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Sample Rigid Pavement Design Tables Based on Version 0.8 of the Mechanistic Empirical Pavement Design Guide

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Partnered Pavement Research Program (PPRC) Contract Strategic Plan Element 4.1:
"Development of the first version of a Mechanistic Empirical Pavement Rehabilitation, Reconstruction and New Pavement Design Procedure for Rigid and Flexible Pavements"

PREPARED FOR:

California Department of Transportation
Division of Research and Innovation
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Abstract:
This Technical Memorandum describes a design of a sample catalog for rigid pavement as requested by the Caltrans Division of Design in 2005. This task is part of a larger project, begun in 1999, to help Caltrans implement mechanistic empirical (ME) procedures. Before implementing the Mechanistic Empirical Pavement Design Guide (MEPDG) software from the NCHRP 1-37a project, Caltrans has adopted a three-step process for evaluating it including: sensitivity analysis or bench testing, validation using data from accelerated pavement testing, and validation (and possibly recalibration) using field data. Upon Caltrans request, the University of California Pavement Research Center (UCPRC) has done a sensitivity study to check the reasonableness of the model predictions. Limited work was done to evaluate the models using APT data due to the closed architecture of the software. Evaluation using field data is underway.

For reasons described in this Memorandum, Caltrans has decided to use simple design tables developed from the software for routine use and to use the actual software will be used only for special projects. Simple design tools based on the software, such as the catalog for jointed plain concrete pavement (JPCP), produce some of the benefits of ME design procedures and serve as a starting point to understand the needs for full scale implementation of ME procedures in the future. In addition to describing development of the design catalog, this Memorandum presents limitations about the catalog and observations about version 0.8 of the MEPDG software.

Key variables to be included in the catalog were selected based on results from sensitivity analyses. A factorial produced 2,160 cases that were loaded into a database. For each combination of inputs (climate, traffic volume, load transfer efficiency, base type, subgrade type, spectra), the least thickness resulting in distresses that fall within the failure criteria is designated as the design thickness. Results were then compiled into the design tables that are contained in this Memorandum.

Keywords:
NCHRP 1-37a, MEPDG, Rigid Pavement Design

Proposals for implementation:
The catalog will be modified by Caltrans and is to be incorporated in the Highway Design Manual

Related documents:
UCPRC-DG-2006-01

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EXECUTIVE SUMMARY

This Technical Memorandum describes a sample design catalog for rigid pavement as requested by the Caltrans Division of Design in 2005. This task is part of a larger project, begun in 1999, to help Caltrans implement mechanistic empirical (ME) procedures. Facilitated by the release of NCHRP 1-37a software, Mechanistic Empirical Pavement Design Guide (MEPDG), Caltrans decided formally in 2005 to adopt ME design procedures for designing pavements in the state. Because the MEPDG is nationally calibrated with very few sections from California, Caltrans has adopted a three-step process for evaluating the software before implementing it. The three steps in the evaluation process are:

1. Bench testing or sensitivity analysis of the software
2. Validation of the software using Accelerated Pavement Test data
3. Validation and possibly recalibration of the software using field data.

At Caltrans request, the UCPRC has done a sensitivity study to check the reasonableness of the model predictions. Limited work was done to evaluate the models using APT data due to the closed architecture of the software. Evaluation using field data is underway. The sensitivity study showed that even though the model predictions are generally reasonable, there are some anomalies and issues with the software that need to be addressed before it be used for routine design. Also, the huge amount of input information required to run the software requires large institutional changes within Caltrans and a vast amount of personnel training. For these reasons, Caltrans has decided to use simple design tables developed from the software for routine projects and to use the actual software only for special projects. Simple design tools based on the software, such as a catalog, produce some of the benefits of ME design procedures and serve as a starting point to understand the needs for a full-scale implementation of ME procedures in future. For development of these design tables, Caltrans Division of Design asked for the development of a sample catalog to determine the variability, accuracy, and reasonableness of the tables. Caltrans did not want to wait for upgrades to the current version (version 0.8) of the software and for local calibration to be completed. Caltrans requested UCPRC to generate a sample catalog containing design tables using the locally uncalibrated 0.8 version of the software for select sites in different climate regions.

This tech memo explains the need for using simple design tools such as a catalog instead of the actual software, the issues that had to be addressed to transition from current empirical design procedures to design tables based on ME principles, and the procedure adopted for developing these design tables. Key variables to be included in the catalog were selected based on results from sensitivity analyses. Various combinations of different factor levels of these variables were run and the results synthesized into design tables based on a set of failure criteria.

1. INTRODUCTION

1.1. Objective

The objective of this study is to generate a sample catalog of simple design tables based on Mechanistic Empirical Pavement Design Guide (MEPDG) software developed as part of the NCHRP 1-37a project for rigid pavement design in California. In 2005 Caltrans Division of Design asked the University of California Pavement Research Center (UCPRC) to develop to develop these design tables as part of the Partnered Pavement Research Program's Strategic Plan, Item Number 4.1: "Development of the first version of a Mechanistic Empirical Pavement Rehabilitation, Reconstruction and New Pavement Design Procedure for Rigid and Flexible Pavements".

1.2. Background

Caltrans has decided to adopt Mechanistic Empirical (ME) design procedures. A white paper signed by senior Caltrans management in 2005 formally established the Department's objective to implement ME design. At the current time Caltrans is considering the use of the NCHRP 1-37a software for new concrete pavements. However, since the models in the NCHRP 1-37a software are nationally calibrated with very few sections from California, Caltrans decided to evaluate the software prior to implementing it and the Division of Design adopted the following three-stage process:

1. Sensitivity analysis or bench testing of the software
2. Validation using Accelerated Pavement Test (APT) data
3. Validation and, if necessary, recalibration using field data

The first step, sensitivity analysis, was finished by Kannekanti and Harvey (2005, 2006) using the 0.8 version of the software. APT data has been used to verify the reasonableness of deflection calculations using finite element analysis that were the basis for the stress calculations in the 1-37a software. Neither this work nor the ongoing work on model validation in the field is discussed in this paper.

Sensitivity analysis of the models showed that the model predictions are generally reasonable. The cracking model was found to be extremely sensitive to surface absorptivity and coefficient of thermal expansion (CTE) of the concrete. It was found that the subgrade type and the use of granular subbase did not substantially affect the rigid pavement distresses. The main conclusion from the sensitivity analysis was that even though model predictions are reasonable, predictions from the software should be coupled with local experience, especially while designing the unbound layers.

One of the observations from the sensitivity study was that the models require about 100 inputs to run the software and most of these inputs are not currently being measured by Caltrans. Details can be found in a report by Kannekanti and Harvey (2005) and a gap analysis performed by Rambach (2005). To begin measuring these inputs and eventually considering them in specifications will require resources and institutional changes within Caltrans and the contracting industry. It can be argued that the default values could be used where there is no data but most of the current pavement designers (and, for some variables, even the researchers!) in California are not in a position to judge the reasonableness of many default values. Inappropriate use of default inputs or blindly using the models could result in major errors and unreasonable designs (Kannekanti and Harvey, 2005). A couple of example observations of the use of the 0.8 version of the software that results in bad designs are:

1. The software indicates that portland cement concrete (PCC) and cement-treated base (CTB) can be placed directly over soft clay subgrades.
2. Inappropriate values of coefficient of thermal expansion (CTE) and/or surface absorptivity may be selected that reduce the initial cost of the design, but cannot be achieved with available materials (currently Caltrans has no specifications for CTE and surface absorptivity).

These conclusions were further corroborated by workshops conducted internally by Caltrans in early 2005. The workshops indicated that the I-37a software is too complicated for routine use and requires substantial training, large resource commitments, and institutional changes for Caltrans to adopt it as a desktop tool for routine design. The fact that about 80 percent of the projects built by Caltrans cost less than $5 million raised questions about the economical feasibility of using NCHRP 1-37a software for all projects. The Department’s current plan is that 1-37a will be used by a core group of about twenty to thirty pavement designers trained at a high level and dedicated to design or to review designs, for expensive large scale projects. All routine and small-scale projects would still use ME but in the form of simple design tools that can be easily used. Caltrans Division of Design decided that the simple design tool for jointed plain concrete pavement (JPCP) designs would be a catalog with design tables generated by running the ME design software. Use of the catalog will introduce the concepts of ME and the variables required for ME.

2. TRANSITION FROM EMPIRICAL DESIGN TO MECHANISTIC EMPIRICAL DESIGNS

Once the sensitivity analysis was completed and the findings were found to be reasonable, in 2005 Caltrans Division of Design decided to try using the 0.8 version software to create a sample catalog to test the procedures and reasonableness of the approach. The catalog was developed by running a factorial using the 1-37a software and synthesizing the results into simple design tables. In order to make the transition as smooth and simple as possible, the format of the design tables in the catalog was kept similar to the existing tables. A key advantage of using a catalog is that it provides the power of the models without the designers actually having to run the 1-37a software. Other major advantages of the sample tables developed from ME analysis are: consideration of climate region and shoulder types, explicit consideration of CTE, consideration of reliability, and the ability to set design life based on failure criteria tied to explicit levels of distress (transverse cracking and faulting).

2.1. New Challenges

Owing to the empirical nature of the past and existing design procedures, some issues had to be addressed for the first time in developing a catalog based on 1-37a runs.

2.1.1 *Design Life and Failure Criteria*

Structures from the existing design tables were originally designed for twenty years only without a clear definition of failure. Many of these pavements have provided service lives greater than twenty years. Because of the power of ME concepts Caltrans Division of Design decided to develop the catalog for pavement service life longer than twenty years. The structures will be designed based on a forty-year design life. The use of ME also brought a need to define failure criteria. Previously, distress criteria were defined only for assessing pavement condition and for triggering maintenance activities. The failure criteria set by Caltrans for developing the catalog are:

1. Transverse Cracking: 10 percent slabs cracked
2. Faulting: 0.1 in
3. IRI: 160 in/mi

All the failure criteria include a reliability level of 90 percent. Criteria for spalling were not set due to doubts about the spalling model in the 1-37a software. At the end of design life the pavements should require only minor repair such as diamond grinding and 1 percent slab replacement.

2.1.2 *Defining Climate Regions*

California was classified into nine distinct climate regions (as shown in Figure 1) based on the temperature and precipitation data. A small sensitivity study showed some of the nine different climate regions could be grouped together. The factorial used for this is described in Table 1(a). The factorial resulted in 1,758 cases. For the exercise, weather stations were selected from different climate regions. The weather stations used for each of the climate regions are shown in Table 1(b). Finding weather stations with good data in some of these climate regions was very laborious and none in the 1-37a software's climate database had more than five years' data. Some of the major weather stations in California had little or no data included in the software's climate database. For this reason, the weather stations may not necessarily represent the typical conditions in the overall climate region, and the results are to be viewed in this light. Two plots showing the mean faulting and cracking for all the climate zones are shown in Figures 2(a) and 2(b).

In the factorial, San Francisco, Dagget, and Santa Rosa were used as representative weather stations for Coastal (including North, Central, and South Coast), Desert and Low/South Mountain climate regions, respectively. No sample design tables were developed for the High Mountain and High Desert climate regions because very few concrete pavements are built in these locations. It is hoped that future versions of the software will enable use of climate data from other databases that have much more comprehensive data — such as the CDIM climate database software developed for Caltrans from initial FHWA work (PaveSys, 2004).

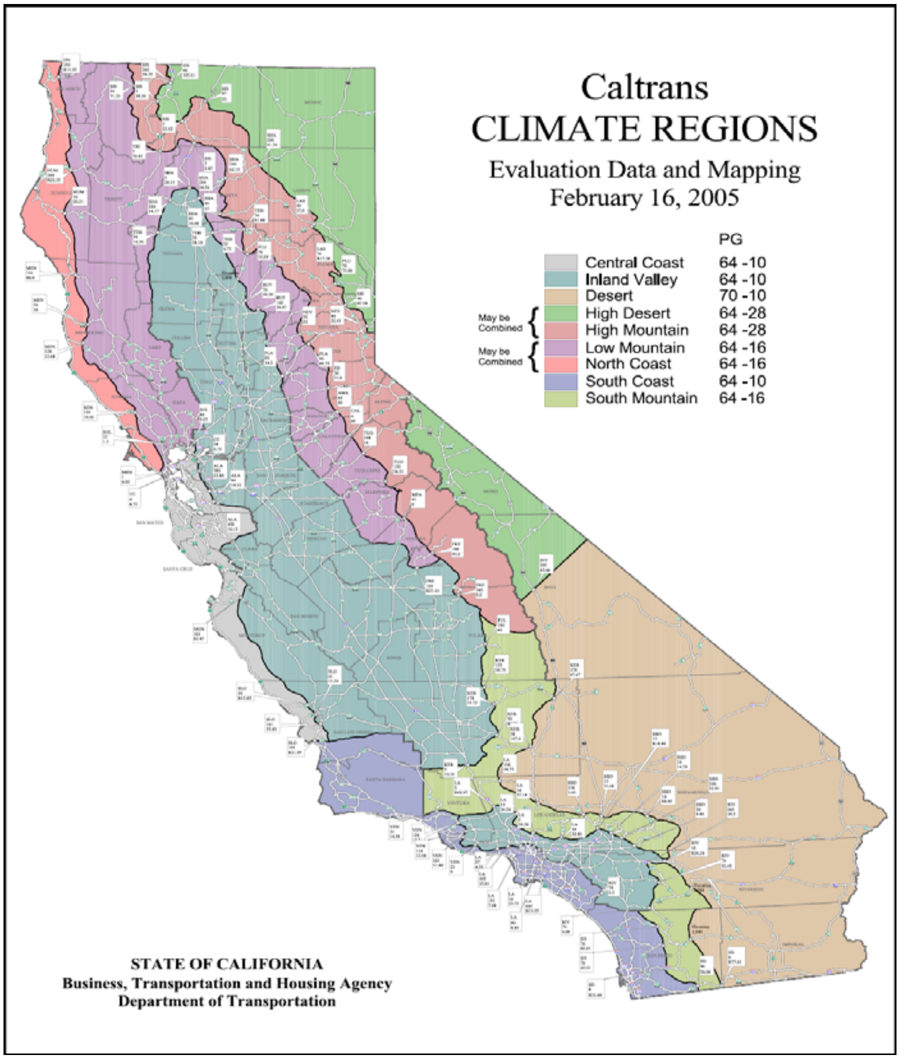

Figure 1. Climate regions in California.

Table 1(a). Factorial for Climate Region Analysis

Variable	Factor Levels	Factors
Spectra	2	Urban, Rural
PCC Thickness	2	8”, 12”
Load Transfer Efficiency	2	Dowels, No Dowels
Shoulder Type	3	Asphalt, Tied and Widened Truck Lane
Joint Spacing	2	15’ and 19’
Surface Absorptivity	2	0.65 and 0.95
Coefficient of Thermal Expansion	2	4x10e-6 /F and 7x10e-6 /F
Climate Regions	9	See table 1(b)
Traffic	1	Traffic Index of 16 (126 million ESALs)
Base Type	1	Cement-treated Base
Subgrade	1	Poorly graded sand (SP)

Table 1(b). Climate Data for the Different Climate Regions

Sta. No.	Climate Zone	Weather Station City	Months of Data Available	Lowest Air Temp. (C)	Highest air Temp. (C)
1	Central Coast	San Francisco	63	0.1	35.2
2	Inland Valley	Sacramento	44	-3.3	41.4
3	Desert	Dagget	17	-6.4	44.7
4	High Desert	Alturas	43	-23.8	37.7
5	High Mountain	Blue Canyon	66	-9.7	31.7
6	Low Mountain	Santa Rosa	43	-3.8	38.7
7	North Coast	Crescent City	16	-1.8	29.6
8	South Coast	Long Beach	64	1	39.5
9	South Mountain	Sandberg	66	-6.9	35.7

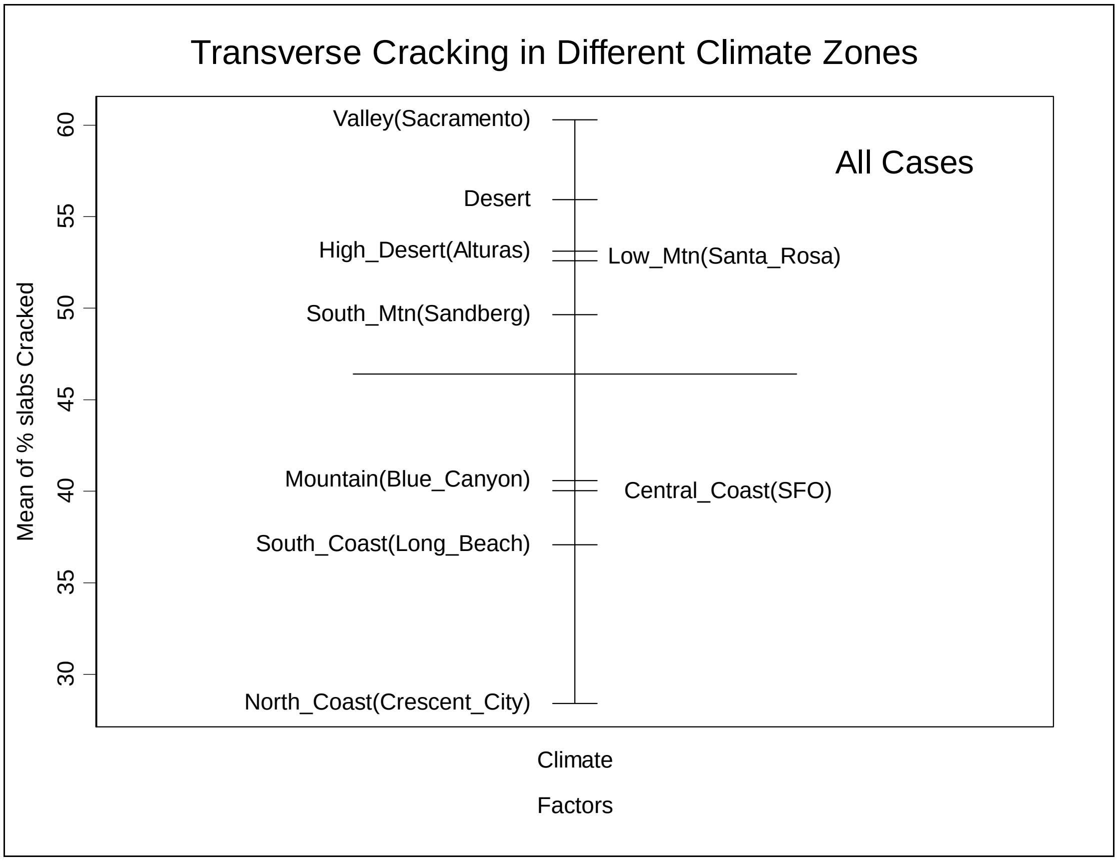

Figure 2(a). Mean transverse cracking in different climate regions.

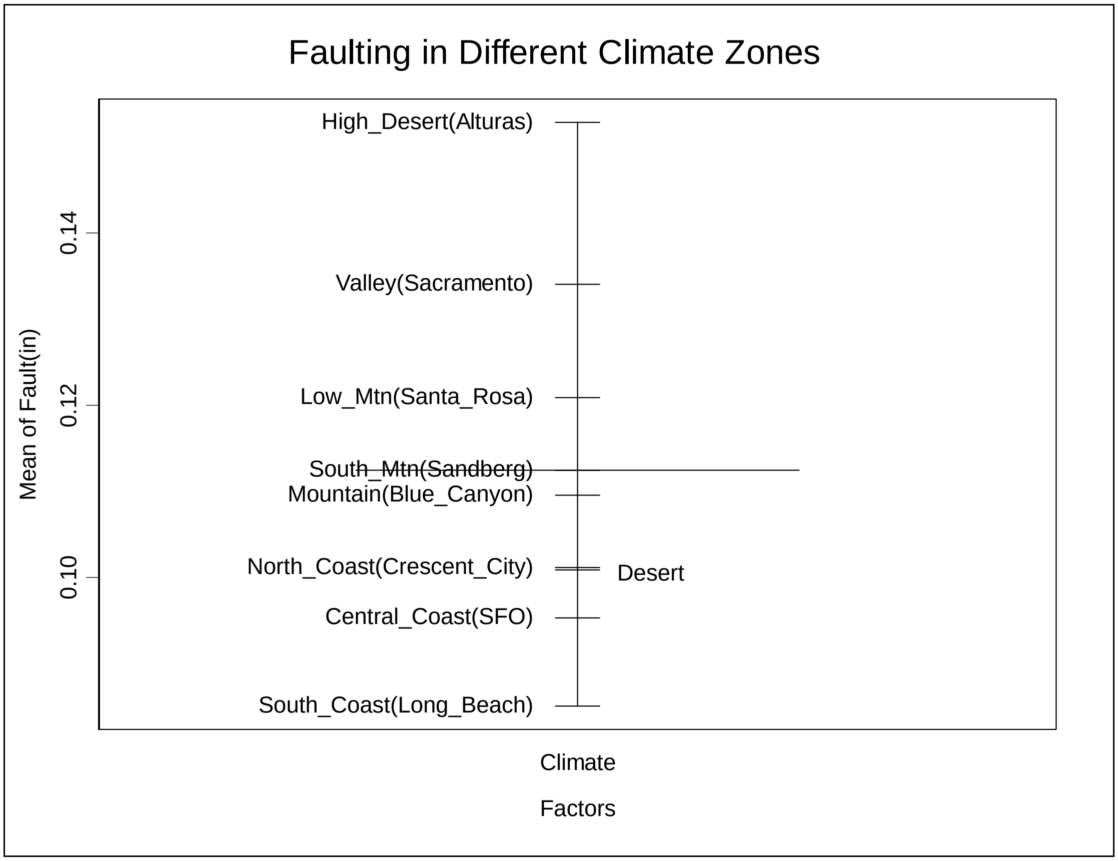

Figure 2(b). Mean faulting in different climate regions.

3. CATALOG DEVELOPMENT

3.1. The Factorial

The factorial was based on the sensitivity analysis results. The factors and the factor levels used were:

1. Climate: Central Coast, Desert, Low Mountain
2. Traffic Index (TI): 9, 11, 13, and 17 (1, 6, 20, and 210 million ESALs, respectively)
3. Spectra: Urban and Rural
4. PCC thickness: [*]

   7, 8, 9 inches for TI of 9

   8, 9, 10, 12 inches for TI of 11

   9, 10, 12, 14 inches for TI of 13 and 17
5. Base Type : Cement-treated base (CTB), asphalt concrete base (ACB) and granular base (for TI less than 11)
6. Subgrade: CH and SP
7. Load Transfer: Dowels, No Dowels
8. Shoulder Type: Asphalt, Wide, Tied shoulders
9. Granular subbase: Yes for CH subgrade, No for SP subgrade

3.2. Rationale behind the Factorial Selection

This section explains the rationale used in determining the factors and the factor levels used for the generation of the catalog.

[*] Due to a traffic miscalculation AADTTs used for running the software did not match the TI values mentioned here. The difference is very marginal and is accounted for in the analysis (traffic interpolations).

3.2.1 *Soil Type*

According to the existing design process, soil type is a key variable and is classified based on its California R-value (determined by test method CTM 301), as follows:

a. Soils with R-value between 10 and 40, and
b. Soils with R-value greater than 40.

In California, soils with R-value less than 10 must be treated to achieve an R-value of 10 before placing concrete pavement. The 1-37a software requires the soil to be classified by either the AASHTO or Unified Soil Classification (USC) system. A small sensitivity study was done to identify the soil classifications that should be used for running the factorial. The results from this sensitivity study matched the results from previous studies by Kannekanti and Harvey (2005) that subgrade type did not have much effect on the distresses, as shown in Table 2(a). However, CH (High Plasticity Clay) subgrade was chosen to represent all soils that have R-values between 10 and 40. SP (Poorly graded sand) subgrade was chosen to represent all soils with R-value greater than 40. Subgrade type was primarily used to determine granular layer requirements.

3.2.2 *Base Types*

Since 1983 Caltrans has used lean concrete base (LCB), with limited use of asphalt concrete (hot mixed asphalt) base (ACB). However, because the software did not have the option of lean concrete base, cement-treated base (CTB) was used instead. Though the existing design tables do not provide designs for granular bases this option was explored for lower traffic volumes. It was expected that there would not have been enough calibration data for PCC slabs over granular bases at high traffic volumes, so this option was used for only lower traffic volumes ($TI \leq 11$). This expectation proved to be correct as some cases run at higher traffic volumes showed granular bases to be better than— or at least as good as — stabilized bases for typical Caltrans pavements, which did not seem reasonable. This will be discussed later in this memo.

3.2.3 *Unbound Layers Design*

According to the 1-37a software results granular subbase under stabilized bases did not have any affect on the distresses (Kannekanti and Harvey, 2005). Also, the thickness of the base layers did not have a big effect on the model predictions. These predictions did not seem reasonable, so the current Caltrans practice of base and subbase layer design was retained for the catalog. The current Caltrans tables call for the use of granular subbase only for subgrades with R-values between 10 and 40. Table 2(c) shows the thickness of the base and subbase for CH subgrades. SP subgrades use the same values but without subbase. Subbase is not required when granular base is used.

3.2.4 *Spectra*

California has more than 100 Weigh-in-Motion (WIM) stations distributed throughout the state. These enable Caltrans to have a very comprehensive traffic database (Lu and Harvey, 2006). Two extreme axle load distributions found in the database were used for catalog runs and designated as “rural” and “urban” (Kannekanti and Harvey, 2005).

3.2.5 *Shoulder Types*

The thicknesses are designed for the weaker of the two longitudinal joints [see Table 2(b)]. Even when a widened lane is used the pavement structures have to be designed as either tied or untied shoulder because the inner longitudinal joint is weaker. Lane delineation is often moved for traffic reasons, particularly in urban areas. The widened truck lane was not used in the catalog calculations, but it can be used for the outside shoulder.

3.2.6 *PCC Thickness*

To reduce software run time, the PCC thicknesses evaluated were chosen based on the traffic volume. Very thick slabs were not chosen for lower traffic volume and vice versa. The maximum slab thickness analyzed was 14 inches.

Table 2. Rationale for Factorial Inputs (a) Soil Type (b) Shoulder Type and (c) Base and Subbase Thicknesses for CH Subgrade

(a)

Subgrade Type	No Dowels			Dowels		
	Faulting (in)	Cracking (%)	IRI (in/mile)	Faulting (in)	Cracking (%)	IRI (in/mile)
GW	0.519	97.6	416.1	0.022	97.6	155.7
SP	0.478	96.7	394.1	0.022	96.7	155.5
CL	0.402	92.6	350.9	0.055	92.6	169.2
CH	0.372	89	332.3	0.061	89	169.7

(b)

Inside Longitudinal Joint	Outside Longitudinal Joint	Critical Shoulder Type to be Used for Selection
Untied	Untied	Untied
	Tied	Untied
	Wide Truck Lane	Untied
Tied	Untied	Untied
	Tied	Tied
	Wide Truck Lane	Tied

(c)

TI	CTB		ACB		GB
	Base (in)	Subbase (in)	Base (in)	Subbase (in)	Base (in)
<9	4.2	6	4.2	6	12
9.5 to 10	4.2	6	4.2	6	12
10.5 to 11	4.8	7.2	4.8	7.2	12
11.5 to 12	4.8	7.2	4.8	7.2	12
12.5 to 13	6	8.4	6	8.4	12
13.5 to 14	6	8.4	6	8.4	12
14.5 to 15	6	8.4	6	8.4	12
15.5 to 16	6	8.4	6	8.4	12
16.5 to 17	6	8.4	6	8.4	12

3.2.7 *Traffic Volume*

Traffic Index (TI) related to ESALs as follows:

$$TI = 9.0 \times \left(ESAL / 10^{6} \right)^{0.119}$$

Even though TI is not a direct input to the 1-37a software, it is still used in the catalog to provide continuity with current practice and because axle load spectra, even considering the two extreme cases used for the catalog calculations, did not show a substantial effect for a given TI. Axle load spectra, TI, and other site-specific traffic data in the Caltrans WIM data base were used to calculate Average Annual Daily Truck Traffic (AADTT), which is a direct input to the software.

3.2.8 *Key Assumptions*

All the inputs used for running the factorial are shown in Appendix A. Key assumptions were made for the catalog, some of which have a significant effect on the thicknesses, follow:

1. 90 percent reliability level.
2. Forty-year design life.
3. Default value of 0.85 for surface absorptivity; chosen because the models were calibrated with this value.
4. Coefficient of thermal expansion of concrete was chosen to be slightly conservative ($6.0 \times 10^{-6} / {}^{o}F$) based on test results of a limited number of existing pavements. The results from CTE testing by the Federal Highway Administration Turner-Fairbank Highway Research Center (FHWA-TFHRC) of seventy-seven cores as part of the Long Term Pavement Performance (LTPP) program is shown in Figure 3. The box plots shows that about 75 percent of California's aggregate would be at or below $6.0 \times 10^{-6} / {}^{o}F$ and the median value is slightly less than $5.5 \times 10^{-6} / {}^{o}F$. More extensive testing is currently being done as part of the field calibration.
5. Concrete 28-day flexural strength of 626 psi.

6. Dowel diameter was chosen to be 1.25 inches for PCC slabs less than 8.5 inches and 1.5 inches for slabs greater than 8.5 inches.
7. Erodibility Index for base is assumed as one for CTB, two for ACB, and three for granular base.
8. Joint spacing was fixed at a value of 13.5 feet. The current Caltrans specification requires joints to be placed at successive repeated intervals of 12, 15, 13, and 14 feet. The option of random joint spacing was not functional in the software, so an average joint spacing of 13.5 feet was used for the catalog runs.
9. It is assumed that the base and surface layers are unbonded, which is standard Caltrans practice.
10. Default values were used for the material properties of stabilized bases and unbound layers.

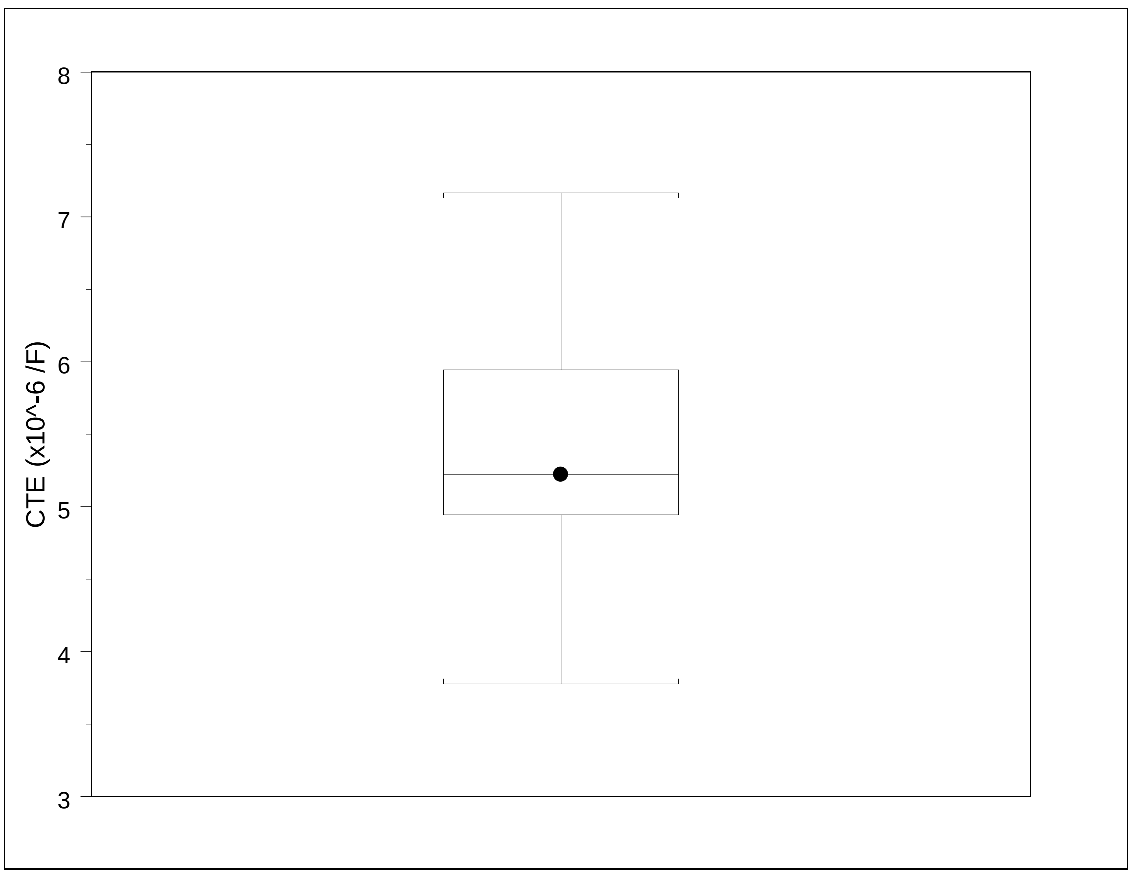

Figure 3. CTE of cores sampled from California LTPP pavements as of 04-26-2005.

3.3. The Catalog

The factorial mentioned in the previous section resulted in 2,160 cases that were loaded into a database. For each combination of inputs (climate, traffic volume, load transfer efficiency, base type, subgrade type, spectra), the least thickness resulting in distresses that are within the failure criteria (10 percent cracking, 0.1 in faulting, or roughness of 160 in/mi) is designated as design thickness. In many cases the design thickness had to be interpolated from thicknesses that had distresses on either side of the failure criteria. When cracking was the critical distress, exponential interpolation of the thicknesses yielded good results. When faulting was the critical distress, linear interpolation gave satisfactory results. For roughness, exponential interpolation was preferred. Design thickness was linearly interpolated for TIs between 9 and 17 that were not considered in the factorial. Pavement structures resulting from all the combinations of inputs were compiled in design tables. All the design tables in the catalog are shown in Appendix B.

4. LIMITATIONS OF THE CATALOG

4.1. Use of Granular Bases at High TIs

Cases were run to check if selecting granular bases instead of stabilized bases could be provided as an option in the catalog. Cases were run for a traffic index of 17, urban spectra for Coastal areas, and rural spectra in Desert climate regions. The cases were run for both tied and untied shoulders and for CH subgrade. The results showed that in some cases, especially in Desert climate, structures with granular bases are thinner than structures with cement-treated bases. A couple of examples are shown in Table 3. Results from rest of the cases are included in the catalog shown in Appendix B. The results suggest that the models were not calibrated with granular base sections at high traffic volumes.

Table 3. Examples of Structures with Granular Bases at a High TI

Key Inputs	**PCC Thickness when AC Base is Used (in)**	**PCC Thickness when CTB is Used (in)**	**PCC thickness when Granular Base is Used (in)**
TI:17, Desert Climate, Rural Spectra, Dowels, Tied Shoulders	13.31	12.98	12.81
TI:17, Desert Climate, Rural Spectra, Dowels, Untied Shoulders	13.58	13.3	13.27

4.2. Limitations of the Catalog

Following are some of the issues that were known or discovered during the development of the catalog.

1. The catalog was developed using models that are not yet locally calibrated with California field data.
2. The catalog was generated with limited climate data available at the time of the study.
3. Few structures in the catalog failed by the IRI criterion, suggesting that IRI is being underpredicted. This will be checked during field validation.
4. The catalog does not provide the option of granular base at higher TI values. When granular bases are used at higher TI values, they proved to be better alternatives than stabilized base. This did not seem reasonable and suggests that the models may not be well calibrated at higher traffic volumes, especially for granular bases.

5. There was very little difference in results for rural versus urban load spectra.
6. Thick slabs without dowels had double the predicted faulting of the corresponding doweled pavement, but still relatively low faulting levels. It is uncertain whether 12- to 14-inch thick undoweled slabs were included in the calibration of the models. Personal communication with one of the developers of the models revealed that very little data from California's undoweled pavements had gone into the calibration database.
7. Some software problems were found in version 0.8 used for the development of the catalog. For example, this version of the software predicts thinner sections that supposedly perform better than thicker sections and asphalt shoulders that perform better than tied shoulders and a widened truck lane. Operationally, when a file is saved with a different name, the climate data is internally saved as zero in some cases. In order to prevent such errors from affecting the catalog, the results and the intermediate climate files for all the cases were checked manually for the abovementioned problems. More details about these problems can be found in a report by Kannekanti and Harvey (2005).

4.3. Observations

1. Though MEPDG is a powerful tool, it is not economical to use it for all projects. Implementing the 1-37a software requires a large amount of personnel training and institutional changes.
2. One approach to tackle potential barriers to implementation of ME is to generate a catalog using the 1-37a software. This can produce some of the benefits of ME design procedures and serve as a starting point to understand the needs for full-scale implementation of ME procedures in future.
3. The catalog has many advantages over the existing design tables. It takes into account climatic effects, shoulder types, base types, and subgrade types on pavement performance. It is considered to be a first step to ME implementation.

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6. APPENDIX A (INPUTS USED)

Table A-1 Traffic Inputs

Traffic	Value	Source
Number of lanes in design direction	2	
% trucks in design direction	50	
% trucks in design lane	100	
Operational speed	57.6	WIM
Number of lanes in design direction	2	
Mean wheel location(in)	18	default
Traffic wander standard deviation(in)	10	default
Design lane width (ft)	12	default
Average axle width (ft)	8.5	default
Dual tire spacing(in)	12	default
Singe Tire	120	default
Dual tire	120	default
Tandem axle	51.6	default
Tridem axle	49.2	default
Quad axle	49.2	default
Short (ft)	12	default
Medium (ft)	15	default
Long (ft)	18	default
Short (%)	49.4	WIM
Medium (%)	24.3	WIM
Long (%)	26.3	WIM

Table A-2 AADT for Different TIs*

TI	Rural Spectra	Urban Spectra
9	66	117
11	357	629
13	1454	2561
17	13860	24402

* * Due to a traffic miscalculation AADTTs used for running the software did not match the TI values mentioned here. The difference is very marginal and is accounted for in the analysis (traffic interpolations).

Table A-3 Vehicle Class Distribution for Rural and Urban Areas

Vehicle Class	Rural Vehicle Class Distribution	Urban Vehicle Class Distribution
Type 4 (%)	0.6	1
Type 5 (%)	11.9	39
Type 6 (%)	2.8	7.4
Type 7 (%)	0.1	1.1
Type 8 (%)	4.2	8
Type 9 (%)	62.3	18.9
Type 10 (%)	2.2	0.1
Type 11 (%)	8.4	13.9
Type 12 (%)	5.8	0.7
Type 13 (%)	1.7	0.2

Table A-4 Hourly Distribution for Rural and Urban Areas

Hour	Rural Hourly Distribution	Urban Hourly Distribution
MIDNIGHT	2.8	1.56
1	2.2	1.19
2	1.9	1.13
3	1.8	1.11
4	1.9	1.54
5	2.0	2.54
6	2.4	3.66
7	3.0	5.51
8	3.9	5.95
9	4.7	6.74
10	5.4	6.54
11	5.7	6.54
12	5.9	6.80
13(NOON)	6.0	6.73
14	6.0	6.66
15	6.1	6.45
16	6.0	6.22
17	5.8	5.60
18	5.5	4.93
19	5.2	3.73
20	4.6	2.89
21	4.3	2.30
22	3.7	1.97
23	3.3	1.72

Table A-5 Number of Axle Types per Truck Class (both Urban and Rural)

TruckType	Single	Tandem	Tridem
4	1.342	0.649	0
5	2	0	0
6	1	1	0
7	1.893	0.893	0.107
8	2.583	0.494	0
9	1	2	0
10	1	1	1
11	5	0	0
12	4	1	0
13	2.6	2.4	0.2

Axle Load Spectra for both rural and urban areas are not reported here because it is not practical to show them in a Microsoft *Word* document.

Table A-6 Rural Monthly Adjustment Factors

MONTH	CLASS 4	CLASS 5	CLASS 6	CLASS 7	CLASS 8	CLASS 9	CLASS 10	CLASS 11	CLASS 12	CLASS 13
JANUARY	0.85	0.74	0.68	0.26	0.76	0.9	0.89	0.76	0.91	0.73
FEBRUARY	0.81	0.74	0.67	0.37	0.73	0.95	0.96	0.82	0.99	0.42
MARCH	0.93	0.91	0.7	0.76	0.96	0.98	1.07	0.86	0.97	2.47
APRIL	1.08	1.04	0.95	0.82	0.99	1.03	1.06	0.92	0.94	0.41
MAY	1.17	0.94	1.02	1.19	0.97	1.02	1.02	0.91	0.94	1.03
JUNE	1.04	1.06	1.16	1.09	1.18	1	0.92	1.04	1.07	1.36
JULY	1.16	1.37	1.29	1.33	1.3	1.02	1.03	1.11	0.96	0.69
AUGUST	0.98	1.17	1.17	1.35	1.44	0.99	1.07	1.16	1.07	1.43
SEPTEMBER	1.01	1.08	1.23	1.23	1.17	0.97	0.93	1.16	1.06	1.56
OCTOBER	1.06	1.18	1.26	1.72	0.94	1.02	0.97	1.32	0.98	0.44
NOVEMBER	1.01	0.94	0.9	0.43	0.82	1.05	1.01	0.97	1.02	1.01
DECEMBER	0.9	0.82	0.97	1.44	0.74	1.06	1.04	0.96	1.08	0.47

Table A-7 Urban Monthly Adjustment Factors

MONTH	CLASS 4	CLASS 5	CLASS 6	CLASS 7	CLASS 8	CLASS 9	CLASS 10	CLASS 11	CLASS 12	CLASS 13
JANUARY	1.16	0.91	0.89	0.6	0.95	0.96	0.99	0.45	0.58	0.86
FEBRUARY	1.19	0.93	0.94	0.96	1.1	0.98	1	0.77	1.09	0.86
MARCH	1.32	1.1	1.18	1.46	1.36	1.13	1.35	1.8	1.92	1.15
APRIL	0.95	1.16	1.15	1.18	1.19	1.07	1.16	2.18	2.37	0.99
MAY	1.02	1.1	1.03	0.98	1.13	1.1	1.23	1.8	1.85	1.02
JUNE	0.99	1.16	1.05	1.36	1.04	1.02	0.96	1.47	1.05	1.38
JULY	0.86	1.04	1.07	1.07	0.9	0.99	0.85	0.76	0.53	0.89
AUGUST	0.82	1.01	1.1	1.32	0.89	0.98	0.84	0.6	0.5	0.88
SEPTEMBER	0.89	0.89	0.83	0.76	0.9	0.9	0.71	0.47	0.42	1.11
OCTOBER	1.03	0.93	0.94	0.64	0.85	0.89	0.84	0.56	0.47	0.81
NOVEMBER	0.86	0.89	0.94	1.06	0.9	0.99	1.03	0.64	0.55	1.31
DECEMBER	0.92	0.88	0.88	0.6	0.8	0.99	1.05	0.5	0.66	0.72

Table A-8 Climate Inputs

Climate Data Inputs	Value	Source
Annual average depth of water table (ft)	30	Default value
Climate data file	SFO for coastal	CT decision
	Santa Rosa for mountain	CT decision
	Dagget for valley	CT decision

Table A-9 Design Features Used

Design Features Inputs	Value	Source
Permanent curl/ warp effective temperature difference (F)	-10	Default
Joint spacing (ft)	13.5	CT decision
Sealent type	Silicone	assumed CT practice
Dowel diameter (in)	1.25" for slabs < 8.5" and 1.5" for slabs > 8.5"	CT decision
Dowel spacing (in)	12	Default
Tied PCC shoulder LTE (%)	40	Default
Widened slab width (ft)	14	Default
PCC - Base interface	Unbonded	CT practice
Erodibility Index	1 for LCB 2 for ACB 3 for granular base	Software recommendation

Table A-10 Surface Property Inputs

Drianage Properties	Value	Source
Surface shortwave absorptivity	0.85	default
Infiltration	Minor (10%)	default
Drainage path length (ft)	12	default
Pavement cross slope (%)	2	default

Table A-11 Material Property Inputs for All the Layers

Material Properties	Value	Source	Level*
PCC General properties			
Unit weight (pcf)	150	default	
Poisson's ratio	0.2	default	
PCC thermal properties			
Coefficient of thermal expansion (/F x 10^{-6})	6	Decision by CT	
Thermal conductivity	1.25	default	
Heat Capacity	0.28	default	
PCC mix properties			
Cement type	Type II	from UCB mix	
Cementitious material content (lb/yd^3)	657	from UCB mix	
Water/cement ratio	0.42	from UCB mix	
PCC zero stress temperature (F)	101	default	
Ultimate shrinkage at 40% RH (micro strain)	537	default	
Reversible shrinkage (% of ultimate shrinkage)	50	default	
Time to develop 50% of ultimate shrinkage (days)	35	default	
curing method	Curing compound	CT practice	
PCC strength properties			
28 day PCC modulus of rupture (psi)	626	from UCB mix	Level 3
Cement stabilized material properties			
Unit weight (pcf)	150	default	
Poisson's ratio	0.2	default	
Elastic / Resilient modulus (psi)	2000000	default	
Thermal conductivity (BTU/hr-ft-F)	1.25	default	
Heat capacity (BTU/lb-F)	0.28	default	
Asphalt concrete Base properties			
Asphalt Mix Properties			
Cumulative % retained 3/4 inch sieve	0	from UCB mix	Level 2
Cumulative % retained 3/8 inch sieve	32	from UCB mix	Level 2
Cumulative % retained # 4 sieve	52	from UCB mix	Level 2
% Passing #200 sieve	5.5	from UCB mix	Level 2
Asphalt Binder Property	Conventional Viscosity grade of AC 10		Level 3
General Asphalt Properties			
Reference Temperature (F)	70	default	Level 1
Poisson's Ratio	0.35	default	Level 1
Thermal conductivity asphalt (BTU/hr-	0.67	default	Level 1

* Level is reported for only those inputs that had the option of entering inputs at different levels. Level 3 is the simplest level with little or no testing required; level 2 and level 1 require more comprehensive inputs.

ft-F)			
Heat capacity asphalt (BTU /lb-F)	0.23	default	Level 1
Effective Binder Content	11.662	from UCB mix	Level 1
Air Void (%)	8	from UCB mix	Level 1
Total unit weight (pcf)	148	from UCB mix	Level 1
Granular Base Properties			
Soil Classification	A-1-a		
Poisson's ratio	0.35	default	
Coefficient of lateral pressure, Ko	0.5	default	
Resilient Modulus (psi)	40000	default	Level 3
ICM properties (granular base)			
Plasticity Index	1	default	
Passing # 200 sieve (%)	3	default	
Passing # 4 sieve (%)	20	default	
D60 (mm)	8	default	
Compacted unbound material	Yes		
Granular Subbase when used with stabilized bases			
Soil Classification	A-1-a		
Poisson's ratio	0.35	default	
Coefficient of lateral pressure, Ko	0.5	default	
Resilient Modulus (psi)	40000	default	Level 3
ICM properties (granular subbase)			
Plasticity Index	1	default	
Passing # 200 sieve (%)	3	default	
Passing # 4 sieve (%)	20	default	
D60 (mm)	8	default	
Compacted unbound material	Yes		
SP subgrade			
Poisson's ratio	0.35	default	
Coefficient of lateral pressure, Ko	0.5	default	
Resilient Modulus (psi)	28000	default	Level 3
ICM properties (SP subgrade)			
Plasticity Index	0	default	
Passing # 200 sieve (%)	10	default	
Passing # 4 sieve (%)	80	default	
D60 (mm)	1	default	
Compacted unbound material	Yes		
CH subgrade			
Poisson's ratio	0.35	default	
Coefficient of lateral pressure, Ko	0.5	default	
Resilient Modulus (psi)	5000	UCB judgment	Level 3
ICM properties (CH subgrade)			
Plasticity Index	35	default	
Passing # 200 sieve (%)	75	default	
Passing # 4 sieve (%)	95	default	
D60 (mm)	0.01	default	
Compacted unbound material	Yes		

7. APPENDIX B (THE CATALOG)*

Table B-1 Catalog Index

Climate	Subgrade	Spectra	Shoulder Type	Page Number
San Francisco	CH	Rural	Untied	30
			Tied	31
		Urban	Untied	32
			Tied	33
	SP	Rural	Untied	34
			Tied	35
		Urban	Untied	36
			Tied	37
Dagget	CH	Rural	Untied	38
			Tied	39
		Urban	Untied	40
			Tied	41
	SP	Rural	Untied	42
			Tied	43
		Urban	Untied	44
			Tied	45
Santa Rosa	CH	Rural	Untied	46
			Tied	47
		Urban	Untied	48
			Tied	49
	SP	Rural	Untied	50
			Tied	51
		Urban	Untied	52
			Tied	53

* Thicknesses appear as inches in this Appendix.

Weather Station: San Francisco
Climate Region: Central Coast
Subgrade: CH (10 < R < 40)
Spectra: Rural
Shoulder: Untied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	**ACB**	**GB**	**CTB**	**ACB**	**GB**
9	PCC	7.22	7.35	7.75	7.21	7.21	7.21
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	7.76	8.21	9.61	7.74	7.74	7.74
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	8.68	9.27	11.47	8.26	8.26	8.26
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	9.97	10.54	--	8.79	8.79	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	11.01	11.49	--	9.17	9.32	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	11.89	12.23	--	9.44	9.85	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	12.77	12.97	--	9.72	10.37	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	13.69	13.70	--	10.00	10.90	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	NA*	NA*	--	10.28	11.43	--
	Base			--	6.00	6.00	--
	Gran Subbase			--	8.50	8.50	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: San Francisco
Climate Region: Central Coast
Subgrade: CH (10 < R < 40)
Spectra: Rural
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	7.21	7.28	7.65	7.21	7.21	7.21
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	7.74	7.96	9.27	7.74	7.74	7.74
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	8.57	8.95	10.89	8.26	8.26	8.26
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	9.70	10.24	--	8.79	8.79	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	10.70	11.24	--	9.07	9.15	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	11.62	12.05	--	9.20	9.39	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	12.53	12.87	--	9.32	9.63	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	13.45	13.68	--	9.45	9.88	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	14.00	NA*	--	9.57	10.12	--
	Base	6.00		--	6.00	6.00	--
	Gran Subbase	8.50		--	8.50	8.50	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: San Francisco
Climate Region: Central Coast
Subgrade: CH (10 < R < 40)
Spectra: Urban
Shoulder: Untied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	7.43	7.06	7.29	7.44	7.16	7.53
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	7.91	7.95	8.96	7.89	7.56	7.98
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	8.25	8.79	10.64	8.38	7.93	8.42
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	9.42	9.95	--	8.66	8.42	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	10.70	11.22	--	8.91	8.90	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	11.35	11.79	--	9.36	9.41	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	11.99	12.36	--	9.82	9.92	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	12.63	12.92	--	10.28	10.44	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	13.28	13.49	--	10.73	10.95	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--

Weather Station: San Francisco
Climate Region: Central Coast
Subgrade: CH (10 < R < 40)
Spectra: Urban
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	6.88	6.83	6.73	6.90	6.90	6.99
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	7.46	7.70	8.49	7.40	7.40	7.45
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	7.92	8.50	10.25	7.90	7.90	7.91
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	9.11	9.68	--	8.40	8.40	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	10.41	10.97	--	8.96	8.95	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	11.10	11.57	--	9.16	9.19	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	11.78	12.17	--	9.36	9.42	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	12.46	12.77	--	9.57	9.66	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	13.14	13.37	NA*	9.77	9.90	11.42
	Base	6.00	6.00	--	6.00	6.00	18.00
	Gran Subbase	8.50	8.50	--	8.50	8.50	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: San Francisco
Climate Region: Central Coast
Subgrade: SP (R > 40)
Spectra: Rural
Shoulder: Untied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	7.92	7.33	8.41	7.92	7.32	7.81
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	8.51	8.14	9.86	8.51	8.11	8.43
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	9.21	9.17	11.31	9.04	8.78	9.06
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	10.01	10.43	--	9.52	9.33	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	10.83	11.38	--	10.00	9.89	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	11.66	12.14	--	10.49	10.48	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	12.50	12.90	--	10.98	11.06	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	13.34	13.66	--	11.47	11.64	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	14.00	NA*	--	11.95	12.22	--
	Base	6.00		--	6.00	6.00	--
	Gran Subbase	0.00		--	0.00	0.00	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: San Francisco
Climate Region: Central Coast
Subgrade: SP (R > 40)
Spectra: Rural
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	7.44	7.21	8.07	7.44	7.21	7.26
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	8.16	7.74	9.41	8.16	7.74	7.93
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	8.89	8.68	10.74	8.70	8.26	8.59
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	9.61	10.03	--	9.07	8.79	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	10.43	11.04	--	9.46	9.29	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	11.30	11.83	--	9.87	9.78	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	12.17	12.61	--	10.28	10.27	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	13.04	13.40	--	10.69	10.76	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	13.92	14.00	--	11.10	11.25	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--

Weather Station: San Francisco
Climate Region: Central Coast
Subgrade: SP (R > 40)
Spectra: Urban
Shoulder: Untied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	8.17	7.52	7.85	8.17	7.54	7.94
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	8.69	8.19	9.30	8.69	8.11	8.40
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	9.17	8.78	10.75	9.24	8.72	8.87
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	9.87	9.90	--	9.57	9.18	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	10.56	11.12	--	9.88	9.62	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	11.33	11.79	--	10.32	10.15	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	12.11	12.46	--	10.76	10.67	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	12.88	13.13	--	11.20	11.19	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	13.65	13.80	--	11.64	11.72	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--

Weather Station: San Francisco
Climate Region: Central Coast
Subgrade: SP (R > 40)
Spectra: Urban
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	7.62	6.85	7.53	7.62	6.86	7.50
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	8.17	7.61	8.93	8.17	7.58	8.05
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	8.68	8.29	10.33	8.74	8.38	8.60
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	9.44	9.49	--	9.19	8.69	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	10.19	10.80	--	9.64	8.96	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	11.00	11.53	--	10.06	9.44	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	11.81	12.26	--	10.49	9.92	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	12.62	13.00	--	10.92	10.40	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	13.43	13.73	--	11.35	10.88	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--

Weather Station: Dagget
Climate Region: Desert / Valley
Subgrade: CH (10 < R < 40)
Spectra: Rural
Shoulder: Untied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	7.92	8.17	8.55	7.92	8.17	8.14
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	8.60	9.11	10.25	8.60	9.11	8.93
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	9.47	10.07	11.95	9.39	10.03	9.72
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	10.53	11.05	--	10.30	10.93	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	11.41	11.82	--	11.05	11.63	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	12.17	12.46	--	11.71	12.20	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	12.93	13.10	--	12.37	12.78	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	13.69	13.74	--	13.03	13.35	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	NA*	NA*	NA*	13.69	13.92	13.27
	Base				6.00	6.00	18.00
	Gran Subbase				8.50	8.50	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: Dagget
Climate Region: Desert / Valley
Subgrade: CH (10 < R < 40)
Spectra: Rural
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	7.32	7.42	8.21	7.29	7.41	7.66
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	8.13	8.45	9.91	8.01	8.45	8.39
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	9.09	9.55	11.62	8.71	9.34	9.13
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	10.21	10.72	--	9.40	10.11	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	11.16	11.60	--	10.17	10.85	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	11.99	12.31	--	11.00	11.57	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	12.83	13.01	--	11.82	12.29	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	13.66	13.72	--	12.65	13.02	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	NA*	NA*	NA*	13.48	13.74	12.81
	Base				6.00	6.00	18.00
	Gran Subbase				8.50	8.50	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: Dagget
Climate Region: Desert / Valley
Subgrade: CH (10 < R < 40)
Spectra: Urban
Shoulder: Untied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	8.13	7.80	8.07	8.13	7.82	8.27
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	8.59	8.61	9.58	8.59	8.53	8.76
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	8.93	9.37	11.09	9.00	9.21	9.24
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	9.97	10.40	--	9.66	10.08	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	11.05	11.47	--	10.30	11.00	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	11.79	12.31	--	11.01	11.61	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	12.53	13.16	--	11.72	12.23	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	13.26	14.00	--	12.43	12.85	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	14.00	NA*	--	13.14	13.46	--
	Base	6.00		--	6.00	6.00	--
	Gran Subbase	8.50		--	8.50	8.50	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: Dagget
Climate Region: Desert / Valley
Subgrade: CH (10 < R < 40)
Spectra: Urban
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	7.69	7.52	7.63	7.70	7.57	7.76
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	8.23	8.34	9.22	8.19	8.14	8.25
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	8.66	9.11	10.80	8.68	8.72	8.74
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	9.70	10.16	--	9.13	9.29	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	10.79	11.23	--	9.50	9.81	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	11.59	12.15	--	10.33	10.64	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	12.39	13.08	--	11.16	11.46	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	13.20	14.00	--	11.99	12.29	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	14.00	NA*	--	12.81	13.12	--
	Base	6.00		--	6.00	6.00	--
	Gran Subbase	8.50		--	8.50	8.50	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: Dagget
Climate Region: Desert / Valley
Subgrade: SP (R > 40)
Spectra: Rural
Shoulder: Untied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	**ACB**	**GB**	**CTB**	**ACB**	**GB**
9	PCC	8.88	9.04	9.10	8.88	9.05	9.10
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	9.59	10.18	10.02	9.59	10.19	10.02
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	10.37	11.07	10.94	10.37	11.07	10.94
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	11.24	11.68	--	11.24	11.68	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	11.93	12.24	--	11.93	12.24	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	12.51	12.76	--	12.51	12.76	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	13.09	13.28	--	13.09	13.28	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	13.67	13.79	--	13.67	13.79	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	14.00	NA*	--	14.00	NA*	--
	Base	6.00		--	6.00	6.00	--
	Gran Subbase	0.00		--	0.00	0.00	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: Dagget
Climate Region: Desert / Valley
Subgrade: SP (R > 40)
Spectra: Rural
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	8.16	7.66	8.31	8.16	7.66	8.15
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	8.70	8.55	9.28	8.70	8.55	8.71
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	9.24	9.54	10.25	9.24	9.54	9.27
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	9.79	10.61	--	9.79	10.61	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	10.50	11.44	--	10.47	11.40	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	11.32	12.10	--	11.24	12.01	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	12.14	12.76	--	12.01	12.61	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	12.96	13.43	--	12.79	13.21	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	13.79	14.00	--	13.56	13.81	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--

Weather Station: Dagget
Climate Region: Desert / Valley
Subgrade: SP (R > 40)
Spectra: Urban
Shoulder: Untied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	8.85	8.53	8.75	8.85	8.53	8.80
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	9.36	9.30	9.54	9.36	9.30	9.35
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	9.81	10.05	10.33	9.81	10.05	9.89
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	10.63	10.87	--	10.63	10.87	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	11.51	11.74	--	11.51	11.73	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	12.08	12.26	--	12.08	12.30	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	12.64	12.79	--	12.64	12.86	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	13.20	13.32	--	13.20	13.43	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	13.76	13.84	--	13.76	14.00	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--

Weather Station: Dagget
Climate Region: Desert / Valley
Subgrade: SP (R > 40)
Spectra: Urban
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	8.52	7.80	8.42	8.52	7.80	8.48
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	9.02	8.38	9.16	9.02	8.38	8.94
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	9.51	8.90	9.90	9.51	8.90	9.40
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	10.07	9.74	--	10.07	9.74	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	10.61	10.61	--	10.63	10.63	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	11.27	11.35	--	11.19	11.28	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	11.94	12.09	--	11.75	11.93	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	12.60	12.83	--	12.32	12.58	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	13.26	13.57	--	12.88	13.23	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--

Weather Station: Santa Rosa
Climate Region: Low Mountain
Subgrade: CH (10 < R < 40)
Spectra: Rural
Shoulder: Untied

TI	**Structure**	**No Dowels with base type**			**Dowels with base type**		
		CTB	**ACB**	**GB**	**CTB**	**ACB**	**GB**
9	PCC	7.76	8.15	8.80	7.76	8.15	8.07
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	8.59	9.08	10.61	8.59	9.08	8.93
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	9.56	10.08	12.43	9.44	10.00	9.80
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	10.67	11.15	--	10.33	10.90	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	11.55	11.95	--	11.12	11.63	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	12.27	12.55	--	11.86	12.26	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	13.00	13.15	--	12.59	12.89	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	13.71	13.76	--	13.33	13.51	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	NA*	NA*	--	14.00	14.00	--
	Base			--	6.00	6.00	--
	Gran Subbase			--	8.50	8.50	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: Santa Rosa
Climate Region: Low Mountain
Subgrade: CH (10 < R < 40)
Spectra: Rural
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	**ACB**	**GB**	**CTB**	**ACB**	**GB**
9	PCC	7.36	7.47	8.44	7.29	7.40	7.41
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	8.27	8.64	10.28	8.02	8.38	8.35
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	9.28	9.79	12.12	8.80	9.38	9.28
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	10.41	10.91	--	9.63	10.40	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	11.33	11.75	--	10.48	11.21	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	12.11	12.41	--	11.32	11.89	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	12.90	13.08	--	12.16	12.57	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	13.68	13.74	--	13.01	13.24	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	NA*	NA*	--	13.85	13.92	--
	Base			--	6.00	6.00	--
	Gran Subbase			--	8.50	8.50	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: Santa Rosa
Climate Region: Low Mountain
Subgrade: CH (10 < R < 40)
Spectra: Urban
Shoulder: Untied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	7.76	7.67	8.22	7.79	7.71	7.85
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	8.49	8.64	9.85	8.33	8.45	8.48
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	9.16	9.61	11.48	8.84	9.17	9.11
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	10.16	10.60	--	9.54	10.03	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	11.22	11.63	--	10.21	10.93	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	11.87	12.42	--	11.02	11.61	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	12.52	13.21	--	11.83	12.28	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	13.16	14.00	--	12.64	12.95	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	13.81	NA*	--	13.45	13.63	--
	Base	6.00		--	6.00	6.00	--
	Gran Subbase	8.50		--	8.50	8.50	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: Santa Rosa
Climate Region: Low Mountain
Subgrade: CH (10 < R < 40)
Spectra: Urban
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	**ACB**	**GB**	**CTB**	**ACB**	**GB**
9	PCC	7.47	7.30	7.86	7.52	7.38	7.62
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
10	PCC	8.20	8.33	9.53	8.02	8.00	8.15
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	6.00	6.00	0.00	6.00	6.00	0.00
11	PCC	8.88	9.37	11.20	8.51	8.56	8.68
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	7.20	7.20	7.20	7.20	7.20	7.20
12	PCC	9.91	10.38	--	9.09	9.43	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	7.20	7.20	--	7.20	7.20	--
13	PCC	11.00	11.47	--	9.62	10.33	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
14	PCC	11.70	12.06	--	10.50	11.09	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
15	PCC	12.39	12.65	--	11.39	11.85	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
16	PCC	13.09	13.24	--	12.27	12.61	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--
17	PCC	13.79	13.82	--	13.16	13.37	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	8.50	8.50	--	8.50	8.50	--

Weather Station: Santa Rosa
Climate Region: Low Mountain
Subgrade: SP (R > 40)
Spectra: Rural
Shoulder: Untied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	8.51	8.83	9.56	8.51	8.83	8.91
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	9.35	9.85	11.00	9.35	9.85	9.71
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	10.19	10.70	12.45	10.19	10.70	10.51
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	11.02	11.38	--	11.02	11.38	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	11.75	12.01	--	11.71	11.98	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	12.42	12.59	--	12.28	12.52	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	13.07	13.18	--	12.86	13.05	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	13.73	13.77	--	13.44	13.59	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	NA*	NA*	--	14.00	14.00	--
	Base			--	6.00	6.00	--
	Gran Subbase			--	0.00	0.00	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: Santa Rosa
Climate Region: Low Mountain
Subgrade: SP (R > 40)
Spectra: Rural
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	7.84	7.50	9.14	7.84	7.39	7.94
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	8.47	8.74	10.62	8.47	8.36	8.56
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	9.32	9.88	12.10	9.05	9.27	9.18
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	10.36	10.90	--	9.57	10.13	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	11.22	11.72	--	10.16	10.86	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	11.97	12.39	--	10.80	11.49	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	12.71	13.06	--	11.44	12.12	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	13.45	13.73	--	12.08	12.75	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	14.00	NA*	--	12.73	13.38	--
	Base	6.00		--	6.00	6.00	--
	Gran Subbase	0.00		--	0.00	0.00	--

* Required slab thickness greater than 14 inches according to the models.

Weather Station: Santa Rosa
Climate Region: Low Mountain
Subgrade: SP (R > 40)
Spectra: Urban
Shoulder: Untied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	8.58	8.24	8.70	8.58	8.25	8.61
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	9.14	9.05	10.20	9.14	9.00	9.19
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	9.65	9.86	11.70	9.65	9.72	9.77
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	10.42	10.75	--	10.41	10.56	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	11.23	11.72	--	11.22	11.47	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	11.87	12.22	--	11.79	11.94	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	12.52	12.72	--	12.36	12.41	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	13.16	13.22	--	12.93	12.88	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	13.81	13.73	--	13.50	13.35	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--

Weather Station: Santa Rosa
Climate Region: Low Mountain
Subgrade: SP (R > 40)
Spectra: Urban
Shoulder: Tied

TI	Structure	No Dowels with base type			Dowels with base type		
		CTB	ACB	GB	CTB	ACB	GB
9	PCC	8.05	7.42	8.64	8.05	7.51	8.02
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
10	PCC	8.56	8.45	10.03	8.55	8.11	8.46
	Base	5.00	5.00	12.00	5.00	5.00	12.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
11	PCC	8.97	9.51	11.42	9.07	8.72	8.90
	Base	5.00	5.00	8.00	5.00	5.00	8.00
	Gran Subbase	0.00	0.00	0.00	0.00	0.00	0.00
12	PCC	9.92	10.44	--	9.46	9.30	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
13	PCC	10.93	11.45	--	9.82	9.85	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
14	PCC	11.62	11.97	--	10.36	10.54	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
15	PCC	12.31	12.49	--	10.91	11.24	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
16	PCC	13.01	13.01	--	11.46	11.94	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--
17	PCC	13.70	13.54	--	12.00	12.64	--
	Base	6.00	6.00	--	6.00	6.00	--
	Gran Subbase	0.00	0.00	--	0.00	0.00	--