___.
  - Minimum Value . . . . . . . ___ ___ ___ ___.
- (C) Number of Tests . . . . . . . . . . . ___ ___ ___.
- (D) Standard Deviation . . . . . . . . . ___ ___ ___.

SLUMP (inches) (AASHTO T119 OR ASTM C143)
- (A) Mean . . . . . . . . . . . . . . . . . . . . ___.___
- (B) Range:
  - Minimum Value . . . . . . . . . . . ___.___
  - Maximum Value . . . . . . . . . . . ___.___
- (C) Standard Deviation . . . . . . . . . . . . ___.___
- (D) Number of Tests . . . . . . . . . . . ___ ___ ___.

TYPE CEMENT USED
See Cement Type Codes, Table A.11 . . . . . . ___ ___

ENTRAINED AIR CONTENT, (PERCENT) (AASHTO T152 OR ASTM C231)
- (A) Mean . . . . . . . . . . . . . . . . . . . . ___.___
- (B) Range:
  - Minimum Value . . . . . . . . . . . ___.___
  - Maximum Value . . . . . . . . . . . ___.___

COMPOSITION OF COARSE AGGREGATE

| | TYPE | PERCENT |
|---|---|---|
| Crushed Stone . . . . . . . . 1 | | |
| Gravel . . . . . . . . . . . 2 | ___ | ___ ___ ___. |
| Crushed Gravel . . . . . . . 3 | ___ | ___ ___ ___. |
| Crushed Slag . . . . . . . . 4 | ___ | ___ ___ ___. |
| Manufactured Lightweight. . 5 | | |
| Recycled Concrete . . . . . 6 | | |
| Other (Specify) ____________ 7 | | |

MEAN COMPRESSIVE STRENGTH (PSI) ___ ___ ___ ___    NUMBER OF DAYS ___ ___

NOTE: [1] Use a separate sheet for each rigid pavement layer.

SHEET 13
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

RIGID PAVEMENT LAYERS, CONCRETE MIXTURE DATA[1] (CONTINUED)

LAYER NUMBER (FROM SHEET 8) ___

METHOD USED TO CURE CONCRETE ___

Membrane Curing Compound . . . . . . 1
Burlap Curing Blankets . . . . . . . 2
Waterproof Paper Blankets . . . . . 3
White Polyethylene Sheeting . . . . 4
Burlap-Polyethylene Blanket . . . 5
Cotton Mat Curing . . . . . . . . 6
Hay . . . . . . . . . . . . . . . 7
Other ____________ (Specify) 8

METHOD USED TO FINISH CONCRETE ___

Tine . . . . . . . . . . . . . . . . . 1
Broom . . . . . . . . . . . . . . . . 2
Burlap Drag . . . . . . . . . . . . . 3
Grooved Float . . . . . . . . . . 4
Astro Turf . . . . . . . . . . . 5
Other ____________ (Specify) 6

ELASTIC MODULUS (KSI):

Minimum . . . . . . . ___ ___ ___ ___ ___.
Maximum . . . . . . . ___ ___ ___ ___ ___.
Mean . . . . . . . . . ___ ___ ___ ___ ___.
Standard Deviation. . ___ ___ ___ ___ ___.
Number of Tests. . . . . . . . . ___ ___.

TEST METHOD FOR ELASTIC MODULUS ___

Indirect Tensile Test on Cores (ASTM C496-85) . . . . . . . . . . 1
Compression Test on Cores (ASTM C39-84) . . . . . . . . . . . . . 2
Compression Test on Cylinders During Initial Construction (ASTM C39-84) . . . . . . . . . . . . . 3
Calculated Using ACI Relation Between Elastic Modulus and Compressive Strength (ACI 318-83, Section 8.5) . . . . . . . . . . . . . . . . . 4
Other Specify) ______________________________ 5

IN-SERVICE CONCRETE STRENGTH FROM CORING:

Elastic Modulus from Indirect Tensile Test, KSI ___ ___ ___ ___ ___
Modulus of Rupture from USAF Correlation, PSI ___ ___ ___ ___
Modulus of Elasticity KSI, (Backcalculated) ___ ___ ___ ___

NOTE: [1] Use a separate sheet for each rigid pavement layer.

SHEET 14
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

RIGID PAVEMENT LAYERS, IN-SERVICE CONCRETE MIXTURE DATA[1] (CONTINUED)

LAYER NUMBER (FROM SHEET 8) ___

FLEXURAL STRENGTH, PSI:
(28-DAY MODULUS OF RUPTURE, BASED ON THIRD POINT LOADING, AASHTO T97 OR ASTM C78)

Minimum . . . . . . . . . ___ ___ ___ ___ ___.
Maximum . . . . . . . . . ___ ___ ___ ___ ___.
Mean . . . . . . . . . . ___ ___ ___ ___ ___.
Standard Deviation . . . ___ ___ ___ ___ ___.
Number of Tests . . . . . . . . . . . ___ ___.

INDIRECT TENSILE STRENGTH OF CONCRETE (PSI):
(TEST METHOD AASHTO T198 OR ASTM C496)

Minimum . . . . . . . . . . . ___ ___ ___ ___.
Maximum . . . . . . . . . . . ___ ___ ___ ___.
Mean . . . . . . . . . . . . ___ ___ ___ ___.
Standard Deviation . . . . ___ ___ ___ ___.
Number of tests . . . . . . . . . . . ___ ___.

NOTE: [1] Data to be obtained from coring of in-service pavement.

SHEET 15
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

UNBOUND OR STABILIZED BASE OR SUBBASE
MATERIAL DESCRIPTION[1]

LAYER NUMBER (FROM SHEET 8) ___

AASHTO SOIL CLASSIFICATION (SEE CODES, TABLE A.10) ___ ___

PERCENT BINDER (PASSING NO. 40 SIEVE) ___ ___

PERCENT PASSING NO. 200 SIEVE ___ ___

STABILIZED BASE COURSE:

TYPE OF STABILIZING AGENT ___

| | | | |
|---|---|---|---|
| Asphalt Cement | 1 | Fly Ash | 6 |
| Emulsified Asphalt | 2 | Lime/Fly Ash | 7 |
| Cutback Asphalt | 3 | Portland Cement/Fly Ash | 8 |
| Portland Cement | 4 | Other (Specify)__________ | 9 |
| Lime | 5 | | |

K-VALUE AT TOP OF BASE[2] (PCI) ___ ___ ___

DENSITY (LBS/$FT^3$) ___ ___ ___

PERCENT MOISTURE ___ ___

PERMEABILITY (IN/HR) ___ ___.___

DRAINABILITY (a, m, u, or combination) ___/___

a - acceptable
m - marginal
u - unacceptable

NOTES: [1] Use a separate sheet for each base or subbase layer.

[2] Back-calculated from 9 kip FWD data.

SHEET 16
INVENTORY DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

SUBGRADE DATA

AASHTO SOIL CLASSIFICATION (SEE CODES, TABLE A.10) ___ ___

CBR (ESTIMATE FROM OTHER DATA IF NOT AVAILABLE) ___ ___ ___

RESISTANCE (R-VALUE) ___ ___ ___

MODULUS OF SUBGRADE REACTION (K-VALUE, PCI) ___ ___ ___

PERCENT PASSING NO. 200 SIEVE ___ ___.___

PLASTICITY INDEX ___ ___.___

LIQUID LIMIT ___ ___.___

PLASTIC LIMIT ___ ___.___

RESILIENT MODULUS[1] (PSI) ___ ___ ___

NATURAL DRAINAGE CLASSIFICATION[2] ___

Excessively Drained . . . . . . . . . . . . . 1
Somewhat Excessively Drained . . . . . . . . 2
Well Drained . . . . . . . . . . . . . . . . 3
Moderately Well Drained . . . . . . . . . . . 4
Somewhat Poorly Drained . . . . . . . . . . . 5
Poorly Drained . . . . . . . . . . . . . . . 6
Very Poorly Drained . . . . . . . . . . . . . 7

HYDROLOGICAL GROUP[2] (A, B, C, D, OR COMBINATION) ___/___

PERMEABILITY (IN/HR) ___.___ ___

DEPTH TO HIGH WATER TABLE (FEET) ___.___

% MOISTURE ___ ___.___

NATURAL DRAINAGE INDEX (NDI) ___

DRAINABILITY (k, j, i) ___

i - poor
j - average
k - good

NOTES: [1] Back-calculated from 9 kip FWD data.

[2] See USDA SCS or other soil survey.

# TRAFFIC

# DATA SHEETS

SHEET 1
TRAFFIC DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

## HISTORICAL DATA
## TRAFFIC VOLUME AND DISTRIBUTION[1]

LANE NUMBER ___

| YEAR | ONE WAY AADT | ONE WAY % TRUCKS[2] | ONE WAY LANE DISTRIBUTION OF TRUCKS (%) |
|---|---|---|---|
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |
| ___ ___ | ___ ___ ___ ___ ___. | ___ ___. | ___ ___ ___. |

ADJUSTMENT FACTOR ___.___ ___

TYPE OF FACTOR ___
1. (W-4) TABLES
2. WIM DATA
3. OTHER ________________

NOTES: [1] Use as many sheets as needed to include available data since the section was opened to traffic.

[2] Excluding pickups and panels.

SHEET 1b
TRAFFIC DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

HISTORICAL DATA
TRAFFIC ESALS AND DISTRIBUTION[1]

LANE ___

YEAR ___

TRUCK FACTOR ___.___ ___

ADJUSTED ESALS ___ ___ ___ ___ ___ ___ ___

ADJUSTED CUMULATIVE ESALS ___ ___ ___ ___ ___ ___ ___

CUMULATIVE ESALS ON OVERLAY ___ ___ ___ ___ ___ ___ ___

SHEET 2
TRAFFIC DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

MONITORED DATA FOR
VEHICLE CLASSIFICATION

DATE OF SURVEY: ___/___/___

HOUR MONITORED FROM: ___ ___ ___ ___

HOUR MONITORED TO: ___ ___ ___ ___

LANE: ___

2-AXLE, 6-TIRE SINGLE UNIT TRUCKS: ___ ___ ___ ___

3-AXLE SINGLE UNIT TRUCKS: ___ ___ ___ ___

$4^+$-AXLE SINGLE UNIT TRUCKS: ___ ___ ___ ___

$4^-$-AXLE SINGLE UNIT TRUCKS: ___ ___ ___ ___

5-AXLE SINGLE UNIT TRUCKS: ___ ___ ___ ___

$6^+$-AXLE SINGLE UNIT TRUCKS: ___ ___ ___ ___

$5^-$-AXLE MULTI-TRAILER TRUCKS: ___ ___ ___ ___

6-AXLE MULTI-TRAILER TRUCKS: ___ ___ ___ ___

$7^+$-AXLE MULTI-TRAILER TRUCKS: ___ ___ ___ ___

ALL OTHER VEHICLE TYPES: ___ ___ ___ ___

SHEET 3 THRU 9
TRAFFIC DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

MONITORED DATA
WEIGH-IN-MOTION TRAFFIC DATA

DATE OF SURVEY: ___/___/___

VEHICLE CLASS: ___ ___

LANE: ___

LOAD 1: ___ ___ ___ ___ ___ AXLE SPACING 1: ___ ___.___ ___

LOAD 2: ___ ___ ___ ___ ___ AXLE SPACING 2: ___ ___.___ ___

LOAD 3: ___ ___ ___ ___ ___ AXLE SPACING 3: ___ ___.___ ___

LOAD 4: ___ ___ ___ ___ ___ AXLE SPACING 4: ___ ___.___ ___

LOAD 5: ___ ___ ___ ___ ___ AXLE SPACING 5: ___ ___.___ ___

LOAD 6: ___ ___ ___ ___ ___ AXLE SPACING 6: ___ ___.___ ___

LOAD 7: ___ ___ ___ ___ ___ AXLE SPACING 7: ___ ___.___ ___

LOAD 8: ___ ___ ___ ___ ___

# MAINTENANCE

# DATA SHEETS

SHEET 1
MAINTENANCE DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

C-78

## HISTORICAL MAINTENANCE INFORMATION

| YEAR | MAINT. CASE NO. (CASE) | WORK TYPE CODE (TABLE A.17) | LOCATION ON PAVE-MENT CODE (TABLE A.18) | MAINT. MATERIAL CODE (TABLE A.19) | WORK QUANTITY | THICKNESS (INCHES) | PROCEDURES WHERE APPLICABLE |
|---|---|---|---|---|---|---|---|
| __ __ | __ __ __ | __ __ | __ __ | __ __ | __ __ __ __. | __ __.__ | __ __ __ |
| __ __ | __ __ __ | __ __ | __ __ | __ __ | __ __ __ __. | __ __.__ | __ __ __ |
| __ __ | __ __ __ | __ __ | __ __ | __ __ | __ __ __ __. | __ __.__ | __ __ __ |
| __ __ | __ __ __ | __ __ | __ __ | __ __ | __ __ __ __. | __ __.__ | __ __ __ |
| __ __ | __ __ __ | __ __ | __ __ | __ __ | __ __ __ __. | __ __.__ | __ __ __ |
| __ __ | __ __ __ | __ __ | __ __ | __ __ | __ __ __ __. | __ __.__ | __ __ __ |

NOTE: This data will frequently be very difficult to convert from existing records, but it is sufficiently important that every effort should be made to obtain it.

SHEET 2
MAINTENANCE DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

## PATCHES, SUBSEALING, AND DIAMOND GRINDING/MILLING DATA

PATCHES -- FULL DEPTH:

| LOCATION OF PATCHES | QUANTITY | AVERAGE SIZE, SQUARE YARDS |
|---|---|---|
| JOINT | ___ | ___.___ |
| INTERMEDIATE CRACK | ___ | ___.___ |
| REPLACED SLAB | ___ | ___.___ |

PATCHES -- PARTIAL DEPTH:

| LOCATION OF PATCHES | QUANTITY | AVERAGE SIZE, SQUARE YARDS |
|---|---|---|
| JOINT | ___ | ___.___ |
| INTERMEDIATE CRACK | ___ | ___.___ |
| REPLACED SLAB | ___ | ___.___ |

SUBSEALING:

DATE (MO/YR) ___ ___/___ ___

TYPICAL NUMBER OF SUBSEALING HOLES
NEAR CRACK OR JOINT ___ ___

TYPE OF GROUT ___
Limestone-Cement . . . . 2
Pozzolan-Cement . . . . 3
Other. . . ______________ 6

GRINDING/MILLING:

DATE OF WORK (MO/YR) ___ ___/___ ___

METHOD USED ___
Diamond Grinding . . . . 1
Milling . . . . . . . . 2

EXTENT OF GRINDING/MILLING ___
Entire length of test section . . . . . . 1
At individual joints . . . . . . . . . . 2
Other ______________________________ 3

# MONITORING

# DATA SHEETS

SHEET 1
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

## DATA ON DEFLECTION DEVICE, TEMPERATURES, AND DATES OF MEASUREMENT, AND ROUGHNESS AND SERVICEABILITY

TYPE OF DEFLECTION DEVICE ___

| | |
|---|---|
| Benkelman Beam . . . . . 1 | Falling Weight Deflectometer . . . . . 4 |
| Deflection Beam . . . . 2 | Road Rater . . . . . . . . . . . . . . 5 |
| Dynaflect. . . . . . . . 3 | Other (Specify) ____________________ 6 |

ID NUMBER OF DEFLECTION DEVICE ___ ___ ___ ___ ___ ___ ___ ___ ___

LOCATION OF SENSORS, IN INCHES, FROM CENTER OF LOAD:

| | |
|---|---|
| SENSOR 5 | ___ ___.___ |
| SENSOR 4 | ___ ___.___ |
| SENSOR 3 | ___ ___.___ |
| SENSOR 2 | ___ ___.___ |
| SENSOR 1 | ___ ___.___ |
| SENSOR 0 | 0 0 . 0 |
| SENSOR -1 | ___ ___.___ |

ROUGHNESS AND SERVICEABILITY:

| | | LANE NUMBER[1] 1 | 2 | 3 |
|---|---|---|---|---|
| ROUGHNESS INDEX[2] | (TRIAL 1) | ___ ___ ___ | ___ ___ ___ | ___ ___ ___ |
| | (TRIAL 2) | ___ ___ ___ | ___ ___ ___ | ___ ___ ___ |
| | AVERAGE | ___ ___ ___ | ___ ___ ___ | ___ ___ ___ |
| AZDOT ROUGHNESS INDEX | | ___ ___ ___ | ___ ___ ___ | ___ ___ ___ |
| ROUGHNESS MEASUREMENT SPEED (MPH) | | ___ ___ | ___ ___ | ___ ___ |
| PRESENT SERVICEABILITY RATING (MEAN) | | ___.___ | ___.___ | ___.___ |

NOTES [1] Lane 1 is outer lane, lane 2 is next to lane 1, etc.

[2] Obtained by Mays meter.

SHEET 2
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID __ __ __ - __ __

## DEFLECTION MEASUREMENTS

DATE OF TESTING __ __/__ __/__ __
(Month/Day/Year)
AIR TEMPERATURE (°F) __ __ __
LANE NUMBER __

TIME OF DAY
(24-Hour Clock) __ __ __ __ to __ __ __ __
PAVEMENT TEMPERATURE (°F) __ __ __

| Point No. | Point Distance (Feet) | Location Code[1] | Load (Pounds) | Frequency (Hertz) | -1 | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MEASUREMENTS FROM DEFLECTION SENSORS (MILS) | | | | | | |
| __ __ | __ __ __ __ __ | __ __ | __ __ __ __ __ | __ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ |
| | | | __ __ __ __ __ | __ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ |
| | | | __ __ __ __ __ | __ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ |
| __ __ | __ __ __ __ __ | __ __ | __ __ __ __ __ | __ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ |
| | | | __ __ __ __ __ | __ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ |
| | | | __ __ __ __ __ | __ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ |
| __ __ | __ __ __ __ __ | __ __ | __ __ __ __ __ | __ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ |
| | | | __ __ __ __ __ | __ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ |
| | | | __ __ __ __ __ | __ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ | __ __.__ __ |

[1] Location Code: Midslab -01; Same Slab as 1, But Adjacent to Joint at Outside Corner -02; Next Slab But Adjacent to Same Joint -03; Sensor "-1" perpendicular to other sensors: use prefix of 1- with above, i.e. 11, 12, or 13. Leave "Location Code" Blank for Asphaltic Concrete Pavements and PCC Pavements Without Transverse Joints.

SHEET 3
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

## DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) ___ ___/___ ___/___ ___

LANE NUMBER ___.

| DISTRESS TYPE[1] | SEVERITY LEVEL LOW | SEVERITY LEVEL MODERATE | SEVERITY LEVEL HIGH |
|---|---|---|---|
| BLOWUPS (NUMBER) | ___ ___. | ___ ___. | ___ ___. |
| SPALLING OF TRANSVERSE JOINTS (No. of Joints) | ___ ___. | ___ ___. | ___ ___. |
| SPALLING OF JOINT BETWEEN LANES (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| SPALLING OF LANE/SHOULDER JOINT (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| CRACKING FROM IMPROPER JOINT CONSTRUCTION (Linear Feet) | | | ___ ___ ___. |
| PUMPING AND WATER BLEEDING, (Severity Level - Check one) | ___ | ___ | ___ |
| DURABILITY 'D' CRACKING (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| LONGITUDINAL CRACKING (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| TRANSVERSE CRACKING (No. of Cracks) | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. |

NOTE [1] Distress identification and measurement should be consistent with that provided in the latest revision of "Distress Identification Manual for the Long-Term Pavement Performance (LTPP) Studies"

SHEET 4
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED
PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

LANE NUMBER ___

| DISTRESS TYPE[1] | SEVERITY LEVEL | | |
|---|---|---|---|
| | LOW | MODERATE | HIGH |
| CORNER BREAKS (NUMBER) | | | ___ ___ ___ |
| REACTIVE AGGREGATE (% OF AREA) | ___ ___ | ___ ___ | ___ ___ |
| JOINT SEAL DAMAGE OF TRANSVERSE JOINTS (NUMBER) | ___ ___ | ___ ___ | ___ ___ |
| SLAB DETERIORATION ADJACENT TO PATCH, JRCP ONLY (NUMBER) | ___ ___ | ___ ___ | ___ ___ |
| PATCH OR SLAB REPLACEMENT DETERIORATION | | | |
| (SQUARE FEET) | ___ ___ ___ ___ | ___ ___ ___ ___ | ___ ___ ___ ___ |
| (NUMBER) | ___ ___ | ___ ___ | ___ ___ |
| SCALING AND MAP CRACKING SEVERITY LEVEL (CHECK ONE) | ___ | ___ | ___ |

BLOWHOLES IN AC SHOULDER ___
No AC shoulder . . . . . . . . . . . 1
AC shoulder, no blowholes . . . . 2
Blowholes exist . . . . . . . . . . 3

NOTE: [1] Distress identification and measurement should be consistent with that provided in the latest revision of "Distress Identification Manual for the Long-Term Pavement Performance (LTPP) Studies."

SHEET 5
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES[1] (CONTINUED)

DATE OF SURVEY (MONTH/DAY/YEAR) ___ ___/___ ___/___ ___

LANE NUMBER ___

| Point No. | Point Distance[2] (Feet) | Lane-to-Shoulder[3] Dropoff (In.) |
|---|---|---|
| 1 | ___ ___ ___ ___. | ___.___ |
| 2 | ___ ___ ___ ___. | ___.___ |
| 3 | ___ ___ ___ ___. | ___.___ |
| 4 | ___ ___ ___ ___. | ___.___ |
| 5 | ___ ___ ___ ___. | ___.___ |
| 6 | ___ ___ ___ ___. | ___.___ |
| 7 | ___ ___ ___ ___. | ___.___ |
| 8 | ___ ___ ___ ___. | ___.___ |
| 9 | ___ ___ ___ ___. | ___.___ |
| 10 | ___ ___ ___ ___. | ___.___ |
| 11 | ___ ___ ___ ___. | ___.___ |
| 12 | ___ ___ ___ ___. | ___.___ |
| 13 | ___ ___ ___ ___. | ___.___ |
| 14 | ___ ___ ___ ___. | ___.___ |
| 15 | ___ ___ ___ ___. | ___.___ |
| 16 | ___ ___ ___ ___. | ___.___ |

MINIMUM DROPOFF (INCHES) ___.___
MAXIMUM DROPOFF (INCHES) ___.___
MEAN DROPOFF (INCHES) ___.___
STANDARD DEVIATION OF DROPOFF (INCHES) ___.___

NOTES:

[1] Use additional sheets as needed.

[2] "Point Distance" is the distance in feet from the start of the test section to the point where the measurement was made.

[3] Distress identification and measurement should be consistent with that provided for in the latest version of "Distress identification Manual for the Long-Term Pavement Performance (LTPP) Studies."

SHEET 6
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED
PORTLAND CEMENT CONCRETE SURFACES[1] (CONTINUED)

DATE OF SURVEY (MONTH/DAY/YEAR) ___ ___/___ ___/___ ___

LANE NUMBER ___

| Point No. | Point Distance[2] (Feet) | Lane-to-Shoulder[3] Separation (In.) | Longitudinal Joint Faulting (In.) |
|---|---|---|---|
| 1 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 2 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 3 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 4 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 5 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 6 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 7 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 8 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 9 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 10 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 11 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 12 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 13 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 14 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 15 | ___ ___ ___ ___. | ___.___ | ___.___ |
| 16 | ___ ___ ___ ___. | ___.___ | ___.___ |

MINIMUM SEPARATION (INCHES) ___.___
MAXIMUM SEPARATION (INCHES) ___.___
MEAN SEPARATION (INCHES) ___.___
STANDARD DEVIATION (INCHES) ___.___

NOTES:

[1] Use additional sheets as needed.

[2] "Point Distance" is the distance in feet from the start of the test section to the point where the measurement was made.

[3] Distress identification and measurement should be consistent with that provided in the latest version of "Distress Identification Manual for the Long-Term Pavement Performance (LTPP) Studies."

SHEET 7
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES[1] (CONTINUED)

DATE OF SURVEY (MONTH/DAY/YEAR) ___ ___/___ ___/___ ___
LANE NUMBER ___

| JOINT NO.[2] | JOINT WIDTH (INCHES) | TRANSVERSE JOINT FAULTING[3] (INCHES) | CRACK NO.[2] | CRACK FAULTING[3] (INCHES) |
|---|---|---|---|---|
| 1 | ___.___ ___ | ___.___ ___ | 1 | ___.___ ___ |
| 2 | ___.___ ___ | ___.___ ___ | 2 | ___.___ ___ |
| 3 | ___.___ ___ | ___.___ ___ | 3 | ___.___ ___ |
| 4 | ___.___ ___ | ___.___ ___ | 4 | ___.___ ___ |
| 5 | ___.___ ___ | ___.___ ___ | 5 | ___.___ ___ |
| 6 | ___.___ ___ | ___.___ ___ | 6 | ___.___ ___ |
| 7 | ___.___ ___ | ___.___ ___ | 7 | ___.___ ___ |
| 8 | ___.___ ___ | ___.___ ___ | 8 | ___.___ ___ |
| 9 | ___.___ ___ | ___.___ ___ | 9 | ___.___ ___ |
| 10 | ___.___ ___ | ___.___ ___ | 10 | ___.___ ___ |
| 11 | ___.___ ___ | ___.___ ___ | 11 | ___.___ ___ |
| 12 | ___.___ ___ | ___.___ ___ | 12 | ___.___ ___ |
| 13 | ___.___ ___ | ___.___ ___ | 13 | ___.___ ___ |
| 14 | ___.___ ___ | ___.___ ___ | 14 | ___.___ ___ |
| 15 | ___.___ ___ | ___.___ ___ | 15 | ___.___ ___ |

| | | | |
|---|---|---|---|
| MINIMUM JOINT[3] FAULTING (INCHES) | ___.___ ___ | MINIMUM CRACK[3] FAULTING (INCHES) | ___.___ ___ |
| MAXIMUM JOINT FAULTING (INCHES) | ___.___ ___ | MAXIMUM CRACK FAULTING (INCHES) | ___.___ ___ |
| MEAN JOINT FAULTING (INCHES) | ___.___ ___ | MEAN CRACK FAULTING (INCHES) | ___.___ ___ |
| STANDARD DEVIATION (INCHES) | ___.___ ___ | STANDARD DEVIATION (INCHES) | ___.___ ___ |

NOTES:

1 Use additional sheets as needed.

2 Numbers represent only joints or cracks measured. One joint should be measured at random within each 100-foot interval of the test section for SHRP-LTPP. One transverse crack should also be measured within each 100-Foot interval. If there is no transverse crack, leave the space blank.

3 Enter either positive or negative sign in left space, depending on whether the "approach slab" is higher or lower than the departure slab," respectively.

4 Absolute values are to be entered as maximum and minimum values, and used for calculating means and standard deviations.

# ENVIRONMENTAL

# DATA SHEETS

SHEET 1
ENVIRONMENTAL DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

GENERAL HISTORICAL DATA

| | |
|---|---|
| GENERAL TYPE OF ENVIRONMENT (SEE FIGURE 4) | ___ |
| LATITUDE (DEGREES-MINUTES-SECONDS) | ___ ___-___ ___-___ ___ |
| LONGITUDE (DEGREES-MINUTES-SECONDS) | ___ ___-___ ___-___ ___ |
| FREEZING INDEX (CORPS OF ENGINEERS METHOD, SEE FIGURE 5) | ___ ___ ___ ___ |
| ELEVATION ABOVE SEA LEVEL (FEET) | ___ ___ ___ ___ ___ |
| THORNTHWAITE MOISTURE INDEX | ___ ___ ___ |
| SOURCE OF THORNTHWAITE MOISTURE INDEX | ___ |
| CALCULATED FROM AVAILABLE DATA . . . . . . . . . . 1 | |
| MOISTURE INDEX MAP (FIGURE 6) . . . . . . . . . . 2 | |
| TWO YEARS IN TEN AVERAGE MAXIMUM TEMPERATURE | ___ ___ ___ |
| TWO YEARS IN TEN AVERAGE MINIMUM TEMPERATURE | ___ ___ ___ |
| TWO YEARS IN TEN AVERAGE MAXIMUM PRECIPITATION | ___ ___ ___ |
| TWO YEARS IN TEN AVERAGE MINIMUM PRECIPITATION | ___ ___ ___ |

SHEET 2
ENVIRONMENTAL DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

ANNUAL HISTORICAL DATA

| | |
|---|---|
| NUMBER OF FREEZE-THAW CYCLES DURING THE YEAR | ___ ___ ___ |
| HIGHEST MONTHLY MEAN SOLAR RADIATION (LANGLEYS/DAY) | ___ ___ ___ ___ |
| LOWEST MONTHLY MEAN SOLAR RADIATION (LANGLEYS/DAY) | ___ ___ ___ ___ |
| AVERAGE DEICING SALT APPLICATION DURING THE YEAR (TONS/LANE MILE/YEAR) | ___ ___ |
| AVERAGE MONTHLY PRECIPITATION (INCHES) | ___ ___.___ |
| AVERAGE ANNUAL NUMBER OF DAYS OF PRECIPITATION | ___ ___ ___ |

SHEET 3
ENVIRONMENTAL DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

AVERAGE MONTHLY HISTORICAL DATA

| | AVG. MONTHLY TEMP., °F | AVG. MAX DAILY TEMP., °F | AVG. MIN. DAILY TEMP., °F | AVG. MONTHLY PRECIPITATION, IN. OF WATER |
|---|---|---|---|---|
| JANUARY | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |
| FEBRUARY | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |
| MARCH | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |
| APRIL | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |
| MAY | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |
| JUNE | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |
| JULY | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |
| AUGUST | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |
| SEPTEMBER | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |
| OCTOBER | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |
| NOVEMBER | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |
| DECEMBER | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. | ___ ___.___ |

# GENERAL

# COMMENTS

# SHEET

SHEET 1
GENERAL COMMENT SHEET
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

Please note any comments that are unique to this particular section or any general comments that will help in the analysis of this data.

# PRESTRESSED

# PAVEMENT

# DATA SHEETS

SHEET 8 (8a)
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

DISTRESS SURVEY FOR PRESTRESSED PAVEMENT SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) ___ ___/___ ___/___ ___

LANE NUMBER ___.

| DISTRESS TYPE[1] | SEVERITY LEVEL | | |
|---|---|---|---|
| | LOW | MODERATE | HIGH |
| PRE-STRESSING WIRE CORROSION (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| "D" CRACKING (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| LONGITUDINAL CRACKING (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| TRANSVERSE CRACKING (Number of Cracks) | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. |
| REACTIVE AGGREGATE (% Area) | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. |
| SCALING/MAP CRACKING (% Area) | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. |

NUMBER OF "PAVER STOPS" ___ ___ ___ ___

SHEET 9 (9a)
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

## DISTRESS SURVEY FOR PRESTRESSED PAVEMENT SURFACES (CONTINUED)

LANE NUMBER ___

| DISTRESS TYPE[1] | SEVERITY LEVEL LOW | MODERATE | HIGH |
|---|---|---|---|
| PATCH DETERIORATION (SQUARE FEET) (NUMBER) | ___ ___ ___ ___<br>___ ___ | ___ ___ ___ ___<br>___ ___ | ___ ___ ___ ___<br>___ ___ |
| DETERIORATION ADJACENT TO PATCH (Check One) | ___ | ___ | ___ |
| DETERIORATION ADJACENT TO JOINT (Check One) | ___ | ___ | ___ |
| LONGITUDINAL JOINT SPALLING (Linear Feet) | ___ ___ ___ ___ | ___ ___ ___ ___ | ___ ___ ___ ___ |
| LOCALIZED DETERIORATION (Area) | ___ ___ ___ | ___ ___ ___ | ___ ___ ___ |

### PRESTRESSED PAVEMENT SURFACES - GAP SLAB DISTRESSES

| | |
|---|---|
| JOINT FACE AREA PATCHED (Sq. Ft./ Joint Face) | ___ ___ ___.___ |
| % JOINT FACE PATCHED | ___ ___ ___.___ |
| % PATCH & JOINT FACE SPALLED | ___ ___ ___.___ |

# CONTINUOUSLY

# REINFORCED

# CONCRETE

# PAVEMENT

# DATA SHEETS

SHEET 8 (8b)
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

DISTRESS SURVEY FOR CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) ___ ___/___ ___/___ ___

LANE NUMBER ___.

| DISTRESS TYPE[1] | SEVERITY LEVEL | | |
|---|---|---|---|
| | LOW | MODERATE | HIGH |
| BLOWUP (Number) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| CONSTRUCTION JOINT DETERIORATION (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| CORROSION (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| "D" CRACKING (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| PUNCHOUTS (Number) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| LONGITUDINAL CRACKING (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| TRANSVERSE CRACKING (Number of Cracks) | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. |
| PUMPING (Check Severity) | ___. | ___. | ___. |
| REACTIVE AGGREGATE (% Area) | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. |
| SCALING/MAP CRACKING (% Area) | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. |

AVERAGE CRACK SPACING IN 200 FEET ___ ___.___ ___

NOTE: [1] Distress identification and measurement should be consistent with that provided in the latest revision of "Distress Identification Manual for the Long-Term Pavement Performance (LTPP) Studies"

SHEET 9 (9b)
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

DISTRESS SURVEY FOR CONTINUOUSLY REINFORCED CONCRETE PAVEMENT (CONTINUED)

LANE NUMBER ___

| DISTRESS TYPE[1] | SEVERITY LEVEL LOW | MODERATE | HIGH |
|---|---|---|---|
| PATCH DETERIORATION (SQUARE FEET) | ___ ___ ___ ___ | ___ ___ ___ ___ | ___ ___ ___ ___ |
| (NUMBER) | ___ ___ | ___ ___ | ___ ___ |
| DETERIORATION ADJACENT TO PATCH (Check One) | ___ | ___ | ___ |
| DETERIORATION ADJACENT TO JOINT (Check One) | ___ | ___ | ___ |
| LONGITUDINAL JOINT SPALLING (Linear Feet) | ___ ___ ___ ___ | ___ ___ ___ ___ | ___ ___ ___ ___ |
| TRANSVERSE JOINT SPALLING (Linear Feet) | ___ ___ ___ ___ | ___ ___ ___ ___ | ___ ___ ___ ___ |
| LOCALIZED DETERIORATION (Area) | ___ ___ ___ | ___ ___ ___ | ___ ___ ___ |

NOTE: [1] Distress identification and measurement should be consistent with that provided in the latest revision of "Distress Identification Manual for the Long-Term Pavement Performance (LTPP) Studies."

# 3-LAYER

# SYSTEM

# DATA SHEETS

SHEET 5 (5a)
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

## DESIGN DATA FOR 3-LAYER SYSTEM

LANE ___

DATE OF OVERLAY (MO/YR) ___ ___/___ ___

PRESENCE OF "D" CRACKING OR REACTIVE AGGREGATE
PRIOR TO OVERLAY ___

- NONE............................0
- LOW - Only cracking present.....1
- MEDIUM - Some spalling.........2
- HIGH - Severe spalling..........3

### PRE-OVERLAY REPAIR

| REPAIR TYPE CODES | YEAR | TYPE |
|---|---|---|
| JOINT SEALING...............02 | ___ ___ | ___ ___ |
| SLAB REPLACEMENT............07 | ___ ___ | ___ ___ |
| AC SHLDR. RESTORATION.......10 | ___ ___ | ___ ___ |
| GRINDING....................12 | ___ ___ | ___ ___ |
| SLAB JACKING................15 | ___ ___ | ___ ___ |
| OTHER, SPECIFY _____________53 | ___ ___ | ___ ___ |

(SEE TABLE A.17 FOR OTHER CODES)

SHEET 10 (10a)
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

DISTRESS SURVEY FOR 3-LAYER SYSTEM PAVEMENT SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) ___ ___/___ ___/___ ___

LANE NUMBER ___.

| DISTRESS TYPE[1] | SEVERITY LEVEL | | |
|---|---|---|---|
| | LOW | MODERATE | HIGH |
| RAVELING/WEATHERING (Square Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| BLEEDING (Square Feet) | | | ___ ___ ___ ___. |
| ALLIGATOR (FATIGUE) CRACKING (Square Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| BLOCK CRACKING (Square Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| LONGITUDINAL CRACKING (Linear Feet) | ___ ___ ___ ___. | ___ ___ ___ ___. | ___ ___ ___ ___. |
| TRANSVERSE CRACKING (Number of Cracks) | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. |
| POTHOLES (Number) | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. |
| TRANSVERSE JOINT REFLECTION CRACKING (Number of Cracks) | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. |
| CRACK BETWEEN LANE AND SHOULDER (Linear Feet) | ___ ___ ___. | ___ ___ ___. | ___ ___ ___. |

NOTE: [1] Distress identification and measurement should be consistent with that provided in the latest revision of "Distress Identification Manual for the Long-Term Pavement Performance (LTPP) Studies"

SHEET 11 (11a)
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

DISTRESS SURVEY FOR 3-LAYER SYSTEM PAVEMENT SURFACE
(CONTINUED)

LANE NUMBER ___

| DISTRESS TYPE[1] | SEVERITY LEVEL LOW | MODERATE | HIGH |
|---|---|---|---|
| PATCH DETERIORATION (SQUARE FEET) | ___ ___ ___ ___ | ___ ___ ___ ___ | ___ ___ ___ ___ |
| (NUMBER) | ___ ___ | ___ ___ | ___ ___ |
| REFLECTION CRACKING ABOVE LONGITUDINAL JOINT (Linear Feet) | ___ ___ ___ ___ | ___ ___ ___ ___ | ___ ___ ___ ___ |
| PUMPING AND WATER BLEEDING SEVERITY LEVEL (Check One) | ___ | ___ | ___ |
| TRANSVERSE REFLECTION CRACKING AT PATCH JOINT (Number) | ___ ___ | ___ ___ | ___ ___ |

NOTE: [1] Distress identification and measurement should be consistent with that provided in the latest revision of "Distress Identification Manual for the Long-Term Pavement Performance (LTPP) Studies."

SHEET 13 (13a)
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

DISTRESS SURVEY FOR 3-LAYER SYSTEM PAVEMENT SURFACE
(CONTINUED)

DATE OF SURVEY (MONTH/DAY/YEAR) ___ ___/___ ___/___ ___

LANE NUMBER ___

| Point No. | Point Distance[1] (Feet) | Lane-to-Shoulder[2] Dropoff (In.) |
|---|---|---|
| 1 | ___ ___ ___ ___. | ___.___ |
| 2 | ___ ___ ___ ___. | ___.___ |
| 3 | ___ ___ ___ ___. | ___.___ |
| 4 | ___ ___ ___ ___. | ___.___ |
| 5 | ___ ___ ___ ___. | ___.___ |
| 6 | ___ ___ ___ ___. | ___.___ |
| 7 | ___ ___ ___ ___. | ___.___ |
| 8 | ___ ___ ___ ___. | ___.___ |
| 9 | ___ ___ ___ ___. | ___.___ |
| 10 | ___ ___ ___ ___. | ___.___ |
| 11 | ___ ___ ___ ___. | ___.___ |
| 12 | ___ ___ ___ ___. | ___.___ |
| 13 | ___ ___ ___ ___. | ___.___ |
| 14 | ___ ___ ___ ___. | ___.___ |
| 15 | ___ ___ ___ ___. | ___.___ |
| 16 | ___ ___ ___ ___. | ___.___ |

MINIMUM DROPOFF (INCHES) ___.___
MAXIMUM DROPOFF (INCHES) ___.___
MEAN DROPOFF (INCHES) ___.___
STANDARD DEVIATION OF DROPOFF (INCHES) ___.___

NOTES: [1] "Point Distance" is the distance in feet from the start of the test section to the point where the measurement was made.

[2] Distress identification and measurement should be consistent with that provided for in the latest version of "Distress identification Manual for the Long-Term Pavement Performance (LTPP) Studies."

SHEET 12 (12a)
MONITORING DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

DISTRESS SURVEY FOR 3-LAYER SYSTEM PAVEMENT SURFACE
(CONTINUED)

DATE OF SURVEY (MONTH/DAY/YEAR) ___ ___/___ ___/___ ___
LANE NUMBER ___

| LEFT WHEEL PATH Point No. | Point[1] Distance (Feet) | Rut Depth (Inches) | RIGHT WHEEL PATH Point No. | Point[1] Distance (Feet) | Rut Depth (Inches) |
|---|---|---|---|---|---|
| 1 | ___ ___ ___ ___. | ___.___ ___ | 1 | ___ ___ ___ ___. | ___.___ ___ |
| 2 | ___ ___ ___ ___. | ___.___ ___ | 2 | ___ ___ ___ ___. | ___.___ ___ |
| 3 | ___ ___ ___ ___. | ___.___ ___ | 3 | ___ ___ ___ ___. | ___.___ ___ |
| 4 | ___ ___ ___ ___. | ___.___ ___ | 4 | ___ ___ ___ ___. | ___.___ ___ |
| 5 | ___ ___ ___ ___. | ___.___ ___ | 5 | ___ ___ ___ ___. | ___.___ ___ |
| 6 | ___ ___ ___ ___. | ___.___ ___ | 6 | ___ ___ ___ ___. | ___.___ ___ |
| 7 | ___ ___ ___ ___. | ___.___ ___ | 7 | ___ ___ ___ ___. | ___.___ ___ |
| 8 | ___ ___ ___ ___. | ___.___ ___ | 8 | ___ ___ ___ ___. | ___.___ ___ |
| 9 | ___ ___ ___ ___. | ___.___ ___ | 9 | ___ ___ ___ ___. | ___.___ ___ |
| 10 | ___ ___ ___ ___. | ___.___ ___ | 10 | ___ ___ ___ ___. | ___.___ ___ |
| 11 | ___ ___ ___ ___. | ___.___ ___ | 11 | ___ ___ ___ ___. | ___.___ ___ |
| 12 | ___ ___ ___ ___. | ___.___ ___ | 12 | ___ ___ ___ ___. | ___.___ ___ |
| 13 | ___ ___ ___ ___. | ___.___ ___ | 13 | ___ ___ ___ ___. | ___.___ ___ |
| 14 | ___ ___ ___ ___. | ___.___ ___ | 14 | ___ ___ ___ ___. | ___.___ ___ |
| 15 | ___ ___ ___ ___. | ___.___ ___ | 15 | ___ ___ ___ ___. | ___.___ ___ |
| 16 | ___ ___ ___ ___. | ___.___ ___ | 16 | ___ ___ ___ ___. | ___.___ ___ |

| | | | |
|---|---|---|---|
| MIN. RUT DEPTH (INCHES) | ___.___ ___ | MIN. RUT DEPTH (INCHES) | ___.___ ___ |
| MAX. RUT DEPTH (INCHES) | ___.___ ___ | MAX. RUT DEPTH (INCHES) | ___.___ ___ |
| MEAN RUT DEPTH (INCHES) | ___.___ ___ | MEAN RUT DEPTH (INCHES) | ___.___ ___ |
| STANDARD DEVIATION (INCHES) | ___.___ ___ | STANDARD DEVIATION (INCHES) | ___.___ ___ |

NOTE: [1] "Point Distance" is the distance in feet from the start of the test section to the point where the measurement was made.

# REHABILITATION

# DATA SHEET

SHEET 4
REHABILITATION DATA
ADOT/ERES CONSULTANTS STUDY
"CONCRETE PAVEMENT PERFORMANCE
AND REHABILITATION"

AZ PROJECT ID ___ ___ ___ - ___ ___

ASPHALT CONCRETE OVERLAY, ASPHALT PROPERTIES

| | | | | |
|---|---|---|---|---|
| LAYER NUMBER[1] | ___ | ___ | ___ | ___ |
| THICKNESS, INCHES | ___ ___.___ | ___ ___.___ | ___ ___.___ | ___ ___.___ |
| ASPHALT GRADE (see Table A.16) | ___ ___ | ___ ___ | ___ ___ | ___ ___ |
| MARSHALL STABILITY (LBS) | ___ ___ ___ ___ | ___ ___ ___ ___ | ___ ___ ___ ___ | ___ ___ ___ ___ |
| HVEEM STABILITY | ___ ___ ___ | ___ ___ ___ | ___ ___ ___ | ___ ___ ___ |
| PERCENT AIR VOIDS | ___ ___.___ | ___ ___.___ | ___ ___.___ | ___ ___.___ |
| MARSHALL FLOW (0.01 IN.) | ___ ___ ___ ___ | ___ ___ ___ ___ | ___ ___ ___ ___ | ___ ___ ___ ___ |
| SPECIFIC GRAVITY, $G_{mb}$ | ___.___ ___ ___ | ___.___ ___ ___ | ___.___ ___ ___ | ___.___ ___ ___ |

NOTE: [1] Use the same layer numbers as designated on Sheet 8, INVENTORY DATA. That is, the highest number is the surface layer, the next highest is the layer directly beneath the surface layer, and so on.

# APPENDIX D

# SUMMARY OF WEIGH-IN-MOTION DATA

# APPENDIX D SUMMARY OF WEIGH-IN-MOTION DATA

This appendix provides a summary of the 18-kip Equivalent Single-Axle Load (ESAL) data obtained from the weigh-in-motion (WIM) data that was collected on selected sites. WIM data, in the form of truck weight data and vehicle classification data, was collected for 48 continuous hours in the outer lane (lane 3) at the following locations:

- Site 1—Interstate 10, MP 137.0, EB
- Site 2—Interstate 10, MP 140.0, WB
- Site 3—Interstate 17, MP 209.5, NB
- Site 4—S.R. 360, MP 3.0, EB

The ESAL data is summarized in tables D-1 through D-12. The data is broken out by single-, tandem, and tridem axle configuration. The 48-hour count the number of axle loads in each axle type is provided, and these are converted to the number of 18-kip ESAL applications by each axle load and type using the appropriate load equivalency factor (LEF). These calculations were then used to determine an average truck factor (TF) for trucks on that particular pavement. These in turn were used in the estimation of cumulative 18-kip ESAL applications that each pavement had sustained.

Table D-1. Summary of WIM ESAL data, single-axle loads, site 1.

*Site 1 : I-10 EB MP 137 (between 67th and 75th Street)*
*Traffic Count from 4/25 to 4/29*
*Axle Load Data from Lane 3*
*10" Pavement*

| Single Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 1999 | 0 | 0.0002 | 0.0000 |
| 2000 - 3999 | 17 | 0.0020 | 0.0340 |
| 4000 - 5999 | 389 | 0.0100 | 3.8900 |
| 6000 - 7999 | 757 | 0.0320 | 24.2240 |
| 8000 - 9999 | 602 | 0.0810 | 48.7620 |
| 10000 - 11999 | 342 | 0.1750 | 59.8500 |
| 12000 - 13999 | 331 | 0.3380 | 111.8780 |
| 14000 - 15999 | 176 | 0.6010 | 105.7760 |
| 16000 - 17999 | 100 | 1.0000 | 100.0000 |
| 18000 - 19999 | 74 | 1.5800 | 116.9200 |
| 20000 - 21999 | 67 | 2.3800 | 159.4600 |
| 22000 - 23999 | 0 | 3.4500 | 0.0000 |
| 24000 - 25999 | 0 | 4.8500 | 0.0000 |
| 26000 - 27999 | 0 | 6.6100 | 0.0000 |
| 28000 - 29999 | 0 | 8.7900 | 0.0000 |
| 30000 - 31999 | 0 | 11.4000 | 0.0000 |
| 32000 - 33999 | 0 | 14.6000 | 0.0000 |
| 34000 - 35999 | 0 | 18.3000 | 0.0000 |
| 36000 - 37999 | 0 | 22.7000 | 0.0000 |
| 38000 - 39999 | 0 | 27.9000 | 0.0000 |
| | **Total ESAL's =** | | **730.7940** |

Table D-2. Summary of WIM ESAL data, tandem-axle loads, site 1.

*Site 1 : I-10 EB MP 137 (between 67th and 75th Street)*
*Traffic Count from 4/25 to 4/29*
*Axle Load Data from Lane 3*
*10" Pavement*

| Tandem Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 5999 | 0 | 0.0020 | 0.0000 |
| 6000 - 7999 | 7 | 0.0050 | 0.0350 |
| 8000 - 9999 | 12 | 0.0120 | 0.1440 |
| 10000 - 11999 | 29 | 0.0250 | 0.7250 |
| 12000 - 13999 | 59 | 0.0470 | 2.7730 |
| 14000 - 15999 | 82 | 0.0810 | 6.6420 |
| 16000 - 17999 | 154 | 0.1320 | 20.3280 |
| 18000 - 19999 | 231 | 0.2040 | 47.1240 |
| 20000 - 21999 | 195 | 0.3050 | 59.4750 |
| 22000 - 23999 | 152 | 0.4410 | 67.0320 |
| 24000 - 25999 | 102 | 0.6200 | 63.2400 |
| 26000 - 27999 | 56 | 0.8500 | 47.6000 |
| 28000 - 29999 | 58 | 1.1400 | 66.1200 |
| 30000 - 31999 | 56 | 1.5000 | 84.0000 |
| 32000 - 33999 | 63 | 1.9500 | 122.8500 |
| 34000 - 35999 | 73 | 2.4800 | 181.0400 |
| 36000 - 37999 | 74 | 3.1200 | 230.8800 |
| 38000 - 39999 | 92 | 3.8700 | 356.0400 |
| 40000 - 41999 | 204 | 4.7400 | 966.9600 |
| 42000 - 43999 | 1 | 5.7500 | 5.7500 |
| 44000 - 45999 | 0 | 6.9000 | 0.0000 |
| 46000 - 47999 | 1 | 8.2100 | 8.2100 |
| 48000 - 49999 | 0 | 9.6800 | 0.0000 |
| 50000 - 51999 | 0 | 11.3000 | 0.0000 |
| 52000 - 53999 | 0 | 13.2000 | 0.0000 |
| 54000 - 55999 | 0 | 15.2000 | 0.0000 |
| | Total ESAL's = | | 2336.9680 |

Table D-3. Summary of WIM ESAL data, tridem-axle loads, site 1.

| *Site 1 : I-10 EB MP 137 (between 67th and 75th Street)* |
|---|
| *Traffic Count from 4/25 to 4/29* |
| *Axle Load Data from Lane 3* |
| *10" Pavement* |

| Tridem Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 11999 | 0 | 0.0090 | 0.0000 |
| 12000 - 13999 | 0 | 0.0160 | 0.0000 |
| 14000 - 15999 | 0 | 0.0270 | 0.0000 |
| 16000 - 17999 | 1 | 0.0440 | 0.0440 |
| 18000 - 19999 | 2 | 0.0660 | 0.1320 |
| 20000 - 21999 | 0 | 0.0980 | 0.0000 |
| 22000 - 23999 | 0 | 0.1390 | 0.0000 |
| 24000 - 25999 | 1 | 0.1940 | 0.1940 |
| 26000 - 27999 | 0 | 0.2630 | 0.0000 |
| 28000 - 29999 | 0 | 0.3510 | 0.0000 |
| 30000 - 31999 | 0 | 0.4600 | 0.0000 |
| 32000 - 33999 | 0 | 0.5940 | 0.0000 |
| 34000 - 35999 | 0 | 0.7560 | 0.0000 |
| 36000 - 37999 | 0 | 0.9500 | 0.0000 |
| 38000 - 39999 | 0 | 1.1800 | 0.0000 |
| 40000 - 41999 | 0 | 1.4500 | 0.0000 |
| 42000 - 43999 | 0 | 1.7700 | 0.0000 |
| 44000 - 45999 | 0 | 2.1300 | 0.0000 |
| 46000 - 47999 | 0 | 2.5500 | 0.0000 |
| 48000 - 49999 | 1 | 3.0200 | 3.0200 |
| 50000 - 51999 | 0 | 3.5600 | 0.0000 |
| 52000 - 53999 | 0 | 4.1600 | 0.0000 |
| 54000 - 55999 | 0 | 4.8400 | 0.0000 |
| 56000 - 57999 | 0 | 5.5900 | 0.0000 |
| 58000 - 59999 | 0 | 6.4200 | 0.0000 |
| 60000 - 61999 | 1 | 7.3300 | 7.3300 |
| 62000 - 63999 | 0 | 8.3300 | 0.0000 |
| 64000 - 65999 | 0 | 9.4200 | 0.0000 |
| 66000 - 67999 | 0 | 10.6000 | 0.0000 |
| 68000 - 69999 | 0 | 11.9000 | 0.0000 |
| | **Total ESAL's =** | | **10.7200** |

| | |
|---|---|
| **Total 18 KIP ESAL's =** | **3078.4820** |
| **Number of Trucks Weighed =** | **1574** |
| **Truck Factor =** | **1.9558** |

Table D-4. Summary of WIM ESAL data, single-axle loads, site 2.

| *Site 2 : I-10 WB MP 140 (between 43rd and 51st Street)*<br>*Traffic Count from 4/25 to 4/27*<br>*Axle Load Data from Lane 3*<br>*10" Pavement* |
|---|

| Tandem Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 5999 | 3 | 0.0020 | 0.0060 |
| 6000 - 7999 | 35 | 0.0050 | 0.1750 |
| 8000 - 9999 | 127 | 0.0120 | 1.5240 |
| 10000 - 11999 | 263 | 0.0250 | 6.5750 |
| 12000 - 13999 | 368 | 0.0470 | 17.2960 |
| 14000 - 15999 | 428 | 0.0810 | 34.6680 |
| 16000 - 17999 | 353 | 0.1320 | 46.5960 |
| 18000 - 19999 | 381 | 0.2040 | 77.7240 |
| 20000 - 21999 | 366 | 0.3050 | 111.6300 |
| 22000 - 23999 | 238 | 0.4410 | 104.9580 |
| 24000 - 25999 | 258 | 0.6200 | 159.9600 |
| 26000 - 27999 | 197 | 0.8500 | 167.4500 |
| 28000 - 29999 | 156 | 1.1400 | 177.8400 |
| 30000 - 31999 | 112 | 1.5000 | 168.0000 |
| 32000 - 33999 | 85 | 1.9500 | 165.7500 |
| 34000 - 35999 | 85 | 2.4800 | 210.8000 |
| 36000 - 37999 | 61 | 3.1200 | 190.3200 |
| 38000 - 39999 | 44 | 3.8700 | 170.2800 |
| 40000 - 41999 | 35 | 4.7400 | 165.9000 |
| 42000 - 43999 | 43 | 5.7500 | 247.2500 |
| 44000 - 45999 | 24 | 6.9000 | 165.6000 |
| 46000 - 47999 | 14 | 8.2100 | 114.9400 |
| 48000 - 49999 | 0 | 9.6800 | 0.0000 |
| 50000 - 51999 | 0 | 11.3000 | 0.0000 |
| 52000 - 53999 | 0 | 13.2000 | 0.0000 |
| 54000 - 55999 | 0 | 15.2000 | 0.0000 |
| | **Total ESAL's =** | | **2505.2420** |

Table D-5. Summary of WIM ESAL data, tandem-axle loads, site 2.

| *Site 2 : I-10 WB MP 140 (between 43rd and 51st Street)*<br>*Traffic Count from 4/25 to 4/27*<br>*Axle Load Data from Lane 3*<br>*10" Pavement* |
|---|

| Single Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 1999 | 0 | 0.0002 | 0.0000 |
| 2000 - 3999 | 182 | 0.0020 | 0.3640 |
| 4000 - 5999 | 1234 | 0.0100 | 12.3400 |
| 6000 - 7999 | 1542 | 0.0320 | 49.3440 |
| 8000 - 9999 | 1052 | 0.0810 | 85.2120 |
| 10000 - 11999 | 737 | 0.1750 | 128.9750 |
| 12000 - 13999 | 422 | 0.3380 | 142.6360 |
| 14000 - 15999 | 353 | 0.6010 | 212.1530 |
| 16000 - 17999 | 197 | 1.0000 | 197.0000 |
| 18000 - 19999 | 118 | 1.5800 | 186.4400 |
| 20000 - 21999 | 76 | 2.3800 | 180.8800 |
| 22000 - 23999 | 45 | 3.4500 | 155.2500 |
| 24000 - 25999 | 23 | 4.8500 | 111.5500 |
| 26000 - 27999 | 0 | 6.6100 | 0.0000 |
| 28000 - 29999 | 0 | 8.7900 | 0.0000 |
| 30000 - 31999 | 0 | 11.4000 | 0.0000 |
| 32000 - 33999 | 0 | 14.6000 | 0.0000 |
| 34000 - 35999 | 0 | 18.3000 | 0.0000 |
| 36000 - 37999 | 0 | 22.7000 | 0.0000 |
| 38000 - 39999 | 0 | 27.9000 | 0.0000 |
| | Total ESAL's = | | 1462.1440 |

Table D-6. Summary of WIM ESAL data, tridem-axle loads, site 2.

| |
|---|
| *Site 2 : I-10 WB MP 140 (between 43rd and 51st Street)* |
| *Traffic Count from 4/25 to 4/27* |
| *Axle Load Data from Lane 3* |
| *10" Pavement* |

| Tridem Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 11999 | 0 | 0.0090 | 0.0000 |
| 12000 - 13999 | 1 | 0.0160 | 0.0160 |
| 14000 - 15999 | 3 | 0.0270 | 0.0810 |
| 16000 - 17999 | 0 | 0.0440 | 0.0000 |
| 18000 - 19999 | 2 | 0.0660 | 0.1320 |
| 20000 - 21999 | 1 | 0.0980 | 0.0980 |
| 22000 - 23999 | 4 | 0.1390 | 0.5560 |
| 24000 - 25999 | 1 | 0.1940 | 0.1940 |
| 26000 - 27999 | 1 | 0.2630 | 0.2630 |
| 28000 - 29999 | 2 | 0.3510 | 0.7020 |
| 30000 - 31999 | 1 | 0.4600 | 0.4600 |
| 32000 - 33999 | 0 | 0.5940 | 0.0000 |
| 34000 - 35999 | 0 | 0.7560 | 0.0000 |
| 36000 - 37999 | 0 | 0.9500 | 0.0000 |
| 38000 - 39999 | 0 | 1.1800 | 0.0000 |
| 40000 - 41999 | 0 | 1.4500 | 0.0000 |
| 42000 - 43999 | 1 | 1.7700 | 1.7700 |
| 44000 - 45999 | 1 | 2.1300 | 2.1300 |
| 46000 - 47999 | 0 | 2.5500 | 0.0000 |
| 48000 - 49999 | 0 | 3.0200 | 0.0000 |
| 50000 - 51999 | 0 | 3.5600 | 0.0000 |
| 52000 - 53999 | 1 | 4.1600 | 4.1600 |
| 54000 - 55999 | 0 | 4.8400 | 0.0000 |
| 56000 - 57999 | 0 | 5.5900 | 0.0000 |
| 58000 - 59999 | 0 | 6.4200 | 0.0000 |
| 60000 - 61999 | 0 | 7.3300 | 0.0000 |
| 62000 - 63999 | 0 | 8.3300 | 0.0000 |
| 64000 - 65999 | 0 | 9.4200 | 0.0000 |
| 66000 - 67999 | 0 | 10.6000 | 0.0000 |
| 68000 - 69999 | 0 | 11.9000 | 0.0000 |
| | Total ESAL's = | | 10.5620 |

| | |
|---|---|
| Total 18 KIP ESAL's = | 3977.9480 |
| Number of Trucks Weighed = | 3256 |
| Truck Factor = | 1.2217 |

Table D-7. Summary of WIM ESAL data, single-axle loads, site 3.

| *Site 3 : I-17 NB MP 209.5 (between Thunderbird & Cactus)* |
|---|
| *Traffic Count from 4/25 to 4/27* |
| *Axle Load Data from Lane 3* |
| *9" Pavement* |

| Single Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 1999 | 1 | 0.0002 | 0.0002 |
| 2000 - 3999 | 12 | 0.0020 | 0.0240 |
| 4000 - 5999 | 439 | 0.0100 | 4.3900 |
| 6000 - 7999 | 932 | 0.0320 | 29.8240 |
| 8000 - 9999 | 904 | 0.0820 | 74.1280 |
| 10000 - 11999 | 615 | 0.1760 | 108.2400 |
| 12000 - 13999 | 261 | 0.3410 | 89.0010 |
| 14000 - 15999 | 126 | 0.6040 | 76.1040 |
| 16000 - 17999 | 63 | 1.0000 | 63.0000 |
| 18000 - 19999 | 23 | 1.5700 | 36.1100 |
| 20000 - 21999 | 10 | 2.3400 | 23.4000 |
| 22000 - 23999 | 1 | 3.3600 | 3.3600 |
| 24000 - 25999 | 2 | 4.6700 | 9.3400 |
| 26000 - 27999 | 0 | 6.2900 | 0.0000 |
| 28000 - 29999 | 0 | 8.2800 | 0.0000 |
| 30000 - 31999 | 0 | 10.7000 | 0.0000 |
| 32000 - 33999 | 0 | 13.6000 | 0.0000 |
| 34000 - 35999 | 0 | 17.1000 | 0.0000 |
| 36000 - 37999 | 0 | 21.3000 | 0.0000 |
| 39000 - 39999 | 0 | 26.3000 | 0.0000 |
| | Total ESAL's = | | 516.9212 |

Table D-8. Summary of WIM ESAL data, tandem-axle loads, site 3.

| *Site 3 : I-17 NB MP 209.5 (between Thunderbird & Cactus)*<br>*Traffic Count from 4/25 to 4/27*<br>*Axle Load Data from Lane 3*<br>*9" Pavement* |
|---|

| Tandem Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 5999 | 1 | 0.0020 | 0.0020 |
| 6000 - 7999 | 3 | 0.0050 | 0.0150 |
| 8000 - 9999 | 36 | 0.0130 | 0.4680 |
| 10000 - 11999 | 67 | 0.0260 | 1.7420 |
| 12000 - 13999 | 67 | 0.0480 | 3.2160 |
| 14000 - 15999 | 62 | 0.0820 | 5.0840 |
| 16000 - 17999 | 52 | 0.1330 | 6.9160 |
| 18000 - 19999 | 71 | 0.2060 | 14.6260 |
| 20000 - 21999 | 120 | 0.3080 | 36.9600 |
| 22000 - 23999 | 119 | 0.4440 | 52.8360 |
| 24000 - 25999 | 112 | 0.6220 | 69.6640 |
| 26000 - 27999 | 115 | 0.8500 | 97.7500 |
| 28000 - 29999 | 112 | 1.1400 | 127.6800 |
| 30000 - 31999 | 68 | 1.4900 | 101.3200 |
| 32000 - 33999 | 48 | 1.9200 | 92.1600 |
| 34000 - 35999 | 21 | 2.4300 | 51.0300 |
| 36000 - 37999 | 21 | 3.0300 | 63.6300 |
| 38000 - 39999 | 12 | 3.7400 | 44.8800 |
| 40000 - 41999 | 13 | 4.5500 | 59.1500 |
| 42000 - 43999 | 2 | 5.4800 | 10.9600 |
| 44000 - 45999 | 4 | 6.5300 | 26.1200 |
| 46000 - 47999 | 2 | 7.7300 | 15.4600 |
| 48000 - 49999 | 0 | 9.0700 | 0.0000 |
| 50000 - 51999 | 0 | 10.6000 | 0.0000 |
| 52000 - 53999 | 0 | 12.3000 | 0.0000 |
| 54000 - 55999 | 0 | 14.2000 | 0.0000 |
| | Total ESAL's = | | 881.6690 |

Table D-9. Summary of WIM ESAL data, tridem-axle loads, site 3.

| *Site 3 : I-17 NB MP 209.5 (between Thunderbird & Cactus)* |
|---|
| *Traffic Count from 4/25 to 4/27* |
| *Axle Load Data from Lane 3* |
| *9" Pavement* |

| Tridem Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 11999 | 0 | 0.0090 | 0.0000 |
| 12000 - 13999 | 0 | 0.0170 | 0.0000 |
| 14000 - 15999 | 0 | 0.0280 | 0.0000 |
| 16000 - 17999 | 1 | 0.0440 | 0.0440 |
| 18000 - 19999 | 1 | 0.0670 | 0.0670 |
| 20000 - 21999 | 0 | 0.0990 | 0.0000 |
| 22000 - 23999 | 1 | 0.1410 | 0.1410 |
| 24000 - 25999 | 2 | 0.1950 | 0.3900 |
| 26000 - 27999 | 0 | 0.2650 | 0.0000 |
| 28000 - 29999 | 2 | 0.3540 | 0.7080 |
| 30000 - 31999 | 0 | 0.4630 | 0.0000 |
| 32000 - 33999 | 0 | 0.5960 | 0.0000 |
| 34000 - 35999 | 0 | 0.7570 | 0.0000 |
| 36000 - 37999 | 1 | 0.9480 | 0.9480 |
| 38000 - 39999 | 0 | 1.1700 | 0.0000 |
| 40000 - 41999 | 0 | 1.4400 | 0.0000 |
| 42000 - 43999 | 0 | 1.7400 | 0.0000 |
| 44000 - 45999 | 1 | 2.0900 | 2.0900 |
| 46000 - 47999 | 0 | 2.4900 | 0.0000 |
| 48000 - 49999 | 0 | 2.9400 | 0.0000 |
| 50000 - 51999 | 0 | 3.4400 | 0.0000 |
| 52000 - 53999 | 0 | 4.0000 | 0.0000 |
| 54000 - 55999 | 0 | 4.6300 | 0.0000 |
| 56000 - 57999 | 0 | 5.3200 | 0.0000 |
| 58000 - 59999 | 0 | 6.0800 | 0.0000 |
| 60000 - 61999 | 0 | 6.9100 | 0.0000 |
| 62000 - 63999 | 0 | 7.8200 | 0.0000 |
| 64000 - 65999 | 0 | 8.8300 | 0.0000 |
| 66000 - 67999 | 0 | 9.9000 | 0.0000 |
| 68000 - 69999 | 0 | 11.1000 | 0.0000 |
| | | **Total ESAL's =** | **4.3880** |

| | |
|---|---|
| **Total 18 KIP ESAL's =** | **1402.9782** |
| **Number of Trucks Weighed =** | **1813** |
| **Truck Factor =** | **0.7738** |

Table D-10. Summary of WIM ESAL data, single-axle loads, site 4.

| *Site 4 : SR 360 MP 3 (between Rural & McClintock Street)* |
|---|
| *Traffic Count from 4/25 to 4/28* |
| *Axle Load Data from Lane 3* |
| *13" Pavement* |

| Single Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 1999 | 0 | 0.0002 | 0.0000 |
| 2000 - 3999 | 79 | 0.0020 | 0.1580 |
| 4000 - 5999 | 566 | 0.0100 | 5.6600 |
| 6000 - 7999 | 699 | 0.0320 | 22.3680 |
| 8000 - 9999 | 873 | 0.0800 | 69.8400 |
| 10000 - 11999 | 597 | 0.1730 | 103.2810 |
| 12000 - 13999 | 307 | 0.3360 | 103.1520 |
| 14000 - 15999 | 136 | 0.5990 | 81.4640 |
| 16000 - 17999 | 77 | 1.0000 | 77.0000 |
| 18000 - 19999 | 35 | 1.5900 | 55.6500 |
| 20000 - 21999 | 25 | 2.4100 | 60.2500 |
| 22000 - 23999 | 7 | 3.5400 | 24.7800 |
| 24000 - 25999 | 1 | 5.0400 | 5.0400 |
| 26000 - 27999 | 0 | 6.9800 | 0.0000 |
| 28000 - 29999 | 0 | 9.4600 | 0.0000 |
| 30000 - 31999 | 0 | 12.6000 | 0.0000 |
| 32000 - 33999 | 0 | 16.0000 | 0.0000 |
| 34000 - 35999 | 0 | 20.4000 | 0.0000 |
| 36000 - 37999 | 0 | 25.6000 | 0.0000 |
| 38000 - 39999 | 0 | 31.6000 | 0.0000 |
| | Total ESAL's = | | **608.6430** |

Table D-11. Summary of WIM ESAL data, tandem-axle loads, site 4.

*Site 4 : SR 360 MP 3 (between Rural & McClintock Street)*
*Traffic Count from 4/25 to 4/28*
*Axle Load Data from Lane 3*
*13" Pavement*

| Tandem Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 5999 | 0 | 0.0020 | 0.0000 |
| 6000 - 7999 | 2 | 0.0050 | 0.0100 |
| 8000 - 9999 | 10 | 0.0120 | 0.1200 |
| 10000 - 11999 | 29 | 0.0250 | 0.7250 |
| 12000 - 13999 | 39 | 0.0470 | 1.8330 |
| 14000 - 15999 | 66 | 0.0800 | 5.2800 |
| 16000 - 17999 | 105 | 0.1310 | 13.7550 |
| 18000 - 19999 | 108 | 0.2030 | 21.9240 |
| 20000 - 21999 | 137 | 0.3030 | 41.5110 |
| 22000 - 23999 | 118 | 0.4390 | 51.8020 |
| 24000 - 25999 | 90 | 0.6180 | 55.6200 |
| 26000 - 27999 | 83 | 0.8490 | 70.4670 |
| 28000 - 29999 | 54 | 1.1400 | 61.5600 |
| 30000 - 31999 | 52 | 1.5100 | 78.5200 |
| 32000 - 33999 | 57 | 1.9700 | 112.2900 |
| 34000 - 35999 | 38 | 2.5200 | 95.7600 |
| 36000 - 37999 | 37 | 3.2000 | 118.4000 |
| 38000 - 39999 | 22 | 4.0000 | 88.0000 |
| 40000 - 41999 | 16 | 4.9500 | 79.2000 |
| 42000 - 43999 | 11 | 6.0600 | 66.6600 |
| 44000 - 45999 | 8 | 7.3600 | 58.8800 |
| 46000 - 47999 | 7 | 8.8600 | 62.0200 |
| 48000 - 49999 | 0 | 10.5800 | 0.0000 |
| 50000 - 51999 | 0 | 12.5000 | 0.0000 |
| 52000 - 53999 | 0 | 14.8000 | 0.0000 |
| 54000 - 55999 | 0 | 17.3000 | 0.0000 |
| | **Total ESAL's =** | | **1084.3370** |

Table D-12. Summary of WIM ESAL data, tridem-axle loads, site 4.

*Site 4 : SR 360 MP 3 (between Rural & McClintock Street)*
*Traffic Count from 4/25 to 4/28*
*Axle Load Data from Lane 3*
*13" Pavement*

| Tridem Axle Loads | 48 - Hour Count | Lef | 18 - Kip ESAL's |
|---|---|---|---|
| 0 - 11999 | 0 | 0.0090 | 0.0000 |
| 12000 - 13999 | 0 | 0.0160 | 0.0000 |
| 14000 - 15999 | 0 | 0.0270 | 0.0000 |
| 16000 - 17999 | 0 | 0.0430 | 0.0000 |
| 18000 - 19999 | 0 | 0.0660 | 0.0000 |
| 20000 - 21999 | 0 | 0.0970 | 0.0000 |
| 22000 - 23999 | 0 | 0.1380 | 0.0000 |
| 24000 - 25999 | 3 | 0.1920 | 0.5760 |
| 26000 - 27999 | 3 | 0.2620 | 0.7860 |
| 28000 - 29999 | 2 | 0.3490 | 0.6980 |
| 30000 - 31999 | 1 | 0.4580 | 0.4580 |
| 32000 - 33999 | 1 | 0.5920 | 0.5920 |
| 34000 - 35999 | 0 | 0.7550 | 0.0000 |
| 36000 - 37999 | 1 | 0.9510 | 0.9510 |
| 38000 - 39999 | 1 | 1.1800 | 1.1800 |
| 40000 - 41999 | 1 | 1.4600 | 1.4600 |
| 42000 - 43999 | 1 | 1.7800 | 1.7800 |
| 44000 - 45999 | 1 | 2.1600 | 2.1600 |
| 46000 - 47999 | 0 | 2.6000 | 0.0000 |
| 48000 - 49999 | 0 | 3.1000 | 0.0000 |
| 50000 - 51999 | 0 | 3.6800 | 0.0000 |
| 52000 - 53999 | 0 | 4.3300 | 0.0000 |
| 54000 - 55999 | 0 | 5.0700 | 0.0000 |
| 56000 - 57999 | 0 | 5.9000 | 0.0000 |
| 58000 - 59999 | 0 | 6.8400 | 0.0000 |
| 60000 - 61999 | 0 | 7.8800 | 0.0000 |
| 62000 - 63999 | 0 | 9.0400 | 0.0000 |
| 64000 - 65999 | 0 | 10.3300 | 0.0000 |
| 66000 - 67999 | 0 | 11.7000 | 0.0000 |
| 68000 - 69999 | 0 | 13.3000 | 0.0000 |
| | | **Total ESAL's =** | **10.6410** |

| | |
|---|---|
| **Total 18 KIP ESAL's =** | **1703.6210** |
| **Number of Trucks Weighed =** | **1764** |
| **Truck Factor =** | **0.9658** |

# APPENDIX E

# REHABILITATION SELECTION GUIDELINES

# APPENDIX E REHABILITATION SELECTION GUIDELINES

## 1. INTRODUCTION

Concrete pavements are generally thought of as able to provide long service lives while maintaining a high level of rideability. However, a number of factors can contribute to the accelerated deterioration of a concrete pavement. These factors include poor design and construction practices, materials problems, higher than expected traffic loadings, and harsh environmental conditions. Such factors can be present either singly or in combination with each other. As pavements represent a rather substantial infrastructure investment, it is highly desirable to consider the possibility of rehabilitating pavements that begin to deteriorate, and especially those that experience a premature deterioration, in order to obtain the desired service from that investment.

There are a large number of rehabilitation strategies that are available to restore the condition of concrete pavements. These strategies have been developed and refined over many years to address a wide variety of problems that have occurred on concrete pavements around the country.

The Phoenix urban corridor does not have a large number of miles of concrete pavement. However, the approximately 200 miles of concrete pavement represent a substantial investment. It is in the best interests of the Arizona Department of Transportation to pursue cost-effective strategies that will prolong the life and serviceability of these pavements.

This appendix presents information on the rehabilitation of jointed concrete pavements in the Phoenix urban corridor. A number of rehabilitation techniques are evaluated for their applicability in the urban corridor. This evaluation is based on discussions with ADOT personnel, local contractors, and other experts in the area of concrete pavement rehabilitation. A complete description of the individual rehabilitation techniques is provided in appendix F.

## 2. REHABILITATION PHILOSOPHY

The approach documented in this appendix reflects a philosophy concerning pavement rehabilitation that should be mentioned. It is believed that <u>routine maintenance</u> should be performed on a pavement from the time of construction. Routine pavement maintenance is defined as repairs such as joint and crack sealing and patching that can be performed by maintenance crews. When routine maintenance becomes either too costly, too complex, or insufficient to keep the pavement rideable, rehabilitation of jointed concrete pavements should be performed. Rehabilitation should be performed as long as it can be effective in restoring safety and rideability, and is cost-effective. At that point, appropriate strategies to consider include overlays or reconstruction.

Based on the performance of the concrete pavements in the Phoenix Urban Corridor, it appears that rehabilitation or restoration may be the most desirable approach. This is because none of the pavements are showing any structural deficiencies and should, for the most part, be able to be restored to an acceptable serviceability without an overlay or reconstruction. However, should the rehabilitation costs become excessive (from the proposed patching of many of the joints, for instance), then reconstruction or an unbonded overlay may become a more cost-effective alternative.

## 3. SPECIAL CONSIDERATIONS WHICH AFFECT REHABILITATION

There are several elements of concrete pavements that make their performance in the Phoenix area atypical. The climate is not typical of that to which most pavements are exposed. The average temperatures that these pavements experience are much higher and they do not experience the low temperatures to which much of the rest of the country are exposed. Phoenix has a very low annual rainfall, but the moisture that it does receive often comes over a very short period of time. The traffic volumes are high, although much of that traffic is passenger vehicles. The cost of disrupting traffic is also high, both in terms of user delay and in the risk to workers' lives because of the volume and speed of traffic.

The Phoenix urban corridor also poses some special constraints on rehabilitation strategies due to its unique characteristics. Some of these are safety constraints, including the presence of many entrance/exit ramps with their "gore" areas, and the around-the-clock high volumes of traffic. Physical constraints are posed by the limited right of way and the large number of bridges. There are also constraints that might best be labeled "political." Any project in the urban corridor is very visible and poses a potential public relations liability because of the number of people exposed to it. It is therefore highly desirable to limit high user costs due to prolonged delays from construction projects. There are also constraints presented by construction noise or dust if the project is near a residential neighborhood. Table E-1 summarizes these constraints.

## 4. REHABILITATION OBJECTIVES

There are several major objectives of a rehabilitation strategy that must be taken into account. The primary objective is to provide cost-effective and timely rehabilitation treatments to the pavement in order to maximize the benefits of that pavement. The rehabilitation strategy must be constructable within the constraints of

Table E-1. Special considerations which affect pavement rehabilitation projects in the urban corridor.

---

**SAFETY CONSTRAINTS**

- Frequent merging and "gore" areas
- High traffic volume

**PHYSICAL CONSTRAINTS**

- Limited right of way
- Many bridges

**"POLITICAL" CONSTRAINTS**

- High project visibility
- High user cost of delays
- Construction noise and dust

---

ADOT policy and procedures, and also subject to other specific factors, such as climate, contractor availability, materials availability, and traffic safety. A rehabilitation strategy should also minimize the number of times that rehabilitation work needs to be performed or, conversely, the performance period of the treatments selected should be maximized.

Traffic disruption is a major concern in the Phoenix urban corridor. In that respect, the major objectives must include minimizing the costs of user delays and safety hazards. This is summed up by minimizing the disruption to traffic flow during all rehabilitation work. Strategies must be selected that can be performed rapidly, that will allow the pavement to be opened quickly, and that will last a long time. Consideration should also be given to obtaining the maximum use of lane closures for <u>any</u> activity to coordinate the scheduling of various rehabilitation activities. All of these various objectives are summarized in table E-2.

## 5. DETERMINATION OF REHABILITATION NEEDS

How does an agency determine that rehabilitation is needed? An obvious indicator would be when pavement conditions reach the point that they present a safety hazard to users. Examples of this include poor friction characteristics (resulting in hydroplaning), excessive roughness, and localized safety hazards such as potholes. An overall indicator of the need for rehabilitation is embodied in the "rideability" concept. When a pavement reaches an unacceptable rideability level, rehabilitation is needed. However, identification of when a ride is unacceptable may be much harder to determine or agree on, and must be determined by the given agency.

One way to assess the need for rehabilitation is to study the maintenance demands of a pavement. When routine maintenance levels exceed an agencies ability to perform the work or their budgetary limits, it is probably time to perform some rehabilitative work.

The need for rehabilitation may also be determined when a pavement no longer meets certain standards. An example of this would be when the capacity of a pavement is exceeded and additional traffic lanes need to be added. This also occurs when certain geometric features, such as ramps, signs, and guardrails, need to be improved in order to meet revised safety standards.

Rehabilitation can be scheduled to prolong the life of a pavement, in much the same way that routine maintenance is performed. Timely implementation of rehabilitation strategies can extend a pavement's life and delay the need for either costlier rehabilitation, resurfacing, or reconstruction. These indicators are summarized in table E-3.

Table E-2. Objectives of a pavement rehabilitation strategy in the Phoenix Urban Corridor.

- To provide cost-effective and timely rehabilitation treatments.
- To select rehabilitation strategies which are constructable, practical, and meet both political and physical constraints as well as ADOT policy.
- To minimize the frequency with which rehabilitation work must be performed or maximize the performance of all work.
- To minimize the user delay costs and eliminate safety hazards to both the traveling public and highway workers.
- To maximize the use of lane closures by selecting and scheduling rehabilitation work that can be performed concomitantly.

Table E-3. Factors that determine when pavement rehabilitation is needed.

- When use of the pavement results in a ride that is considered unacceptable to the traveling public.
- When pavement conditions become unsafe, such as with the presence of poor friction characteristics, excessive roughness, or localized potholes.
- When maintenance levels become either too excessive or too costly.
- When appurtenances such as ramps, signs, or guardrails need to be improved to meet current safety standards.
- When failure to perform rehabilitation will result in the need for more costly strategies, or even reconstruction.

The decision tree shown in figure E-1 is a useful means of initiating the decision-making process. The process begins with a regular means of monitoring the pavement condition and maintenance needs. The first step is to identify if there is a structural deficiency. Indicators for a structural deficiency include certain threshold levels for cracked slabs, the rate of cracking, and materials problems. If there is a structural deficiency, pavement rehabilitation is not sufficient, and measures such as overlays or reconstruction are called for. When there is not a structural deficiency, the data must be analyzed to see if there is a functional deficiency. Assistance in the determination of the existence of a functional deficiency for the Phoenix urban corridor's jointed concrete pavements is provided in the decision matrix of table E-4. Guidelines such as these can be used to help the pavement engineer to determine when given distresses and levels will trigger the need for rehabilitation.

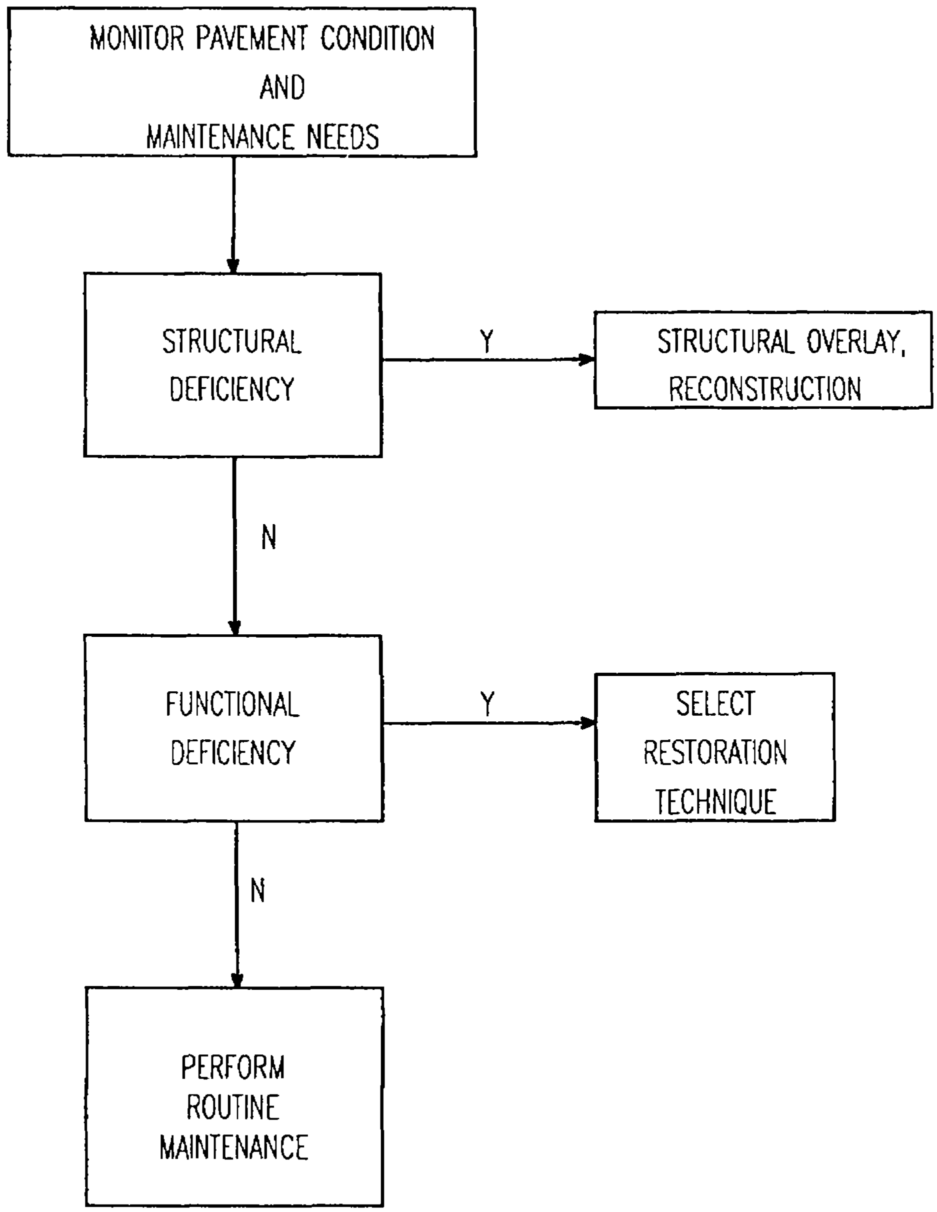
Table E-4 provides a general indication of whether or not there is a need for rehabilitation on a given pavement. More complete information is provided in the decision matrices for specific distresses, such as those shown in figures E-2 through E-4. These show the type of approach that can be followed to determine the exact rehabilitation strategies. The strategies themselves are described in much greater detail in appendix F.

## 6. EXAMPLE APPLICATION

This rehabilitation approach was applied to a Phoenix-area concrete pavement section to evaluate the appropriateness of the rehabilitation recommendations. The pavement evaluated is project section 17-04, located on I-17 between the Dunlap and Northern exits, in the southbound direction. Summary information about the condition of the outer lane of this pavement section is presented in table E-5. At the time of its evaluation, this 23-year old pavement was in fairly good condition. The strip map for this section is shown in figure E-5. As can be seen, the major distresses are the high percentage of spalled joints and the poor condition of both the transverse and the longitudinal lane-shoulder joint sealant.

The rehabilitation decision tree shows that since there is no structural deficiency, the existence of functional deficiencies needs to be determined. The decision matrix shows that the rehabilitation strategies that may be applicable are partial-depth repair and doweled, full-depth repair. The condition of the sealants also indicates the need for resealing of both the transverse joints and lane-shoulder joint. Turning to figure E-4, with the given number of spalled joints of medium and high severity, partial-depth repair or full-depth repair are the probable rehabilitation strategies.

This pavement is one of those constructed with metal joint forming inserts at every fourth joint. This is shown in the strip map, where the spalling is clearly visible in the repetitive pattern. Both partial- and full-depth repair are believed to be




Guidelines for Structural Deficiency:
1) If greater than 10% of the slabs are cracked (or replaced) in the traffic lane.
2) If rate of cracking is rapidly increasing.
3) If there exists serious concrete durability problems.

Guidelines for Functional Deficiency: See distress decision matrix.

Figure E-1. Rehabilitation decision tree.

Table E-4. Jointed concrete pavement restoration decision matrix.

| Distress \ M&R Technique | Do Nothing | Crack Sealing | Transverse Joint Resealing | Longit. Lane-Shoulder Jt. Reseal | Partial Depth Repair | Doweled Full Depth Repair | Slab Replacement | Slab Stabilization | Doweled Load Transfer Restoration | Grinding | Grooving | Three Layer System | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Longitudinal/ Transverse Cracking | L | M, H | | | | M, H | M*, H | | L, M | | | | *Quantity |
| Joint Seal Damage | L | | M, H | M, H | | | | | | | | | |
| Patch Deterioration | L | | | | M | H | H* | | | | | | *Other Distresses? |
| Faulting | L | | L? | | | | | M, H | ? | H | | H* | *Combine with Grinding |
| Transverse Joint Spalling | L | L | | | M, H | M, H | H | | H* | | | | *With Full Depth Repair |
| Poor Load Transfer | L | | | | | | | M*, H* | M*, H* | | | | *Further Data Required |
| Poor Friction Resistance | | | | | | | | | | X* | X* | X* | *Check wet accident rate |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

See specific Distress Decision Matrix for More Complete Elaboration on Strategy

| Severity Level \ Accompanying Distress | None | Spalling | Corner Breaks | Slab Cracking |
|---|---|---|---|---|
| LOW | Joint Resealing, Do Nothing | Do Nothing | Replacement | Do Nothing |
| MEDIUM | Slab Stabilization, Grinding | PDR, Grinding, Slab Stabilization | Replacement | Grinding, Crack Sealing |
| HIGH | Slab Stabilization, Grinding, 3-Layer System | Slab Stabilization. PDR, FDR, Grinding | FDR, Replacement | FDR, Replacement, Grinding |

Figure E-2. Decision matrix for transverse joint faulting.

| Overall Severity \ Quantity, Feet/Mile | < 120 | 120 - 480 | 480 - 850 | > 850 |
|---|---|---|---|---|
| LOW | Do Nothing | Do Nothing | Investigate | Investigate |
| MEDIUM | Crack Sealing | Crack Sealing | Crack Sealing, FDR, Replacement | FDR, Replacement |
| HIGH | Crack Sealing | Crack Sealing FDR | FDR, Replacement | FDR, Replacement |

Figure E-3. Decision matrix for slab cracking.

| Severity Level \ Percent Joints | < 5% | 5% - 15% | 15% - 25% | >25% |
|---|---|---|---|---|
| LOW | Do Nothing | Do Nothing | Do Nothing | PDR, FDR |
| MEDIUM | Do Nothing | PDR | PDR, FDR | FDR |
| HIGH | PDR | FDR | FDR | FDR, Replacement |

Figure E-4. Decision matrix for transverse joint spalling.

Table E-5. Summary of 17-04 condition.

| | |
|---|---|
| **Year of Construction:** 1965 | |
| **Pavement cross-section:** 9" JPCP, 4" AGG base, 6" AGG subbase, on A-1-6 subgrade | |
| **Estimated Accumulated ESAL's:** 22 million (1988) | |
| **Mean Faulting:** 0.02 in | |
| **Percent Spalled Joints:** 40.3 % (6.9% Low, 16.7% Medium, 16.7% High) | |
| **Linear Feet of Cracking:** 3 ft (65 ft due to improper joint construction) | |
| **Shoulder Condition:** Good | |
| **Sealant Condition:** 100% high severity damage; lane-shoulder joint same | |

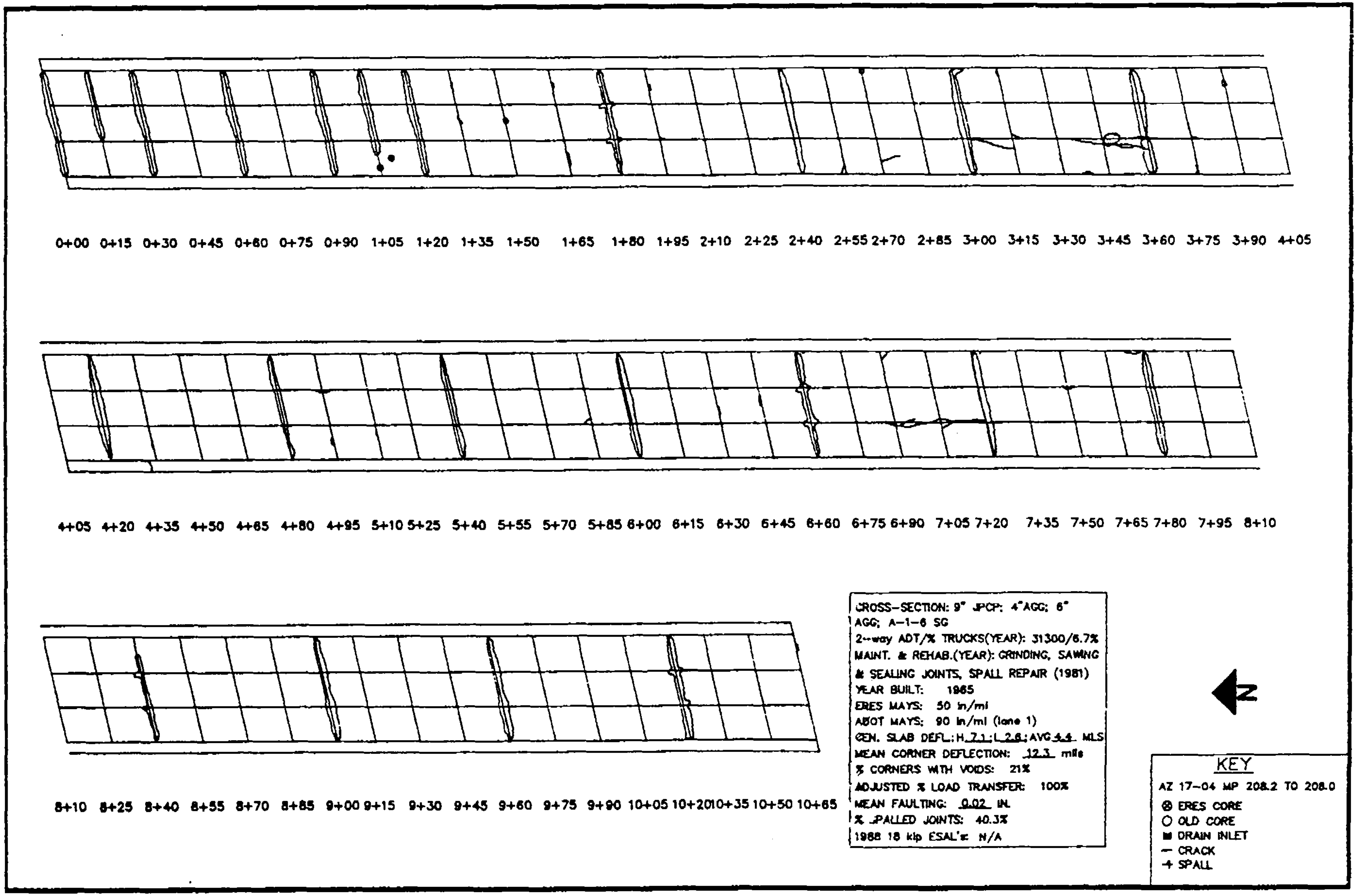



Figure E-5. Strip map for AZ 17-04.

effective alternatives for this pavement, although those joints constructed with the metal joint forming inserts would be better candidates for full-depth repairs because of the extent and severity of the spalling at those locations.

If a substantial amount of joint repair is required for this section, consideration must be given to the possibility of reconstruction or an unbonded overlay. These latter alternatives may become attractive if the costs of the joint repair become excessive in light of their projected service life.

The recommendations obtained using this approach for project 17-04 appeared to be reasonable. While it is quite simplistic and not intended to replace a thorough pavement evaluation and analysis, it appears to provide strong indications as to the most desirable rehabilitation methods. The approach was followed for the other sections in the study and the results reported in chapter 6 of volume I.

## 7. SELECTION OF OTHER REHABILITATION TECHNIQUES

This document does not discuss strategies that are appropriate for pavements that have structural deficiencies. These pavements are typically considered to be candidates for an overlay. A selection of overlay alternatives and some guidelines on their appropriateness are presented in table E-6.

A recent FHWA study provided feasibility guidelines for the construction of various rehabilitation alternatives.[E-1] These are provided in tables E-7 through E-13.

Additional research is needed on the timing of pavement rehabilitation activities in order to maximize their benefits. Too often, by the time significant pavement deterioration is present, more drastic rehabilitation measures are required, which would be particularly inconvenient in the Phoenix Urban Corridor because of user delay costs.

## 8. REFERENCES

E-1. Darter, M. I. and K. T. Hall, "Structural Overlay Strategies for Jointed Concrete Pavements, Volume IV—Guidelines for the Selection of Rehabilitation Alternatives," Federal Highway Administration, FHWA-RD-89-145, June 1990.

Table E-6. Overlay alternatives.

**OBJECTIVE:** *To provide a functional and/or structural improvement to the pavement*

| OVERLAY TYPE | PAVEMENT CONDITION | PRE-OVERLAY REPAIRS |
|---|---|---|
| 3-Layer System | Faulting, joint spalling, polishing | Patching |
| Conventional Asphalt Concrete Overlay (ACOL) | Faulting, cracking, joint spalling, polishing | Extensive patching |
| Sawed and Sealed ACOL | Same as with conventional | Extensive patching |
| Crack-and-Seat with ACOL | Faulting, cracking, joint spalling (more severe than conventional) | None |
| Bonded Portland Cement Concrete (PCC) Overlay | Minimal spalling, faulting, cracking | Patching of all cracks, spalls; slab stabilization |
| Unbonded PCC Overlay | Extensive faulting, cracking, spalling | Minimal, but patching of severely damage areas |

Table E-7. Feasibility guidelines for restoration.[E-1]

| | |
|---|---|
| **CONSTRUCTABILITY** | |
| Vertical Clearance | No problem. |
| Traffic Control | Construction under traffic is common.<br>Rapid repair possible. |
| Construction | Trained personnel required for agency inspector and contractor.<br>Specialized equipment often needed. |
| **PERFORMANCE PERIOD** | |
| Existing Condition | Existing pavement must be in relatively good condition. Limited transverse and longitudinal cracking, D-cracking, or reactive aggregate distress. |
| Extent of Repair | Must repair deteriorated cracks and joints. |
| Subdrainage | Must improve if deficient and truck traffic volume is high. |
| Structural Adequacy | Only limited amount of structural deterioration present. |
| Future Traffic Level | Presence of high truck traffic volume may cause rapid deterioration where structural deterioration exists. |
| Reliability | Fair. Success depends upon the performance of each restoration technique, particularly full-depth repairs. |
| **COST-EFFECTIVENESS** | |
| Initial Cost | Usually lower cost than other alternatives, especially if most deterioration exists in outer lane, and shoulders are in good condition. |
| Life-Cycle Cost | Usually low if structural adequacy is not a problem. |

Table E-8. Feasibility guidelines for bonded PCC overlay.[E-1]

| | |
|---|---|
| **CONSTRUCTABILITY** | |
| Vertical Clearance | Thin (3-in) overlay usually not problem. |
| Traffic Control | Somewhat difficult to construct under traffic. Rapid placement and curing techniques (fast-track paving) are available. |
| Construction | Trained personnel required.<br>Special cleaning equipment needed.<br>Achievement of bond critical.<br>Not widely used so construction experience limited. |
| **PERFORMANCE PERIOD** | |
| Existing Condition | No D-cracking or extensive cracking. |
| Extent of Repair | Must repair deteriorated cracks and joints. |
| Subdrainage | Must improve if deficient. |
| Structural Adequacy | PCC overlay thickness can be provided to increase structural adequacy. |
| Future Traffic Level | Used under any traffic level. |
| Reliability | Fair. Success depends primarily upon achieving permanent bond and proper jointing. |
| **COST-EFFECTIVENESS** | |
| Initial Cost | Usually relatively high.<br>Depends on preoverlay repair needs. |
| Life-Cycle Cost | Competitive with other overlays if future life is substantial. |

Table E-9. Feasibility guidelines for conventional AC overlays.[E-1]

| | |
|---|---|
| **CONSTRUCTABILITY** | |
| Vertical Clearance | Required AC thickness may pose a problem. |
| Traffic Control | Not difficult to construct under traffic.<br>Can be opened to traffic quickly. |
| Construction | Common rehabilitation procedure.<br>AC mixture design critical.<br>Proper construction critical to achieve density. |
| **PERFORMANCE PERIOD** | |
| Existing Condition | The more deterioration present, the thicker the AC overlay required for any given performance period. |
| Extent of Repair | Must repair deteriorated cracks and joints and must provide load transfer across transverse joints to limit reflection crack deterioration. |
| Subdrainage | Must improve if deficient. |
| Structural Adequacy | AC overlay thickness can be provided to increase structural adequacy, but may be substantial. |
| Future Traffic Level | High traffic level may result in excessive rutting, particularly if overlay is thick or mix design is poor. |
| Reliability | Fair. Success depends primarily upon preventing excessive rutting and deterioration of reflection cracks. |
| **COST-EFFECTIVENESS** | |
| Initial Cost | High compared to restoration.<br>Depends greatly on preoverlay repair needs. |
| Life-Cycle Cost | Competitive with other overlays if future life is substantial. |

Table E-10. Feasibility guidelines for AC overlay with sawed and sealed joints.[E-1]

| | |
|---|---|
| **CONSTRUCTABILITY** | |
| Vertical Clearance | Required AC thickness may pose a problem. |
| Traffic Control | Not difficult to construct under traffic. Can be opened to traffic rapidly. Joint sawing requires additional time. |
| Construction | Common rehabilitation procedure, except for joints which must be very accurately sawed. AC mixture design critical. Proper construction critical to achieve density. |
| **PERFORMANCE PERIOD** | |
| Existing Condition | The more deterioration present, the thicker the AC overlay required for any given performance period. |
| Extent of Repair | Must repair deteriorated cracks and joints and must provide load transfer across transverse joints to limit reflection crack deterioration. |
| Subdrainage | Must improve if deficient. |
| Structural Adequacy | AC overlay thickness can be provided to increase structural adequacy, but may be substantial. |
| Future Traffic Level | High traffic level may result in excessive rutting, particularly if overlay is thick or mix design is poor. |
| Reliability | Good. Success depends primarily upon preventing excessive rutting and locating sawed joints accurately above underlying joints and cracks. |
| **COST-EFFECTIVENESS** | |
| Initial Cost | Somewhat higher than conventional AC overlay due to joint sawing. Depends on preoverlay repairs. |
| Life-Cycle Cost | Competitive with other overlays if future life is substantially greater than conventional AC overlays. |

Table E-11 Feasibility guidelines for AC overlay with cracked and seated slab.[E-1]

| | |
|---|---|
| **CONSTRUCTABILITY** | |
| Vertical Clearance | Required AC overlay thickness usually a problem. |
| Traffic Control | Not difficult to construct under traffic. Can be opened to traffic rapidly. Cracking and seating operations requires additional time. |
| Construction | Fairly difficult to crack existing slab sufficiently. AC mixture design critical. Proper construction critical to achieve density. |
| **PERFORMANCE PERIOD** | |
| Existing Condition | Can be applied to more deteriorated concrete pavements. However, if the cracking and seating process does not produce uniform support, with good load transfer across the cracks, serious reflection cracking may develop around the broken pieces. |
| Extent of Repair | Must repair deteriorated cracks and joints and must provide load transfer across transverse joints to limit reflection crack deterioration. |
| Subdrainage | Must improve if deficient. |
| Structural Adequacy | Cracking and seating process reduces concrete slab's structural capacity. Substantial AC overlay thickness must be provided to achieve structural adequacy. |
| Future Traffic Level | High traffic level may result in excessive rutting, particularly if overlay is thick or mix design is poor. High traffic also may result in rocking pieces of concrete, causing reflection cracks in the AC overlay. |

Table E-11. Feasibility guidelines for AC overlay with cracked and seated slab (continued).[E-1]

| | |
|---|---|
| Reliability | Poor to fair. Success depends primarily upon preventing excessive rutting and ensuring that PCC slab is properly cracked. Field performance results to date show that initial delay in onset of reflection cracking is overcome within 6 to 8 years; beyond that time reflection cracking levels equal or exceed those for conventional AC overlays of the same thickness. |
| **COST-EFFECTIVENESS** | |
| Initial Cost | Higher than conventional AC overlay due to cracking and seating and thicker AC overlay required. Depends somewhat on preoverlay repair needs. |
| Life-Cycle Cost | Not competitive with other overlays unless preoverlay repair can be reduced to offset cost of cracking and seating. Life, in terms of rutting and reflection cracking, less than or equal to that of conventional AC overlays of the same thickness. |

Table E-12. Feasibility guidelines for unbonded PCC overlay.[E-1]

| | |
|---|---|
| **CONSTRUCTABILITY** | |
| Vertical Clearance | Required PCC thickness usually a problem. |
| Traffic Control | Difficult to construct under traffic, but can be done using new techniques (zero-clearance paver). Normally cannot be opened to traffic rapidly, except when high-early-strength concrete and special curing techniques used (i.e., fast-track paving). |
| Construction | Does not require any special equipment. |
| **PERFORMANCE PERIOD** | |
| Existing Condition | This overlay can be applied to very deteriorated concrete pavements. |
| Extent of Repair | Very little repair of deteriorated crack and joints is needed. |
| Subdrainage | Improvement recommended if deficient. |
| Structural Adequacy | Substantial PCC overlay thickness must be provided to increase structural adequacy. Minimum thickness of 5 in recommended for low-volume routes, 7 in for higher-volume routes. Joint design is critical. |
| Future Traffic Level | Use under any level of traffic. |
| Reliability | Very good. Can be designed for any desired performance period. |
| **COST-EFFECTIVENESS** | |
| Initial Cost | Higher than conventional AC overlay. |
| Life-Cycle Cost | Not competitive with other overlays unless existing deterioration is significant. |

Table E-13. Feasibility guidelines for reconstruction.[E-1]

| | |
|---|---|
| **CONSTRUCTABILITY** | |
| Vertical Clearance | Reconstructed pavement can be built to any desired grade. |
| Traffic Control | Difficult to construct under traffic, but can be done using new techniques (zero-clearance paver). Normally cannot be opened to traffic rapidly, except when high-early-strength concrete and special curing techniques used (i.e., fast-track paving). |
| Construction | Does not require any special equipment except for removal of old pavement. Recycling of existing slab is an option. Condition of existing base, subbase and subgrade should be considered. |
| **PERFORMANCE PERIOD** | |
| Existing Condition | Generally not a factor in reconstruction performance. Recycling D-cracked or reactive aggregate PCC may require mix design modifications (maximum aggregate size, admixtures). |
| Extent of Repair | None. |
| Subdrainage | New subdrainage system recommended. |
| Structural Adequacy | Can be designed to handle any traffic level. |
| Future Traffic Level | Use under any level of traffic. |
| Reliability | Very good. Can be designed for any desired performance period. |
| **COST-EFFECTIVENESS** | |
| Initial Cost | Normally higher than conventional overlays. |
| Life-Cycle Cost | Not competitive with overlays unless existing deterioration is substantial. |

# APPENDIX F

# CANDIDATE CONCRETE PAVEMENT RESTORATION TECHNIQUES

# APPENDIX F CANDIDATE CONCRETE PAVEMENT RESTORATION TECHNIQUES

## 1. INTRODUCTION

This appendix presents a summary of the various concrete pavement restoration techniques available for use in the Phoenix Urban Corridor. It is expected that many of these would be performed in combination with one another to fully address the problems that a pavement may exhibit. However, in this section, each is evaluated separately for their applicability to the Phoenix Urban Corridor.

A summary of each restoration technique is given, along with a brief history of the ADOT experience with that technique. General guidelines are also provided for its use and installation. Additional information regarding these techniques is provided in the bibliography given at the end of this appendix.

## 2. JOINT AND CRACK SEALANT REPAIR

### Description

Proper joint resealing and crack sealing in jointed concrete pavements entails the placement of sealant materials in well-designed and cleaned pavement joints. The sealant acts as a barrier to moisture and incompressibles entering the joint or crack. Typical uses of sealants in concrete rehabilitation include their placement in transverse joints, longitudinal edge/shoulder joints, and cracks in slabs.

### Reason for Placement

The serviceable life of major highways can be extended by adequately resealing joints and cracks in the pavement. The removal of incompressibles and the prevention of further intrusion is reported to reduce the likelihood of blowups, joint spalling, and joint deterioration during the summer months. Cleaning and sealing transverse joints also can reduce pavement "growth" that may occur as the result of accumulated incompressibles in joints. Pavement growth can create excessive movements near bridges and other structures and necessitate expensive repairs.

Entrance of water at joints is also reduced by joint resealing. As a result, pumping and loss of support problems are reduced. This is especially true at the longitudinal lane joint, where it has been estimated that as much as 80 percent of the water entering from the pavement surface enters the subbase.

### Arizona DOT Experience

The Arizona DOT began sawing and resealing joints in concrete pavements in 1977. However, many of the older concrete pavements in the Phoenix area were not and have not yet been sealed. As a result of this lack of resealing activities and the breakdown of joints containing metal inserts, a recent study on an I-17 rehabilitation project has reported that approximately 40 to 50 percent of the joints were distressed.

Joint sealant material used on new construction since 1972 has included, among others, asphalt rubber, PVC coal tar, and low modulus silicone. Asphalt rubber was reportedly not performing well. Problems with drying, acceptance of incompressibles, and extrusion from joints have been noted. PVC coal tar has been used extensively since 1974 in Arizona and has exhibited variable performance. It has been subject to weathering distress, acceptance of incompressibles, and adhesion failure problems. And, since PVC coal tars have been labeled carcinogenic, the future use of PVC coal tars is questionable. Low modulus silicones have shown good success on Arizona pavements. Silicone sealant life of more than eight years has been observed.

The Arizona DOT has sponsored testing of a number of sealant products on the Superstition Freeway in Phoenix. Among the products tested have been two low-modulus silicone sealants, two asphalt rubber sealants, and two polyurethane sealants. The silicone sealants exhibited good adhesion and resiliency and were performing well after 5 and 8 years. Proper tooling and depth of the silicone surface were noted as critical to good performance. Significant problems with embedding of incompressibles and hardening were encountered in tests of asphalt rubber sealants. Loss of adhesion was noted in one of the test samples. This, however, may have been a result of improper placement procedures. Three component and one component polyurethane sealants were also tested, with the results indicating that the sealants had not performed well. Bond joint failure and tracking of the sealant onto the surface were noted as the major problems. Difficulty in placing the polyurethane sealants was also observed.

### Appropriateness for Use in the Urban Corridor

Transverse joint seal replacement is considered an appropriate maintenance strategy for Phoenix Urban Corridor concrete pavements that exhibit medium and high-severity joint seal damage. Sealant replacement is most appropriate and cost effective in pavements exhibiting blowup or joint spalling tendencies. Near bridge abutments the elimination of incompressibles from transverse joints as a result of joint seal replacement can also be very beneficial.

Replacement of poorly functioning joint sealant at the longitudinal lane/shoulder interface may or may not be appropriate. In the Phoenix area, where average rainfall is 6 to 7 in per year, significant edge pumping problems are not likely to occur, particularly if a stabilized subbase is present. While the replacement of the shoulder joint sealant generally reduces moisture infiltration to the pavement edge, the cost effectiveness of such an activity in Arizona would need to be determined.

It is appropriate to reseal working medium- and high-severity cracks in concrete slabs. These cracks, if filled with incompressibles, can be subject to spall damage and blowups in the same way as pavement joints.

The speed of repair is critical on the Urban Corridor due to the high traffic volumes and the delays resulting from closure of one or more lanes. It is generally recommended that the edges of joint reservoirs be sawed during rehabilitation to facilitate good adhesion of sealant with the concrete. However, if reservoir dimensions are appropriate for design conditions, sandblasting of the edges may be sufficient, and sawing may be eliminated. This practice could reduce repair time for joint seal replacement. A recent Arizona study indicated that good results were obtained when sand blasting was used apart from sawing, and a silicone joint sealant was installed.

It is recommended that joint seal repair projects in the Phoenix area be scheduled for spring and fall. This practice minimizes the relative amount of expansion and compression experienced by the joint sealant material. Traffic disruption can be kept to a minimum by completing repairs during off traffic hours.

**Concurrent Repair Considerations**

Joint resealing can be useful in reducing infiltration of moisture and incompressibles from joints and cracks. However, if other types of pavement damage are present, they should be considered in a comprehensive repair plan. Some rehabilitation options that could be considered for concurrent repair include:

- Slab Stabilization. If high deflections and voids are detected at slab corners or edges, slab stabilization should be examined as a method of restoring support to the slab.

- Restoration of Joint Load Transfer. If deflections are high and load transfer is low across transverse joints, there may be a need for installation of joint load transfer devices. Loaded joint deflections can be reduced by as much as 50 percent by properly working load transfer devices. Cost of large scale repair projects may be prohibitive, however.

- Partial- or Full-Depth Repair. If shallow joint spalls or scaling are present, partial depth repair may be required to improve surface or joint seal reservoir integrity. The necessity for full-depth repair should be assessed if deep spalls, corner breaks, loss of load transfer, or working cracks are present in the pavement.

- Diamond Grinding. The possibility of pavement surface grinding should be examined if the pavement is structurally sound, but exhibits medium faulting or surface polishing.

- Pressure Relief Joints. Pavements demonstrating blowup or "growth" characteristics may require the installation of pressure relief joints.

**Recommendations on Design**

Construction and user delay costs, as well as life-cycle costs, enter into the decision making process for design. As a result, the speed and cost of construction and the lifetime of the joint seal repair must be considered. Among the items to be carefully considered in establishing a cost effective engineering design are the selection of proper materials and the utilization of cost effective construction procedures. As previously noted, the need for concurrent repairs should also be examined.

Selection of joint seal repair material should, among other things, be based on optimization of sealant adhesion, cohesion, resistance to infiltration by incompressibles, resiliency, weathering, setting speeds, life cycle cost, and ease of installation. Research continues in this area. Of the thermoplastic and thermosetting materials in use and undergoing testing by the Arizona DOT, a PVC coal tar sealant has received the most use. Its performance, however, has been variable. Weathering, softening, and adhesion problems have been reported. Low-modulus silicone products have given the most success on Phoenix pavements, although their cost is more than most other joint sealants.

Construction procedures are critical to the performance of any joint sealant material. Joint seal repair should be performed only after the completion of concurrent repairs, as necessary. A few of the more important joint seal rehabilitation design recommendations include:

- Removal of Old Sealant. Initial removal of failed joint sealant has been commonly accomplished through the use of a joint plow, high pressure water blasting, and diamond saw cutting. A V-shaped cutting head should not be used for joint plowing since this tends to spall joint edges. If the sealant does not "gum up" the saw blades, and the shape factor of the existing joint seal reservoir is inadequate, the use of a diamond blade saw to both reshape the reservoir and remove old sealant may speed the repair operation.

- Establishment of Joint Reservoir. The design dimensions of the joint reservoir will be a function of the sealant material used and the expected pavement movement. Use of a single diamond or carbide tipped blade of appropriate width is recommended for forming the reservoir. If the existing joint reservoir is sufficiently wide, sawing can be eliminated only when incompressibles can be removed in another manner.

- Cleaning of Reservoir. Sand blasting of the reservoir is performed to remove cement dust or joint sealant residue from joint sidewalls and to remove incompressibles from the reservoir bottom. For final removal of incompressibles the joint is usually blown out with air. The use of water blasting and wire brushing has been discouraged as a means of cleaning joint reservoirs.

- Placement of Joint Seal Materials. Joint sealant should only be placed in a clean, dry joint reservoir. A backer rod should be installed uniformly to the depth recommended by the sealant manufacturers. Better depth uniformity has been reported in installing backer rod by using the tools designed for installation than by hand. Sealant should be placed in the reservoir according to manufacturer recommendations so that the sealant surface is 1/8 to 1/4 in below the pavement surface.

## 3. PARTIAL-DEPTH SPALL REPAIR

### Description

Partial-depth repair of jointed concrete pavement is described as the removal and replacement of spalled or deteriorated concrete in the upper one-third of the slab. Partial-depth repairs are generally constructed using cementitious materials of normal and rapid set curing properties. These are sometimes modified with additives to obtain rapid setting and high strength properties. Other materials that have been used include epoxy resin mortars, hot applied elastomeric asphalt products, and asphalt concrete. Repairs made using asphalt concrete are generally regarded as only temporary patches.

### Reasons for Placement

Certain types of distresses that affect the top few inches of concrete pavements can be addressed by partial-depth repair methods. These distresses include, but are not limited to, joint and crack spalls, surface scaling, and the early stages of D-cracking or reactive aggregate deterioration.

The service life of nonworking joints and cracks which exhibit medium- and high-severity spalling can be improved by partial depth repair. When spalls extend to less than one-third of the slab thickness, partial-depth repair and joint seal repair can be carried out. The threat of further spalling by removing and sealing out all incompressibles from the joints can be diminished using partial-depth repair.

Surface scaling and D-cracking can lead to a rough pavement surface, joint breakdown, and the possibility of surface debris. If the distresses are limited to the upper one-third of the slab, partial-depth repair may be useful in restoring rideability, joint integrity, and driver safety.

**ADOT Experience**

The majority of joint related distresses on Arizona's concrete pavements are limited to the upper one-half of the slab thickness. As a result, The Arizona DOT has had extensive experience with the use of partial-depth repairs in the Phoenix area. Much of the spalling on the early concrete pavement sections in the Phoenix Urban Corridor is due to the use of a metal insert at every fourth contraction joint. While the purpose of the metal insert was to establish the joint, it resulted in joint spalling as incompressibles became entrapped in the joint. Additional joint spalling occurred as incompressibles became lodged in the sawed transverse joints due to lack of joint sealant or joint seal breakdown. It is believed that some spalling resulted from working joints and the stresses developed in the upper part of the slabs as excessive deflection occurred.

Arizona DOT personnel have used and tested a variety of materials for utilization in partial depth repair. Materials typically used in maintenance of Arizona concrete pavements include cementitious materials, a magnesium phosphate concrete (Set 45), an epoxy resin compound (Cono-crete 149), a rubberized epoxy (MC-64), and a proprietary bituminous patching material (UPM).

Of the cementitious materials, Type III cement was reported as the most cost effective. However, delamination problems have been frequently encountered using cementitious repair materials. Cono-crete 149 has performed satisfactorily and is noted to last 5 to 6 years. MC-64 rubberized epoxy is described as one of the most expensive patching materials in use, and the one that has worked the best. Patches constructed using Set 45 reportedly failed within 6 months to 1 year. UPM patching material has been used by District I maintenance forces and is noted to be the only successful asphalt concrete pothole repair product used by ADOT.

**Appropriateness for Use in the Urban Corridor**

Partial-depth repairs are considered an appropriate measure to address shallow surface defects on Phoenix Urban Corridor concrete pavements. For distresses that are limited to the upper one-third of the slab, they can be a cost-effective rehabilitation strategy.

Of primary concern for partial-depth repair on the concrete pavements in Phoenix is the length and frequency of closure time. Due to high traffic volumes, the disruptions should be minimized. Appropriate means of addressing this concern include the use of high early strength cements, water reducing additives, reinforcing fibers, and other proprietary materials that provide short down times and offer satisfactory performance.

The determination of the suitability of partial-depth repairs for concrete pavements must also take into account the appropriate applications and limitations of this type of repair. Partial-depth repair may be appropriate for renovation of spalls resulting from the use of metal joint inserts and from intrusion of incompressibles into joints. Surface scaling can also be addressed by such methods. Partial-depth repair alone is not appropriate for repair of spalls that have resulted from compressive buildup in jointed concrete pavement. Neither is it sufficient for spalls resulting from dowel misalignment or lockup. Cracks originating from improper joint construction and working cracks resulting from shrinkage, fatigue, or foundation movement should be repaired in other manners. Finally, surface deterioration of the slab that affects the concrete to more than one-third of its depth or exposes dowels or reinforcement in its removal cannot adequately be restored using partial-depth repair methods.

One method of partial-depth spall repair that has proven to be effective and highly-productive in Minnesota is the use of milling machines for the partial-depth removal of concrete material. The machine can be used to remove up to a full-lane width, and produces a rough face for which the repair material to adhere. This procedure may be effective in Arizona for those joints that were formed using the metal insert.

**Recommendations on Design**

Among the typical failure modes of shallow depth repairs in concrete are lack of bond, compression failure, poor consolidation, and incompatible thermal properties. Consequently, it is important for good performance that proper care be taken in material selection, pavement removal, and patch replacement.

- Material Selection. Once it has been determined that partial-depth repair is an appropriate rehabilitation method, the type of patch material must be chosen. The materials typically used by the Arizona DOT have been listed previously. Rapid setting materials are the likely candidates for future use. Care should be taken with epoxy mortars to ensure that the recommended construction procedures are used and the patch material is thermally compatible with the original pavement. In deep patches, some epoxies should be set in lifts to reduce heat buildup during curing.

- Pavement Removal. Removal of all weak concrete is essential to good performance of shallow patches. The extent of deterioration should be determined by sounding the pavement with a steel rod, chains, or a ball peen hammer. Electronic sounding equipment is also commercially available. Adjacent spalls requiring repair should be combined into one patch if the distance between them is less than 24 in. Where spalling has been caused by a metal insert, it is recommended that the insert be sawed out along the entire length of the joint to avoid further deterioration. At least 3 in from the edge of the deteriorated concrete, the repair boundaries should be sawed to a depth of 2 in to reduce spalls due to thin spots along the repair edge. Concrete should then be removed using a light jackhammer to a depth where sound concrete is encountered. The repair surface should then be swept and sand blasted to remove any loose material that may later contribute to delamination.

- Patch Replacement. To achieve satisfactory results, two steps are critical in placement of the patch material: proper consolidation and the placement of a bond breaker over all joints and cracks. The most frequent cause of failure of partial-depth repairs placed directly across transverse joints and cracks is crushing due to the compressive stresses created when the slabs expand. A properly placed bond breaker can eliminate this problem. This insert should extend at least 1 in below the bottom of the patch and 3 in laterally beyond the patch boundaries. Significant care should be taken in placing the bond breaker since failures have resulted where small amounts of patching material filled gaps in the bond breakers. Consolidation of the patch material is necessary to promote good bonding to the original pavement surface by releasing air trapped at the interface. Small internal vibrators, vibrating screeds, rods, or trowels can be used to achieve good consolidation. Suitable curing practices can also improve patch performance.

Concurrent repairs that should be considered when planning for partial- depth repair include slab stabilization, full-depth repair, and diamond grinding. Future spalling at joints repaired with shallow patches can be reduced or eliminated by forming or cutting a joint sealant reservoir at all joints and sealing it with a high quality joint sealant.

## 4. FULL-DEPTH SLAB REPAIR

### Description

A full-depth repair in a jointed concrete pavement is placed to address pavement distress that extends through the entire thickness of the slab or a significant portion thereof. It is constructed using portland cement concrete to provide for long-term performance.

**Reason for Placement**

The primary reason for the placement of full-depth repairs in jointed concrete pavements is to address severe joint and crack deterioration that extends throughout the entire depth of the slab. Additionally, full-slab replacements that encompass the entire length and width of a slab are often placed to repair shattered slabs. It should be noted that deterioration limited to the upper one-half of the concrete surface may be addressed more cost-effectively with a partial-depth repair.

Joint deterioration may be caused by D-cracking, reactive aggregate, incompressibles in the joints, or dowel bar lockup. Loss of support coupled with large corner deflections can result in additional joint deterioration (corner breaks).

Cracks may form in concrete pavements from concrete shrinkage, traffic and environmental loading, or late sawing of or insufficient depth of either the longitudinal or transverse joints. Once initiated, the cracks can spall and break down under traffic loading, becoming "working cracks," that actually accommodate much of the movement associated with the slab. Since these cracks do not have adequate load transfer, additional deterioration, such as faulting and spalling of the crack, results. Also, water can easily infiltrate the pavement structure at a working crack, leading to erosion of the base material beneath the slab and ultimately additional slab cracking.

**Arizona DOT Experience**

The Arizona DOT has no experience with full-depth repairs in the Phoenix area, and limited experience State-wide. This is because many of the necessary elements that contribute to the formation of pavement distresses that are best addressed by full-depth repairs do not exist in Arizona. For instance, ADOT has traditionally not used dowel bars in their concrete pavements, so any dowel-related spalling (due to misalignment or dowel freeze-up) are not present. Furthermore, the small amount of annual rainfall eliminate moisture-associated distresses. Also, the short joint spacing used on Arizona's concrete pavements tends to inhibit the development of shrinkage stresses or thermal stresses that long-jointed pavements experience. Finally, fatigue cracking has not been a problem in Arizona.

The majority of joint-related distresses on Arizona's concrete pavements are believed to be due to a combination of curling/warping stresses and the presence of incompressibles in the joints. Daily and seasonal temperature and moisture cycles produce bending and expansive stresses in the slab; as the slab undergoes this action, the presence of the incompressibles in the joints resist that expansive force, which typically results in spalling of the upper half of the concrete slab. In the past, ADOT has treated this distress with partial-depth repairs, albeit with mixed results.

Full-depth repairs have been used on projects in the Flagstaff and Tucson areas to address severe deteriorated joint conditions. The success of these full-depth repair projects has been mixed; the repairs had faulted and cracked, perhaps due to the repairs being constructed too narrow (only 2 ft wide in some cases). Some slab replacements were constructed on this project, and these are apparently performing well. Good base preparation and the provision of adequate load transfer are essential to ensure the good performance of full-depth repairs.

**Appropriateness for Use in Urban Corridor**

Full-depth repairs are considered appropriate for use on the concrete pavements in the Phoenix Urban Corridor. They can address certain forms of pavement deterioration, such as deep joint spalling and severe transverse or longitudinal cracking, that cannot be adequately addressed by other means.

With the introduction of new concrete patching materials and new water-reducing agents (superplasticizers), it is now possible to achieve opening times of 4 hours or less. The amount of closure time is an item of the utmost concern due to the substantial amount of traffic on the pavements in the urban corridor. Disruptions to traffic must be minimized, and the use of these high-early strength materials can help to satisfy the requirements. Further, repair activities can be limited to one lane at a time to allow for traffic to use the other lanes.

**Recommendations on Design**

The Federal Highway Administration now requires that all 4R work that is performed on primary highways must last a minimum of eight (8) years to be eligible for Federal funding. In light of this requirement, it is imperative that proper 4R designs be adopted for use.

Many factors go into the proper design and construction of a full-depth concrete repair. A few of the more important design recommendations for full-depth repairs include:

- Minimum Width. The width of the repair is recommended to be a at least one full lane, typically 12 ft. Partial-lane width full-depth repairs have not exhibited good performance, as these have typically rocked and cracked prematurely under traffic.

- Minimum Length. A minimum full-depth repair length of 6 ft is recommended to prevent rocking, cracking, and premature failure of the repair. Full-slab replacements should be considered where deterioration is located throughout the slab.

- Thickness. The thickness of the repair is recommended to be the same as the thickness of the original slab.

- Sawing and Removal. Full-depth sawcuts using a diamond blade saw should be made around the perimeter of the area to be repaired. The distressed concrete can then be lifted out whole using lift pins inserted into the slab. This "lift-out" method is very cost-effective and does not disturb the underlying base material.

- Base. Every effort should be made to not disturb the existing base material. This will provide a stable foundation for the full-depth repair. However, if the base is disturbed, it is recommended that it not be repaired but replaced with additional concrete.

- Reinforcement. The placement of steel reinforcement in a full-depth repair is intended to hold any cracks which occur in the full-depth repair tight. Its use should be restricted to those full-depth repairs longer than 10 ft and should only be considered when the existing pavement is reinforced. As the Phoenix Urban Corridor (or the State of Arizona for that matter) does not have any reinforced concrete pavements, this item should not be considered.

- Load Transfer. The use of positive load transfer devices such as dowel bars are generally recommended for medium- to heavily-trafficked pavements. Five dowels in each wheelpath are advised, with a minimum dowel bar diameter of 1.25 in recommended, although larger sizes are encouraged.

- Joints. Both the transverse and longitudinal joints of the full-depth repair joints should be formed or sawed to provide the appropriate reservoir dimensions. The dimensions of the joint reservoir will be a function of the type of sealant proposed and the movements expected at the joint.

- Curing/Opening to Traffic. The time that the repair can be opened to traffic is a function of many items including cement type, types of admixtures, ambient temperatures, and curing (curing compounds, insulation blankets, etc.). In addition, many new proprietary patching materials are now available that can be opened to traffic in as little as four hours or less. A minimum compressive strength of 2000 psi or a minimum modulus of rupture of 250 psi (third-point loading) is generally recommended before opening to traffic.

## 5. SLAB STABILIZATION

### Description

Slab stabilization is defined as the insertion by pressure of a material beneath a slab and/or subbase to both fill voids and to provide a thin layer that should reduce deflections and resist pumping action. Stabilization is typically carried out using cement-pozzolan, cement-limestone, or cement-fine sand slurries. Very hard asphalt cement has also been used occasionally as a stabilization material. Other terms used to describe slab stabilization are pressure grouting, undersealing, and subsealing.

### Reason for Use

Slabs that experience faulting, high deflections, and pumping have generally developed voids beneath the slab or the subbase. These voids often lead to accelerated pavement deterioration by faulting, spalling, and cracking. The intended purpose of slab stabilization is to restore support to the slab by filling the existing voids with nonerodible material. Symptoms of loss of support include increased deflections, transverse joint faulting, and an accumulation of fines near joints and cracks. Stabilization, however, is not intended to raise slabs that have experienced settlement.

### Arizona DOT Experience

It is reported that fifteen percent of the slabs on the I-17 and the I-10 pavements in Phoenix were subsealed in 1979. However, no performance data has been found for these rehabilitated slabs. In addition, the Arizona DOT has used slab stabilization techniques on a section east of Flagstaff. Subsealing was accomplished using blanket coverage, and these repairs were reportedly working well.

### Appropriateness for Use in the Urban Corridor

Properly completed stabilization of slabs exhibiting voids can significantly reduce deterioration of slabs that are not extensively cracked. This restoration of slab support generally can result in longer slab life and in a decreased need for future repairs. Typically slab stabilization is combined with surface grinding to restore structural integrity and surface smoothness. When loss of support has led to extensive slab cracking and faulting, slab stabilization and grinding may not provide a significant extension of pavement life. The possible reduction in required future restoration could make properly completed slab stabilization a cost effective repair option on Phoenix Urban Corridor pavements.

**Recommendations on Design**

The effective completion of slab stabilization requires some care and experience with regard to distress identification, design, construction, and grouting effectiveness testing. A few of the important design and planning recommendations for slab stabilization include:

- Distress Location. Slab stabilization can effectively be performed at joints and cracks where loss of support exists. This includes full-depth repairs that are rocking. The position and extent of voids can be estimated by visual observation of pumping distress and from deflection testing.

- Material Selection. Materials used in slab stabilization include cement grout mixes and oxidized asphalt cement. Cement-pozzolan, cement-limestone, and cement-fine sand grouts have been used with varying success. Cement-pozzolan (fly ash) grouts have shown the most flowability and ability to fill small voids. Additives such as fluidifiers, water reducers, and superplasticizers have been used to improve flowability and reduce setting time.

- Insertion Hole Construction. Insertion holes of 2-in diameter are typically drilled to accommodate a packer. If the subbase material is granular, the hole is drilled just beyond the slab bottom. When stabilized subbase material underlies the slab, drilling extends to the bottom of the stabilized subbase, since voids often exist beneath stabilized subbase material. Care should be taken to avoid spalling the concrete at its base during drilling.

- Grout Pumping. The purpose of stabilization is to fill voids, not to lift slabs. Injection hoses with expandable rubber nozzles that provide a tight fit in the hole are preferable to hoses with metal nozzles. Since lifting slabs can create new voids, the slab corner elevation should be monitored and not raised more than 0.125 in. Typically, pumping at each hole continues until uplift in the pavement is noted, grout is visibly escaping from adjacent cracks and holes, or the pressure exceeds the maximum specified.

- Grout Curing. Grout curing time is a function of slurry temperature, water content, and the presence of additives. Unless otherwise determined, it is recommended that traffic be kept off the stabilized slab for at least 2 to 3 hours.

- Effectiveness Testing. Testing the effectiveness of the stabilization procedure can be accomplished using the deflection testing procedures employed in the void location process. Regrouting may be necessary if voids were insufficiently filled or if new voids were formed during stabilization.

- Concurrent Work. Simultaneous repairs which could critically reduce the potential for future loss of support problems include load transfer restoration and joint seal repair.

## 6. LOAD TRANSFER RESTORATION

### Description

Load transfer restoration in concrete pavements is the post-construction installation of mechanical devices that are intended to transfer load and to reduce the relative deflection across joints or cracks. Devices that have been used for this purpose include a plate and stud device, a double-vee load transfer device, and dowel bars placed in slots.

### Reason for Placement

Properly operating load transfer restoration devices can reduce the loaded slab edge deflections by as much as 50 percent. The installation of load transfer devices tends to increase pavement life and to retard further deterioration due to joint spalling, pumping, faulting, and cracking.

### Arizona DOT Experience

Very little rehabilitation has been noted of Phoenix area concrete pavements using doweled load transfer restoration. Two sets of dowel inserts were reportedly placed on a section of Interstate 17. No information was available as to their performance. Considerable faulting has been observed on the 9-in pavements constructed before 1972. Slight faulting is reported on the thinner sections of the Superstition Freeway built in 1972. These faulting distresses are thought to be due to differential slab curling, excessive deflections, and slight pumping.

### Appropriateness for Use in the Urban Corridor

Doweled load transfer restoration, alone or in combination with other repairs, can be useful in controlling faults and working joints/cracks on Urban Corridor pavements. For transverse joints demonstrating poor load transfer (say, deflection load transfer efficiency less than 50 percent) and loss of support, slab life can be significantly improved by inserting dowels in the wheel paths and stabilizing slabs.

Rapid installation of any repair is required on the Urban Corridor due to high traffic volumes. As a result, it may be necessary to test and use appropriate proprietary quick-setting materials or polymer concretes to replace the removed concrete. There are reports of quick-setting materials being sensitive to temperature and to installation procedure.

### Recommendations on Design

Based on the past performance of the various retrofit load transfer devices, the only one that is currently recommended for use is the retrofit dowel bars. The other devices have not fared well in numerous field trials, exhibiting debonding and an inability to adequately restore load transfer to the existing pavement. Therefore, only the use of retrofit dowel bars will be discussed herein.

For a load transfer system to provide long-term performance, good engineering design must be applied to dowel and repair material specifications. Proper construction and concurrent repair practices also merit good planning and methodology. A few of the important design and planning recommendations for doweled load transfer restoration projects include:

- Dowel Size. Dowel diameter should be large enough to carry the estimated loading. A diameter of at least 1.25 in is recommended for most pavements, although larger diameter dowel bars (say, 1.5 in) are advised for heavy truck routes. The length of the dowel bars is typically 18 in.
- Dowel Spacing. Recent research in retrofit dowel design indicates that good results can be obtained by using 5 dowels in each wheelpath, spaced 12 in apart. The outermost dowel in the outer wheelpath should be 12 in from the outer lane edge.
- Dowel Depth. The longitudinal centerline of the dowel, as it rests on its clip chair, should be at mid-depth of the slab.
- Inset Hole Dimensions. The width of the cut made for insertion of dowels into the concrete should be 3.5 to 4 in. Length of the groove varies with the length of the dowel used with and the diameter of the cutting blade.
- Bond Breaker Insertion. A full depth bond breaker should continue across a joint or crack requiring load transfer restoration. A temporary joint insert is typically used at the surface to form a sealant reservoir.
- Repair Material Properties. Repair material should exhibit strength to carry the required load, have little or no shrinkage tendencies, and bond sufficiently to existing concrete. Bonding adhesives are sometimes used to promote bonding of the old and new materials.
- Consolidation. Cementitious materials require good consolidation to improve strength and adhesive properties. Underconsolidation can result in low strength and bonding problems at the pavement interface. Alternately,

overconsolidation can bring about segregation and the collection of weak cement at the dowel surface.

- Concurrent Work. Prior to dowel placement, subsealing and all necessary partial- and full-depth repairs should be completed. Subsequent to load transfer restoration, surface grinding and joint and crack sealing should be performed.

## 7. GRINDING

### Description

Diamond blade grinding is accomplished in concrete pavements by cutting patterns into hardened concrete with a cutting head made up of closely spaced diamond tipped saw blades. The major purpose of grinding is to provide a smooth pavement surface by removing surface material. Surface distresses typically removed by grinding are transverse joint and crack faulting. In dry climates where significant slab warping has occurred, surface grinding may be used to remove warping at joints. Other uses of diamond blade grinding include texturing of polished concrete surfaces to restore friction properties and the improvement of transverse slope in poorly drained pavements.

### Reason for Use

Faulting at joints or cracks as a result of settlement, pumping, warping, or slab rocking can cause pavement roughness which leads to rider discomfort. The primary purpose for removal of surface irregularities by grinding is to improve pavement smoothness and rideability. Joint faulting typically results from surface warping, from loss or lack of joint load transfer, from settlement due to heavy loads and inadequate pavement support, and from pumping and displacement of subbase or subgrade material.

### Arizona DOT Experience

By the early 1970's significant problems with faulting, slab warping, and curling were reported on the concrete pavements in the Phoenix area. Concrete pavement constructed in the Phoenix area before 1972 typically consisted of a 9-in jointed plain concrete pavement (JPCP) surface, a 4-in aggregate base course (ABC), and a 7-in selected material (SM) subbase. Joints were constructed on 15-foot centers and aggregate interlock was the only means of load transfer. The early I-17 and I-10 freeways were constructed using this design and were the only freeways in the Phoenix urban area until 1972. By 1986, about 44 percent of the pavement on these two freeways had received surface grinding. Additional grinding on I-17 was planned in 1988. Typical rehabilitation for these early pavements has included partial depth spall repair and grinding when Mays Meter readings reached 350 to 400 in/mi. It is not known whether joint seal repair was included in these rehabilitation efforts. No information has been received indicating the use of grinding on the more recent Phoenix pavements.

### Appropriateness for Use in the Urban Corridor

Grinding of curled, warped, and faulted concrete surfaces on Phoenix Urban Corridor pavements is considered, in many cases, to be an appropriate strategy for restoration of surface smoothness. Alone or in combination with other necessary repairs, grinding can significantly improve pavement serviceability.

Length of lane closure time is a drawback of continuous full-width grinding. Production of a typical pavement grinding operation was recently estimated at 50 machine hours per lane mile for aggregates of medium hardness. It is likely that the hard aggregate used in Phoenix area construction would require somewhat longer grinding times. Although concrete grinding can be time-intensive, the results in Arizona are reported as good. Grinding improvements have remained serviceable for 10 to 20 years if structural problems such as voids, corner breaks, D-cracking, cracking, or pumping were not present.

As with any faulted pavement, the appropriateness of grinding rehabilitation should also be determined based on the type and severity of the pavement distresses. Diamond blade grinding is generally recommended on pavements that are structurally adequate and have average faulting less than 0.25 in. Average faulting greater than 0.25 in can be adequately ground, however, costs become excessive. Grinding is also useful on pavements exhibiting poor surface friction characteristics. Conditions which would make grinding inappropriate as a rehabilitation procedure include a large number of working cracks and pumping or voids at joints or cracks.

### Recommendations on Design

A continuously operating properly used grinding machine will produce a smooth pavement surface that provides improved rider comfort and safety. For the ground surface to remain in good condition, appropriate repairs should be made to the pavement prior to and after the grinding operation. Possible repairs prior to grinding include the following:

- Slab Stabilization. If voids exist between the concrete and the subbase, slab stabilization should be used to restore pavement support before surface grinding.

- Load Transfer Restoration. If load transfer across transverse joints or cracks is poor (say, load transfer efficiency less than 50 percent) and the cracks are working cracks, the insertion of load transfer devices should be considered. Properly installed load transfer devices can reduce edge and corner deflections up to 50 percent and prolong the life of the pavement.

- Partial- or Full-Depth Repair. If shallow joint spalling or scaling is present, partial-depth repair may be necessary to improve surface or joint integrity. The appropriateness of full-depth repair should be appraised if deep spalls, corner breaks, loss of load transfer, or working cracks are existent in the pavement.

After the grinding operation is complete, cleaning and joint seal replacement at transverse and longitudinal edge/shoulder joints should be considered. Restoring the seal on transverse joints can inhibit entrance of incompressibles into the joints and thereby reduce the potential of future joint spalling.

## 8. GROOVING

### Description

Diamond blade grooving is performed by cutting patterns into hardened concrete or asphalt concrete with a center to center blade spacing of 0.75 in or greater. The main result of grooving is improvement in pavement surface macrotexture. Grooving is typically cut longitudinally along heavily trafficked pavements at curves and intersections.

### Reason for Use

The concrete surfaces of older well travelled pavements can become worn and smooth as vehicle traffic works to polish the surface aggregate. This abrasion can lead to a loss of friction between tires and pavement. In wet weather, hydroplaning can result. The purpose of grooving a pavement is to restore surface friction, improve tire traction, and ultimately to improve safety by reducing the potential for skidding accidents on highways.

### Arizona DOT Experience

Possibly because of the hardness of the aggregate used in constructing concrete pavements in the Phoenix area, the Arizona DOT has reported very little grooving of its concrete pavements. Two sections of Superstition Freeway were grooved in 1986. Section 1, constructed in 1972, was 1.8 mi long. It was textured by the burlap drag method and had carried about 2.5 million ESAL's in 1986. Section 2, opened in 1975, was 2.03 miles long and had carried about 2.5 million ESAL's. It was originally textured by nylon brooming. No information as to the performance of these sections has been obtained.

Pavements constructed prior to 1972 were textured using burlap drag, and have received no grooving rehabilitation. The tined pavements constructed after 1979 have not been grooved and are reported to have maintained good friction characteristics.

### Appropriateness for Use in the Urban Corridor

As concrete pavements in the Phoenix area continue to receive heavy traffic, the abrasive effects of large numbers of tires will continue to polish the concrete surfaces. Continued monitoring of the skid resistance properties of these pavements will give an indication of the rate of friction loss. The need for pavement grooving should be based on minimum coefficient of friction values and on increases in wet weather accident rates. In cases where a pavement has poor skid properties but is structurally sound, diamond blade grooving may be a more cost-effective rehabilitation method than a surface overlay.

### Recommendations on Design

Cost effective design for grooving of concrete pavements includes, among other things, the proper location for grooving and the optimum groove design.

- Selection of Appropriate Locations. A method for choosing the location of the pavement sections for which grooving would offer the most benefit should take into account the areas in which the most wet weather skidding accidents occur. These locations are typically at curves and intersections.

- Groove Design. The longitudinal groove design that has proven to be most effective for highways consists of grooves spaced at 0.75 in apart. Groove widths from 0.10 to 0.13 in wide and 0.125 to 0.25 in deep have proven successful in many applications.

## 9. THREE-LAYER SYSTEM

### Description

A three-layer overlay system, as generally used in Arizona since the mid-1970's, incorporates a thin overlay placed in two layers with a low-modulus asphalt rubber interlayer. An open graded mix leveling course 0.5 to 0.75 in thick is placed directly on the rigid pavement surface. An asphalt rubber flush-in with cover material follows. The surface layer is typically an open-graded asphalt concrete friction course (ACFC). Variations on the asphalt grading and proportioning have been used as new designs were constructed. This system is presently used as an overlay procedure on faulted or polished concrete pavements. It has also been employed in the rehabilitation of deteriorated asphalt concrete pavements.

**Reason for Use**

Many of the concrete pavements in the Phoenix area have developed faulting distress. Three-layer overlay systems have been used by the Arizona DOT to restore smooth, rideable surfaces to these faulted pavements. The purpose of the asphalt rubber interlayer has been to reduce the rate of reflection crack development in the new surface. An additional benefit derived from three-layer system construction is an improvement in driver safety by increasing surface friction characteristics.

**Arizona DOT Experience**

In 1973, the Arizona DOT began experimenting with the use of asphalt rubber membranes in overlaying old concrete pavements. These test overlays were initially two-layered systems. The second experimental overlay consisted of an open-graded asphalt concrete layer overlaid with asphalt rubber, and surfaced with precoated CM-11 aggregate. Significant problems with windshield damage from flying surface aggregate were encountered. As a result, a third layer of ACFC was placed on subsequent test systems. The success of the resultant three-layer system on an asphalt concrete pavement near Phoenix led to additional installation and testing. The first nonexperimental use of the three-layer system design was in 1985 on a concrete section of Interstate 17.

A three-layer system experimental section placed on I-17 concrete pavement in 1979 reportedly performed satisfactorily between 1979 and 1985. During that time it received approximately 11.5 million 18-kip ESAL's. A system placed on I-17 in 1985 was also reportedly performing well following about 7 million 18-kip ESAL's.

**Appropriateness for Use on the Urban Corridor**

Construction of a three-layer overlay system on deteriorated concrete pavements in the Phoenix Urban Corridor can be a suitable rehabilitation option. For pavements demonstrating faulting or surface polishing, the three-layer system can improve surface rideability, reduce infiltration of moisture and incompressibles, and restore suitable surface friction characteristics. It is less costly and time consuming than grinding and provides a smoother surface. However, three-layer system restoration typically does not last as long as surface grinding. An advantage of three layer system construction over standard asphalt concrete overlay rehabilitation is the decreased loss of clearance beneath bridges.

**Recommendations on Design**

Arizona DOT experience has demonstrated that well-constructed three-layer systems can reduce the rate of reflection cracking and can increase pavement life.

Several of the important planning and design recommendations for proper construction of three layer systems on distressed concrete pavements include:

- Leveling Course. The leveling course provides a smooth surface for the asphalt rubber interlayer to behave as a continuous stress absorbing layer. Success has been reported using open graded asphalt concrete friction courses 0.5 to 0.75 in thick. Recent use of asphalt rubber in the binder of the leveling course has also produced promising results.

- Asphalt Rubber Application. A low-modulus asphalt rubber interlayer provides stress reduction at stress concentration points between the underlying concrete pavement and the asphalt surface course. Experience has shown that a distribution rate of about 0.6 gal/yd$^3$ yields good results. Excessive rates promote instability in the system and can lead to shoving and rutting.

- Surface Course. Provision of a smooth riding surface and protection of the asphalt rubber interlayer are accomplished by the surface course. Typically, this layer is an open-graded ACFC about 0.5 to 0.75 in thick. Asphalt rubber has been used in the binder of the surface course recently to improve flexibility.

- Preoverlay Repair. Structural distresses in the concrete pavement should be addressed before construction of a three-layer system. Consideration of preoverlay repair should be given to pavements displaying large corner deflections, poor load transfer, severe spalling, working cracks, or severe faulting. Possible concurrent repairs include: slab stabilization, load transfer restoration, partial- or full-depth repair, or grinding.

## 10. SUMMARY

This appendix has presented a summary of the various concrete pavement restoration techniques that are available to ADOT for preservation of their concrete pavement system. The intent was to provide a brief overview of the procedures and their applicability to the Phoenix Urban Corridor. Additional information on the techniques is provided in the Bibliography that follows.

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