TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. FHWA/TX-87/460-1	**2. Government Accession No.**	**3. Recipient's Catalog No.**

4. Title and Subtitle TEMPERATURE DIFFERENTIAL EFFECT ON THE FALLING WEIGHT DEFLECTOMETER DEFLECTIONS USED FOR STRUCTURAL EVALUATION OF RIGID PAVEMENTS	**5. Report Date** February 1987 **6. Performing Organization Code**
7. Author(s) Gustavo E. Morales-Valentin, A. H. Meyer, and W. R. Hudson	**8. Performing Organization Report No.** Research Report 460-1
9. Performing Organization Name and Address Center for Transportation Research The University of Texas at Austin Austin, Texas 78712-1075	**10. Work Unit No.** **11. Contract or Grant No.** Research Study 3-8-86-460
12. Sponsoring Agency Name and Address Texas State Department of Highways and Public Transportation; Transportation Planning Division P. O. Box 5051 Austin, Texas 78763-5051	**13. Type of Report and Period Covered** Interim **14. Sponsoring Agency Code**

15. Supplementary Notes

Study conducted in cooperation with the U. S. Department of Transportation, Federal Highway Administration. Research Study Title: "Assessment of Load Transfer Across Joints and Cracks in Rigid Pavements Using the FWD"

16. Abstract

This report presents an analysis of Falling Weight Deflectometer (FWD) deflection data. The data were collected on a controlled test facility and on in-service pavements. The thrust of the study was the investigation of the effect of vertical temperature differential on the FWD deflections.

A methodology for either avoiding or removing the effect of the DT on the FWD deflections is presented. This methodology will improve the present state of the structural evaluation of rigid pavements.

17. Key Words rigid pavement, structural evaluation, nondestructive testing, Falling Weight Deflectometer (FWD), deflection, vertical temperature differential within the pavement slab (DT)	**18. Distribution Statement** No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report) Unclassified	**20. Security Classif. (of this page)** Unclassified	**21. No. of Pages** 134	**22. Price**

Form DOT F 1700.7 (8-69)

TEMPERATURE DIFFERENTIAL EFFECT ON THE FALLING WEIGHT DEFLECTOMETER DEFLECTIONS USED FOR STRUCTURAL EVALUATION OF RIGID PAVEMENTS

by

Gustavo E. Morales-Valentin
A. H. Meyer
W. R. Hudson

Research Report 460-1

Assessment of Load Transfer Across Joints and Cracks in Rigid Pavements Using the FWD
Research Project 3-8-86-460

conducted for

Texas State Department of Highways
and Public Transportation

in cooperation with the
U.S. Department of Transportation
Federal Highway Administration

by the

Center for Transportation Research
Bureau of Engineering Research
The University of Texas at Austin

February 1987

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

PREFACE

This report is the first one under Research Project 3-8-86-460, "Assessment of Load Transfer Across Joints and Cracks in Rigid Pavements Using the Falling Weight Deflectometer." This research project is being conducted at the Center for Transportation Research, The University of Texas at Austin, as part of the Cooperative Highway Research Program sponsored by the Texas State Department of Highways and Public Transportation and the Federal Highway Administration.

A recommended methodology for either avoiding or removing the effect of the vertical temperature differential within the pavement slab on the measured Falling Weight Deflectometer deflections is presented in this report.

The authors are grateful to the staff of the Center for Transportation Research, who provided technical assistance and support. Thanks are also due to Mr. Jerome Daleiden and others at the Texas State Department of Highways and Public Transportation for their cooperation and interest in this research project.

Gustavo E. Morales-Valentin
A. H. Meyer
W. R. Hudson

LIST OF REPORTS

Report 460-1, "Temperature Differential Effect on the Falling Weight Deflectometer Deflections Used for Structural Evaluation of Rigid Pavements", by Gustavo E. Morales-Valentin, A. H. Meyer and W. Ronald Hudson, presents a recommended methodology for either avoiding or removing the effect of the vertical temperature differential within the pavement slab on the measured Falling Weight Deflectometer deflections.

ABSTRACT

This report presents an analysis of Falling Weight Deflectometer (FWD) deflection data. The data were collected on a controlled test facility and on in–service pavements. The thrust of the study was on the investigation of the effect of vertical temperature differential on the FWD deflections.

A methodology for either avoiding or removing the effect of the DT on the FWD deflections is presented. This methodology will improve the present state of the structural evaluation of rigid pavements.

KEYWORDS: Rigid pavement, structural evaluation, nondestructive testing, Falling Weight Deflectometer (FWD), deflection, vertical temperature differential within the pavement slab (DT), insitu material characterization, load transfer evaluation, void detection.

SUMMARY

This report presents the results of an analysis of the pavement temperature data and observed Falling Weight Deflectometer (FWD) deflections. The experimental work was carried out during the spring and summer of 1986 in Texas. The influence of temperature differential (DT) within a pavement on FWD deflections was examined in detail.

The findings of this study are summarized into a proposed methodology for either avoiding or removing the effect that the DT has on the FWD deflections. The implementation of this methodology will result in a significant improvement in the structural evaluation of rigid pavements.

IMPLEMENTATION STATEMENT

Based on the analysis of the field data, consisting of the Falling Weight Deflectometer (FWD) deflections and the vertical temperature differential within the pavement slab (DT), a methodology has been proposed for either avoiding or removing the effect of the DT on the FWD deflections.

It is recommended that the proposed methodology be implemented by the Texas State Department of Highways and Public Transportation (SDHPT) in order to improve the structural evaluation of rigid pavements using the nondestructive testing procedures.

TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION

CHAPTER 2. LITERATURE REVIEW

CHAPTER 3. CONTROLLED TESTING OF A SLAB RESEARCH FACILITY

CHAPTER 4. FIELD TESTING

CHAPTER 5. ANALYSIS OF THE DATA

APPENDICES

CHAPTER 1. INTRODUCTION

GENERAL BACKGROUND

This study is concerned with the nondestructive structural evaluation of rigid pavements using the Falling Weight Deflectometer, which is described in Appendix A. The Texas State Department of Highways and Public Transportation has conducted structural evaluations of rigid pavements, both destructive and nondestructive, throughout Texas for years.

For several years, The Texas State Department of Highways and Public Transportation has used the Dynaflect for nondestructive testing and structural evaluation. Recently the Department purchased a Falling Weight Deflectometer (FWD) and the purpose of this study is to examine the FWD as a nondestructive device for use in structural evaluation of rigid pavements, including the following aspects:

(1) material characterization of the pavement layers,
(2) load transfer at joints and cracks, and
(3) void detection.

There are several variables which influence observed FWD deflections on any given rigid pavement. The road bed soil condition (subgrade support) is the most significant factor to influence pavement deflections measured under or near the test loads. A weak base or subbase layer and voids beneath the concrete pavement or base will result in larger deflections. Environmental factors like temperature variations in the slab and moisture variations influence pavement deflections significantly. The load transfer at transfer joints and cracks also influenced pavement deflections measured near joints. The load transfer is affected by slab curl and the horizontal movement of the slab due to seasonal temperature changes. One important variable, chosen to be monitored in this study is the vertical temperature differential within the slab (DT). The effect of this variable on the observed FWD deflections and the resulting structural evaluation of rigid pavements are analyzed here.

OBJECTIVE AND SCOPE OF THE STUDY

There are three objectives to this study. These are stated as follows:

(1) To field test the procedures for evaluating transverse joint efficiency using the FWD developed as a part of the Research Study 3-8-=84-387 (Ref 1). These procedures will be modified is necessary and adopted for use in evaluating transverse cracks. These tests will include both standard pavement joints and joints at patches.

(2) To develop a method using the FWD to evaluate cracks in a rigid pavement for load, shear, and moment transfer. Cracks may be in the existing pavement or in patches or at patch edges.

(3) To develop a method using the FWD to evaluate longitudinal joints, particularly rigid shoulder joints.

A major thrust of this research study is the investigation of factors that influence the load transfer estimates based on the FWD deflections and the development of methods to take into account these factors. Analyses of the pertinent data collected on the slab research facility at Balcones Research Center (BRC) and on in–service pavements will be used to modify and develop appropriate procedures of the FWD testing. The study emphasis is on the implementation of the FWD testing procedures for the structural evaluation of rigid pavements in Texas.

OVERVIEW OF REPORT

A review of research efforts reported on rigid pavements in Texas and other literature related to deflection testing on rigid pavements revealed that environmental factors like temperature variations within the slab influence deflections of rigid pavements very significantly. the vertical temperature differential (the algebraic difference between the temperatures of the top and the bottom of a concrete slab) greatly influences slab curling and was studied in detail with respect to the FWD deflections.

The vertical temperature differential within the slab (DT) can vary considerably during the day and can result in significant changes of FWD deflection readings. These temperature differentials and the resulting FWD deflections can change greatly in a relatively short period of time, namely a few hours. This effect is important since full FWD evaluation of a pavement section usually takes several hours per day for 1 to 3 days. On most sections, testing is performed all day, during regular working hours, and, thus, daily changes in temperature differential can affect the FWD readings.

Structural evaluation is carried out to compare several areas within a section of pavement and select those needing maintenance or rehabilitation. The FWD load and deflections are the variables involved in structural evaluation. The vertical temperature differential within the slab (DT) can change observed FWD deflections significantly from the morning hours to the afternoon hours for a given load. Therefore, proper structural evaluation requires consideration of the effect of vertical temperature differential within the slab at different times of the day.

Results of this study are presented in this report as follows:

(1) a review of the literature related to nondestructive structural evaluation of rigid pavements, and temperature and curling effects on concrete pavements is presented in Chapter 2,

(2) a description of the experimental work carried out at the testing slab at Balcones Research Center (BRC) and on US 90 near Beaumont is presented in Chapters 3 and 4, respectively,

(3) the data obtained from the experimental work at the testing slab at BRC and on US 90 near Beaumont are presented in Appendices B and C, respectively,

(4) the analysis of the data is presented in Chapter 5, and

(5) the summary and conclusions of the study and recommendations for future work are presented in Chapter 6.

CHAPTER 2. LITERATURE REVIEW

A methodology for nondestructive structural evaluation of rigid pavements using the Falling Weight Deflectometer (FWD) was developed and tested in Research Project 387 (Refs 1, 2, and 3). The methodology proposed in Project 387 characterizes insitu material properties using the elastic layers theory (Ref 4) and evaluates load transfer efficiency in the pavement. The presence of voids beneath the pavement is also studied using the FWD deflection data collected on the slab research facility at Balcones Research Center, Austin, Texas (Ref 5).

Since temperature has been shown to affect deflections of concrete pavements (Refs 6 through 22), this study involves the evaluation of temperature variation on the measured deflection basin. Results of this study can improve the procedures proposed in Project 387 (Refs 1, 2, and 3) and, thus, improve FWD testing for the nondestructive structural evaluation of rigid pavements.

It has been observed that deflection measurements taken at the same spot near the edge or joint of a rigid pavement and for a given load vary significantly during the day. This is due to the variation of the slab temperature during the observation period. The question of which of the different measured deflection basins should be used for the evaluation arises immediately. The results suggest a correction is necessary, and, thus, this study is devoted to defining a methodology to nullify the influence of the temperature differential on the FWD deflection measurements. Using corrected deflection basin data, the structural evaluation can be done in a more realistic and accurate way.

The following is a summary of the nondestructive structural evaluation methodologies proposed and a review of some studies which have already dealt with the temperature effects on concrete pavements.

STRUCTURAL EVALUATION METHODOLOGY

Reference 1 presents the methodology for insitu material characterization based on the FWD deflection data. This approach (Program RPEDD1) uses as input the FWD load, measured deflection, and layer thicknesses, as well as some other data (Refs 1 and 2). It back-calculates the insitu moduli of the layers that comprise the pavement structure by a self-iterative process that involves the inverse application of the ELSYM5 program (Ref 4). The deflection basin used for the material characterization is the basin obtained when the FWD loading plate is located at the center of the pavement slab, that is, away from the edge and from transverse and longitudinal joints and cracks.

Reference 3 presents the methodology for the load transfer evaluation and the void detection procedures. The load transfer is defined as the ratio of the deflection at the unloaded side of the joint to the deflection at the loaded side. It is necessary to have one of the sensors located on the other side of the FWD loading plate in order to measure the deflection at the unloaded side of the joint. The arrangement of the sensors on the FWD proposed by Ref 3 is shown in Fig 2.1. Reference 3 indicates that three levels of dropping weights should be dropped from the four fixed heights established by the FWD. This will develop an approximate peak load ranging between 5,000 and 18,000 pounds.

The void detection procedure presented in Ref 3 is based on two angles which are functions of the deflections measured by the FWD. The distances between the corresponding sensors are also used in this procedure to detect the presence of voids. The arrangement of the sensors on the FWD is the same as that for the load transfer evaluation (refer to Fig 2.1).

The layout of the sensors on the FWD shown in Fig 2.1 can also be used for the insitu material characterization procedure. This makes the field work easier because the same arrangement of sensors can be used for all three procedures (material characterization, load transfer evaluation, and void detection).

In this literature review, the methodology for nondestructive structural evaluation of rigid pavements proposed in Project 387 is the procedure that has been presented in detail. This study (Project 460) must try to refine those procedures and account for the effect of the slab temperature on the FWD deflections. There are other procedures proposed for the nondestructive structural evaluation of rigid pavements by means of the FWD (Refs 5, 21, 22, and 23). Most of the procedures for measuring load transfer across transverse joints use deflections measured at the approach and leave slab (Refs 21, 22, and 23) or some parameters based on the measured deflections (Ref 3). They are all based on the load and deflections measured by the FWD. The reasons to initiate the investigation of the effect the vertical temperature differential within the slab has on the FWD deflections are discussed.

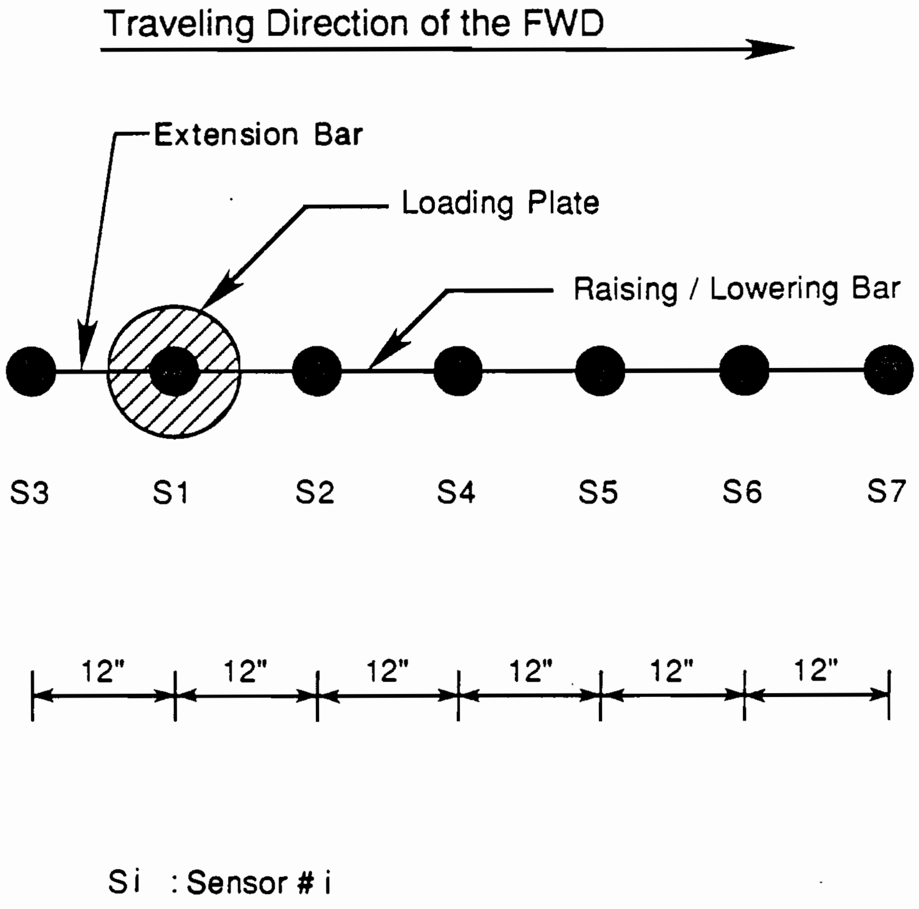


Fig 2.1. Arrangement of the FWD sensors.

DEFLECTION BEHAVIOR OF CONCRETE PAVEMENTS

Deflections of concrete pavements are influenced by several factors:

(1) Road bed soil condition (subgrade support).
(2) Voids under the pavement or beneath the base.
(3) Weak base or subbase.
(4) Changes in aggregate interlock and the resulting load transfer efficiency due to seasonal effect of temperature variations.
(5) Slab curling.

If the road bed soil is strong, very low deflection will be measured. The presence of voids under the pavement or the base, and weak base or subbase layers will result in larger deflections. For the load transfer evaluation across the transverse joints or cracks, deflections are measured near the joints or cracks. The condition of joints or cracks and slab curling are greatly influenced by temperature variations.

Temperature Effects

The average temperature of a concrete slab varies: (1) daily and (2) yearly. Concrete pavement adjusts to yearly seasonal variations in temperatures by contraction or expansion over a considerable period of time. The major effect of seasonal variations in temperature is (1) the development of frictional forces between the concrete slab and the underlying layer and (2) the resulting horizontal movement of the slab.

Daily temperature variations within the concrete slab are more important to deflection measurements, because (1) there is a large deviation in temperature on the concrete surface in a daily cycle and (2) the temperature gradient between the top and bottom of the concrete slab can vary considerably during a 24-hour cycle. The temperature gradient through a concrete slab causes surfaces to curl. For example, if the top of the slab is warmer than the bottom (e.g., near noon on a sunny day), the slab corners will tend to curl downwards. Upward curling will occur when the top surface is cooler than the bottom, such as late on a cool night. A parameter commonly used to study the effect of temperature gradient is temperature differential, the algebraic difference between the temperature of the top and the temperature of the bottom of a concrete slab. The temperature differential (DT) is a positive value when the temperature of the top of the slab is higher than the temperature of the bottom and negative when the bottom of the slab is warmer than the upper surface. The temperature differential is the result of the slow conduction of heat in concrete and is, therefore, a function of the thermal properties of concrete and the thickness of the concrete slab. Maximum temperature differentials occur during the day in the spring and summer.

Curling Effects on Concrete Pavements

Several studies have been made of the effects of curling on concrete pavements. The importance of the curling of the pavement on the deflections due to a given load has been pointed out by several authors.

The curling of a concrete pavement slab due to moisture differential across the depth of the slab has been studied as indicated in Ref 6. Although this is a very important effect, it changes very slowly and, hence, is more a seasonal than a daily effect (Ref 6). This study concentrates on the vertical temperature differential within the slab, since it has a daily effect on the curling of concrete slabs.

The curling due to moisture has a very significant magnitude, as pointed out by Hveem (Ref 7). Hveem indicates very clearly that it is evident that the curling of concrete pavement slabs is a function of temperature and moisture differentials. He even remarks that when the slabs are flat, it is because the curling due to the temperature differential is compensating for the curling due to moisture. He also points out that the variation due to the moisture effect is a great deal less than the variations due to the temperature differential effect. Price (Ref 6) reports that vertical moisture differential curls the slab into the upward curl position and, hence, it adds to any upward curling or compensates for any downward curling due to the temperature differential.

The curling due to temperature differential has been dealt with in several studies, some of which have been reviewed for this project (Refs 6 through 23) and they all coincide in their general findings. These studies indicate that, due to the variation in the vertical temperature differential within the slab, the slab changes from an upward curled position (cool on top) in the early morning into a downward curled position (warm on top) in the afternoon. This demonstrates that the curling effect due to the temperature differential is a daily effect, as opposed to that due to moisture.

Curling displacements can reach very noticeable and important magnitudes, especially at the corners of the pavement slabs. At the AASHO Road Test (Ref 9), corner displacements of between 70 and 125 mils (thousandths of an inch) were measured on several slabs. These slabs were 15 by 12–foot and 40 by 12–foot slabs, with dowelled transverse joints and with thicknesses of 2.5, 5, 9.5, and 12.5 inches. Hveem (Ref 8) shows very interesting prophilograph records in which the elevation of the joint location of a 15–foot–long slab reaches a maximum of 120 mils with respect to the average elevation of the central one-third portion of the slab. The other studies indicate displacements of similar magnitudes. These magnitudes are very important, considering the context of this study. The FWD deflections usually are within the 0 to 40-mil range.

Lang (Ref 12) and Swanberg (Ref 13) have both reported that temperature differentials ranging between -2 and +4°F/inch have been measured in concrete pavement slabs. They have also reported that only 5 percent of the time in a year do the temperature differentials go below -1°F/inch or above +2°F/inch. The average temperature differential values from the AASHO Road Test are also within those limits, as pointed out by Price (Ref 7).

Uddin et al (Refs 14 and 20) performed a detailed study of temperature effects on Dynaflect deflections measured on CRC pavements in Texas. A comprehensive statistical analysis of the temperature and deflection data showed that the temperature differential was the most significant parameter to influence the edge deflections. The study also showed that the edge deflections measured in the early morning hours (negative or approaching zero temperature differential condition) were remarkably larger than the deflections measured in the afternoon hours at high positive temperature differential condition. Other investigations report similar observations (Refs 19, 21, 22, and 23) for deflections measured at joints and corners.

The horizontal movement of a slab due to a change in average temperature of the slab is a function of the coefficients of thermal expansion of concrete, drying shrinkage, joint spacing, base/slab friction restraint and the temperature cycle. This movement is pronounced over longer periods and reflects the seasonal change in temperature. The seasonal change in average slab temperature is gradual and largely affects the bottom of the slab (Ref 11). Therefore, in a daily temperature cycle, the horizontal movement and its effect on deflections measured near joints is not very significant as compared to the effect of slab curl on the deflections (Refs 11, 19, and 21).

The horizontal movement of a slab due to the seasonal changes in the average slab temperature is reflected in the expansion and contraction of the slab and is said to be associated with the degree of "joint locking," reported (for example Ref 22). Persons involved in undersealing work attribute the smaller deflections measured in the afternoon hours (high positive temperature differential and curling down of the slab at joints and corners) to "joint locking." The real explanation is that even in the daily temperature cycle there may be a tendency for changes in the joint opening. A smaller joint opening and curling down of the slab at joints would result in better aggregate interlock, increased load transfer efficiency, and smaller deflections. On the other hand, a wider joint opening would put less restriction on the vertical movement (curl) of slab corners and joints (Refs 19 and 21) which explains larger deflections when the top of the slab is cooler at night or early morning (negative temperature differential).

Summary

Major findings of the past studies conducted on highway pavements in Ohio, Georgia, Texas, and Florida (Refs 11, 14, 19, 20, 21, and 23) and on airport pavements in Texas (Ref 22) to investigate the effect of environmental factors on pavement deflections are summarized below.

(1) Seasonal changes in temperature affect the temperature of the bottom of the slab more than the daily temperature variation.

(2) Daily variation in temperature has more affect on the temperature of the top surface.

(3) Top slab temperature follows the pattern of the daily air temperature variation. The top slab temperature does not correlate well with deflections (Refs 11 and 20).

(4) Larger deflections at slab corners and edges are measured during the early morning hours (negative or zero temperature differential condition). This is the practice recommended for load transfer studies.

(5) Temperature differential within the slab has a strong influence on slab curl and vertical movement and their effects are much more pronounced on corner deflections near the pavement edge than the effect of the horizontal movement on deflections due to the average slab temperature.

(6) The effect of temperature differential on corner deflections is nonlinear. Negative temperature differential has a larger effect (increased deflection) as shown by the Dynaflect deflections in Texas (Refs 14 and 20) and the FWD deflections in Florida (Ref 23).

It has been observed that deflection measurements taken at the same spot near the edge or joint of a rigid pavement and for a given load vary significantly during the day. This is due to the variation of the temperature differential during the observation period. The question of which of the different measured deflection basins should be used for the valuation arises immediately. The results suggest a correction is necessary, and, thus, this study is devoted to defining a methodology to nullify the influence of the temperature differential on the FWD deflection measurements. Using corrected deflection basin data, the structural evaluation of rigid pavements in Texas can be done in a more realistic and accurate way.

As is clearly implied and/or stated in these studies, in the early morning the slab curls upwards. This implies that a portion of the slab near the joints, particularly near the corners, looses contact with the underlying layer. This phenomenon creates a loss of support, or what is referred to as a void, and leads to larger deflections.

CHAPTER 3. CONTROLLED TESTING OF A SLAB RESEARCH FACILITY

INTRODUCTION

This study on the effect of the vertical temperature differential within the slab (DT) on the FWD deflection basin was divided into two phases:

(1) controlled testing of a slab research facility, and

(2) field testing of normal pavement slabs.

The description of the controlled testing which was done at the testing facility at Balcones Research Center (BRC) is presented in this chapter. The description of the field testing is presented in Chapter 4.

The testing facility at Balcones Research Center (BRC) consists of two concrete slabs with a dowelled joint between them. The slabs are 10 inches thick, placed on top of 3 inches of asphaltic concrete, over 6 inches of crushed stone (flexible base), over 7 feet of compacted embankment, and over the existing ground surface in its natural state (no compaction).

A plan view of the BRC testing facility is shown in Fig 3.1. In this figure, the horizontal dimensions of the testing slab as well as the locations of the thermocouples used for this study (T1, T2, and T3) are shown. For more details about the testing slab refer to Ref 16.

The variables which were measured at the BRC testing facility can be classified into two separate categories. The first category includes variables which are used directly in comparing the results of the FWD deflection readings. These variables are termed Direct Variables and will be explained later in this chapter.

The second category of variables are termed Indirect Variables and are also explained later in this chapter. These variables were measured and the data was stored for several reasons. Although these variables are not used directly in the analysis done within this study, they could be used in prediction models for predicting the vertical temperature differential within the slab (DT) without using monitoring devices embedded in the pavement.

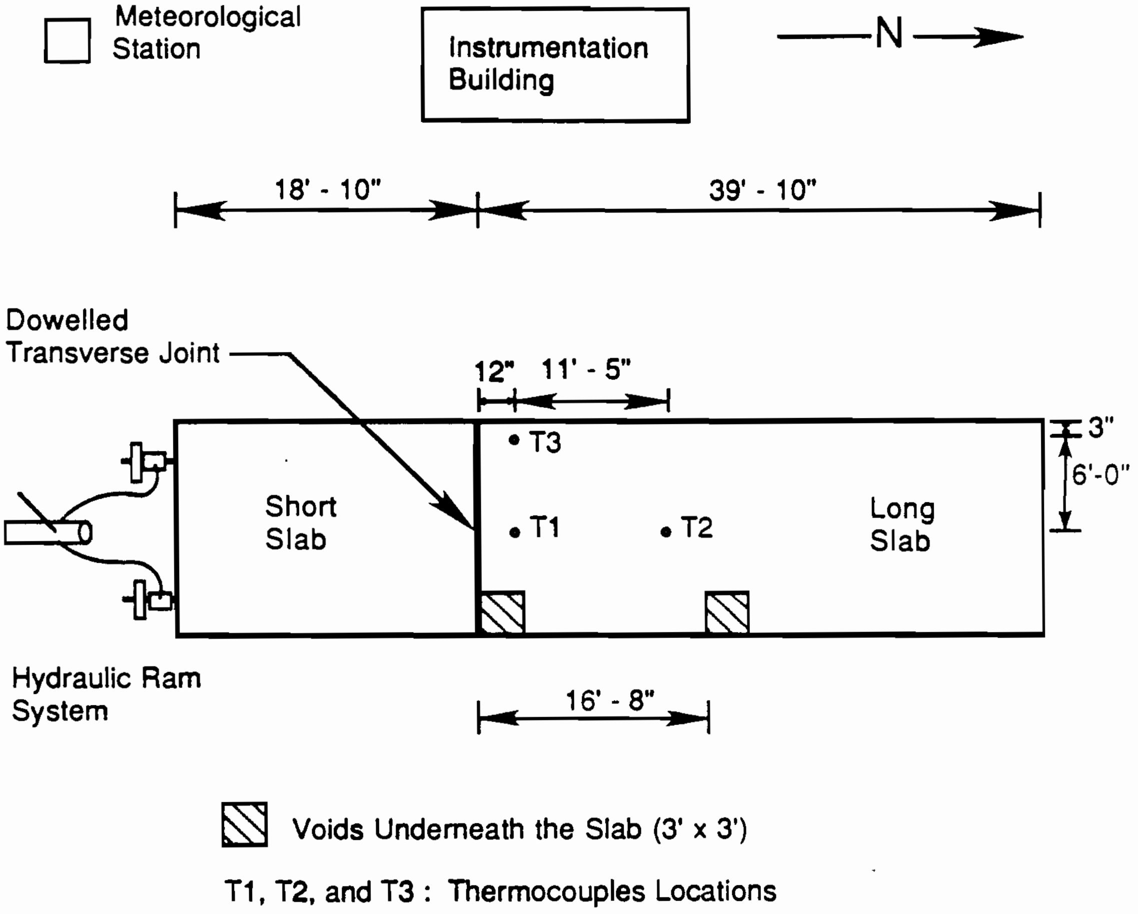


Fig 3.1. Layout of the BRC testing facility (plan view).

VARIABLES MEASURED AND THEIR MEASUREMENT PROCEDURES

The following is a listing of the two categories of variables which were collected at the BRC site:

Direct Variables

(1) joint condition (open and closed),
(2) FWD position (wheel paths and station numbers),
(3) FWD load and deflections, and
(4) slab temperatures.

Indirect Variables

(1) solar radiation,
(2) slab surface temperature,
(3) wind speed,
(3) air temperature, and
(4) ambient relative humidity.

Each one of the variables listed above is explained and/or defined in the following paragraphs. The measurement procedures and the type of instruments used to take the measurements are also presented in this section.

Direct Variables

Joint Condition (Open and Closed). Two different joint conditions were defined, the open joint and the closed joint conditions. These conditions are made possible at the testing slab at BRC by using a hydraulic ram system, which is mounted at the end of the smaller, unbonded slab. The hydraulic ram system provides a constant horizontal pressure equal to 5,000 psi at the system. The ram system allows the small slab to be pushed against the larger, bonded slab. This action closes the dowelled joint existing between the two slabs.

Therefore, when no pressure is applied by the hydraulic ram system, the condition is called open joint, and, when there is pressure applied, the condition is called closed joint.

These two joint conditions provide an opportunity to simulate conditions at two sites which have different joint conditions.

FWD Position (Wheel Paths and Station Numbers). Three wheel paths were defined (refer to Fig 3.2);

(1) side of the slab without void,
(2) side of the slab with void, and
(3) centerline of the slab.

Six stations were defined within each of the three wheel paths. These six stations represent three locations on each wheel path. Each location was tested twice, once for each of the two different joint conditions. The six different stations were numbered 0 through 5.

The three different locations within a given wheel path are

(1) upstream with respect to the transverse joint,
(2) downstream with respect to the transverse joint, and
(3) midspan.

The details regarding the positions of the FWD sensors with respect to the transverse joint are shown in Fig 3.3(a), (b) and (c). The station numbers allocated to each location within a wheel path and for a given joint condition are shown in Table 3.1.

FWD Load and Deflections. A detailed description of the FWD is presented in Appendix A.

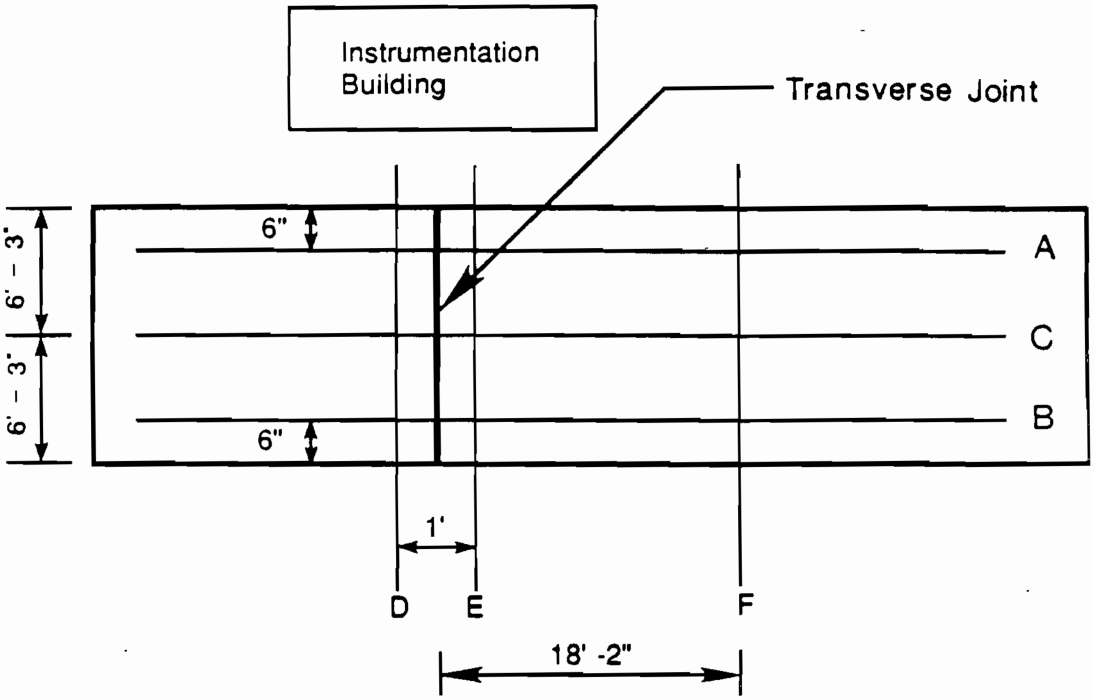
In the testing conducted for this study three weights were dropped from each of the four heights standard for the FWD. The readings taken from the highest dropping height, which develops a load of approximately 16,000 pounds, are the ones used for the analysis in this study, as suggested in Ref 3.

The load and the deflection at the seven sensors (geophones) are read and recorded automatically by means of the HP-85 desk-top computer that is located in the FWD van. The HP-85 prints out a hard copy of the results immediately after the testing is done.

The FWD also automatically measures the ambient temperature by means of a thermometer that is installed on the trailer. These measurements are recorded and printed, together with all the other data which have been collected.

TABLE 3.1. STATION NUMBER ALLOCATION

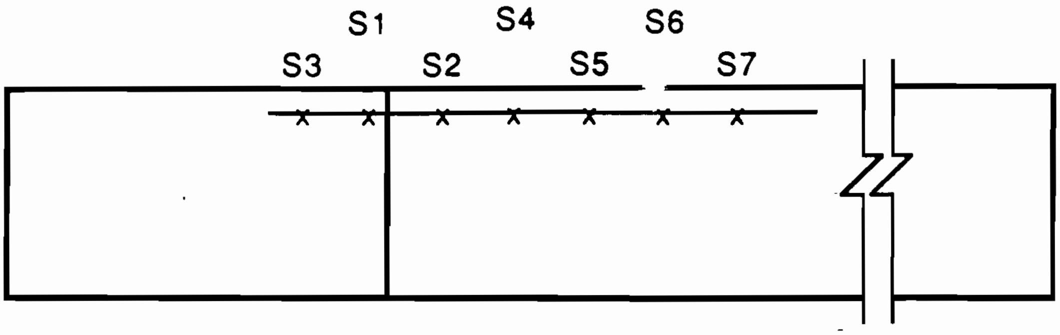
Location	Joint Condition	Station Number
Upstream	Closed	1
	Open	3
Downstream	Closed	0
	Open	2
Midspan	Closed	4
	Open	5



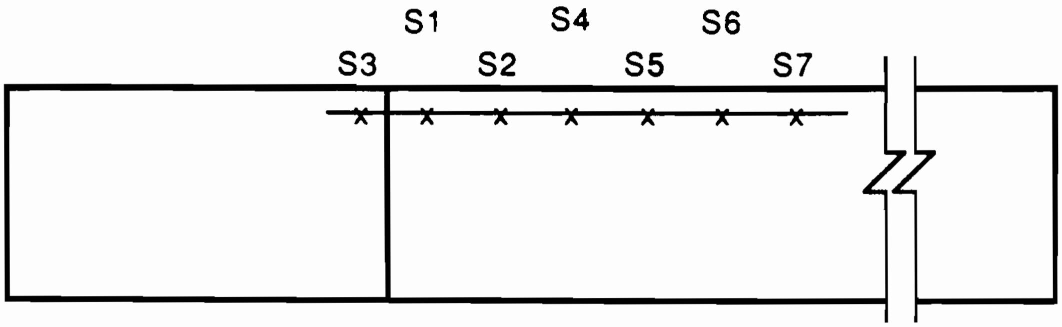
Wheel Paths :
- A: Side of the Slab Without Void Underneath
- B: Side of the Slab With Void Underneath
- C: Centerline of the Slab

Locations :
- D: Upstream With Respect to the Transverse Joint
- E: Downstream With Respect to the Transverse Joint
- F: Midspan

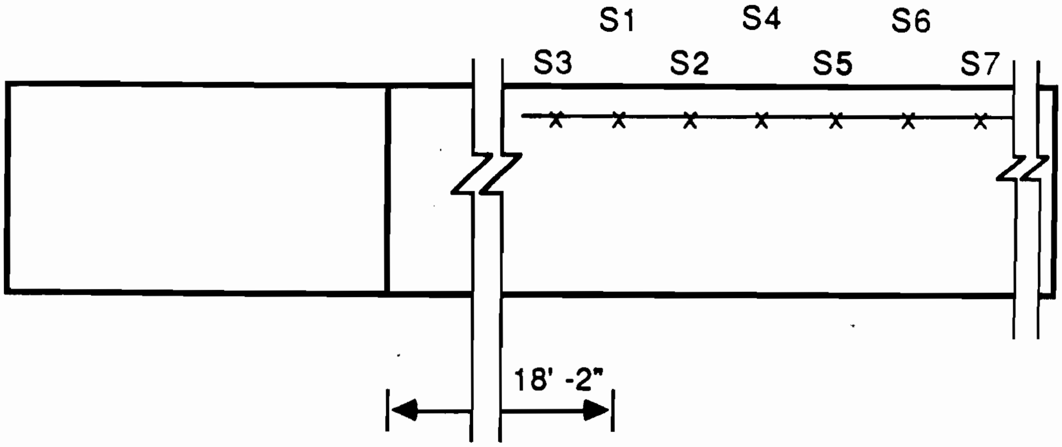
Fig 3.2. The three wheel paths and three different locations within each wheel path at the testing slab (BRC).



(a) Upstream with respect to the transverse joint.



(b) Downstream with respect to the transverse joint.



(c) Midspan.

Fig 3.3. Positions of the FWD within the testing slab at BRC.

Slab Temperatures. Temperatures within the concrete slab were measured by means of embedded thermocouples. Temperatures at three locations (T1, T2, and T3 – refer to Fig 3.1), and at three depths at each location (1 inch , 5 inches , and 9 inches) were measured. An HP-3497A data acquisition system and an HP-150 micro computer read, recorded, and printed out the thermocouple measurements. These instruments were located inside the instrumentation building next to the testing slab at BRC.

The readings of the thermocouples at the same depths were averaged. Each average temperature corresponds to a slab depth of 1 inch , 5 inches , or 9 inches . Assuming a linear distribution of the temperature across the slab depth and using the average temperature values for the 1-inch and the 9-inch depths, the temperatures at the surface and bottom of the slab were obtained. The vertical temperature differential within the slab was obtained by simple subtraction (DT = T surface - T bottom).

Indirect Variables

Solar Radiation. Solar radiation is a very important parameter in the variation of the temperature within the slab. The solar radiation is absorbed by the concrete surface, starting a heat transfer process that carries the heat from the surface toward the bottom of the slab. Concrete is a slow heat conductor, and, therefore, the heat transfer process takes time. This heat transfer process causes the vertical temperature differential within the pavement to develop.

It is important to measure the actual solar radiation at a given location and time. Solar radiation used to be measured at several stations throughout Texas and the United States, but over the last few years more and more stations have stopped monitoring solar radiation. Therefore, to obtain records of solar radiation for given locations is not easy and may not be possible. Cloudiness has a very strong influence on solar radiation. If two consecutive days within the same season were monitored for solar radiation, the results would be very different if one day was cloudy or partly cloudy and the other day was clear.

Solar radiation measurements for this study were obtained by using a LI-COR (LI-1776) solar monitor. The pyranometer of the solar monitor was placed on top of the testing slab. Instantaneous solar radiation readings were automatically integrated and recorded over one-hour periods.

Slab Surface Temperature. The temperature at the surface of the slab was measured with a flat circular surface thermometer fabricated by PTC Instruments (surface temperature thermometer - Model 310F). The thermometer was placed on the surface of the testing slab at 2 feet from the transverse joint and 2 feet from the edge of the slab. The temperature was recorded manually.

Wind Speed. The wind speed was measured with the Dwyer Mark II wind speed indicator which is installed on the instrumentation building next to the BRC testing slab. The speed was recorded manually.

Air Temperature. The air temperature was measured with a mechanical meteorological station, which records the ambient temperature on a strip chart. The meteorological station used was the Belfort hygrothermograph.

Ambient Relative Humidity. The ambient relative humidity was measured and recorded by the same meteorological station that recorded the air temperature.

DESCRIPTION OF THE TEST

The typical work plan for the testing consisted of running tests for a full day at the six stations within a given wheel path. The next day, the procedure was repeated but on a different wheel path.

The testing routine was repeated hourly from 8:30 am to 4:30 pm for a total of nine sets of readings per day. This was done in order to be able to appreciate the variation of the vertical temperature differential within the slab during the day and to record its effect on the FWD deflections. The daily testing routine was composed of the measurement and recording of all the variables in both categories at each one of the six stations within the given wheel path. In this way, data for the six stations at the three different wheel paths were recorded on three different days. It is very important to point out that this study focuses on the daily variation of the vertical temperature differential within the slab and its effect on the FWD deflections. It should also be noted that the testing in this study was all carried out within the same season, namely the summer. More testing should be done in the future in order to evaluate any possible seasonal effect of the temperature differential on the FWD deflections.

There was a secondary test which consisted of measuring the curling movements in the pavement slab at the testing facility at BRC. This was done with five linear variable differential transducers (LVDTs) which were mounted on a wooden beam that spanned the width of the slab. The beam was supported outside of the slab on the gravel shoulder adjacent to the slab. Although this procedure is not exactly the same as the one used at the AASHO Road Test (Ref 8), it is very similar. For a better understanding of the arrangement of the LVDTs on the beam and the position of the beam on the slab, refer to Fig 3.4.

The purpose of this testing was to monitor the trend and magnitude of the vertical displacements due to the curling effects of the pavement at the joint. In this secondary testing everything was computerized. Once the LVDTs were zeroed and the program initialized, the temperatures were measured by means of the thermocouples and the relative displacements were measured by means of the LVDTs. The program automatically recorded and printed hard copies of the data collected by means of the HP data acquisition system and the HP micro computer located inside the instrumentation building. This testing is called secondary because it is used as a back-up for some of the ideas and conclusions drawn from this study.

Summaries of the data collected at the BRC testing facility are presented in Appendix B.

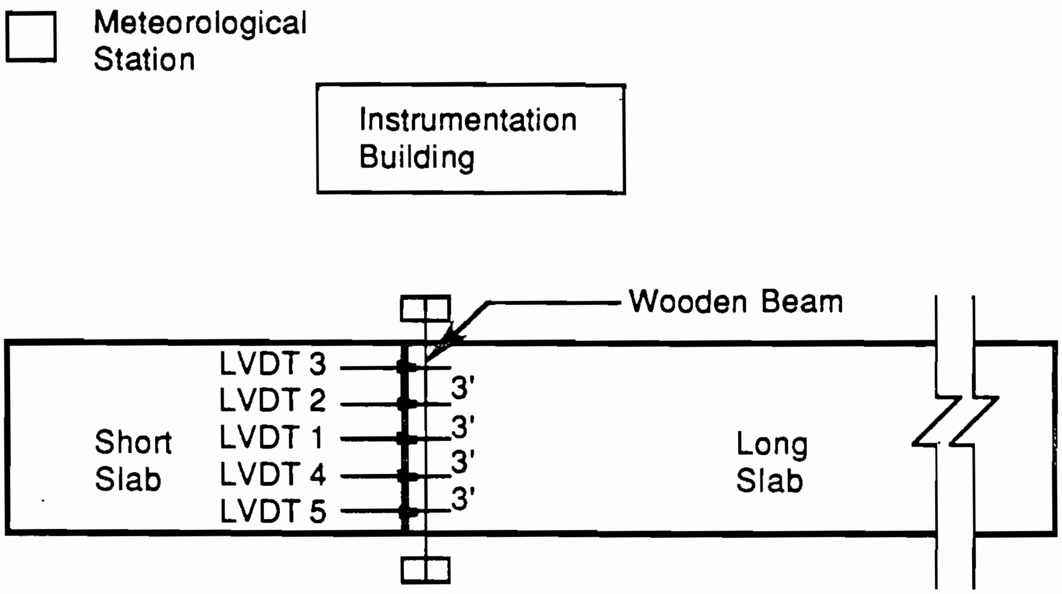


Fig 3.4. Arrangement of the LVDTs and position of the beam within the BRC testing slab.

CHAPTER 4. FIELD TESTING

DESCRIPTION OF THE FIELD TEST SITE

The field test site was located on US 90 (College Street) eastbound, between FM 364 (Station 233) and IH 10 (Station 11), at Beaumont, Texas. Refer to Figs 4.1, and 4.2 for detailed map references. Three testing sections were selected, as shown in Fig 4.3, and the data was collected on September 10 and 11, 1986.

The pavement at this location is a two-lane, one-way, jointed reinforced concrete pavement. It is a 10-inch-thick pavement with a transverse joint spacing of 60 feet and a grooved (sawed) longitudinal joint dividing the two lanes. For more details of the cross section of the pavement structure refer to Fig 4.4. Most of the slabs contain one or two transverse cracks in between the transverse joints.

VARIABLES MEASURED AND THEIR MEASUREMENT PROCEDURES

The variables measured were the same as those measured in the controlled slab study at BRC. The measurement procedures employed for some of the variables were somewhat different. The purpose of this section of Chapter 4 is to point out the differences in the measurement procedures. Those variables which were measured with the same procedures as those employed at BRC are not mentioned in this section.

In reference to the direct variables, only the slab temperatures were measured in a different way. The temperatures within the slab were measured by means of thermistors and a resistance measuring device (an ohmmeter). The thermistors were grouted into small holes (1–1/2–inch–diameter holes) drilled at 2 feet from the edge and 2 feet from the transverse joint. The thermistors were placed in the holes at three different depths, 1, 5, and 9 inches from the concrete surface. Therefore, one thermistor would be at middepth while the other two would be 1 inch from the surface and 1 inch from the bottom of the 10-inch-thick concrete slab. These are the same depths as in the testing slab at BRC. After placing the thermistors in the drilled holes, the holes were filled with a cement paste in order to avoid a disruption of the continuum which is needed to make an accurate temperature measurement within the concrete slab. The thermistors were placed and grouted into the holes the day

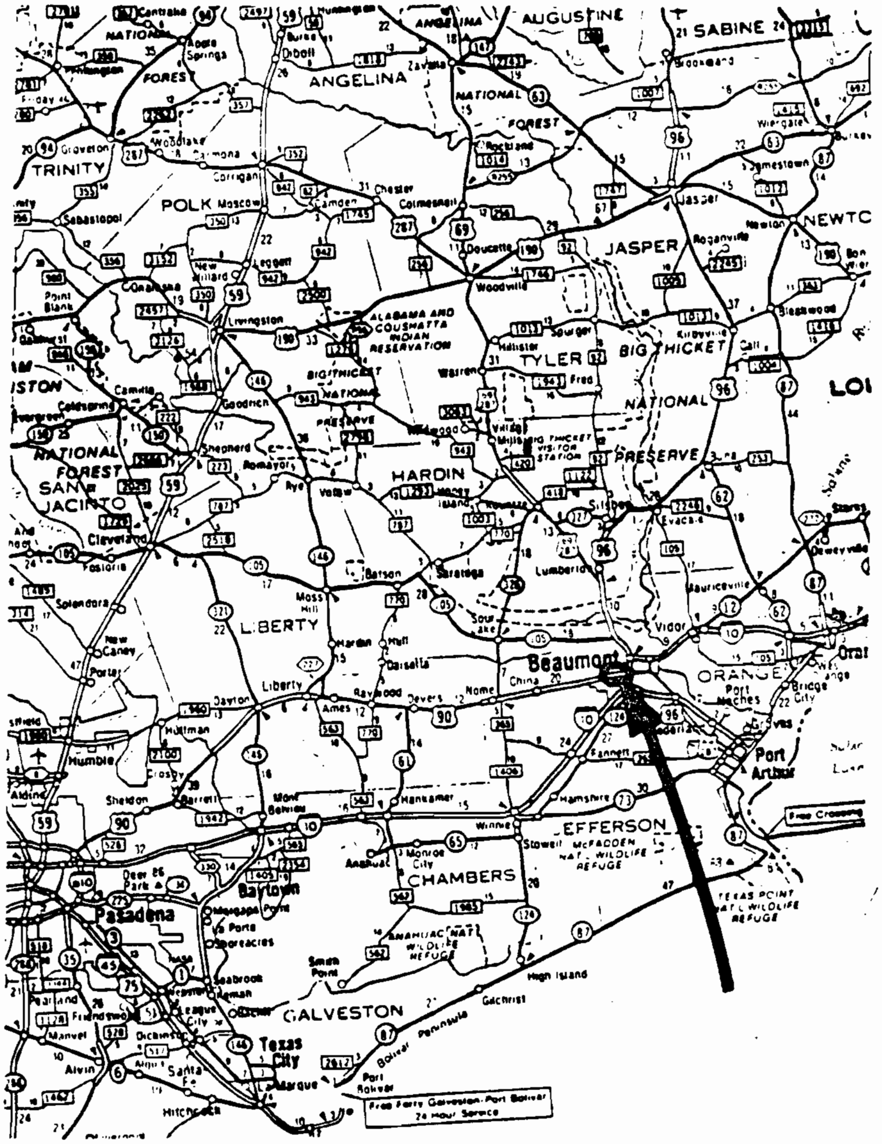


Fig 4.1. Site location.

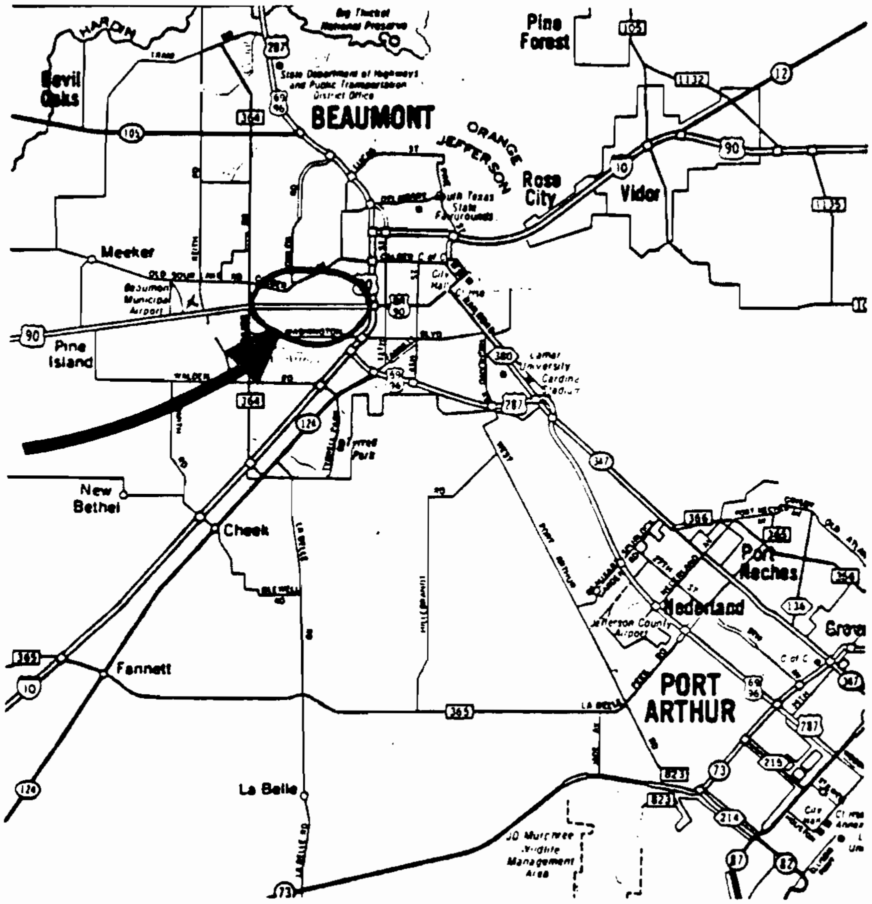


Fig 4.2. Site location.

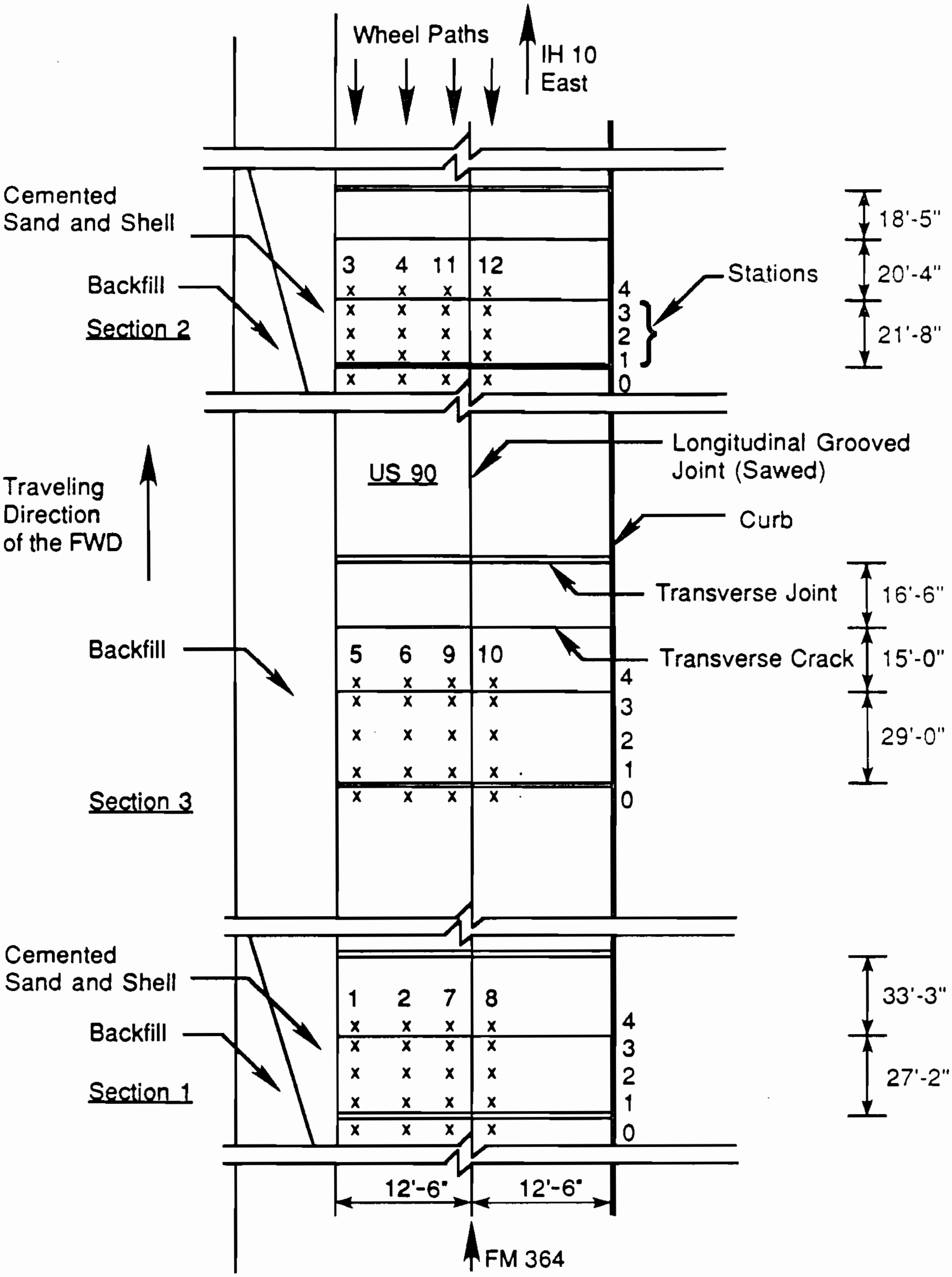
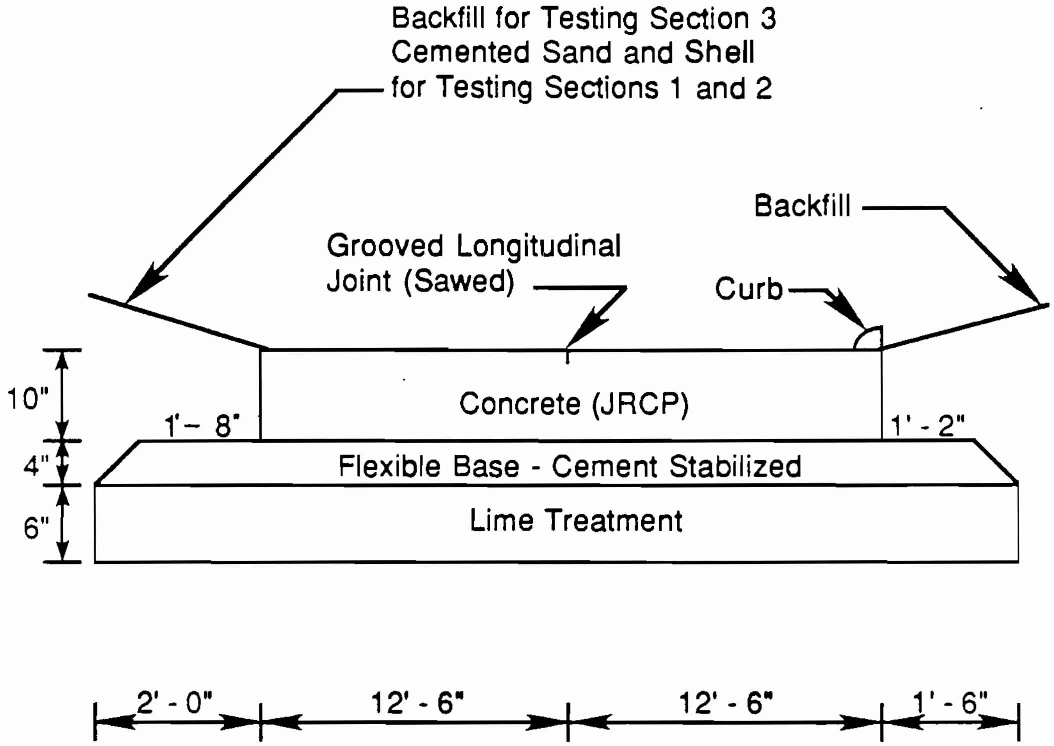


Fig 4.3. Test sections (slabs), wheel paths and station numbers at the US 90 test site.



Notes :

- Transverse Joints Spacing = 60' - 6" (Dowelled Joints)
- 1 or 2 Transverse Cracks in Every Slab

Fig 4.4. Cross–section of the pavement structure at the US 90 test site.

before the testing was done in order to let the cement paste set and establish thermal equilibrium with the surrounding pavement.

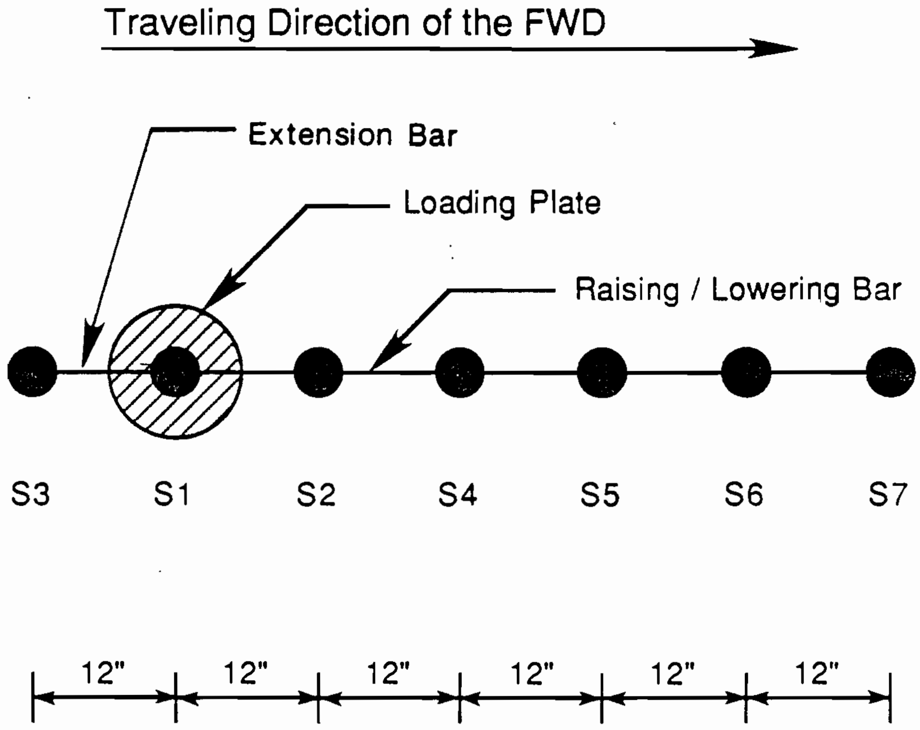
In reference to the "Indirect Variables", the air temperature and the slab surface temperature were measured in different ways. The air temperature was measured by means of a thermistor exposed to the air, using an ohmmeter. The slab surface temperature was measured with the flat surface thermometer (refer to Chapter 3) and an Omegascope infrared Pyrometer (Model OS-2000A). The Omegascope infrared Pyrometer is an infrared gun which provides a digital readout of the surface temperature of any object being aimed at. Based on the fact that different surfaces have different emissivity coefficients, the emissivity of the surface being aimed at must be entered on the Omegascope before testing. In this case, a concrete pavement surface, an average value of 0.94 was used for the emissivity coefficient. The wind speed and the ambient relative humidity were not monitored in the Beaumont testing procedure.

DESCRIPTION OF THE TEST

The testing positions within the US 90 test site were as shown in Fig 4.3. There were four wheel paths and five stations within each wheel path. The wheel paths and stations were tested on each of the three test sections. In Fig 4.3, the Xs represent the position of the FWD loading plate at each test section. The FWD was always traveling towards the east. Not all the wheel paths could be tested on the same day because of time constraints. The wheel path at the edge of the mainlane and the one at the middle of the left-hand lane were tested on the first day. The wheel paths at the left and right-hand sides of the longitudinal grooved joint were tested the following day.

Figure 4.5 shows the arrangement of the FWD sensors for the first day of testing. The sensors were rearranged into the positions shown in Fig 4.6 for the second day of testing. The arrangement of the FWD sensors shown in Fig 4.6 was proposed by this project (Research Project 460) in order to evaluate the load transfer across longitudinal joints; the FWD can be used in the field without causing the tremendous traffic problem it would create if it were positioned perpendicular to the longitudinal joints.

Due to circumstances beyond our control, the thermistors used to measure the temperature differentials failed at some of the test sections. The FWD was used at all the



Si : Sensor # i

Fig 4.5. Arrangement of the FWD sensors when used at the edge of the mainlane and at the middle of the left–hand lane.

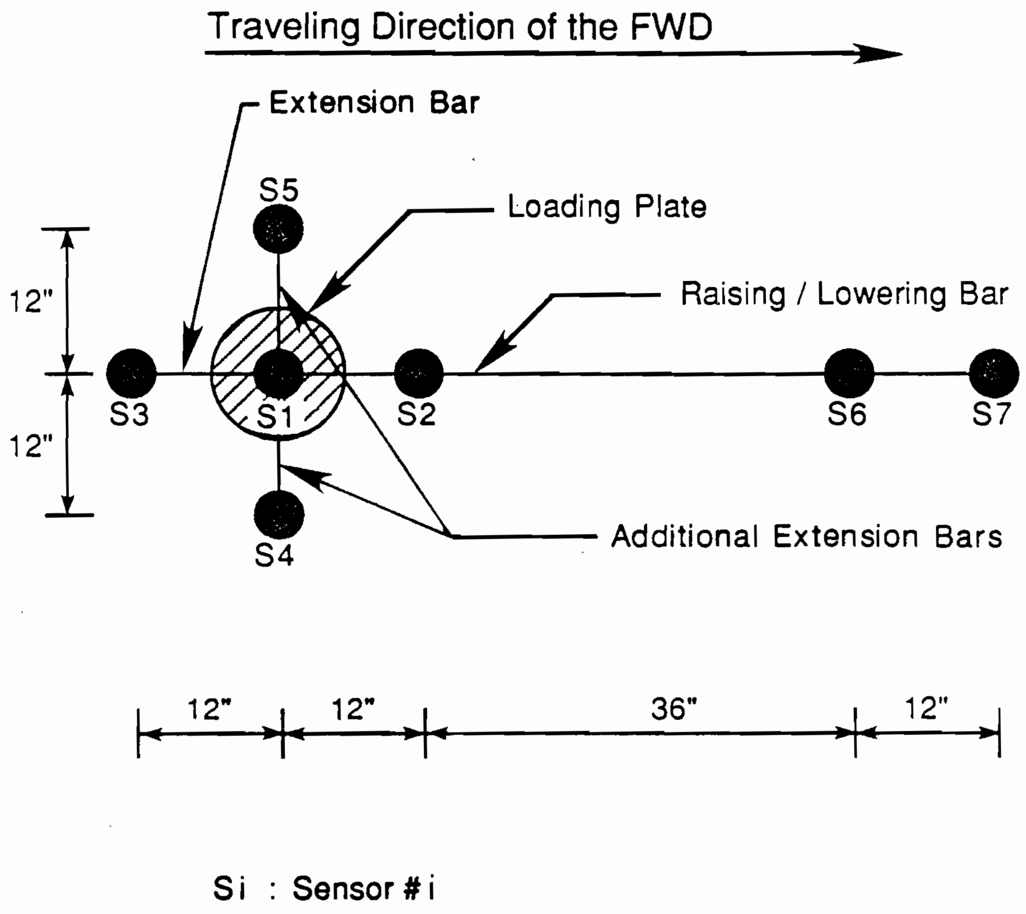


Fig 4.6. Arrangement of the FWD sensors when used at both sides of the longitudinal mainlane joint.

wheel paths and stations indicated in Fig 4.3 but it was impossible to measure the temperature differential at all of the test sections indicated.

The data are complete for test section 1, wheel paths 1 and 2, and test section 2, wheel paths 3, 4, 11, and 12. For the remainder of the sections and wheel paths there are no measurements of the temperature differential. The complete data set is presented in Appendix C and used in the analysis of the data (Chapter 5).

CHAPTER 5. ANALYSIS OF THE DATA

The pavement temperature data and the FWD deflection data collected at the BRC slab research facility and the in-service pavement section are analyzed and the results are presented in this chapter. The BRC data also included independent measurements of the vertical movement of the slab during curling of the slab due to the temperature differential within the slab.

LVDTS AND THERMOCOUPLES MEASUREMENTS

Temperatures Characteristics

Air Temperature. Figures 5.1 and 5.2 show plots of the ambient temperatures at the BRC testing facility for two sets of three–consecutive–day readings, April 23, 24, and 25, 1986 and July 19, 20, and 21, 1986, respectively. These plots show the cyclic characteristic of the air temperature for consecutive days within a given season. It can clearly be noted from these figures that the variation of the air temperature is similar for both sets of data even though they were taken three months apart. The variation of the air temperature within a day (maximum minus minimum) is 20 to 22°F for both sets of data even though the minimum and maximum air temperatures differ. July is a warmer month than April, and, hence, the minimum and maximum air temperatures have increased approximately 15°F.

Slab Temperatures. Figures 5.3 and 5.4 show plots of the average temperature of the slab at three depths (top, mid–depth, and bottom) for the same three–day periods, respectively. The maximum and minimum slab temperatures shown in those figures, as well as the temperature shift between the two sets of data for a given location, are as follows:

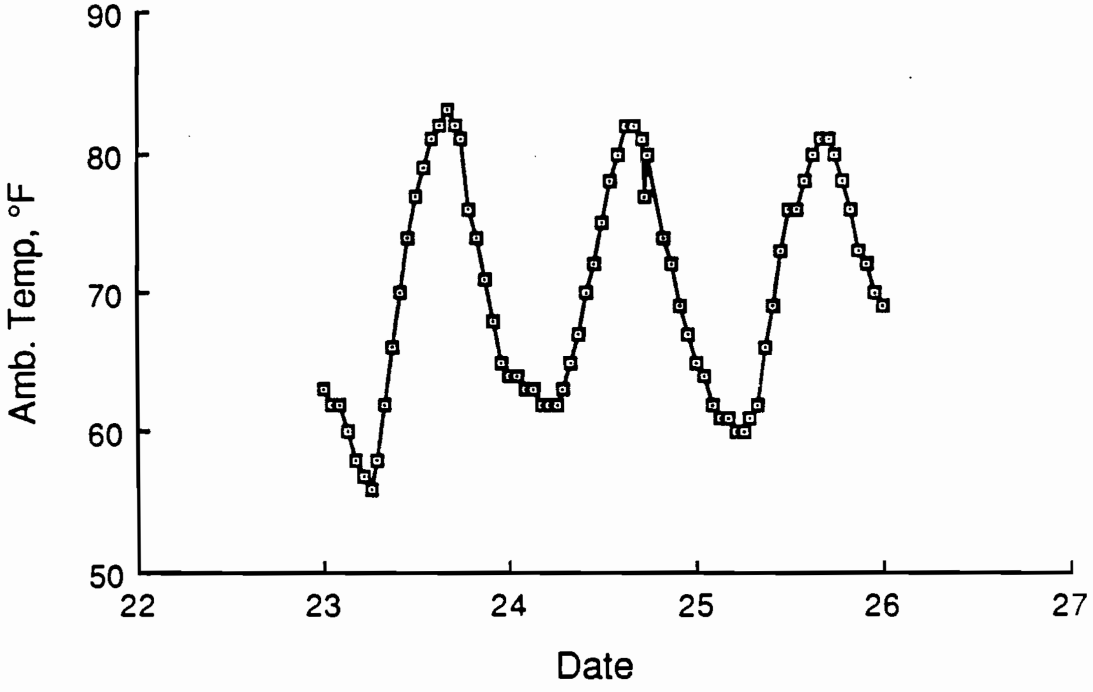


Fig 5.1. Ambient temperature at the BRC testing facility for three consecutive days (April 23, 24, and 25, 1986).

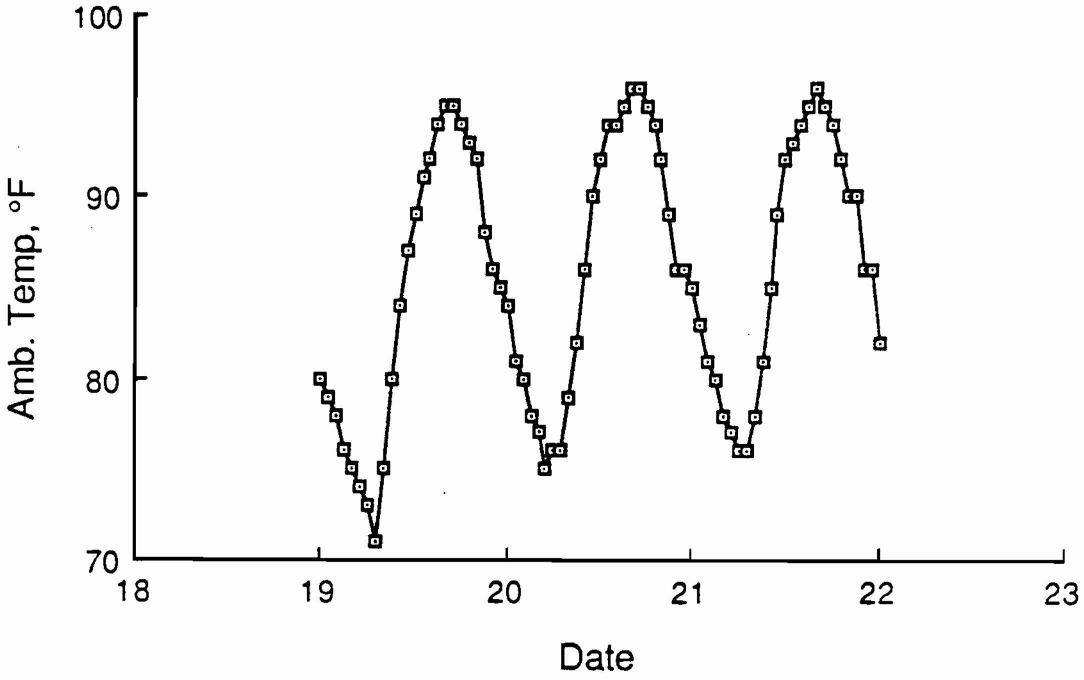


Fig 5.2. Ambient temperature at the BRC testing facility for three consecutive days (July 19, 20, and 21, 1986).

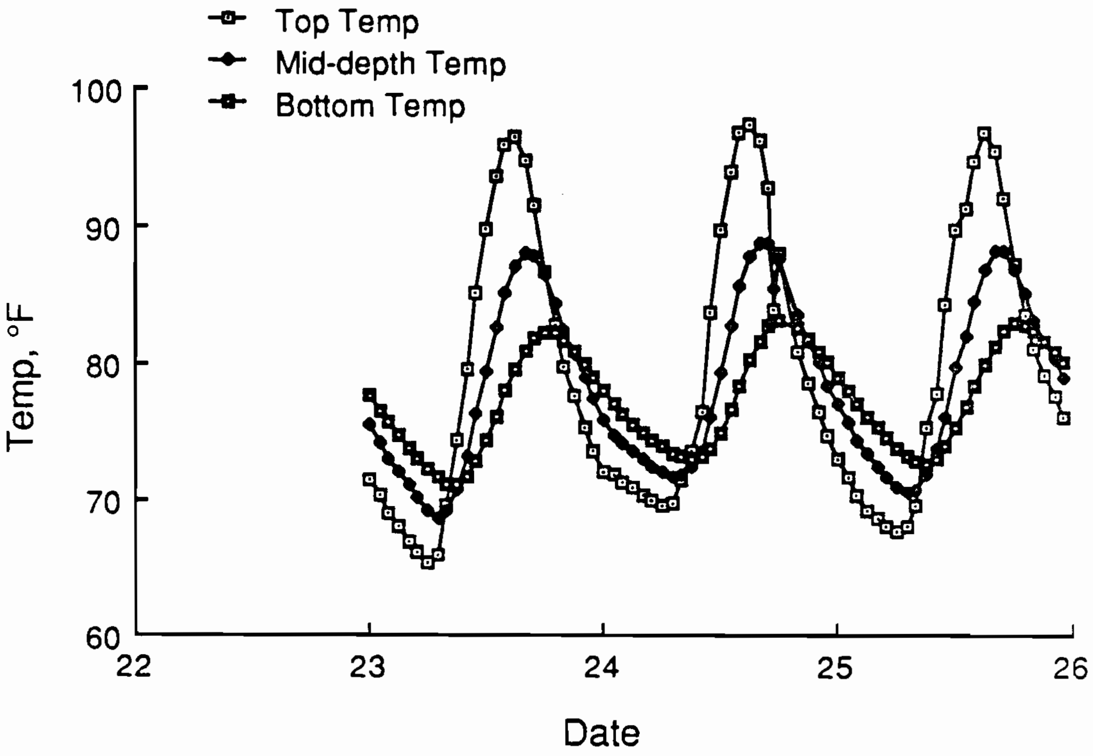


Fig 5.3. Slab temperatures at the BRC testing facility for three consecutive days (April 23, 24, and 25, 1986).

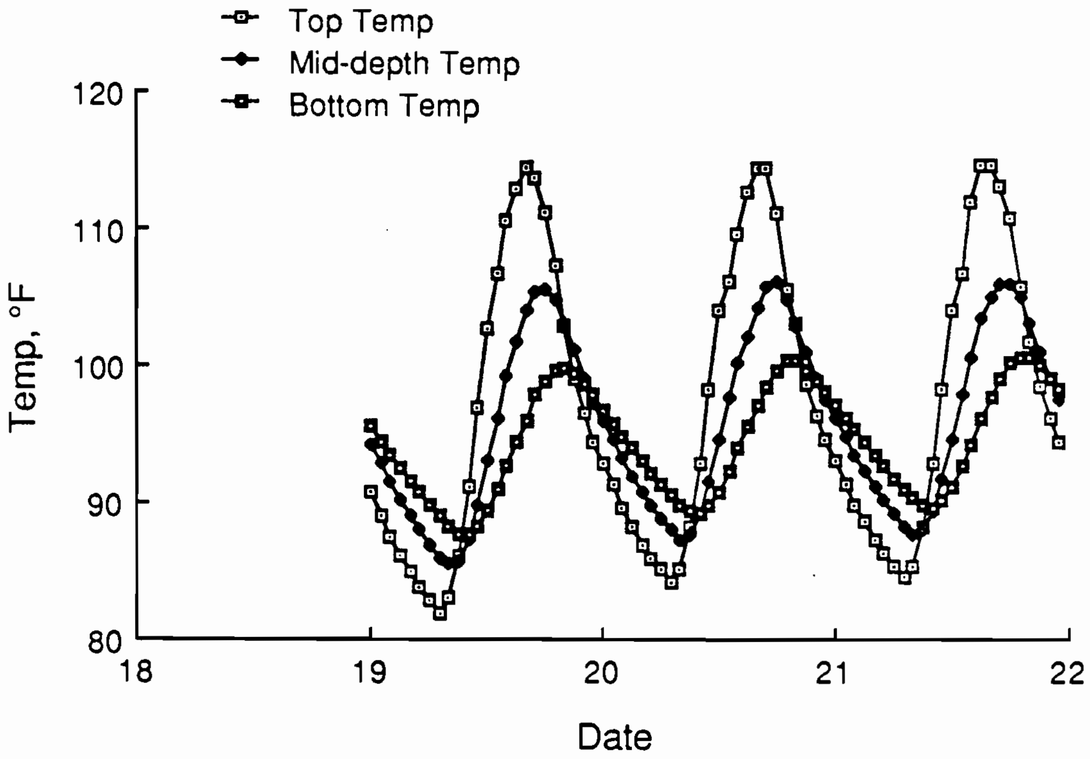


Fig 5.4. Slab temperatures at the BRC testing facility for three consecutive days (July 19, 20, 21, 1986).

		April	July	Shift
Top temperature	max	97	115	18
	min	68	84	16
Middepth temperature	max	88	106	18
	min	71	87	16
Bottom temperature	max	83	100	17
	min	73	89	16

If it is assumed that a linear distribution of temperatures within the slab depth exists, the middepth temperature becomes the average slab temperature. The middepth slab temperature has shifted up approximately 17°F from April to July. This shift is higher than the approximately 15°F shift in the ambient temperature. The difference between the maximum and minimum daily middepth temperatures is approximately 18°F, which is slightly lower than the 20 to 22°F difference in the air temperatures.

Vertical Temperature Differential Within the Slab (DT). Figures 5.5 and 5.6 show plots of the vertical temperature differential within the slab (DT) for two periods of three consecutive days, April 23 through 25 and July 19 through 21, respectively. It should be noted that the maximum and minimum values for DT within a day are approximately the same for the two data sets (see Tables B.1 and B.3). This situation exists even though there were almost three months between the readings. In this case the range of the DT (DT max - DT min) within a day for these two data sets is approximately the same.

Characteristics of the Displacements at the Transverse Joint Due to Curling Effects

Figures 5.7 and 5.8 show plots of the readings of LVDTs 1, 2, and 3 for April 23 through 25 and July 19 through 21, respectively. Figures 5.9 and 5.10 show plots of the readings of LVDTs 1, 4, and 5 for the same dates. As expected, because of their positiona along the joint (refer to Fig 3.4), LVDTs 2 and 4, as well as 3 and 5, recorded very similar displacements. The magnitudes of the displacements measured with the LVDTs along the slab joint are as follows:

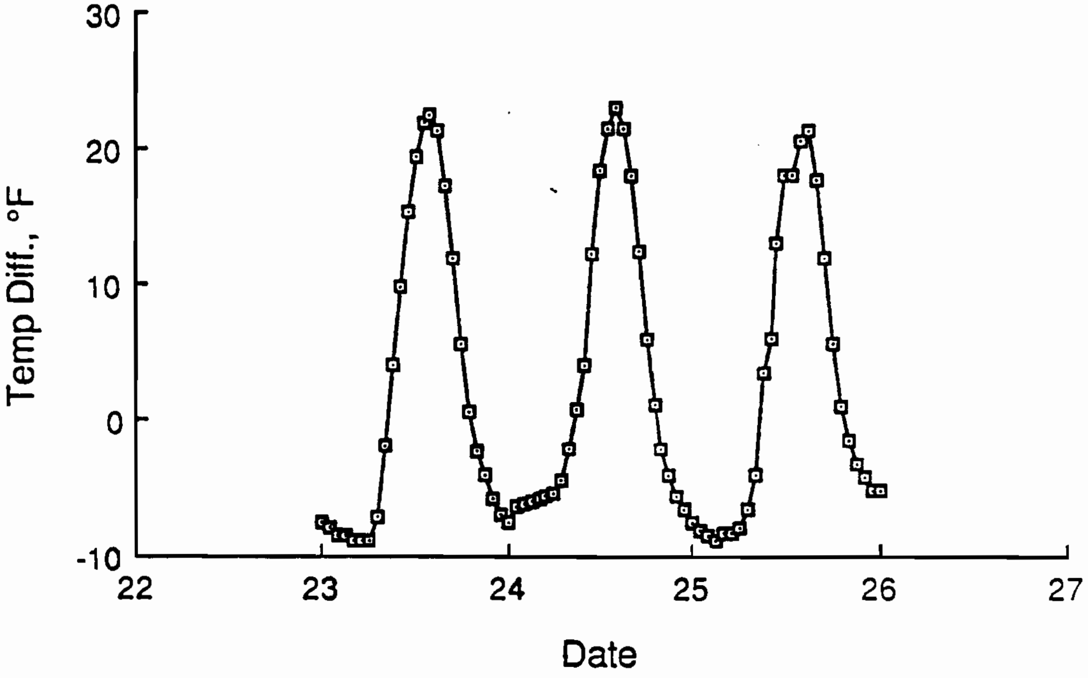


Fig 5.5. Vertical temperature differential within the slab (DT) at the BRC testing facility for three consecutive days (April 23, 24, and 25, 1986).

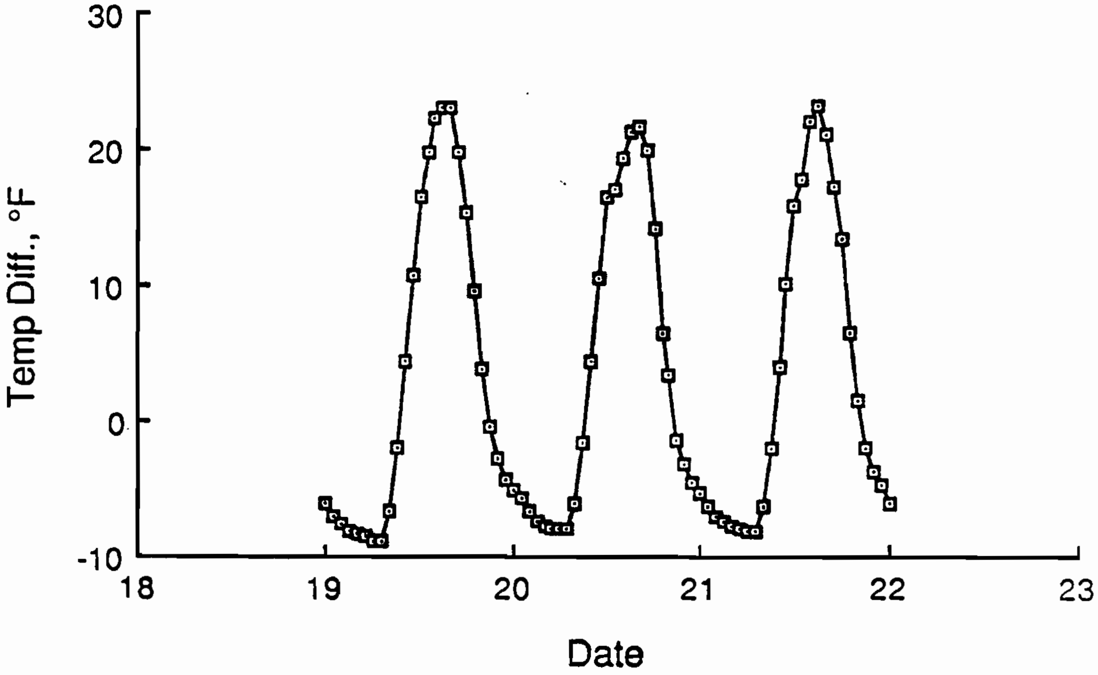


Fig 5.6. Vertical temperature differential within the slab (DT) at the BRC testing facility for three consecutive days (July 19, 20, 21, 1986).

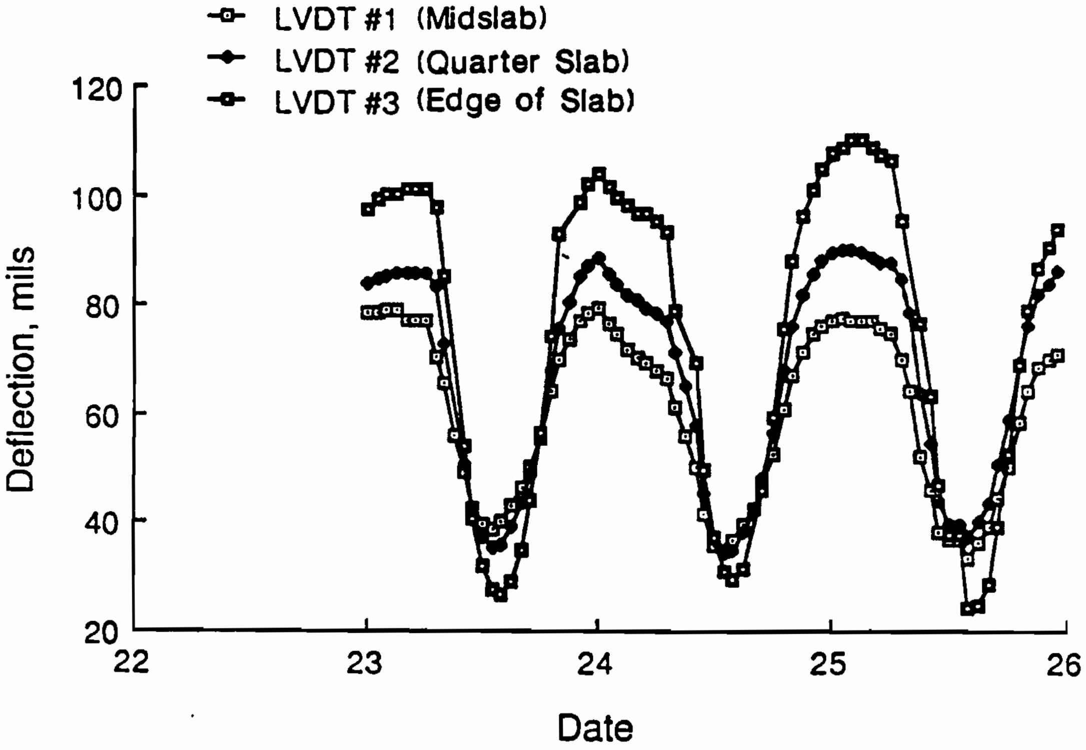


Fig 5.7. Vertical displacement or deflection readings at LVDTs 1, 2, and 3 (midslab, quarter slab, and edge of slab, respectively) at the BRC testing facility for three consecutive days (April 23, 24, and 25, 1986).

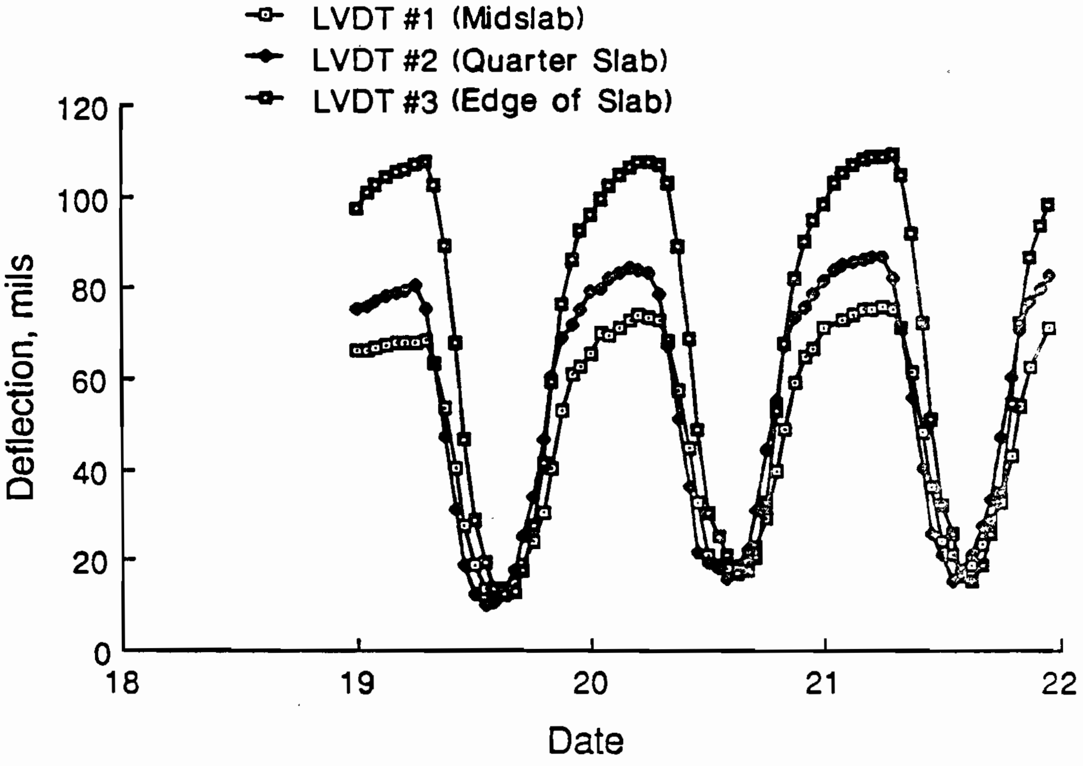


Fig 5.8. Vertical displacement or deflection readings at LVDTs 1, 2, and 3 (midslab, quarter slab, and edge of slab, respectively)at the BRC testing facility for three consecutive days (July 19, 20, and 21, 1986).

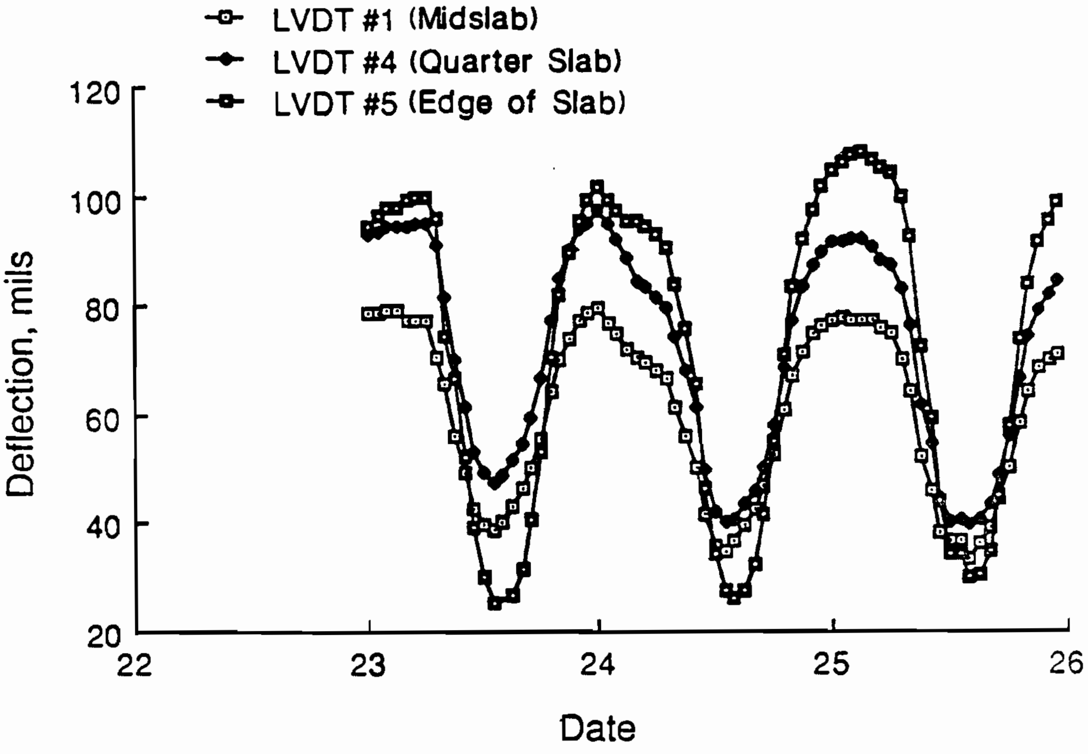


Fig 5.9. Vertical displacement or deflection readings at LVDTs 1, 4, and 5 (midslab, quarter slab, and edge of slab, respectively)at the BRC testing facility for three consecutive days (April 23, 24, and 25, 1986).

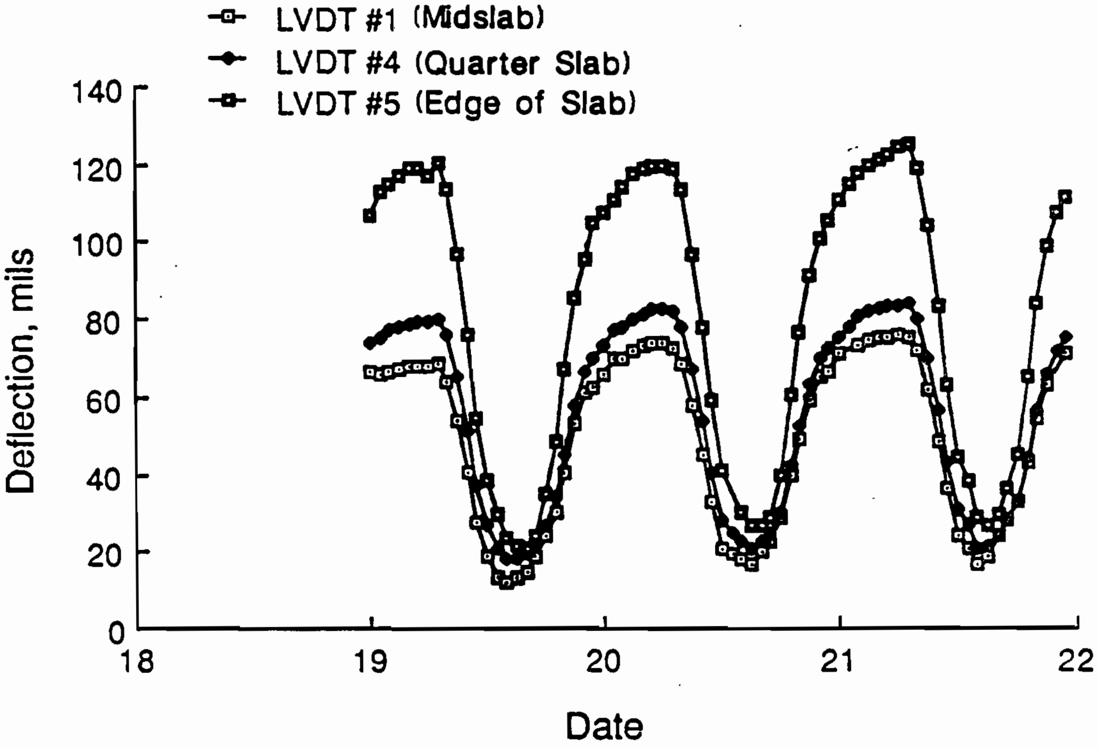


Fig 5.10. Vertical displacement or deflection readings at LVDTs 1, 4, and 5 (midslab, quarter slab, and edge of slab, respectively)at the BRC testing facility for three consecutive days (July 19, 20, and 21, 1986.

Corners (LVDTs 3 and 5)	April:	75	to	80	mils
	July:	90	to	100	mils
Middle (LVDT 1)	April:	40	to	45	mils
	July:	60	to	65	mils
Intermediate (LVDTs 2 and 4)	April:	50	to	55	mils
	July:	60	to	70	mils

The maximum vertical movement at the corner of the 10-inch slab at BRC is very similar to that reported at the AASHO Road Test for 9.5-inch slabs. This constitutes an interesting and useful check of the data collected at BRC.

Figures 5.7 through 5.10 show that the downward movement of the corners starts between 6:30 and 7:00 a.m. and finishes around 2:30 or 3:00 p.m. for both data sets. This clearly indicates that within normal working hours the corners of the slab are moving downwards most of the time. Since the downward movement of the corners implies an increase in the support area of the slab, lower deflection measurements would be expected as this area increases.

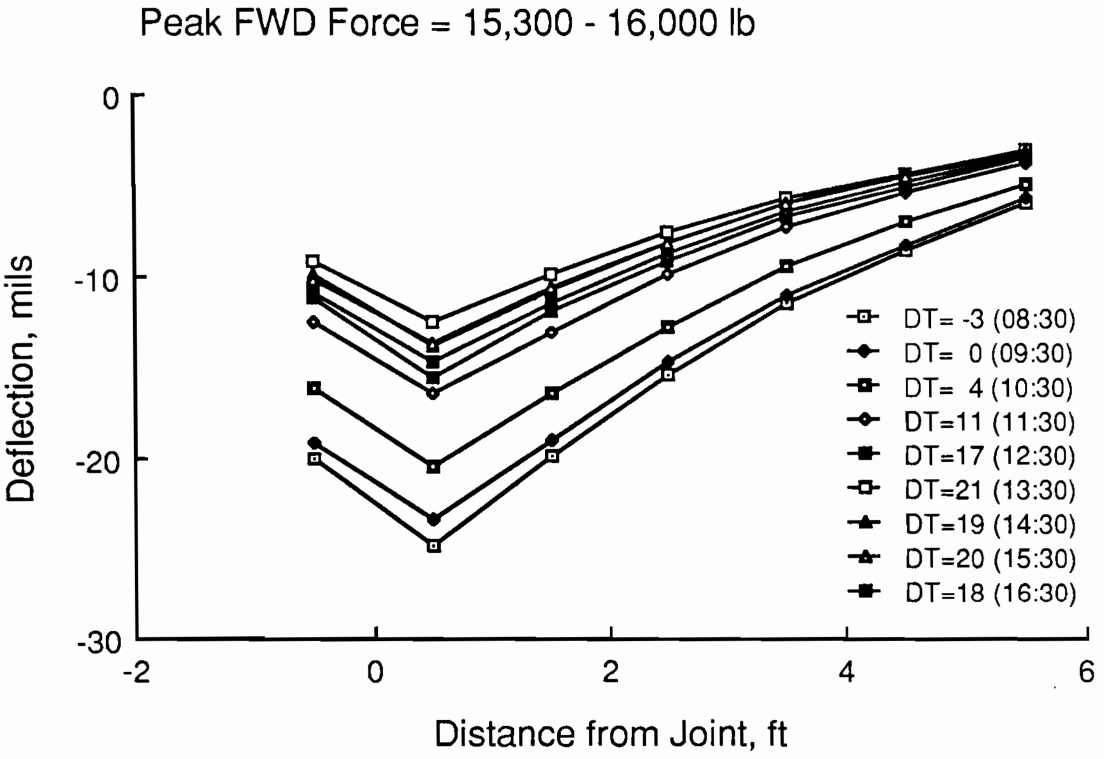
The middle position along the joint (LVDT 1) (Figs 5.7 through 5.10) also moves vertically. The vertical movement at the middle position (LVDT 1) is approximately 60 percent of that at the corners (LVDTs 3 and 5) and approximately 90 percent of that at the intermediate positions (LVDTs 2 and 4).

FWD AND THERMOCOUPLE OR THERMISTOR MEASUREMENTS

Variation of the FWD Deflection Basin During the Day

It was noted that the deflections measured at a given spot on the pavement slab varied with the time of day at which they were measured. The critical variable is not the time of day, but the vertical temperature differential within the slab.

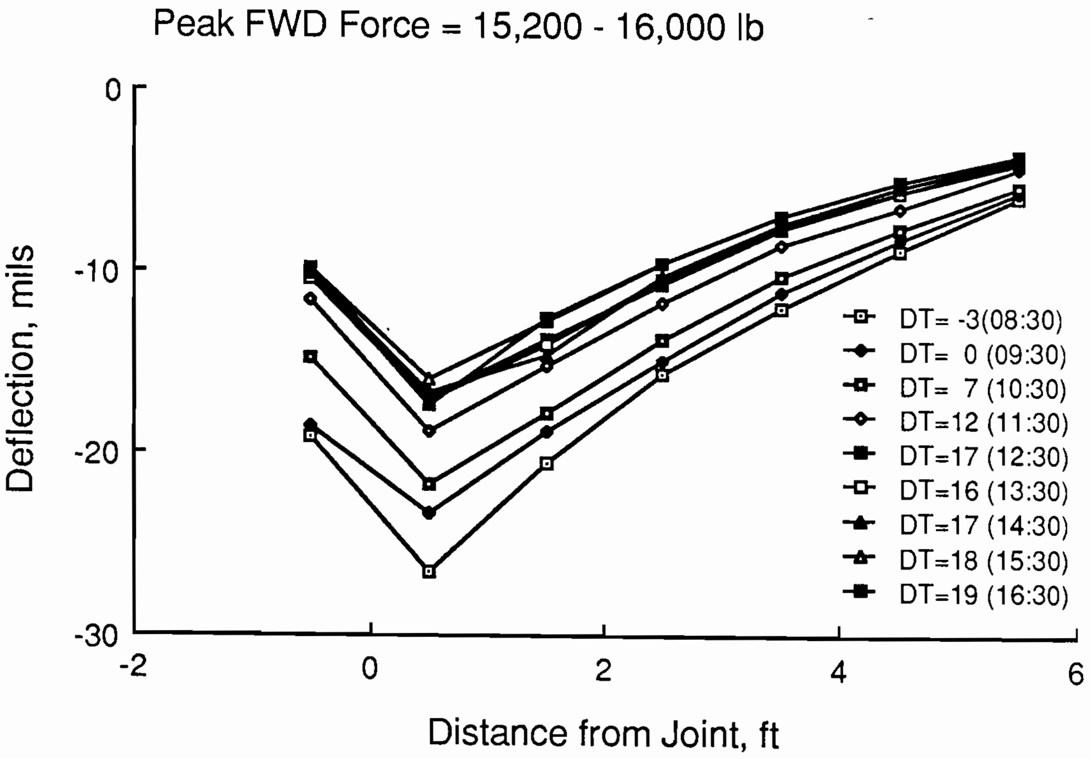
The deflection basin varied significantly as the DT varied. For a visual appreciation of this variation refer to Figs 5.11, 5.12, and 5.13. These figures show the variation of the deflection basin within a day, at a given wheel path and station. The different wheel paths and stations within the BRC slab are described in Chapter 3. In these figures, the legend shows the



Notes: - Connected data points do not represent the true basin shape and are shown for identity only.

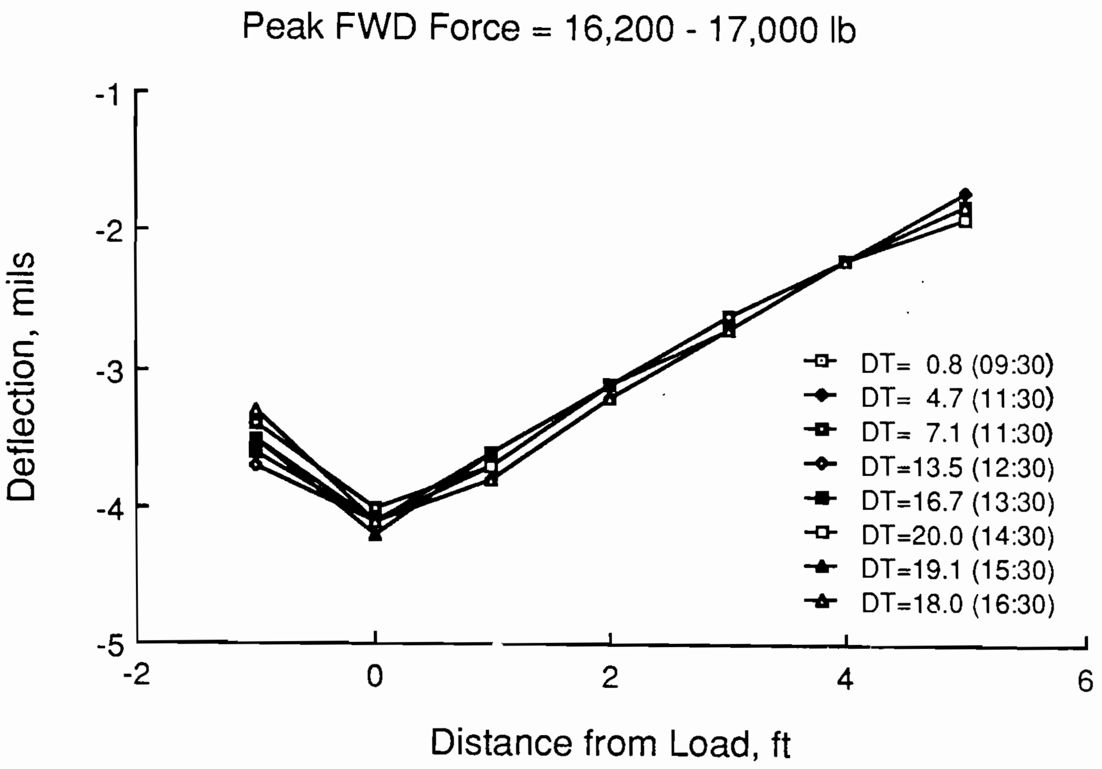
- The deflection basins were measured at the downstream position (station 2), at the side of the slab without void, and under the open joint condition.

Fig 5.11. Deflection basins at slab edge, BRC testing facility, June 24, 1986, for different DT values.



Notes:
- Connected data points do not represent the true basin shape and are shown for identity only.
- The deflection basins were measured at the downstream position (station 2), at the side of the slab with void, and under the open joint condition.

Fig 5.12. Deflection basins at slab edge, BRC testing facility, June 25, 1986, for different DT values.



Notes:
- Connected data points do not represent the true basin shape and are shown for identity only.
- The deflection basins were measured at the midspan position (station 5), at the centerline of the slab without void and under the open joint condition.

Fig 5.13. Deflection basins at midspan, BRC testing facility, August 12, 1986, for different DT values.

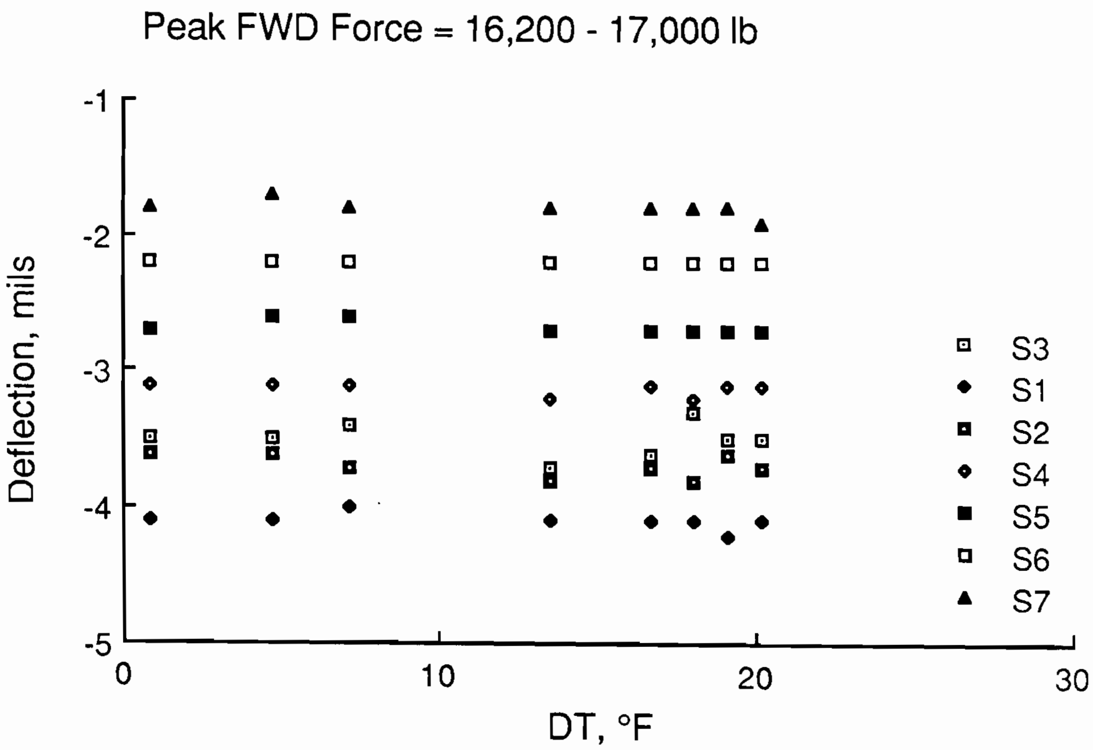
DT at which the FWD deflections were measured. It also shows, in parentheses, the time of day at which the measurements were made. The time of day is given just as a reference; the critical variable is DT. From these figures, it can be seen that the deflection basin varies with the DT variation. When the DT increases, the FWD deflections that describe the deflection basin decrease, and, conversely, when the DT decreases, the FWD deflections increase.

Relationship Between the Two Variables - FWD Deflections and DT

The next step in the analysis process was to plot the information in a different way. This was done in order to find out the relationship existing between DT and the FWD deflections. Plots were made to show the FWD deflections for each of the seven sensors versus the DT at which the deflections were measured. Samples of these plots are shown in Figs 5.14 through 5.19.

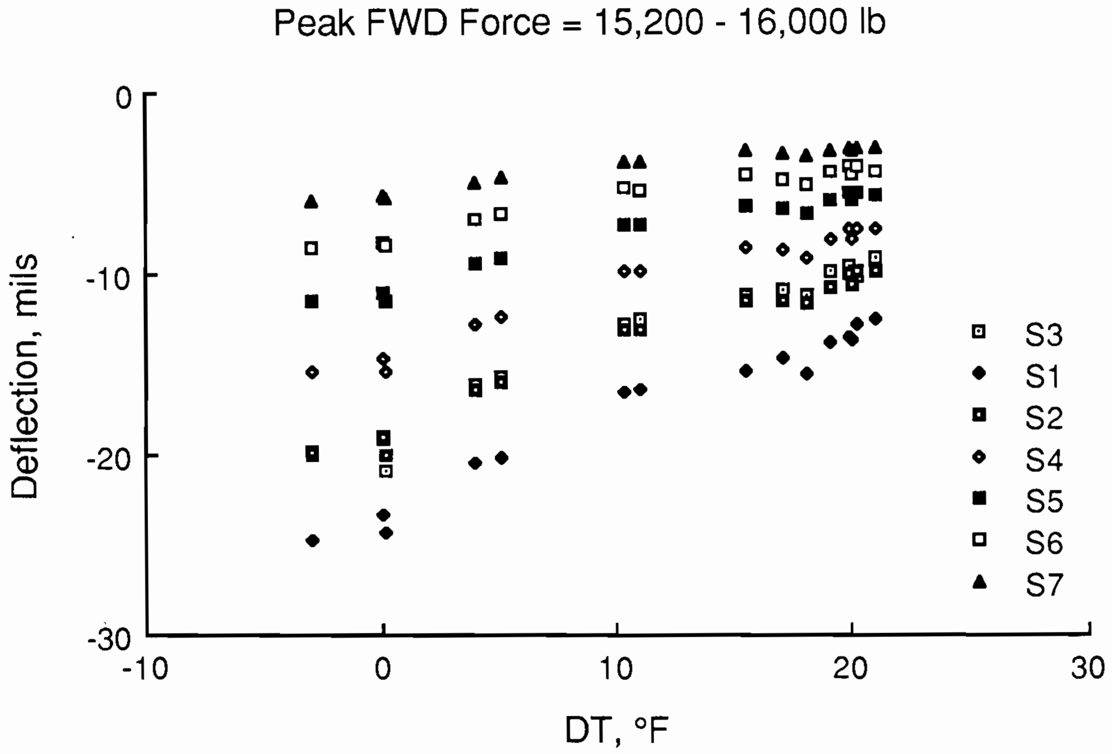
Figures 5.15, 5.16, 5.18 and 5.19 show the effect that the change of the DT has on the FWD deflections. Figures 5.15 and 5.16 show that for a given DT the FWD will measure the same deflection even if the measurements are taken a month and a half apart. It must be pointed out that for these inferences to be valid there are some very important requirements: (1) the weather must be similar (May, June, July, August, and September have very similar weather in Texas, although the maximum and minimum temperatures vary within this period), (2) there must be no rain during or immediately prior to the testing, and (3) there should be no water accumulation in the area surrounding the pavement. If any of these requirements is not met, the resulting FWD measurements can vary considerably. The presence of water would induce curling due to moisture, which, as has already been pointed out in Chapter 2, could have a very significant magnitude. Such a situation would introduce a condition uncontrollable within the scope of this particular study.

These factors have a major effect. It is possible that a difference in the third requirement explains the noticeable difference in the DT values measured at two slabs in Beaumont. For identification of the section (or slab) numbers refer to Chapter 4, particularly to Fig 4.3. Slab 1 and slab 2, approximately 300 feet apart from each other, show significantly different DT values for testing done within a given day. Slab 1 shows DT values similar to those from BRC, that is, a minimum of -5°F and a maximum of 21°F, or a 26°F total variation during the working hours. Measurements at slab 2 for the same day and with the same procedures show a minimum of -5°F and a maximum of 11°F, a 16°F variation.



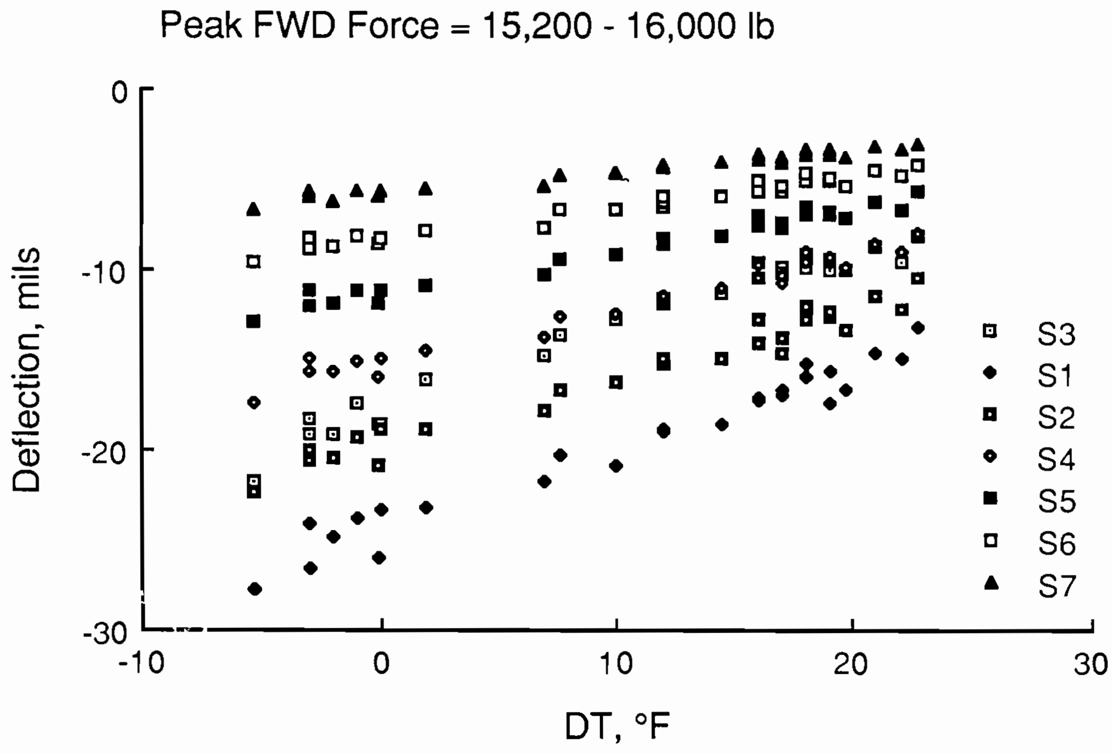
Note: The deflections were measured at the midspan position (station 5), at the centerline of the slab, and under the open joint condition.

Fig 5.14. Deflections at each of the seven FWD sensors (S1 through S7) measured at midspan, BRC testing facility, August 12, 1986.



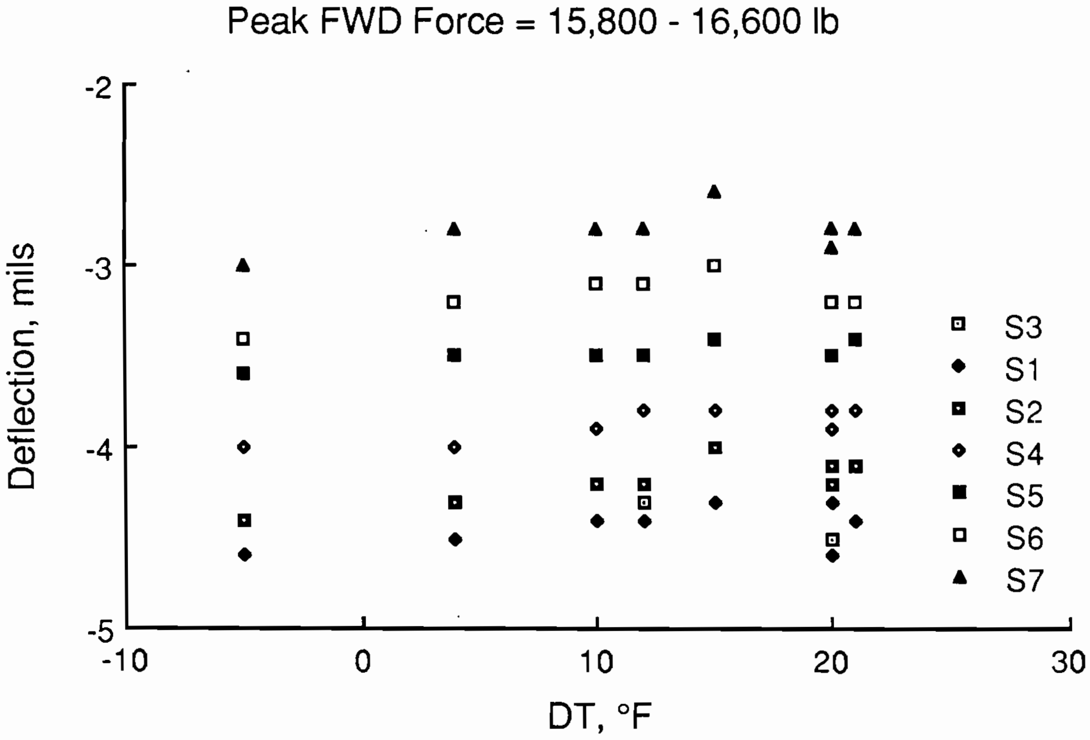
Note: The deflections were measured at the downstream position (station 2), at the side of the slab without void, and under the open joint condition.

Fig 5.15. Deflections at each of the seven FWD sensors (S1 through S7) measured at slab edge, BRC testing facility, June 24 and August 5, 1986.



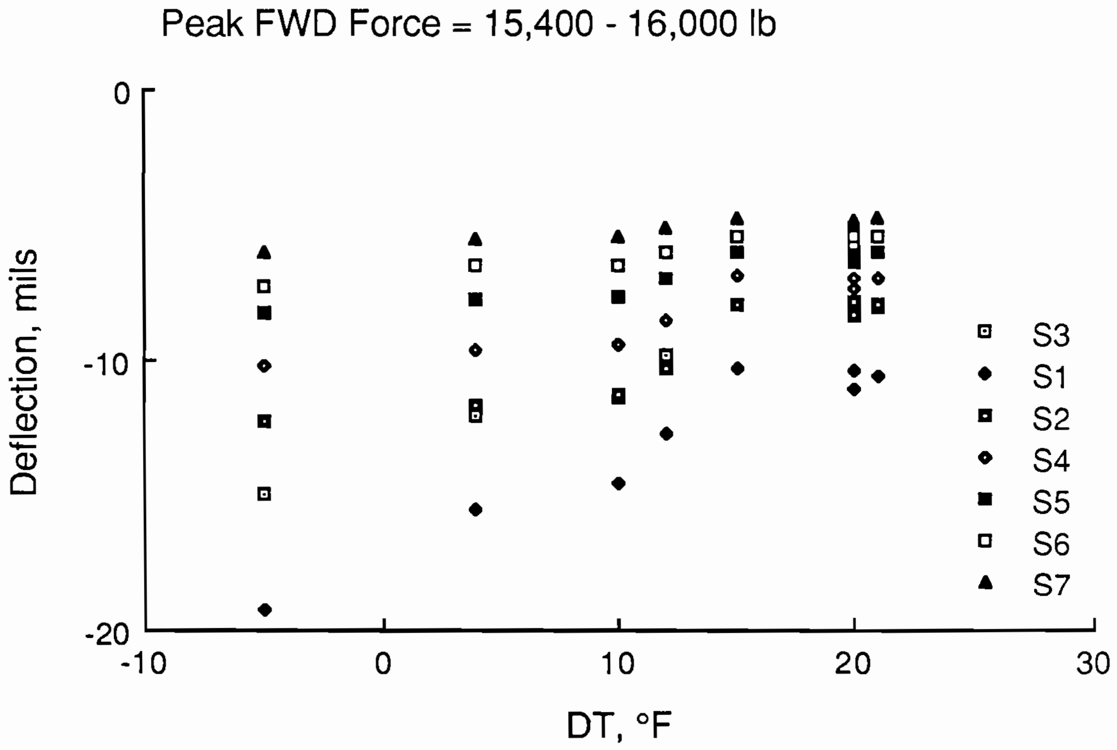
Note: The deflections were measured at the downstream position (station 2), at the side of the slab with void, and under the open joint condition.

Fig 5.16. Deflections at each of the seven FWD sensors (S1 through S7) measured at slab edge, BRC testing facility, June 25 and 26, and August 8, 1986.



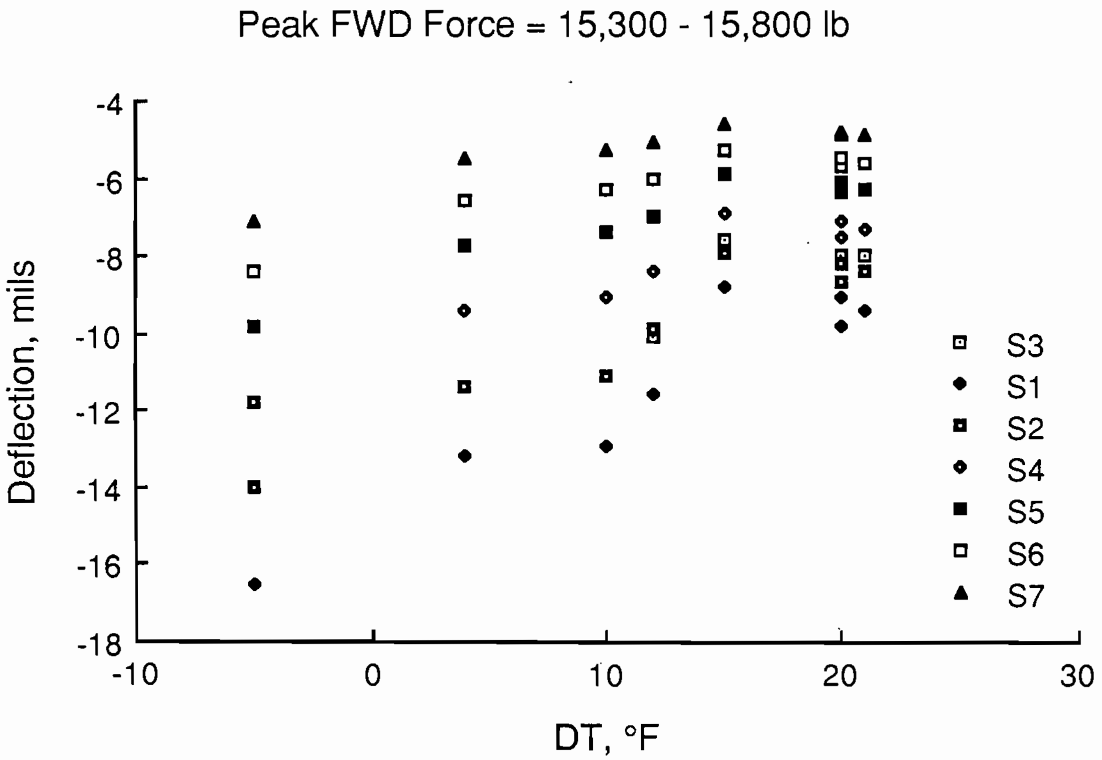
Note: The deflections were measured at the testing section or slab 1, at station 2 within wheel path 2.

Fig 5.17. Deflections at each of the seven FWD sensors (S1 through S7) measured at midspan US 90 test site, September 10, 1986.



Note: The deflections were measured at the testing section or slab 1, at station 0 within wheel path 1.

Fig 5.18. Deflections at each of the seven FWD sensors (S1 through S7) measured at slab edge, US 90 test site, September 10, 1986.



Note: The deflections were measured at the testing section or slab 1, at station 1 within wheel path 1.

Fig 5.19. Deflections at each of the seven FWD sensors (S1 through S7) measured at slab edge, US 90 test site, September 10, 1986.

This is significantly lower than the measurements at slab 1 or at the BRC testing slab. The DT measurements done the next day at slab 2 show a minimum of -3°F, a maximum of 10°F, and, hence, a 13°F variation. A possible explanation for this kind of behavior is the fact that a few feet away from slab 2 there was an area of approximately 100 feet^2 of accumulated water on top of the concrete slab. Due to the water accumulation on top of the concrete slab, the moisture condition of slab 2 was significantly different than that of slab 1. Due to the presence of the water, slab 2 had different DT values, even though other conditions remained the same. It is important to note that, if there are water accumulations on a pavement slab, the slab behavior is extremely difficult to predict.

Figures 5.14 through 5.19 show how the FWD deflections vary with the DT variation. These plots show that the relationship between DT and the FWD deflections at the middle of the slab, as well as at the upstream and downstream positions with respect to the transverse joint, is linear. Therefore, linear regression was applied to the deflections at each of the FWD sensors (Si) and to the DT values in order to find the equations of the straight lines that best fit the data points and the corresponding coefficients of correlation (R). The straight line equations will have the form

$$Si = A + B * DT$$

where A is the deflection at sensor i corresponding to a DT = 0 condition (the intersection of the straight line with the deflection axis), and B is the slope of the straight line.

The values of A and B in the straight line equations and the R values for each of the seven sensors for the data corresponding to Figs 5.14 through 5.19 are shown in Tables 5.1 through 5.6, respectively. Tables 5.2, 5.3, 5.5, and 5.6 show very high coefficients of correlation (R). This indicates that there is a high correlation and that the straight lines fit the data points very well. In Tables 5.1 and 5.4 the equations show that the FWD deflections at the middle of the slab, away from joints and cracks, remain almost constant, and, hence, they are independent of DT. This is backed up by the low R values, which indicate no correlation between the variables.

It must be pointed out that, although the trends are the same, the equations of the straight lines are different for the data sets from BRC and from Beaumont, as shown in Tables 5.1 through 5.6, although both pavements are 10-inch-thick concrete pavements. There are several possible reasons for this kind of observation. The magnitude of deflections

TABLE 5.1. COEFFICIENTS (A AND B) OF THE BEST FIT STRAIGHT LINE EQUATIONS (Si = A + B * DT) FOR EACH OF THE FWD SENSORS, AND CORRESPONDING CORRELATION COEFFICIENTS (R) FOR THE FWD AT MIDSPAN, BRC TESTING FACILITY, AUGUST 12, 1986 (DATA SHOWN IN FIG 5.14)

Sensor	A	B	R
S3	-3.50	0.000	0.00
S1	-4.06	-0.003	0.44
S2	-3.62	-0.010	0.45
S4	-3.10	-0.002	0.26
S5	-2.63	-0.003	0.56
S6	-2.20	0.000	0.00
S7	-1.75	-0.004	0.57

TABLE 5.2. COEFFICIENTS (A AND B) OF THE BEST FIT STRAIGHT LINE EQUATIONS (Si = A + B * DT) FOR EACH OF THE FWD SENSORS, AND CORRESPONDING CORRELATION COEFFICIENTS (R) FOR THE FWD AT SLAB EDGE, BRC TESTING FACILITY, JUNE 24 AND AUGUST 5, 1986 (DATA SHOWN IN FIG 5.15)

Sensor	A	B	R
S3	-18.75	0.46	-0.97
S1	-23.37	0.58	-0.89
S2	-18.62	0.43	-0.98
S4	-14.34	0.33	-0.98
S5	-10.65	0.25	-0.98
S6	-7.87	0.19	-0.97
S7	-5.47	0.12	-0.97

TABLE 5.3. COEFFICIENTS (A AND B) OF THE BEST FIT STRAIGHT LINE EQUATIONS (Si = A + B * DT) FOR EACH OF THE FWD SENSORS, AND CORRESPONDING CORRELATION COEFFICIENTS (R) FOR THE FWD AT SLAB EDGE, BRC TESTING FACILITY, JUNE 25 AND 26, AND AUGUST 8, 1986 (DATA SHOWN IN FIG 5.16)

Sensor	A	B	R
S3	-17.74	0.44	-0.98
S1	-24.32	0.44	-0.98
S2	-19.67	0.37	-0.98
S4	-15.15	0.30	-0.98
S5	-11.29	0.23	-0.98
S6	-8.28	0.17	-0.98
S7	-5.77	0.12	-0.98

TABLE 5.4. COEFFICIENTS (A AND B) OF THE BEST FIT STRAIGHT LINE EQUATIONS (Si = A + B * DT) FOR EACH OF THE FWD SENSORS, AND CORRESPONDING CORRELATION COEFFICIENTS (R) FOR THE FWD AT MIDSPAN, US 90 TEST SITE, SEPTEMBER 10, 1986 (DATA SHOWN IN FIG 5.17)

Sensor	A	B	R
S3	-4.32	0.01	-0.33
S1	-4.52	0.01	-0.50
S2	-4.32	0.01	-0.82
S4	-3.97	0.01	-0.79
S5	-3.55	0.01	-0.71
S6	-3.25	0.01	-0.51
S7	-2.88	0.01	-0.45

TABLE 5.5. COEFFICIENTS (A AND B) OF THE BEST FIT STRAIGHT LINE EQUATIONS (Si = A + B * DT) FOR EACH OF THE FWD SENSORS, AND CORRESPONDING CORRELATION COEFFICIENTS (R) FOR THE FWD AT SLAB EDGE, US 90 TEST SITE, SEPTEMBER 10, 1986 (DATA SHOWN IN FIG 5.18)

Sensor	A	B	R
S3	-13.30	0.27	-0.97
S1	-17.14	0.34	-0.96
S2	-11.93	0.19	-0.92
S4	-9.86	0.13	-0.92
S5	-7.95	0.09	-0.92
S6	-6.85	0.07	-0.94
S7	-5.72	0.05	-0.94

TABLE 5.6. COEFFICIENTS (A AND B) OF THE BEST FIT STRAIGHT LINE EQUATIONS (Si = A + B * DT) FOR EACH OF THE FWD SENSORS, AND CORRESPONDING CORRELATION COEFFICIENTS (R) FOR THE FWD AT SLAB EDGE, US 90 TEST SITE, SEPTEMBER 10, 1986 (DATA SHOWN IN FIG 5.19)

Sensor	A	B	R
S3	-11.63	0.17	-0.90
S1	-14.81	0.28	-0.95
S2	-12.63	0.22	-0.95
S4	-10.53	0.17	-0.95
S5	-8.69	0.14	-0.95
S6	-7.41	0.10	-0.93
S7	-6.23	0.08	-0.90

is largely influenced by the subgrade and base conditions. The differences in subgrade and base at the two locations may influence deflections and therefore lead to differences in coefficients of the straight lines. Other differences could be due to the different joint spacing, crack spacing, layers underneath the concrete surface layer, or moisture in the slab. Slab moisture is very important, as noted in Chapter 2, due to the fact that the curling due to moisture is significantly large, although it is considered as a seasonal effect more than a daily effect. Then, there are multiple variables that could cause the difference between the FWD deflections measured at these two sites. These multiple variables make the problem of finding a unique correction factor or equation very complex. Therefore, a methodology, rather than a unique correlation factor or equation, is proposed for controlling the effect of DT on the FWD deflections.

METHODOLOGY TO AVOID THE FWD DEFLECTION VARIATION DUE TO THE DT EFFECT

Recommendations proposed in this report are based on testing done in warm summer weather in Texas during the months of May, June, July, August, and September of 1986.

Within such a time period, testing can be properly scheduled within the testing day in order to avoid the variation of the FWD deflections due to DT variation during the day.

It has been found that FWD deflections measured at the midspan position within the centerline wheel path, with the purpose of insitu material characterization, remain generally constant within the testing day (refer to Fig 5.13). Thus, FWD deflections at this position are independent of DT and can be measured at any time of the day with the same results.

On the other hand, FWD deflections measured in the wheel path at the edge of the pavement in order to evaluate load transfer and detect voids do vary within the testing day (refer to Figs 5.11 and 5.12). It has also been noted that DT and FWD deflections measured during the afternoon hours remain almost constant, while those measured during the morning hours vary rapidly and significantly.

Therefore, in order to avoid the variation of the FWD deflections due to the DT variation during the day, it is recommended that the testing day be scheduled as follows:

(1) Testing at the midspan position within the centerline wheel path with the purpose of insitu material characterization could be done any time during the day.

(2) Testing in the wheel path at the edge of the pavement to evaluate load transfer and detect voids should be done during the morning hours. The measured deflections can be used to calculate joint efficiency at its lowest state.

In this way, the variation of the FWD deflections due to the DT variation is minimized and, hence, no correction is needed.

If testing in the wheel path at the edge of the pavement is performed all day long and is not restricted to the afternoon hours, then the deflections will have to be corrected or "standardized". Two methods are possible for this purpose:

(1) use the deflections for DT = 0 as the standardized or normalized deflections or

(2) use the deflections for the highest daily DT common to all testing days as the standardized or normalized deflections.

The first method is more mathematically correct since, when DT = 0, the effect of the DT on the FWD deflections has been compensated for. The second method is somewhat more practical in the sense that, although it does not compensate for the DT effect, it normalizes all deflections to a given standardized condition. This condition is the one corresponding to the highest daily DT common to the testing days. This is a useful condition because the pavement slab corners and edges are curled downward during most of the working day. The curled-up position in the early morning hours creates voids or partial loss of subgrade support at the pavement slab corners. These effects may be eliminated during the afternoon hours when the high positive DT values are present. In addition, the downward curling of slab corners also results in greater aggregate interlock at the joint. These factors lead to lower deflection values at the slab corner and edge and subsequently the better load transfer efficiency.

On the other hand, higher deflections will be measured during early morning hours (negative temperature differential) at slab corners and edges. Therefore the load transfer efficiency will be at its lowest in the early morning hours of maximum negative temperature differential. The reduced load transfer can have significant influence on the performance of in-service pavements. Therefore, it is preferable to correct all daytime deflection measurements at corners and edges to a standard zero temperature differential condition in order to make reasonable estimates of the load transfer efficiency.

The problem with the correction methods is that two points are needed in order to define the equation of the straight line that describes the relationship between the DT and the deflection at a given sensor. Therefore, it is necessary to test several stations during the morning hours and then to retest them during the afternoon hours. In this way, the two test points that can define the straight lines are available. Once the straight line equations are defined, the FWD deflections can be standardized or normalized immediately. For details on the measurement procedures refer to Chapter 4.

CHAPTER 6. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The results, conclusions, and recommendations stated in this report are based on testing done in warm summer weather in Texas during the months of May, June, July, August, and September 1986.

The LVDT and thermocouple measurements show that the edge of the slab, and particularly the corners of the slab, are in continuous vertical movement as the DT changes. Further, this movement is downwards during most of the normal working day. For this study, which covers measurements taken during summer conditions, the downward movements at the corners start at approximately 6:30 a.m. and end around 3:00 p.m. Due to this continuous downward movement, the concrete slab gains contact area with the underlying layer. This in turn reduces the FWD deflections as the DT increases, indicating a reduction in the size of the void (loss of contact area) created because of the deformed shape of the slab (curled-up position).

Tests run with the FWD have shown that, indeed, the FWD deflections measured in the wheel path at the edge of the pavement decrease while the DT increases. These tests provide the data needed to analyze the relationship existing between the FWD deflections and the DT. It has been determined that the relationship between these two variables is linear.

The LVDTs used at the BRC slab show that, between the hours of 1:00 and 4:00 p.m., the slab corners are almost stationary. The corner movements at this time of day are very small and slow compared to the movements observed between the hours of 7:00 a.m. and noon. At the same time, the DT values show a very small variation during the afternoon hours as compared to the one experienced during the morning hours. Therefore, the afternoon constitutes a good time period for measuring deflections with the FWD without worrying about the DT effects. In other words, for measurements taken within the afternoon hours the variation of the deflections due to DT is minimized since the DT variation is minimum. This is shown in the FWD deflections measured at the BRC slab. The FWD deflection basins measured in the afternoon show almost no variation. Thus, it is recommended that testing in the wheel path at the edge of the pavement to evaluate load transfer and detect voids be done within the afternoon hours. However, it must be recognized that in the early morning hours (at negative or approaching zero temperature differential) larger corner deflections are measured, which may lead to lower load transfer efficiency. This is critical for pavement performance. Some agencies recommended this time to measure deflections for evaluation of load transfer (Ref

21). Therefore, there is a need to correct the deflections measured in the afternoon hours to a standard condition of zero temperature differential.

Testing for material characterization, which is done at the middle of the slab, away from cracks and joints, can be done at any time of the day since it has been observed in this study that the FWD deflection basin at this location does not vary with DT variations.

Based on all this, this study recommends scheduling the testing day in order to avoid the DT effect on the FWD deflections. The recommended schedule is as follows:

(1) testing at the middle of the slab, for material characterization, can be done any time during the day, and

(2) testing in the wheel path at the edge of the pavement or corner of the slab to evaluate load transfer and detect voids may be done during morning hours in order to evaluate joint efficiency at its low levels.

In this way, the effect of DT on the FWD deflections is avoided. Thus, the slab temperatures used to define DT do not have to be measured and, hence, the testing process is faster and simpler.

If testing in the wheel path at the edge of the pavement is done all day long, then the deflections will have to be standardized. This is necessary because of the curling down of the slab and the horizontal restraint due to higher surface temperature. This condition will occur during noon and afternoon hours and will develop in the joint locking, resulting in small deflections and high load transfer efficiency. A procedure has been proposed to compensate the effect of the DT on the FWD deflections by correcting the FWD deflections to zero temperature differential condition

Although scheduling the testing day rather than testing in the wheel path at the edge of the pavement all day is recommended, this study has proposed a methodology for compensating for the DT effect on the FWD deflections in order to normalize the FWD deflections so they can be adequately used in the structural evaluation of rigid pavements.

This study recommends more testing to be done in order to evaluate any possible seasonal effect on the FWD deflections. The testing should be done approximately every three months and for at least two years in order to have not less than two measurement sets for each of the four different weather seasons. In this way, any seasonal effect on the FWD deflections could be observed and analyzed.

REFERENCES

1. Uddin, W., A. H. Meyer, W. R. Hudson, and K. H. Stokoe II, "A Structural Evaluation Methodology for Pavements Based on Dynamic Deflections," Research Report 387-1, Center for Transportation Research, The University of Texas at Austin, August 1985.
2. Uddin, W., A. H. Meyer, and W. R. Hudson, "A User's Guide for Pavement Evaluation Programs RPEDD1 and FPEDD1," Research Report 387-2, Center for Transportation Research, The University of Texas at Austin, August 1985.
3. Ricci, E. A., A. H. Meyer, W. R. Hudson, and K. H. Stokoe II, "The Falling Weight Deflectometer for Nondestructive Evaluation of Rigid Pavements," Research Report 387-3F, Center for Transportation Research, The University of Texas at Austin, November 1985.
4. Ahlborn, Gale, "ELSYM5 3/72 - 3, Elastic Layered System with One to Ten Normal Identical Circular Uniform Loads," Unpublished computer application, Institute of Transportation and Traffic Engineering, University of California at Berkeley, 1972.
5. White, R., W. R. Hudson, A. H Meyer, and K. H. Stokoe II, "Design and Construction of a Rigid Pavement Research Facility," Research Report 355-1, Center for Transportation Research, The University of Texas at Austin, September 1984.
6. Crovetti, J. A., and M. I. Darter, "Void Detection for Jointed Concrete Pavements," a paper prepared for the 1985 Annual Meeting of the Transportation Research Board, Washington, D. C., January 1985.
7. Price, G. E., "Curling of Rigid Pavement Slabs due to Temperature Differentials," Thesis, The University of Texas at Austin, 1967.
8. Hveem, F. N., "Slab Warping Affects Pavement Joint Performance," Journal of American Concrete Institute, Vol. 47, 1951, Pages 797-808.
9. The AASHO Road Test "Report 5, Pavement Research," Special Report 61E, Highway Research Board , Washington, D. C., 1962.
10. Eisenmann, J., "Analysis of Restrained Curling Stresses and Temperature Measurements in Concrete Pavements," Publication SP25, Symposium on Effect of Temperature on Concrete, American Concrete Institute , 1968, Pages 235-250.

11. Minkarah, I., Cook, J. P., and Jaghoory, S., "Vertical Movement of Jointed Concrete Pavements," Transportation Research Record No. 990, 1985, Pages 9-16.

12. Lang, F. C., "Temperature and Moisture Variations in Concrete Pavements," Proceedings, Highway Research Board, Vol. 21, 1941, pp 260-271.

13. Swanberg, J. H., "Temperature Variation in a Concrete Pavement and the Underlying Subgrade," Proceedings, Highway Research Board, Vol. 25, 1945, pp 169-180.

14. Uddin, W., S. Nazarian, W. R. Hudson, A. H. Meyer, and Kenneth Stokoe II, "Investigations into Dynaflect Deflections in Relation to Location/Temperature Parameters and Insitu Material Characterization of Rigid Pavements," Research Report 256-5, Center for Transportation Research, The University of Texas at Austin, December 1983.

15. De Solminihac, H., J. P. Covarrubias, and C. Larrain, "Diseño y Desarrollo de Mediciones de Problemas Físicos en Losas de Hormigon de Pavimento," Universidad Catolica de Chile, 1984.

16. Covarrubias, J. P., H. De Solminihac, and C. Larrain, "Estudio Experimental del Movimiento Diferencial en Losas de Hormigon de Pavimentos," Universidad Catolica de Chile, 1984.

17. Arndt, W. J., "Temperature Changes and Duration of High and Low Temperatures in a Concrete Pavement," Proceedings, 23rd Annual Meeting of Highway Research Board, 1943, pp 273-278.

18. Barber, E. S., "Calculation of Maximum Pavement Temperatures from Weather Reports," Highway Research Bulletin 168, Highway Research Board, Washington, D. C., 1957.

19. Gulden, Wouter, and J. B. Thornton, "Pavement Restoration Measures to Precede Joint Resealing," Transportation Research Record 752, Transportation Research Board, 1980, pp 6-15.

20. Uddin, W., A. H. Meyer, and W. R. Hudson, "A Study of Factors Influencing Deflections of CRC Pavements," Transportation Research Record 993, Transportation Research Board, 1984.

21. Gulden, Wouter, and Danny Brown, "Establishing Load Transfer in Existing Jointed Concrete Pavements," Transportation Research Record 1043, Transportation Research Board, 1985, pp 23-32.

22. Armaghani, Jamshid M., John M. Lybas, Mang Tia, and Byron E. Ruth, "Concrete Pavement Joint Stiffness Evaluation Using FEACONS III and the Falling Weight Deflectometer," a paper presented at the 65th Annual Meeting of the Transportation Research Board, January 1986.
23. Foxworthy, Paul T., and Michael I. Darter, "Preliminary Concepts for FWD Testing and Evaluation of Rigid Airfield Pavements," Transportation Research Record1070, Transportation Research Board, 1986.

APPENDIX A. THE DYNATEST MODEL 8000 FALLING WEIGHT DEFLECTOMETER

APPENDIX A. THE DYNATEST MODEL 8000 FALLING WEIGHT DEFLECTOMETER

The following is a description of the Dynatest Model 8000 Falling Weight Deflectometer (FWD) which was used in this study. This description has been extracted from Ref 3.

The Dynatest Model 8000 FWD is a trailer mounted device which is towed by a van at regular highway speeds. The total weight of the trailer and the impulse generating device is less than 2,000 pounds. The transient pulse generating device is the trailer mounted frame capable of directing different mass configurations to fall from a preselected height, perpendicular to the surface. This gives the capability of producing a wide range of peak force amplitudes due to the fact that the peak force can be changed by varying the mass and/or the height from where the mass is dropped. The assembly consists of the mass, the frame, the loading plate, and a rubber buffer, which acts as a spring. The operation of lifting and dropping the mass is done by means of an electro-hydraulic system. There is a manual hydraulic system that could be used in case of a malfunction of the electrically activated system.

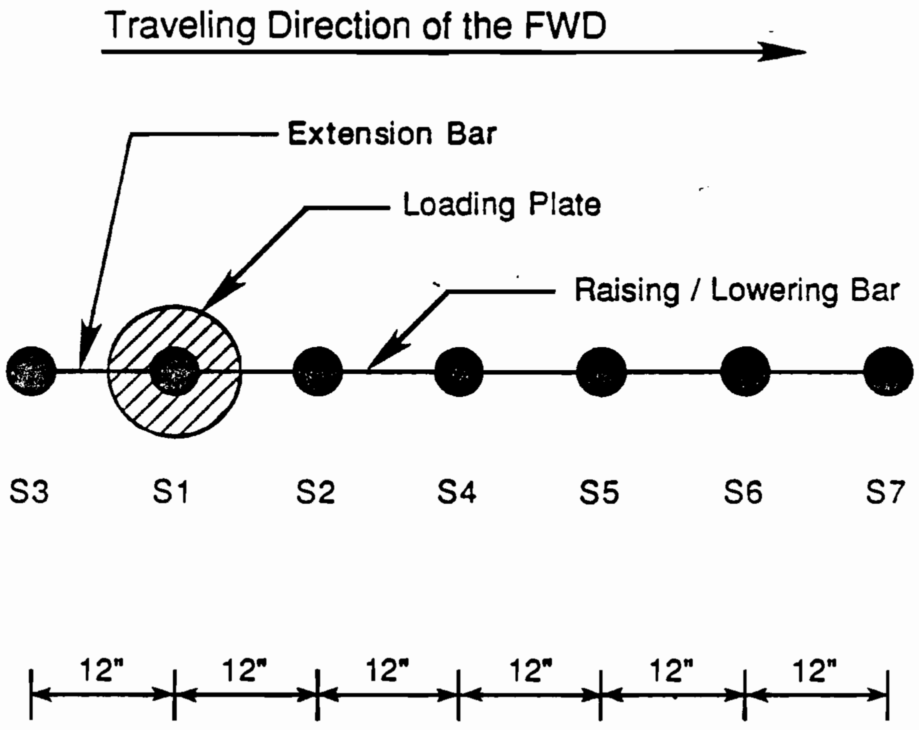
The falling weight/buffer subassembly is such that four different mass configurations can be used. All four mass configurations produce a transient load pulse of approximately 25 to 30 miliseconds which can be represented by a half-sine wave of that duration. Each of the falling weight/buffer combinations is constructed to be capable of releasing the weight from various heights. Therefore, different peak loads can be obtained for the four specified mass configurations as shown in Table A.1.

For routine testing, a loading plate 11.8 inches (300mm) in diameter is used. The mass guide shaft is perpendicular to the road surface in the measuring mode as well as the transport mode. The system includes a load cell capable of accurately measuring the force that is applied perpendicular to the loading plate. The load cell can be removed for calibration.

The system can provide seven separate deflection measurements per test. One of the deflection sensing transducers, also referred to as geophones or sensors, measures the deflection of the pavement surface through the center of the loading plate. The six remaining transducers can be positioned along the raise/lower bar, at distances of up to 7 feet from the center of the loading plate. An extension bar, which constitutes an extension of the raise/lower bar, is provided to measure the deflection on the other side of the loading plate (refer to Fig A.1). This extension bar facilitates load transfer studies on rigid pavements. All

TABLE A.1. FWD PEAK LOADING FORCES WHEN THE FOUR DIFFERENT WEIGHTS ARE DROPPED FROM THE FOUR DIFFERENT HEIGHTS

Falling Weight (lb)	Peak Loading Force (lbf)
110	1500 - 4000
220	3000 - 8000
440	5500 - 16000
660	8000 - 24000



Si : Sensor # i

Fig A.1. Arrangement of the FWD sensors when used in load transfer studies (same as Fig 2.1).

deflection sensing transducer holders are spring loaded, insuring good contact between the transducers and the surface being tested. Testing is done by lowering the loading plate/mass/seismic detector bar assembly to the pavement surface and then, lifting and dropping the drop weights from the preselected heights. This procedure is accomplished from the inside of the towing vehicle.

This specific FWD system (Dynatest Model 8000 FWD) includes a Hewlett Packard Model 85 Computer. The Model 85 features a cassette tape recording/playback device, a CRT display, and a thermal printer for obtaining hardcopies of data from field testing and keyed-in site identification information. All testing operations are performed from the keyboard of the computer.

The step by step routine test procedure is as follows.

(1) The FWD trailer is towed to the test location and positioned in the desired test location.

(2) The processing equipment and the HP-85 computer which are carried in the towing vehicle are activated.

(3) The mass configuration is selected and secured in place.

(4) A test sequence is identified and programmed from the HP-85 keyboard (site identification, height and number of drops per test point, etc.). When the operator enters a "run" command, the FWD loading plate/buffer/geophone bar assembly is lowered to the pavement surface. The weight is dropped (e.g., four times) from the pre-programmed height and the plate and bar assembly are raised again.

(5) A beep signal indicates that driving to the next test location is allowed. The test sequence described in Step 4 lasts approximately one minute.

(6) The measured set of deflection data (peak values of geophone responses) is displayed on the HP-85 CRT screen for direct visual inspection.

(7) If the operator does not enter a "skip" command within a preprogrammed time, the deflection data together with the peak force magnitude and site identification information are printed in the thermal paper and stored on the HP-85 magnetic tape cassette.

APPENDIX B

SUMMARY OF DATA OBTAINED IN THE CONTROLLED SLAB STUDY

APPENDIX B. SUMMARY OF DATA OBTAINED IN THE CONTROLLED SLAB STUDY

Summaries of the data collected at the BRC testing facility are shown in Tables B.1 through B.18 on the following pages. Tables B.1 through B.4 summarize the data collected when the beam with the LVDTs was used. Tables B.5 through B.18 summarize the data collected when the FWD was used. In these tables, a dash means that the corresponding datum was not collected because of rain, equipment failure, or some other reason. The titles of the tables are self explanatory. Details on the testing, including the LVDT and thermocouple locations, as well as the wheel paths and station numbers, are presented in Chapter 3.

TABLE B.1. AMBIENT AND SLAB TEMPERATURES AT BRC SLAB, APRIL 23-25, 1986

Date	Hour	Ambient Temperature (°F)	Thermocouples Temperatures (Average Values) (°F)			Temperature Differential (DT) (°F)
			T Top	T Mid	T Bot	
4/23	0	63	71.6	75.6	77.6	-7.5
4/23	1	62	70.3	74.3	76.6	-7.9
4/23	2	62	69.0	73.1	75.7	-8.4
4/23	3	60	68.0	72.1	74.8	-8.5
4/23	4	58	66.9	71.1	73.9	-8.8
4/23	5	57	66.1	70.1	73.1	-8.8
4/23	6	56	65.4	69.3	72.4	-8.8
4/23	7	58	66.0	68.7	71.7	-7.1
4/23	8	62	69.6	69.2	71.2	-2.0
4/23	9	66	74.4	70.8	71.2	4.0
4/23	10	70	79.6	73.3	71.8	9.8
4/23	11	74	85.1	76.3	72.9	15.3
4/23	12	77	89.9	79.5	74.4	19.4
4/23	13	79	93.7	82.6	76.1	22.0
4/23	14	81	96.0	85.2	78.0	22.5
4/23	15	82	96.6	87.1	79.6	21.3
4/23	16	83	94.9	88.0	81.0	17.4
4/23	17	82	91.5	87.8	81.9	12.0
4/23	18	81	86.8	86.5	82.4	5.5
4/23	19	76	82.8	84.5	82.3	0.6
4/23	20	74	79.8	82.5	81.7	-2.4
4/23	21	71	77.6	80.7	80.9	-4.1
4/23	22	68	75.4	79.1	80.0	-5.8
4/23	23	65	73.6	77.5	79.1	-6.9
4/24	0	64	72.1	76.0	78.1	-7.5
4/24	1	64	72.0	74.9	77.1	-6.4
4/24	2	63	71.4	74.3	76.3	-6.1
4/24	3	63	70.9	73.7	75.6	-5.9
4/24	4	62	70.4	73.1	75.0	-5.8
4/24	5	62	70.0	72.5	74.5	-5.6
4/24	6	62	69.7	72.1	74.0	-5.4
4/24	7	63	69.9	71.7	73.5	-4.5
4/24	8	65	71.5	71.9	73.2	-2.1
4/24	9	67	73.7	72.5	73.1	0.8
4/24	10	70	76.5	73.6	73.3	4.0
4/24	11	72	83.8	76.2	73.9	12.4
4/24	12	75	89.8	79.5	75.0	18.5

(continued)

TABLE B.1. (CONTINUED)

Date	Hour	Ambient Temperature (°F)	Thermocouples Temperatures (Average Values) (°F)			Temperature Differential (DT) (°F)
			T Top	T Mid	T Bot	
4/24	13	78	94.0	82.9	76.7	21.6
4/24	14	80	96.9	85.7	78.5	23.0
4/24	15	82	97.5	87.9	80.3	21.5
4/24	16	82	96.3	88.9	81.8	18.1
4/24	17	81	92.8	88.9	82.8	12.5
4/24	18	80	88.0	87.6	83.3	5.9
4/24	19	77	84.1	85.6	83.2	1.1
4/24	20	74	81.0	83.6	82.7	-2.1
4/24	21	72	78.6	81.8	81.9	-4.1
4/24	22	69	76.6	80.1	81.0	-5.5
4/24	23	67	74.8	78.5	80.1	-6.6
4/25	0	65	73.1	77.1	79.1	-7.5
4/25	1	64	71.7	75.8	78.1	-8.0
4/25	2	62	70.3	74.5	77.1	-8.5
4/25	3	61	69.2	73.4	76.2	-8.8
4/25	4	61	68.7	72.5	75.3	-8.3
4/25	5	60	68.1	71.8	74.7	-8.3
4/25	6	60	67.6	71.0	73.9	-7.9
4/25	7	61	68.0	70.6	73.2	-6.5
4/25	8	62	69.6	70.7	72.8	-4.0
4/25	9	66	75.4	72.0	72.6	3.5
4/25	10	69	77.9	73.9	73.1	6.0
4/25	11	73	84.5	76.2	74.0	13.1
4/25	12	76	89.8	79.9	75.3	18.1
4/25	13	76	91.3	82.2	76.9	18.0
4/25	14	78	94.9	84.6	78.4	20.6
4/25	15	80	97.0	87.0	80.0	21.3
4/25	16	81	95.5	88.2	81.4	17.6
4/25	17	81	92.1	88.3	82.5	12.0
4/25	18	80	87.4	87.0	83.0	5.5
4/25	19	78	83.7	85.1	82.9	1.0
4/25	20	76	81.2	83.3	82.5	-1.6
4/25	21	73	79.2	81.8	81.8	-3.3
4/25	22	72	77.6	80.4	81.0	-4.3
4/25	23	70	76.1	79.1	80.2	-5.1
4/26	0	69	75.3	78.0	79.4	-5.1

TABLE B.2. LVDTs READINGS AT BRC SLAB, APRIL 23-25, 1986

Date	Hour	LVDTs Readings (Mils)				
		LVDT 1	LVDT2	LVDT3	LVDT4	LVDT5
4/23	0	78.7	83.8	97.4	93.2	94.5
4/23	1	78.8	84.8	99.2	93.6	96.5
4/23	2	79.1	85.6	100.3	94.7	97.8
4/23	3	79.1	85.8	100.4	94.7	98.1
4/23	4	77.4	85.7	101.2	94.6	99.2
4/23	5	77.4	86.0	101.3	94.8	99.6
4/23	6	77.3	85.9	101.4	95.1	99.9
4/23	7	74.8	83.6	98.0	91.3	95.8
4/23	8	65.5	72.7	85.3	81.4	82.4
4/23	9	56.2	60.9	69.5	70.2	66.5
4/23	10	49.3	50.6	54.1	61.5	52.1
4/23	11	42.8	41.7	40.7	53.4	39.0
4/23	12	39.5	37.1	32.2	49.2	30.2
4/23	13	38.6	35.3	27.7	47.3	25.5
4/23	14	40.4	35.9	26.9	48.7	24.5
4/23	15	43.3	39.3	29.6	51.5	26.9
4/23	16	46.5	43.7	34.9	54.8	31.7
4/23	17	50.2	49.0	44.1	59.2	40.8
4/23	18	55.4	56.2	56.6	66.4	53.3
4/23	19	64.1	68.0	74.4	77.0	70.5
4/23	20	70.0	75.7	86.0	84.7	82.1
4/23	21	74.0	80.9	93.3	90.0	89.6
4/23	22	77.1	85.2	98.7	93.9	95.4
4/23	23	78.8	87.4	102.1	95.0	99.3
4/24	0	79.5	88.7	104.2	97.3	101.7
4/24	1	76.5	86.0	101.5	94.8	99.1
4/24	2	74.6	84.1	99.6	92.2	97.2
4/24	3	72.1	82.0	98.3	88.8	95.7
4/24	4	70.7	80.9	97.7	84.5	95.3
4/24	5	69.5	79.6	96.9	83.3	94.4
4/24	6	68.1	78.6	95.7	81.3	93.2
4/24	7	66.5	77.1	93.6	79.4	90.9
4/24	8	61.2	71.3	87.4	74.2	84.1
4/24	9	56.0	65.2	79.2	68.2	75.6
4/24	10	50.2	57.8	69.3	61.2	65.5
4/24	11	41.6	45.3	50.0	49.7	46.6
4/24	12	35.7	37.2	37.2	42.2	34.2

(continued)

TABLE B.2. (CONTINUED)

		LVDTs Readings (Mils)				
Date	Hour	LVDT 1	LVDT2	LVDT3	LVDT4	LVDT5
4/24	13	35.1	34.3	30.9	40.2	27.9
4/24	14	36.6	35.0	29.4	40.9	26.3
4/24	15	39.8	38.3	31.4	43.4	27.9
4/24	16	42.7	42.2	36.3	45.9	32.3
4/24	17	46.8	48.3	45.8	50.2	41.4
4/24	18	52.6	56.6	59.3	57.9	54.9
4/24	19	61.1	67.9	75.9	68.7	71.2
4/24	20	67.3	76.1	88.2	77.3	83.7
4/24	21	71.6	81.9	96.3	83.5	92.0
4/24	22	74.7	85.7	101.4	87.3	97.3
4/24	23	76.3	88.4	105.3	89.8	101.5
4/25	0	77.4	89.7	107.9	91.6	104.5
4/25	1	77.5	90.1	109.1	91.5	106.0
4/25	2	77.2	90.2	110.3	92.2	107.6
4/25	3	77.3	89.8	110.3	92.0	107.8
4/25	4	77.0	88.8	108.9	90.6	106.4
4/25	5	75.7	88.0	107.7	88.1	105.1
4/25	6	74.6	88.0	106.6	87.4	104.0
4/25	7	69.8	84.9	102.5	82.9	99.7
4/25	8	64.1	78.6	95.7	76.3	92.4
4/25	9	52.3	63.7	76.6	61.9	72.3
4/25	10	45.9	54.7	63.2	54.5	59.6
4/25	11	38.5	44.1	47.1	44.4	43.8
4/25	12	36.7	39.8	37.6	40.1	34.5
4/25	13	36.7	39.9	37.6	40.6	34.2
4/25	14	33.3	37.3	24.2	39.6	30.3
4/25	15	36.3	40.3	24.7	40.7	30.6
4/25	16	39.3	43.5	28.8	43.6	34.8
4/25	17	44.3	50.7	39.3	48.8	45.0
4/25	18	50.2	59.0	52.6	56.1	58.0
4/25	19	58.7	69.5	69.1	66.4	74.0
4/25	20	64.2	76.3	79.2	74.5	84.1
4/25	21	68.5	81.9	86.6	79.1	91.5
4/25	22	69.8	84.0	90.6	81.9	95.5
4/25	23	71.1	86.2	94.0	84.5	98.9
4/26	0	69.9	86.1	94.4	83.0	99.2

TABLE B.3. AMBIENT AND SLAB TEMPERATURES AT BRC SLAB, JULY 19-21, 1986

Date	Hour	Ambient Temperature (°F)	Thermocouples Temperatures (Average Values) (°F)			Temperature Differential (DT) (°F)
			T top	T mid	T bot	
7/19	0	80	90.8	94.3	95.5	-5.9
7/19	1	79	89.0	92.8	94.5	-6.9
7/19	2	78	87.5	91.5	93.5	-7.5
7/19	3	76	86.1	90.2	92.5	-8.0
7/19	4	75	85.0	89.1	91.6	-8.3
7/19	5	74	83.9	88.0	90.7	-8.5
7/19	6	73	82.8	87.0	89.9	-8.9
7/19	7	71	81.9	86.0	89.0	-8.9
7/19	8	75	83.0	85.5	88.3	-6.6
7/19	9	80	86.2	85.8	87.7	-1.9
7/19	10	84	91.2	87.4	87.7	4.4
7/19	11	87	96.9	89.9	88.3	10.8
7/19	12	89	102.6	93.1	89.4	16.5
7/19	13	91	106.7	96.2	90.9	19.8
7/19	14	92	110.6	99.3	92.7	22.4
7/19	15	94	112.9	101.7	94.5	23.0
7/19	16	95	114.5	104.0	96.0	23.1
7/19	17	95	113.7	105.4	97.8	19.9
7/19	18	94	111.2	105.6	98.9	15.4
7/19	19	93	107.3	104.8	99.6	9.6
7/19	20	92	102.9	103.1	99.8	3.9
7/19	21	88	99.1	101.1	99.4	-0.4
7/19	22	86	96.5	99.1	98.6	-2.6
7/19	23	85	94.4	97.4	97.8	-4.3
7/20	0	84	92.8	95.9	96.8	-5.0
7/20	1	81	91.3	94.6	95.8	-5.6
7/20	2	80	89.7	93.3	94.9	-6.5
7/20	3	78	88.2	92.0	94.0	-7.3
7/20	4	77	87.0	90.8	93.1	-7.6
7/20	5	75	86.0	89.8	92.2	-7.8
7/20	6	76	85.1	88.8	91.3	-7.8
7/20	7	76	84.3	88.0	90.6	-7.9
7/20	8	79	85.1	87.4	89.9	-6.0
7/20	9	82	88.2	87.7	89.4	-1.5
7/20	10	86	92.9	89.2	89.3	4.5
7/20	11	90	98.3	91.6	89.8	10.6
7/20	12	92	104.0	94.6	90.8	16.5

(continued)

TABLE B.3. (CONTINUED)

Date	Hour	Ambient Temperature (°F)	Thermocouples Temperatures (Average Values) (°F) T top	T mid	T bot	Temperature Differential (DT) (°F)
7/20	13	94	106.1	97.7	92.4	17.1
7/20	14	94	109.6	100.1	94.0	19.5
7/20	15	95	112.6	102.2	95.5	21.4
7/20	16	96	114.5	104.3	97.1	21.8
7/20	17	96	114.5	105.8	98.5	20.0
7/20	18	95	111.1	106.2	99.7	14.3
7/20	19	94	105.5	104.8	100.3	6.5
7/20	20	92	103.1	102.9	100.3	3.5
7/20	21	89	98.7	100.9	99.7	-1.3
7/20	22	86	96.4	99.1	98.9	-3.1
7/20	23	86	94.6	97.5	98.1	-4.4
7/21	0	85	93.0	96.2	97.1	-5.1
7/21	1	83	91.3	94.8	96.2	-6.1
7/21	2	81	89.8	93.5	95.3	-6.9
7/21	3	80	88.6	92.3	94.4	-7.3
7/21	4	78	87.4	91.2	93.5	-7.6
7/21	5	77	86.4	90.2	92.6	-7.8
7/21	6	76	85.4	89.2	91.8	-8.0
7/21	7	76	84.6	88.3	91.0	-8.0
7/21	8	78	85.4	87.7	90.3	-6.1
7/21	9	81	88.3	88.1	89.8	-1.9
7/21	10	85	92.9	89.4	89.7	4.0
7/21	11	89	98.3	91.8	90.2	10.1
7/21	12	92	104.0	94.7	91.2	16.0
7/21	13	93	106.8	97.8	92.6	17.8
7/21	14	94	112.0	100.5	94.3	22.1
7/21	15	95	114.7	103.4	96.1	23.3
7/21	16	96	114.6	105.0	97.7	21.1
7/21	17	95	113.0	106.0	99.1	17.4
7/21	18	94	110.8	106.0	100.1	13.4
7/21	19	92	105.8	105.0	100.6	6.5
7/21	20	90	101.7	103.0	100.5	1.5
7/21	21	90	98.4	100.9	100.0	-2.0
7/21	22	86	96.2	99.1	99.1	-3.6
7/21	23	86	94.5	97.5	98.2	-4.6
7/22	0	82	92.6	96.1	97.3	-5.9

TABLE B.4. LVDTs READINGS AT BRC SLAB, JULY 19-21, 1986

Date	Hour	LVDTs Readings (Mils)				
		LVDT 1	LVDT2	LVDT3	LVDT4	LVDT5
7/19	0	66.3	75.3	97.3	74.2	107.3
7/19	1	66.1	76.2	100.8	75.5	112.8
7/19	2	66.9	77.5	102.9	77.1	115.1
7/19	3	67.6	78.5	104.4	78.3	117.4
7/19	4	68.0	79.0	105.4	78.9	118.9
7/19	5	68.0	79.3	106.1	79.3	119.2
7/19	6	67.8	79.6	107.2	79.4	117.1
7/19	7	68.8	80.5	107.8	80.3	120.4
7/19	8	63.7	75.3	102.8	76.2	113.5
7/19	9	53.8	63.7	89.4	65.4	96.9
7/19	10	40.3	47.5	68.3	51.0	76.3
7/19	11	27.6	31.1	46.9	37.2	54.8
7/19	12	18.8	19.0	28.6	26.8	38.7
7/19	13	13.6	12.6	19.4	21.1	29.4
7/19	14	12.1	10.5	13.7	18.1	23.4
7/19	15	13.6	11.2	12.5	18.5	21.7
7/19	16	15.0	13.3	13.3	19.5	20.6
7/19	17	18.9	17.8	17.7	22.4	23.9
7/19	18	24.0	25.2	27.8	27.0	35.1
7/19	19	30.4	34.2	41.5	34.1	48.7
7/19	20	40.3	46.5	59.4	45.1	67.3
7/19	21	53.2	60.8	76.8	58.2	85.2
7/19	22	61.2	69.3	86.6	66.7	95.7
7/19	23	62.9	72.3	92.6	69.8	104.8
7/20	0	66.0	75.5	96.3	73.1	107.6
7/20	1	70.2	79.5	99.7	77.2	111.2
7/20	2	69.9	80.1	102.6	77.9	114.2
7/20	3	71.8	82.3	105.2	80.1	117.6
7/20	4	73.1	83.6	106.8	81.4	119.2
7/20	5	74.3	84.7	107.7	82.5	119.6
7/20	6	73.8	84.4	107.8	82.5	119.6
7/20	7	73.0	83.8	107.4	81.9	119.0
7/20	8	68.4	79.2	103.3	78.2	113.7
7/20	9	57.9	67.4	89.5	67.3	97.1
7/20	10	44.9	51.5	69.4	53.6	78.2
7/20	11	32.8	36.4	48.8	40.5	59.4
7/20	12	21.2	22.1	30.3	28.3	41.0

(continued)

TABLE B.4. (CONTINUED)

Date	Hour	LVDTs Readings (Mils)				
		LVDT 1	LVDT2	LVDT3	LVDT4	LVDT5
7/20	13	19.3	19.4	25.6	25.1	35.9
7/20	14	18.4	18.3	21.2	22.8	30.3
7/20	15	17.1	16.4	17.4	21.0	26.7
7/20	16	19.9	19.3	18.0	22.7	27.0
7/20	17	23.2	22.5	20.5	25.1	28.7
7/20	18	29.2	31.3	32.7	30.5	39.7
7/20	19	39.8	44.7	53.0	42.4	60.9
7/20	20	48.9	55.6	68.1	52.6	76.9
7/20	21	59.4	67.4	82.5	63.3	91.8
7/20	22	65.3	73.9	90.8	69.9	101.0
7/20	23	66.9	76.3	95.2	72.7	105.6
7/21	0	69.0	78.8	98.9	75.4	111.0
7/21	1	71.4	81.9	103.1	78.3	115.2
7/21	2	73.5	84.0	105.3	80.8	117.7
7/21	3	74.7	85.3	107.1	82.1	120.0
7/21	4	75.5	86.2	108.2	83.0	121.1
7/21	5	75.7	86.6	108.9	83.4	122.5
7/21	6	75.9	86.9	109.2	83.7	124.2
7/21	7	75.7	86.9	109.4	83.9	125.4
7/21	8	71.7	82.6	105.0	80.3	119.0
7/21	9	61.6	71.6	92.4	69.9	104.2
7/21	10	48.5	56.0	72.6	56.5	83.7
7/21	11	36.1	40.3	51.6	43.0	63.3
7/21	12	24.5	25.8	32.5	30.7	44.3
7/21	13	21.1	21.6	26.2	26.6	38.5
7/21	14	16.6	15.8	16.9	20.9	28.7
7/21	15	18.9	17.7	15.4	21.6	26.6
7/21	16	23.9	21.5	19.0	24.1	29.4
7/21	17	28.6	27.7	26.2	28.2	36.1
7/21	18	33.0	33.7	35.1	33.1	45.2
7/21	19	43.3	47.4	54.8	44.2	65.4
7/21	20	54.2	60.6	72.9	56.3	83.8
7/21	21	63.0	70.9	87.1	65.7	98.7
7/21	22	69.0	77.2	94.2	72.1	107.4
7/21	23	71.4	80.1	98.5	75.3	112.0
7/22	0	74.4	83.3	102.8	78.6	116.3

TABLE B.5. WHEEL PATH: SIDE OF THE BRC SLAB WITHOUT VOID, MAY 22, 1986

Time (Hr:mi)	Relat Humid (%)	Metereol Station Air Temp (°F)	Wind Speed (Mph)	Solar Radiation (Btu/ft2)	Slab Surface Temp (°F)	Thermocouples Temps (Average Values) (°F)			Temps at Surf & Bottom of the Slab (°F)		Temp Diff (DT) (°F)
						T Top	T Mid	T Bot	T Surf	T Bott	
8:30		68	--	--	--	71.8	72.5	74.2	71.5	74.5	-3.0
9:00	--										
9:30		70	--	--	--	74.6	73.1	74.0	74.7	73.9	0.8
10:30		74	--	--	--	78.0	74.7	74.2	80.7	73.5	7.2
11:30		76	--	--	--	85.4	77.7	74.9	86.7	73.6	13.1
12:00	--										
12:30		79	--	--	--	90.4	80.7	76.2	92.1	74.5	17.6
13:30		81	--	--	--	94.8	83.9	77.9	97.0	75.7	21.3
14:30		82	--	--	--	98.0	86.8	79.7	100.3	77.4	22.9
15:00	--										
15:30		84	--	--	--	99.9	89.3	81.6	102.2	79.3	22.9
16:30		84	--	--	--	100.1	91.0	83.3	102.2	81.2	21.0

TABLE B.6. FWD DATA. WHEEL PATH: SIDE OF THE BRC SLAB WITHOUT VOID, MAY 22, 1986

Time	Joint Condition	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	O:Open, C:Closed	Station Number	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30	C	1	69	16072	18.4	23.5	12.4	9.9	7.6	5.7	4.1
		0	69	16480	15.0	19.0	15.3	11.9	9.0	6.7	4.9
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--
9:30	C	1	72	15880	15.7	19.7	10.8	8.7	6.6	5.1	3.7
		0	72	16424	13.0	16.5	13.3	10.5	8.0	6.0	4.4
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--
10:30	C	1	77	16232	13.5	16.9	9.0	7.1	5.4	4.1	3.1
		0	77	16472	10.4	13.1	10.8	8.4	6.3	4.8	3.5
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--
11:30	C	1	80	16704	11.6	14.4	8.3	6.5	5.0	3.8	2.9
		0	80	16568	9.2	11.6	9.4	7.3	5.6	4.3	3.2
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--
12:30	C	1	83	16568	10.2	12.3	7.8	6.2	4.8	3.7	2.8
		0	83	16640	8.3	10.6	8.6	6.8	5.2	4.0	3.0
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--
13:30	C	1	86	16416	9.5	11.7	7.5	6.1	4.5	3.6	2.7
		0	86	15896	7.8	10.7	8.6	6.6	5.1	3.9	3.0
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--
14:30	C	1	87	16744	8.9	11.9	7.3	5.8	4.5	3.5	2.6
		0	87	16472	7.6	9.8	8.1	6.3	4.9	3.7	2.8
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--
15:30	C	1	87	16168	8.6	10.7	10.4	5.7	4.4	3.4	2.6
		0	87	16592	8.7	9.6	7.9	6.3	4.8	3.7	2.8
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--
16:30	C	1	89	16288	9.3	11.2	7.6	6.0	4.6	3.5	2.6
		0	89	16520	7.9	10.0	8.1	6.5	4.9	3.8	2.9
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--

TABLE B.7. WHEEL PATH: SIDE OF THE BRC SLAB WITHOUT VOID, JUNE 24, 1986

Time (Hr:mi)	Relat Humid (%)	Metereol Station Air Temp (°F)	Wind Speed (Mph)	Solar Radiation (Btu/ft2)	Slab Surface Temp (°F)	Thermocouples Temps (Average Values) (°F)			Temps at Surf & Bottom of the Slab (°F)		Temp Diff (DT) (°F)
						T Top	T Mid	T Bot	T Surf	T Bott	
8:30		77	0	81	81	83	84	86	83	86	-3
9:00	80										
9:30		78	0	100	82	86	85	86	86	86	0
10:30		81	0	245	94	90	86	86	90	86	4
11:30		85	5	281	104	96	89	87	97	86	11
12:00	52										
12:30		85	5	297	112	101	92	88	103	86	17
13:30		87	10	263	114	106	95	89	108	87	21
14:30		86	10	299	107	106	97	91	108	89	19
15:00	40										
15:30		88	10	235	114	108	99	92	110	90	20
16:30		89	6	225	104	108	100	94	110	92	18

TABLE B.8. FWD DATA. WHEEL PATH: SIDE OF THE BRC SLAB WITHOUT VOID, JUNE 24, 1986

Time	Joint Condition	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	O:Open, C:Closed	Station Number	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30	C	1	84	15456	19.4	24.1	13.4	10.6	8.1	6.1	4.3
		0	85	15888	15.9	20.4	16.5	13.0	9.6	7.2	5.1
	O	3	86	15624	27.1	31.7	14.0	11.2	8.4	6.3	4.5
		2	86	15896	20.0	24.8	19.8	15.4	11.4	8.5	5.9
9:30	C	1	83	15448	18.7	22.6	12.6	9.9	7.6	5.7	4.1
		0	84	15744	15.3	19.5	15.7	12.3	9.1	6.9	4.9
	O	3	87	15552	24.5	30.1	13.1	10.4	8.0	6.1	4.3
		2	87	15720	19.2	23.4	19.0	14.6	11.0	8.2	5.7
10:30	C	1	90	15640	15.9	19.9	10.9	8.6	6.5	4.9	3.4
		0	93	15672	12.3	16.6	13.4	10.4	7.8	5.8	4.1
	O	3	87	15256	21.9	26.5	11.4	9.0	6.8	5.2	3.7
		2	87	15520	16.1	20.4	16.4	12.7	9.4	7.0	4.9
11:30	C	1	87	16016	12.6	15.8	8.6	6.8	5.2	4.0	2.9
		0	86	15816	9.4	13.1	10.4	8.2	6.1	4.7	3.4
	O	3	89	15512	17.3	20.9	9.0	7.2	5.4	4.1	3.0
		2	88	15584	12.4	16.4	13.0	9.9	7.3	5.4	3.8
12:30	C	1	87	16144	11.0	13.9	7.7	6.1	4.7	3.7	2.6
		0	88	15984	8.1	11.5	9.2	7.2	5.4	4.2	3.1
	O	3	87	15696	14.9	19.5	8.1	6.4	4.9	3.7	2.7
		2	87	15672	10.8	14.6	11.4	8.7	6.4	4.8	3.4
13:30	C	1	88	16328	10.3	12.9	7.4	5.8	4.5	3.5	2.6
		0	89	15760	7.7	11.0	9.2	6.9	5.2	4.0	3.0
	O	3	89	15920	13.3	17.0	7.3	5.7	4.2	3.3	2.4
		2	88	15984	9.2	12.4	9.8	7.6	5.7	4.3	3.0
14:30	C	1	89	16336	10.8	13.5	7.7	6.0	4.7	3.6	2.7
		0	89	15648	8.1	11.6	9.2	7.1	5.3	4.1	3.0
	O	3	89	15864	13.9	17.8	7.9	6.2	4.7	3.6	2.6
		2	89	15400	9.8	13.7	10.7	8.1	6.0	4.4	3.2
15:30	C	1	89	16344	10.5	13.4	7.6	6.0	4.6	3.6	2.6
		0	89	15784	7.8	10.9	8.9	6.9	5.2	4.0	3.0
	O	3	89	15832	14.5	19.1	7.8	6.1	4.6	3.5	2.6
		2	89	15552	10.1	13.6	10.6	8.1	6.0	4.5	3.2
16:30	C	1	91	16120	10.6	13.3	8.0	6.3	4.8	3.7	2.8
		0	89	15688	8.4	12.1	9.4	7.4	5.6	4.3	3.1
	O	3	89	15728	15.2	19.7	8.6	6.9	5.3	3.9	2.8
		2	89	15360	11.2	15.5	11.9	9.2	6.7	5.0	3.5

TABLE B.9. WHEEL PATH: SIDE OF THE BRC SLAB WITH VOID, JUNE 25, 1986

Time (Hr:mi)	Relat Humid (%)	Metereol Station Air Temp (°F)	Wind Speed (Mph)	Solar Radiation (Btu/ft2)	Slab Surface Temp (°F)	Thermocouples Temps (Average Values) (°F)			Temps at Surf & Bottom of the Slab (°F)		Temp Diff (DT) (°F)
						T Top	T Mid	T Bot	T Surf	T Bott	
8:30		76	5	78	73	83	84	86	83	86	-3
9:00	76										
9:30		80	5	150	83	86	85	86	86	86	0
10:30		85	5	211	93	91	87	86	92	85	7
11:30		86	5	240	97	97	89	87	98	86	12
12:00	48										
12:30		86	12	254	100	101	92	88	103	86	17
13:30		86	10	200	92	102	95	90	104	88	16
14:30		88	6	226	102	104	96	91	106	89	17
15:00	45										
15:30		87	11	231	102	106	98	92	108	90	18
16:30		88	11	207	106	108	100	93	110	91	19

TABLE B.10. FWD DATA. WHEEL PATH: SIDE OF THE BRC SLAB WITH VOID, JUNE 25, 1986

Time	Joint Condition	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	O:Open, C:Closed	Station Number	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30	C	1	82	15552	20.9	22.7	16.4	13.3	10.3	7.7	5.5
		0	81	15648	17.0	21.7	17.7	14.0	10.5	7.9	5.5
	O	3	82	15424	30.3	30.6	17.6	13.7	10.2	7.5	5.3
		2	82	15672	19.1	26.5	20.6	15.7	12.0	8.8	6.0
9:30	C	1	87	15728	19.7	21.7	14.6	11.7	9.1	7.0	4.9
		0	87	15400	15.0	20.3	16.4	12.9	9.6	7.2	5.1
	O	3	88	15520	24.5	26.8	20.5	12.7	9.5	7.4	5.3
		2	89	15448	18.5	23.4	18.9	15.0	11.1	8.3	5.7
10:30	C	1	89	15992	15.9	18.2	12.3	9.9	7.6	6.0	4.2
		0	90	15464	12.4	19.5	14.9	11.6	8.8	6.6	4.7
	O	3	88	15680	19.3	22.9	13.3	11.6	8.1	6.3	4.5
		2	86	15248	14.8	21.7	17.8	13.8	10.3	7.7	5.3
11:30	C	1	87	15752	12.0	14.6	9.5	7.5	5.7	4.5	3.2
		0	86	15304	9.7	15.7	12.8	10.0	7.4	5.6	3.9
	O	3	87	15624	14.3	18.2	10.3	8.3	6.4	4.9	3.5
		2	86	15368	11.6	18.9	15.2	11.7	8.6	6.5	4.4
12:30	C	1	86	15776	10.8	13.1	8.5	6.8	5.2	4.1	3.0
		0	88	15440	8.7	14.6	11.9	9.2	6.8	5.2	3.6
	O	3	87	15808	12.8	16.2	9.2	7.3	5.5	4.3	3.0
		2	88	15232	9.9	17.0	13.8	10.7	7.7	5.6	4.0
13:30	C	1	87	15664	10.6	13.1	8.2	6.5	5.0	3.8	2.8
		0	87	15472	8.6	14.3	11.5	9.0	6.6	4.9	3.6
	O	3	88	15680	13.3	17.8	9.3	7.4	5.7	4.3	3.1
		2	89	15960	10.5	17.1	14.0	10.5	7.6	5.6	3.9
14:30	C	1	89	15840	10.1	12.2	8.1	6.4	4.9	3.8	2.8
		0	86	15408	8.5	14.7	11.6	9.0	6.6	4.9	3.5
	O	3	88	15624	13.4	16.6	9.1	7.2	5.5	4.2	3.0
		2	89	15320	10.2	16.6	14.7	10.3	7.4	5.3	3.8
15:30	C	1	89	15656	10.6	13.3	8.1	6.5	5.0	3.7	2.8
		0	90	15504	8.2	14.1	11.4	8.7	6.4	4.7	3.4
	O	3	90	15784	12.4	15.9	8.6	6.9	5.2	3.9	2.9
		2	91	15320	9.8	16.0	12.7	9.6	7.0	5.1	3.6
16:30	C	1	90	15920	10.0	12.0	7.9	6.3	4.8	3.7	2.7
		0	89	15352	8.0	13.5	10.9	8.4	6.2	4.5	3.3
	O	3	89	15720	12.6	15.8	8.5	6.8	5.2	3.9	2.8
		2	89	15384	10.0	17.4	12.6	9.6	7.0	5.1	3.6

TABLE B.11. WHEEL PATH: SIDE OF THE BRC SLAB WITH VOID, JUNE 26, 1986

Time (Hr:mi)	Relat Humid (%)	Metereol Station Air Temp (°F)	Wind Speed (Mph)	Solar Radiation (Btu/ft2)	Slab Surface Temp (°F)	Thermocouples Temps (Average Values) (°F)			Temps at Surf & Bottom of the Slab (°F)		Temp Diff (DT) (°F)
						T Top	T Mid	T Bot	T Surf	T Bott	
8:30		78	2	47	76	84	85	87	84	87	-3
9:00	74										
9:30		80	3	77	78	85	85	86	85	86	-1
10:30		82	2	181	82	88	86	86	88	86	2
11:30		86	5	216	98	95	88	87	96	86	10
12:00	51										
12:30		86	6	164	96	98	91	88	99	87	12
13:30		87	5	173	100	99	93	89	100	88	12
14:30		89	2	244	108	102	94	90	104	88	16
15:00	44										
15:30		89	8	221	112	106	97	91	108	89	19
16:30		90	11	216	110	107	99	93	109	91	18

TABLE B.12. FWD DATA. WHEEL PATH: SIDE OF THE BRC SLAB WITH VOID, JUNE 26, 1986

Time	Joint Condition	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	O:Open, C:Closed	Station Number	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30	C	1	81	15440	19.9	23.5	15.9	11.9	9.1	6.9	4.9
		0	81	15672	15.4	20.8	16.9	13.6	9.9	7.3	5.2
	O	3	80	15368	24.0	28.2	16.1	12.0	9.3	6.8	4.9
		2	80	15592	18.2	24.1	20.0	15.0	11.1	8.2	5.7
9:30	C	1	82	15232	18.6	22.2	14.1	11.2	8.6	6.4	4.7
		0	83	15520	14.4	20.2	16.8	13.0	9.6	7.1	5.1
	O	3	83	15272	23.6	28.3	15.2	11.9	9.0	7.2	4.9
		2	85	15472	17.4	23.7	19.3	15.1	11.1	8.1	5.7
10:30	C	1	85	15224	17.4	20.5	13.3	10.6	8.1	6.1	4.4
		0	86	15432	13.5	19.6	15.9	12.5	9.2	6.8	4.9
	O	3	87	15008	22.3	26.8	14.6	11.5	8.6	6.6	4.7
		2	87	15368	16.1	23.2	18.8	14.5	10.8	7.8	5.5
11:30	C	1	92	15688	13.7	16.2	10.7	8.4	6.4	4.9	3.5
		0	93	15304	10.5	17.3	13.7	10.6	7.8	5.8	4.1
	O	3	92	15280	16.5	20.6	11.6	9.3	7.1	5.3	3.8
		2	92	15376	12.8	20.8	16.3	12.5	9.2	6.7	4.7
12:30	C	1	93	15664	12.7	15.4	9.6	7.6	5.8	4.4	3.2
		0	93	15336	9.9	16.1	12.8	9.9	7.3	5.3	3.9
	O	3	92	15384	15.4	19.2	10.8	8.5	6.6	4.9	3.6
		2	93	15328	11.9	19.0	15.2	11.8	8.6	6.2	4.4
13:30	C	1	94	15776	11.8	14.4	9.2	7.3	5.5	4.2	3.1
		0	93	15328	9.6	15.6	12.6	9.5	7.0	5.1	3.7
	O	3	92	15512	14.7	18.4	10.4	9.7	6.3	4.7	3.4
		2	93	15384	11.7	18.8	14.9	11.4	8.3	5.9	4.2
14:30	C	1	93	15768	10.9	13.4	8.4	6.7	5.2	3.9	2.8
		0	95	15272	8.3	14.4	11.2	8.8	6.4	4.7	3.4
	O	3	94	15824	13.2	16.6	8.8	7.0	5.3	4.0	2.8
		2	97	15400	9.6	17.2	12.7	9.7	6.9	5.1	3.6
15:30	C	1	96	15944	9.8	12.0	7.8	6.2	4.7	3.7	2.8
		0	97	15432	7.7	13.4	10.5	8.2	5.9	4.5	3.2
	O	3	97	15800	11.9	15.1	8.3	6.6	5.0	3.8	2.8
		2	96	15504	9.4	15.6	12.3	9.3	6.8	4.9	3.4
16:30	C	1	94	15920	9.7	12.1	7.6	6.1	4.7	3.5	2.6
		0	94	15488	7.7	12.5	10.1	7.8	5.8	4.3	3.1
	O	3	95	15880	11.9	15.2	8.3	6.5	4.9	3.7	2.8
		2	95	15544	9.2	15.2	12.0	9.0	6.5	4.7	3.4

TABLE B.13. WHEEL PATH: SIDE OF THE BRC SLAB WITHOUT VOID, AUGUST 5, 1986

Time (Hr:mi)	Relat Humid (%)	Metereol Station Air Temp (°F)	Wind Speed (Mph)	Solar Radiation (Btu/ft2)	Slab Surface Temp (°F)	Thermocouples Temps (Average Values) (°F)			Temps at Surf & Bottom of the Slab (°F)		Temp Diff (DT) (°F)
						T Top	T Mid	T Bot	T Surf	T Bott	
8:30		--	--	--	--	--	--	--	--	--	--
9:00	80										
9:30		78	5	159	91	89.1	87.4	88.9	89.1	88.9	0.2
10:30		81	7	200	94	93.2	89.2	89.1	93.7	88.6	5.1
11:30		84	5	254	104	98.1	91.5	89.8	99.1	88.8	10.3
12:00	43										
12:30		87	7	296	106	103.3	94.5	90.9	104.9	89.4	15.5
13:30		89	4	313	112	108.2	97.6	92.4	110.2	90.4	19.8
14:30		90	12	216	118	110.3	100.6	94.1	112.3	92.1	20.2
15:00	43										
15:30		--	--	--	--	--	--	--	--	--	--
16:30		--	--	--	--	--	--	--	--	--	--

TABLE B.14. FWD DATA. WHEEL PATH: SIDE OF THE BRC SLAB WITHOUT VOID, AUGUST 5, 1986

Time	Joint Condition	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	O:Open, C:Closed	Station Number	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30	C	1	--	--	--	--	--	--	--	--	--
		0	--	--	--	--	--	--	--	--	--
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--
9:30	C	1	82	15720	17.6	21.2	12.8	10.2	7.7	5.8	4.1
		0	81	15688	15.7	18.8	15.5	11.9	8.8	6.6	4.7
	O	3	81	15432	26.0	30.1	13.8	10.9	8.4	6.3	4.7
		2	82	15936	20.8	24.4	20.0	15.3	11.4	8.4	5.8
10:30	C	1	86	15736	13.4	16.7	10.0	7.7	5.8	4.4	3.2
		0	87	15824	10.7	14.9	11.6	9.0	6.6	5.1	3.7
	O	3	86	15616	20.3	25.2	11.1	8.8	6.7	5.0	3.6
		2	87	15568	15.6	20.1	16.0	12.3	9.1	6.6	4.6
11:30	C	1	89	16264	11.7	14.6	8.4	6.6	5.0	3.8	2.8
		0	90	15768	8.8	12.4	9.7	7.5	5.6	4.2	3.1
	O	3	92	15312	17.5	22.4	9.2	7.2	5.4	4.1	2.9
		2	90	15648	12.8	16.5	13.1	9.9	7.2	5.2	3.7
12:30	C	1	93	16616	11.4	14.0	7.6	6.1	4.6	3.5	2.5
		0	91	15656	8.2	12.4	9.3	7.1	5.3	4.0	3.0
	O	3	92	16048	16.5	20.5	7.9	6.3	4.6	3.5	2.5
		2	92	15768	11.2	15.4	11.4	8.6	6.2	4.5	3.2
13:30	C	1	92	16504	10.6	12.9	7.3	5.8	4.4	3.4	2.6
		0	94	15744	7.7	11.5	8.6	6.7	5.0	3.7	2.8
	O	3	95	16176	14.5	18.4	6.9	5.4	4.1	3.2	2.2
		2	94	15640	9.6	13.5	10.0	7.6	5.5	4.0	3.0
14:30	C	1	93	16256	10.3	12.9	7.4	5.8	4.4	3.4	2.5
		0	92	15800	7.8	10.7	8.4	6.7	5.0	3.8	2.8
	O	3	96	16040	14.5	18.5	7.2	5.7	4.3	3.2	2.4
		2	94	15680	10.1	12.8	9.9	7.5	5.5	4.1	3.0
15:30	C	1	--	--	--	--	--	--	--	--	--
		0	--	--	--	--	--	--	--	--	--
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--
16:30	C	1	--	--	--	--	--	--	--	--	--
		0	--	--	--	--	--	--	--	--	--
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--

(continued)

TABLE B.14. (CONTINUED)

Time	Joint Condition	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	O:Open, C:Closed	Station Number	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30	C	4	--	--	--	--	--	--	--	--	--
	O	5	--	--	--	--	--	--	--	--	--
9:30	C	4	82	16168	7.5	8.5	7.7	6.5	5.2	4.1	3.1
	O	5	84	15936	7.5	8.5	7.8	6.5	5.2	4.1	3.1
10:30	C	4	84	16304	6.8	7.6	7.0	6.0	4.8	3.8	2.9
	O	5	86	15992	6.7	7.9	7.1	5.9	4.7	3.7	2.9
11:30	C	4	90	16040	6.9	7.6	7.0	5.9	4.7	3.7	2.8
	O	5	92	16296	6.2	6.9	6.5	5.3	4.2	3.5	2.6
12:30	C	4	93	16272	6.2	6.9	6.4	5.3	4.3	3.4	2.7
	O	5	93	16144	6.3	6.9	6.4	5.3	4.3	3.5	2.7
13:30	C	4	94	16464	6.0	6.7	6.2	5.2	4.2	3.4	2.6
	O	5	96	16320	6.0	6.7	6.3	5.3	4.3	3.4	2.6
14:30	C	4	95	15968	6.2	7.2	6.5	5.4	4.3	3.4	2.7
	O	5	97	16176	6.2	6.8	6.3	5.2	4.2	3.3	2.6
15:30	C	4	--	--	--	--	--	--	--	--	--
	O	5	--	--	--	--	--	--	--	--	--
16:30	C	4	--	--	--	--	--	--	--	--	--
	O	5	--	--	--	--	--	--	--	--	--

TABLE B.15. WHEEL PATH: SIDE OF THE BRC SLAB WITH VOID, AUGUST 8, 1986

Time (Hr:mi)	Relat Humid (%)	Metereol Station Air Temp (°F)	Wind Speed (Mph)	Solar Radiation (Btu/ft2)	Slab Surface Temp (°F)	Thermocouples Temps (Average Values) (°F)			Temps at Surf & Bottom of the Slab (°F)		Temp Diff (DT) (°F)
						T Top	T Mid	T Bot	T Surf	T Bott	
8:30		76	5	42	68	83.2	85.7	87.5	82.7	88.0	-5.3
9:00	84										
9:30		78	8	90	76	86.2	85.9	87.7	86.0	87.9	-1.9
10:30		79	10	141	77	87.6	86.8	87.7	87.6	87.7	-0.1
11:30		84	10	233	103	94.0	88.3	87.9	94.8	87.1	7.7
12:00	55										
12:30		87	10	303	105	100.3	91.3	88.7	101.8	87.3	14.5
13:30		89	11	264	108	105.8	94.9	90.1	107.8	88.1	19.7
14:30		91	7	285	113	108.5	97.7	91.8	110.6	89.7	20.9
15:00	36										
15:30		93	6	299	120	111.7	100.4	93.6	114.0	91.3	22.7
16:30		93	10	--	113	113.1	102.8	95.4	115.3	93.2	22.1

TABLE B.16. FWD DATA. WHEEL PATH: SIDE OF THE BRC SLAB WITH VOID, AUGUST 8, 1986

Time	Joint Condition	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	O:Open, C:Closed	Station Number	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30	C	1	76	15488	23.0	25.8	16.2	12.7	9.9	7.5	5.4
		0	77	15616	16.5	22.6	18.3	14.2	10.6	7.8	5.7
	O	3	76	15344	31.6	41.8	17.5	13.7	10.2	7.8	5.7
		2	76	15440	21.8	27.7	22.3	17.4	12.9	9.6	6.7
9:30	C	1	81	15672	21.4	23.1	14.6	12.0	9.0	6.8	5.0
		0	81	15384	14.3	21.4	17.3	13.1	9.9	7.4	5.3
	O	3	82	15456	26.0	29.7	15.1	12.3	9.6	7.2	5.3
		2	82	15520	19.2	24.8	20.5	15.7	11.9	8.7	6.2
10:30	C	1	82	15712	20.2	24.1	15.1	12.2	8.7	6.5	4.6
		0	83	15640	14.3	22.3	18.0	13.6	9.9	7.4	5.3
	O	3	84	15080	23.1	28.5	13.8	11.0	8.4	6.4	4.7
		2	83	15624	18.6	26.0	20.9	16.0	11.9	8.6	6.0
11:30	C	1	91	15656	14.6	16.2	10.9	8.7	6.6	4.9	3.6
		0	90	15472	11.2	17.8	14.7	11.0	8.1	5.9	4.3
	O	3	89	15304	18.8	26.5	11.2	9.2	6.8	5.1	3.7
		2	90	15472	13.6	20.3	16.6	12.6	9.4	6.7	4.8
12:30	C	1	91	16080	12.5	16.4	9.0	7.2	5.5	4.2	3.1
		0	92	15272	9.2	16.6	13.3	10.0	7.4	5.4	3.9
	O	3	92	15888	14.8	19.2	9.1	7.3	5.5	4.2	3.0
		2	92	15320	11.3	18.6	15.0	11.0	8.1	5.9	4.1
13:30	C	1	95	15992	10.7	12.5	8.1	6.4	4.9	3.7	2.8
		0	93	15272	8.3	14.8	11.9	8.8	6.5	4.9	3.6
	O	3	94	15960	12.5	15.7	8.0	6.3	4.9	3.7	2.7
		2	93	15320	10.0	16.6	13.3	9.9	7.1	5.3	3.8
14:30	C	1	95	16000	9.7	11.5	7.5	6.0	4.5	3.5	2.7
		0	95	15888	7.9	13.1	10.4	8.0	5.8	4.3	3.1
	O	3	95	15864	10.7	13.9	7.2	5.7	4.2	3.2	2.5
		2	94	15504	8.7	14.6	11.5	8.5	6.2	4.5	3.2
15:30	C	1	97	16128	8.9	10.4	7.1	5.6	4.3	3.3	2.5
		0	98	15536	7.0	11.8	10.5	7.1	5.3	4.0	2.9
	O	3	98	15976	9.8	12.8	6.9	5.4	4.1	3.2	2.4
		2	97	15520	8.1	13.2	10.4	8.0	5.7	4.2	3.1
16:30	C	1	98	16016	10.1	12.2	7.5	6.0	4.6	3.5	2.6
		0	98	15248	7.8	13.7	11.1	8.2	6.0	4.5	3.2
	O	3	97	15952	11.9	14.9	7.7	6.1	4.6	3.5	2.6
		2	97	15480	9.6	15.0	12.2	9.0	6.6	4.8	3.4

(continued)

TABLE B.16. (CONTINUED)

Time	Joint Condition	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	O:Open, C:Closed	Station Number	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30	C	4	77	16408	7.4	8.7	8.1	6.7	5.3	4.0	3.0
	O	5	76	16192	7.5	8.5	8.1	6.8	5.2	4.0	3.0
9:30	C	4	79	16280	7.6	9.2	8.1	6.7	5.3	4.1	3.1
	O	5	83	16144	7.8	8.8	8.3	6.9	5.4	4.2	3.1
10:30	C	4	81	15944	6.5	7.4	7.0	6.1	4.8	3.7	2.8
	O	5	84	15792	6.7	7.5	7.1	6.1	4.8	3.7	2.8
11:30	C	4	90	15920	6.5	7.3	6.9	5.9	4.7	3.6	2.7
	O	5	90	15704	6.5	7.5	7.1	6.0	4.8	3.7	2.8
12:30	C	4	92	15880	6.4	7.5	6.8	5.8	4.7	3.5	2.7
	O	5	93	15928	6.7	8.2	7.0	5.9	4.6	3.6	2.8
13:30	C	4	94	15856	5.7	6.5	6.1	5.2	4.0	3.1	2.6
	O	5	94	15912	6.0	6.9	6.4	5.4	4.2	3.2	2.6
14:30	C	4	95	16184	5.8	6.6	6.2	5.3	4.0	3.2	2.4
	O	5	96	15872	5.8	6.9	6.2	5.2	4.0	3.2	2.4
15:30	C	4	97	15864	5.8	6.7	6.1	5.1	4.0	3.1	2.4
	O	5	99	15776	5.8	6.7	6.3	5.3	4.2	3.2	2.4
16:30	C	4	98	15696	5.8	6.9	6.3	5.4	4.2	3.2	2.5
	O	5	95	15696	5.8	7.1	6.4	5.4	4.2	3.3	2.4

TABLE B.17. WHEEL PATH: CENTERLINE OF THE BRC SLAB, AUGUST 12, 1986

Time (Hr:mi)	Relat Humid (%)	Metereol Station Air Temp (°F)	Wind Speed (Mph)	Solar Radiation (Btu/ft2)	Slab Surface Temp (°F)	Thermocouples Temps (Average Values) (°F)			Temps at Surf & Bottom of the Slab (°F)		Temp Diff (DT) (°F)
						T Top	T Mid	T Bot	T Surf	T Bott	
8:30		--	--	--	--	--	--	--	--	--	--
9:00	82										
9:30		79	1	--	88	85.1	83.1	84.5	85.2	84.4	0.8
10:30		80	3	--	92	88.5	85.1	84.8	89.0	84.3	4.7
11:30		82	5	--	100	91.2	86.6	85.5	91.9	84.8	7.1
12:00	65										
12:30		87	7	--	107	97.2	88.7	86.4	98.6	85.1	13.5
13:30		88	7	--	109	100.9	91.7	87.6	102.6	85.9	16.7
14:30		90	5	--	112	105.4	94.4	89.2	107.4	87.2	20.2
15:00	46										
15:30		90	7	--	114	106.2	96.8	90.9	108.1	89.0	19.1
16:30		91	8	--	110	106.7	98.3	92.3	108.5	90.5	18.0

TABLE B.18. FWD DATA. WHEEL PATH: CENTERLINE OF THE BRC SLAB, AUGUST 12, 1986

Time	Joint Condition	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	O:Open, C:Closed	Station Number	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30	C	1	--	--	--	--	--	--	--	--	--
		0	--	--	--	--	--	--	--	--	--
	O	3	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--
9:30	C	1	86	16352	5.4	6.7	5.1	4.2	3.3	2.6	2.0
		0	86	16008	5.1	6.4	5.0	4.0	3.2	2.5	1.9
	O	3	83	16208	7.1	9.3	6.1	4.7	3.7	2.8	2.2
		2	84	15968	6.3	9.0	6.9	5.3	4.0	3.0	2.2
10:30	C	1	83	16648	5.3	6.5	5.0	4.1	3.2	2.5	2.0
		0	83	16040	4.9	6.2	4.8	3.9	3.1	2.5	1.9
	O	3	82	16248	6.5	8.6	5.7	4.5	3.4	2.7	2.1
		2	83	15872	5.8	8.2	6.3	4.8	3.7	2.8	2.1
11:30	C	1	85	16232	5.2	6.3	5.0	4.1	3.2	2.6	2.0
		0	85	16000	4.9	6.0	4.7	3.8	3.0	2.5	1.8
	O	3	89	15936	6.0	7.8	5.4	4.3	3.3	2.6	2.0
		2	88	15840	5.4	7.6	5.9	4.5	3.5	2.7	2.0
12:30	C	1	88	16072	5.3	6.3	4.9	3.9	3.2	2.6	2.0
		0	88	15920	4.9	5.8	4.6	3.7	2.9	2.4	1.9
	O	3	88	15952	5.7	7.5	5.1	4.1	3.2	2.5	1.9
		2	89	15784	5.2	7.1	5.4	4.3	3.3	2.6	2.0
13:30	C	1	95	16224	5.3	6.3	4.9	3.9	3.2	2.5	2.0
		0	92	15776	4.8	6.1	4.6	3.8	3.0	2.4	1.9
	O	3	93	16136	5.5	7.0	4.9	3.9	3.1	2.4	1.9
		2	92	15880	5.0	6.7	5.2	4.1	3.2	2.5	2.0
14:30	C	1	92	15832	5.4	6.2	4.9	3.9	3.2	2.5	2.0
		0	92	15816	4.8	5.6	4.5	3.6	2.9	2.4	2.0
	O	3	91	15808	5.4	6.7	4.9	3.9	3.1	2.4	1.8
		2	93	15824	4.9	6.4	5.0	3.9	3.1	2.5	1.9
15:30	C	1	92	15936	5.3	6.1	4.9	4.0	3.2	2.6	2.0
		0	93	15824	4.9	5.6	4.5	3.7	2.9	2.4	1.9
	O	3	92	15864	5.4	6.8	5.0	4.0	3.1	2.4	1.9
		2	93	15744	5.0	6.4	5.0	4.0	3.2	2.5	1.9
16:30	C	1	91	16104	5.2	6.0	4.8	3.9	3.1	2.5	2.0
		0	90	15848	4.8	5.8	4.5	3.7	2.9	2.4	1.8
	O	3	92	15840	5.4	7.0	5.1	4.1	3.2	2.6	2.0
		2	91	15760	5.1	6.8	5.3	4.2	3.2	2.6	1.9

(continued)

TABLE B.18. (CONTINUED)

Time	Joint Condition	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	O:Open, C:Closed	Station Number	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30	C	4	--	--	--	--	--	--	--	--	--
	O	5	--	--	--	--	--	--	--	--	--
9:30	C	4	84	17168	3.6	4.0	3.6	3.3	2.6	2.2	1.7
	O	5	82	16944	3.5	4.1	3.6	3.1	2.7	2.2	1.8
10:30	C	4	80	16960	3.6	4.1	3.6	3.1	2.6	2.1	1.7
	O	5	84	16832	3.5	4.1	3.6	3.1	2.6	2.2	1.7
11:30	C	4	85	16456	3.6	4.1	3.6	3.1	2.6	2.2	1.8
	O	5	89	16480	3.4	4.0	3.7	3.1	2.6	2.2	1.8
12:30	C	4	91	16720	3.6	4.2	3.7	3.1	2.6	2.3	1.8
	O	5	86	16640	3.7	4.1	3.8	3.2	2.7	2.2	1.8
13:30	C	4	93	16216	3.6	4.1	3.7	3.2	2.7	2.2	1.8
	O	5	92	16536	3.6	4.1	3.7	3.1	2.7	2.2	1.8
14:30	C	4	90	16712	3.6	4.2	3.8	3.2	2.7	2.2	1.9
	O	5	91	16248	3.5	4.1	3.7	3.1	2.7	2.2	1.9
15:30	C	4	91	16896	3.6	4.0	3.7	3.2	2.7	2.3	1.9
	O	5	92	16248	3.5	4.2	3.6	3.1	2.7	2.2	1.8
16:30	C	4	91	16456	3.5	4.2	3.7	3.2	2.7	2.3	1.8
	O	5	93	16480	3.3	4.1	3.8	3.2	2.7	2.2	1.8

APPENDIX C

SUMMARY OF DATA OBTAINED IN THE FIELD TESTING

APPENDIX C. SUMMARY OF DATA OBTAINED IN THE FIELD TESTING

Summaries of the data collected at US 90 near Beaumont are shown in Tables C.1 through C.9 on the following pages. The titles of the tables are self explanatory. Details on the testing, including the slab or testing section, wheel path, and station numbers, are presented in Chapter 4.

TABLE C.1. BEAMOUNT SLAB 1 WHEEL PATHS 1 AND 2, SEPTEMBER 10, 1986

Time	Air Temp	Solar Radiation	Slab Surface Temp (°F)		Thermistors Temps (Average Values) (°F)			Temps at Surf & Bottom of the Slab (°F)		Temp Diff (DT)
(Hr:mi)	(°F)	(Btu/ft2)	Infra Gun	Surf Therm	T Top	T Mid	T Bot	T Surf	T Bott	(°F)
8:00- -9:00	82	68	84	75	80	81	84	79	84	-5
9:00- -10:00	87	126	88	88	87	83	84	88	84	4
10:00- -11:00	91	147	99	97	92	85	84	93	83	10
11:00- -12:00	92	222	100	96	95	87	85	96	84	12
12:00- -13:00		260								
13:00- -14:00	91	250	111	105	105	95	89	107	87	20
14:00- -15:00	97	256	119	117	108	97	91	110	89	21
15:00- -16:00	95	184	120	116	109	99	93	111	91	20
16:00- -17:00	93	56	112	108	107	100	95	109	94	15

TABLE C.2. FWD DATA FROM BEAUMONT SLAB 1 WHEEL PATH 1, SEPTEMBER 10, 1986

Time	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	Station #	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:00- -9:00	0	79	15960	14.9	19.2	12.2	10.1	8.2	7.2	6.0
	1	79	15608	11.8	16.5	14.0	11.8	9.8	8.4	7.1
	2	79	16576	9.9	10.4	10.0	9.2	8.3	7.5	6.5
	3	79	15728	11.4	12.4	11.6	10.3	8.9	8.0	6.8
	4	79	15880	11.6	12.3	11.3	10.1	8.8	7.8	6.6
9:00- -10:00	0	88	15632	12.0	15.5	11.6	9.6	7.7	6.5	5.5
	1	88	15688	11.4	13.2	11.4	9.4	7.7	6.6	5.5
	2	86	16184	8.1	8.5	8.2	7.6	6.9	6.3	5.5
	3	86	15640	8.8	9.5	9.0	7.7	6.6	6.4	4.9
	4	84	15560	9.0	9.5	8.7	7.8	6.9	6.0	5.2
10:00- -11:00	0	91	15464	11.3	14.5	11.2	9.4	7.6	6.5	5.4
	1	90	15384	11.1	12.9	11.1	9.1	7.4	6.3	5.3
	2	90	16080	7.3	7.6	7.3	6.7	6.0	5.5	4.9
	3	88	15608	7.9	8.6	8.1	7.1	6.1	5.3	4.6
	4	88	15680	8.2	8.4	7.9	7.0	6.1	5.5	4.7
11:00- -12:00	0	90	15408	9.8	12.7	10.2	8.5	7.0	6.0	5.1
	1	90	15672	10.1	11.6	9.9	8.4	7.0	6.0	5.1
	2	89	15808	7.4	7.8	7.4	6.8	6.1	5.5	4.9
	3	89	15720	7.6	8.1	7.8	6.9	5.9	5.3	4.6
	4	88	15672	7.8	8.2	7.6	6.7	5.9	5.2	4.6
13:00- -14:00	0	94	15952	8.3	11.0	8.3	7.3	6.4	5.7	5.0
	1	95	15784	8.1	9.8	8.7	7.5	6.4	5.7	4.9
	2	94	15800	7.6	7.8	7.5	6.7	5.9	5.5	5.0
	3	93	15720	7.5	8.1	7.5	6.7	5.8	5.6	5.0
	4	93	15608	7.6	7.9	7.3	6.5	5.8	5.3	4.5
14:00- -15:00	0	97	15736	8.0	10.5	7.9	7.0	6.0	5.4	4.7
	1	97	15720	8.0	9.4	8.4	7.3	6.3	5.6	4.9
	2	96	16072	6.9	7.3	6.9	6.3	5.7	5.2	4.7
	3	93	15720	7.4	7.8	7.4	6.6	5.7	5.2	4.5
	4	91	15560	7.3	7.8	7.3	6.5	5.8	5.2	4.6
15:00- -16:00	0	94	15648	8.2	10.3	7.8	7.0	6.1	5.4	4.8
	1	95	15800	8.0	9.1	8.2	7.1	6.1	5.5	4.8
	2	94	15648	6.9	7.3	6.9	6.3	5.7	5.2	4.7
	3	92	15728	7.7	8.3	7.8	7.1	6.2	5.5	4.7
	4	92	15728	7.6	8.2	7.6	6.7	6.0	5.3	4.6
16:00- -17:00	0	94	15696	7.9	10.2	7.9	6.9	6.0	5.4	4.7
	1	94	15712	7.8	8.8	7.9	6.9	5.9	5.3	4.6
	2	93	15904	6.7	7.0	6.7	6.1	5.4	5.2	4.5
	3	92	15656	7.2	7.7	7.3	6.6	5.7	5.1	4.5
	4	92	15768	7.4	7.9	7.5	6.7	5.8	5.1	4.5

TABLE C.3. FWD DATA FROM BEAUMONT SLAB 1 WHEEL PATH 2, SEPTEMBER 10, 1986

Time	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	Station #	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:00- -9:00	0	80	15880	6.8	11.0	6.6	5.5	4.6	3.9	3.2
	1	80	16136	6.7	8.9	6.9	5.7	4.6	4.3	3.4
	2	80	16744	4.4	4.6	4.4	4.0	3.6	3.4	3.0
	3	80	16288	4.4	4.7	4.4	4.0	3.7	3.5	3.1
	4	79	16688	4.6	4.7	4.5	4.1	3.7	3.3	3.0
9:00- -10:00	0	86	15816	6.6	9.2	6.3	5.2	4.4	3.7	2.9
	1	86	15744	6.6	9.6	6.6	5.3	4.4	4.0	3.3
	2	86	16312	4.3	4.5	4.3	4.0	3.5	3.2	2.8
	3	86	15976	4.4	4.5	4.3	3.8	3.3	3.3	3.0
	4	86	16520	4.3	4.6	4.3	3.9	3.5	3.2	2.8
10:00- -11:00	0	89	15624	6.5	9.4	6.4	5.2	4.4	4.1	3.9
	1	89	15608	6.3	9.0	6.4	5.2	4.6	4.1	3.1
	2	89	15816	4.2	4.4	4.2	3.9	3.5	3.1	2.8
	3	88	15960	4.6	4.8	4.3	4.0	3.5	3.3	3.0
	4	87	16144	4.3	4.7	4.3	4.0	3.6	3.5	3.0
11:00- -12:00	0	89	15600	6.7	10.0	6.4	5.1	4.4	3.8	3.1
	1	89	15728	6.3	7.7	6.2	5.2	4.4	3.8	3.1
	2	89	15808	4.3	4.4	4.2	3.8	3.5	3.1	2.8
	3	89	15920	4.4	4.7	4.3	4.0	3.6	3.2	2.8
	4	90	15840	4.2	4.7	4.2	3.9	3.5	3.2	2.7
13:00- -14:00	0	94	15808	6.2	9.2	5.9	4.9	4.1	3.5	3.0
	1	93	16000	6.0	10.9	5.6	4.7	4.1	3.8	3.2
	2	93	16112	4.5	4.3	4.1	3.8	3.5	3.2	2.9
	3	92	16000	4.2	4.4	4.2	3.8	3.4	3.2	2.8
	4	92	16296	4.1	4.5	4.2	3.8	3.4	3.1	2.7
14:00- -15:00	0	94	15728	6.2	9.5	5.9	4.8	4.1	3.5	3.0
	1	96	15768	5.6	9.5	5.3	4.6	3.9	3.4	2.8
	2	96	15872	4.1	4.4	4.1	3.8	3.4	3.2	2.8
	3	93	15912	4.4	4.6	4.4	4.0	3.7	3.2	2.9
	4	93	16640	4.2	4.6	4.2	3.9	3.5	3.2	2.7
15:00- -16:00	0	92	15648	6.6	11.0	5.8	4.9	4.1	3.8	3.2
	1	94	15616	5.7	8.0	5.4	4.6	3.9	3.5	2.9
	2	94	16008	4.2	4.6	4.2	3.9	3.5	3.2	2.8
	3	92	15896	4.4	4.6	4.4	4.0	3.6	3.1	2.8
	4	91	15952	4.2	4.3	4.2	3.8	3.4	3.0	2.6
16:00- -17:00	0	92	15632	5.6	8.4	5.7	4.8	3.9	3.5	2.9
	1	93	15752	5.7	9.0	5.5	4.7	4.0	3.5	3.0
	2	92	15856	4.0	4.3	4.0	3.8	3.4	3.0	2.6
	3	90	15880	4.3	4.7	4.3	3.9	3.5	3.2	2.7
	4	88	15952	4.3	4.5	4.3	4.0	3.6	3.2	2.8

TABLE C.4. BEAMOUNT SLAB 2 WHEEL PATHS 3 AND 4, SEPTEMBER 10, 1986

Time	Air Temp	Solar Radiation	Slab Surface Temp (°F)		Thermistors Temps (Average Values) (°F)			Temps at Surf & Bottom of the Slab (°F)		Temp Diff (DT)
(Hr:mi)	(°F)	(Btu/ft2)	Infra Gun	Surf Therm	T Top	T Mid	T Bot	T Surf	T Bott	(°F)
8:00--9:00	82	68	87	82	81	82	85	80	85	-5
9:00--10:00	86	126	92	90	82	82	84	82	84	-2
10:00--11:00	94	147	98	102	85	83	84	85	84	1
11:00--12:00	93	222	106	103	86	84	85	86	85	1
12:00--13:00		260								
13:00--14:00	95	250	113	105	93	88	86	95	86	9
14:00--15:00	95	256	112	104	95	89	86	97	86	11
15:00--16:00	95	184	110	105	96	91	88	98	88	10
16:00--17:00	89	56	105	93	97	93	88	99	88	11

TABLE C.5. FWD DATA FROM BEAUMONT SLAB 2 WHEEL PATH 3, SEPTEMBER 10, 1986

Time (Hr:mi)	FWD Position Station #	FWD Ambient Temp (°F)	FWD Load (Lbs)	FWD Deflections (Mils)						
				S3	S1	S2	S4	S5	S6	S7
8:00- -9:00	0	82	15656	15.3	19.0	11.9	9.8	8.0	6.7	5.4
	1	82	15752	10.5	25.8	18.3	14.7	11.6	9.3	7.3
	2	83	16016	9.9	10.3	9.7	8.8	7.7	6.9	5.9
	3	83	16096	11.0	11.6	11.2	9.9	8.6	7.5	6.2
	4	83	15776	11.1	11.8	11.0	9.9	8.5	7.5	6.2
9:00- -10:00	0	88	15408	16.1	19.9	10.9	8.6	7.1	5.9	4.7
	1	88	15288	10.9	22.6	15.2	12.1	9.4	7.8	6.1
	2	88	15760	9.4	9.0	9.4	7.9	6.6	6.3	5.4
	3	88	15536	9.9	10.6	10.0	8.7	7.4	6.4	5.3
	4	88	15624	10.3	10.6	9.7	8.5	7.4	6.4	5.3
10:00- -11:00	0	86	15376	15.1	18.7	10.8	8.5	6.9	5.9	4.9
	1	86	15096	11.3	23.7	14.3	11.6	9.0	7.5	6.0
	2	87	15544	8.9	9.3	8.8	7.9	6.9	6.1	5.2
	3	88	15504	9.8	10.4	9.7	8.5	7.1	6.2	5.2
	4	88	15608	9.8	10.3	9.5	8.4	7.1	6.2	5.2
11:00- -12:00	0	93	15248	14.6	18.2	11.0	8.6	7.0	5.9	4.9
	1	93	15160	11.3	21.2	12.5	10.7	8.3	6.8	5.5
	2	92	15528	9.0	9.5	8.9	8.0	6.9	6.3	5.3
	3	92	15512	9.7	10.5	9.7	8.5	7.1	6.1	5.1
	4	92	15408	9.7	10.4	9.5	8.3	7.0	6.2	5.2
13:00- -14:00	0	97	15760	13.4	16.8	10.0	8.2	7.3	6.1	5.1
	1	98	15368	11.5	18.8	10.9	9.9	7.9	6.7	5.6
	2	97	15632	8.4	8.9	8.3	7.5	6.5	5.7	5.0
	3	95	15520	8.9	9.5	8.7	7.7	6.7	5.7	4.8
	4	94	15728	8.6	9.5	8.6	8.0	6.6	5.8	4.9
14:00- -15:00	0	97	15344	13.2	16.0	11.1	8.2	7.5	6.5	5.3
	1	97	15496	11.4	18.0	10.5	9.6	7.8	6.5	5.5
	2	95	15616	8.6	9.1	8.5	7.6	6.6	5.9	5.1
	3	94	15576	9.0	9.5	8.8	7.7	6.7	5.8	4.9
	4	94	15784	9.0	9.6	8.7	7.7	6.6	5.8	4.9
15:00- -16:00	0	93	15424	13.2	15.9	11.6	9.0	7.4	6.2	5.1
	1	94	15360	11.9	20.4	11.4	9.6	7.9	6.5	5.4
	2	94	15536	8.7	9.5	8.5	7.7	6.6	5.9	5.1
	3	94	15592	9.1	8.0	8.8	7.8	6.7	5.8	4.9
	4	94	15704	8.9	9.6	8.8	7.7	6.6	5.7	4.9
16:00- -17:00	0	91	15416	13.0	15.9	12.1	9.4	7.7	6.3	5.2
	1	91	15176	12.2	20.9	12.5	10.7	8.0	6.6	5.4
	2	90	15784	8.8	9.2	8.7	7.8	6.7	6.0	5.2
	3	90	15600	9.3	9.7	9.0	7.9	6.7	5.9	5.0
	4	89	15696	8.9	9.7	8.9	7.8	6.7	5.8	5.0

TABLE C.6. FWD DATA FROM BEAUMONT SLAB 2 WHEEL PATH 4, SEPTEMBER 10, 1986

Time	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	Station #	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:00- -9:00	0	83	15616	8.7	14.4	7.8	6.4	5.1	4.2	3.3
	1	83	15792	7.6	17.3	9.6	7.7	6.1	5.0	4.0
	2	83	15984	5.6	5.2	5.6	4.7	4.2	3.9	3.4
	3	83	15960	5.5	5.9	5.5	4.8	4.2	3.7	3.3
	4	83	16648	5.6	5.9	5.4	4.8	4.1	3.7	3.1
9:00- -10:00	0	88	15548	8.3	12.3	7.7	6.1	4.7	4.3	3.4
	1	88	15576	7.6	16.9	8.5	6.9	5.4	4.5	3.5
	2	89	15864	5.2	5.4	5.0	4.5	4.0	3.7	3.1
	3	89	15840	5.4	6.0	5.7	4.8	4.0	3.6	3.0
	4	89	16440	5.6	6.2	5.4	4.7	4.1	3.5	2.9
10:00- -11:00	0	89	15608	8.0	12.4	7.5	6.1	4.8	3.9	3.0
	1	89	15688	7.7	16.1	8.3	6.8	5.4	4.4	3.5
	2	89	15792	5.1	5.3	5.0	4.4	3.9	3.6	3.0
	3	89	15864	5.6	6.0	5.9	4.4	3.5	4.0	2.9
	4	89	15840	5.6	6.1	5.4	4.7	4.0	3.6	3.0
11:00- -12:00	0	93	15648	7.4	10.8	7.8	6.4	5.2	4.3	3.5
	1	94	16160	7.6	13.3	8.2	6.2	5.0	4.2	3.3
	2	93	15816	5.0	5.2	4.9	4.3	3.8	3.5	3.0
	3	94	15848	5.2	6.0	5.4	4.6	3.9	3.6	2.9
	4	94	15848	5.6	7.3	5.4	4.7	4.1	3.5	2.9
13:00- -14:00	0	94	15712	6.7	12.2	7.6	6.1	5.0	4.2	3.4
	1	94	15440	7.1	14.5	6.9	5.8	4.7	4.1	3.2
	2	95	15920	5.1	5.3	4.9	4.5	3.9	3.5	3.0
	3	95	15864	5.4	6.1	5.6	4.8	4.0	3.6	3.0
	4	95	16008	5.5	6.8	5.3	4.7	4.0	3.5	2.9
14:00- -15:00	0	94	15704	6.7	13.3	7.5	5.9	5.0	4.1	3.4
	1	94	15544	7.2	14.2	6.8	5.7	4.8	4.1	3.3
	2	95	15944	5.2	5.4	5.1	4.6	4.1	3.7	3.2
	3	96	15856	5.3	5.8	5.4	4.7	3.9	3.5	3.0
	4	97	15952	5.5	10.4	5.3	4.8	4.1	3.5	2.9
15:00- -16:00	0	94	15776	6.9	14.7	7.6	6.2	5.1	4.3	3.6
	1	95	15648	7.3	14.0	6.9	5.8	4.9	4.1	3.4
	2	95	15824	5.1	5.5	5.0	4.6	4.1	3.6	3.1
	3	95	15984	5.5	5.6	5.4	4.6	3.9	3.6	3.1
	4	96	16576	5.2	5.7	5.2	4.7	4.0	3.4	2.9
16:00- -17:00	0	90	15800	6.7	11.6	7.3	6.1	5.0	4.2	3.4
	1	90	15480	7.1	14.2	7.1	5.7	4.7	4.2	3.5
	2	90	15880	5.2	5.3	5.0	4.5	3.9	3.7	3.2
	3	89	15952	4.8	5.4	5.0	4.4	3.9	3.3	2.9
	4	87	15760	5.1	9.8	5.1	4.6	4.0	3.5	2.8

TABLE C.7. BEAUMONT SLAB 2 WHEEL PATHS 11 AND 12, SEPTEMBER 11, 1986

Time	Air Temp	Solar Radiation	Slab Surface Temp (°F)		Thermistors Temps (Average Values) (°F)			Temps at Surf & Bottom of the Slab (°F)		Temp Diff (DT)
(Hr:mi)	(°F)	(Btu/ft2)	Infra Gun	Surf Therm	T Top	T Mid	T Bot	T Surf	T Bott	(°F)
8:30--9:45	92	177	94	92	86	86	88	85	88	-3
9:45--11:00	96	231	102	104	89	87	88	89	88	1
11:00--12:15	98	272	114	108	92	89	88	93	88	5
12:15--13:30	90	186	105	105	95	90	89	97	89	8
13:30--14:45	94	215	115	108	96	92	90	98	90	8
14:45--16:00	90	226	107	100	98	94	90	100	90	10

TABLE C.8. FWD DATA FROM BEAUMONT SLAB 2 WHEEL PATH 11, SEPTEMBER 11, 1986

Time	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	Station #	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30- -9:45	0	84	16000	9.2	12.3	8.8	10.1	9.8	4.7	4.1
	1	84	15952	8.8	14.3	9.4	10.6	11.9	4.9	4.1
	2	85	15928	6.5	6.9	6.5	6.3	6.0	5.2	4.9
	3	85	16040	6.5	6.9	6.6	6.6	6.0	5.1	4.6
	4	85	16440	6.5	7.0	6.6	6.6	6.0	5.4	4.8
9:45- -11:00	0	89	15920	8.6	11.1	8.7	9.2	9.1	5.0	4.2
	1	89	15864	8.7	12.5	8.8	9.4	10.5	4.9	4.1
	2	89	15904	6.2	6.4	6.3	6.2	5.6	5.4	4.9
	3	90	16648	6.5	7.1	6.6	6.8	6.1	5.1	4.5
	4	90	16944	6.4	6.8	6.5	6.7	6.0	4.9	4.5
11:00- -12:45	0	92	15560	8.2	10.8	8.3	8.9	8.7	5.1	4.3
	1	93	15856	8.3	12.2	8.8	9.1	10.1	4.8	4.1
	2	93	15992	5.9	6.2	6.0	6.1	5.6	4.9	4.5
	3	94	15904	6.5	6.8	6.6	6.7	6.0	5.0	4.3
	4	94	16792	6.5	6.8	6.5	6.7	6.0	4.9	4.4
12:45- -13:30	0	87	15832	8.1	10.6	8.0	8.8	8.4	4.6	3.9
	1	87	15952	8.2	12.3	8.3	9.2	9.9	4.7	3.9
	2	88	15928	6.2	6.4	6.2	6.1	5.7	5.1	4.7
	3	90	15872	6.4	6.7	6.5	6.5	5.8	5.1	4.6
	4	90	16832	6.3	6.7	6.4	6.6	5.8	4.9	4.4
13:30- -14:45	0	93	15688	7.9	10.4	8.2	8.5	8.3	4.9	4.1
	1	93	15992	8.1	11.8	8.5	8.8	9.7	4.6	4.1
	2	94	15760	6.1	6.4	6.2	5.9	5.5	5.0	4.7
	3	93	15832	6.5	6.9	6.4	6.4	5.9	5.1	4.6
	4	92	15992	6.4	6.9	6.6	6.3	5.9	5.2	4.6
14:45- -16:00	0	94	15784	7.8	10.2	8.0	8.5	8.2	4.5	4.1
	1	94	15792	8.0	11.9	8.6	8.8	9.8	4.7	4.0
	2	92	15920	6.0	6.4	6.1	6.1	5.5	4.8	4.4
	3	92	15872	6.0	6.4	6.1	6.3	5.4	4.8	4.3
	4	93	16648	6.0	6.4	6.1	6.3	5.6	4.8	4.3

TABLE C.9. FWD DATA FROM BEAUMONT SLAB 2 WHEEL PATH 12, SEPTEMBER 11, 1986

Time	FWD Position	FWD Ambient Temp	FWD Load	FWD Deflections (Mils)						
(Hr:mi)	Station #	(°F)	(Lbs)	S3	S1	S2	S4	S5	S6	S7
8:30- -9:45	0	85	16480	9.2	11.7	8.8	9.7	9.9	4.8	4.1
	1	86	16504	8.9	13.7	9.1	12.1	10.1	4.9	4.2
	2	86	15944	6.4	6.5	6.4	5.9	6.1	5.1	4.8
	3	86	15944	6.5	6.9	6.6	6.2	6.6	5.1	4.5
	4	86	15888	6.6	7.0	6.5	6.2	6.5	5.2	4.7
9:45- -11:00	0	90	16384	8.7	10.7	8.7	9.0	8.9	5.1	4.2
	1	90	16728	8.7	12.9	8.8	12.1	9.6	4.7	4.0
	2	90	16008	6.1	6.4	6.2	5.7	6.1	5.0	4.5
	3	90	15928	6.5	7.0	6.6	6.2	6.6	4.9	4.3
	4	90	16192	6.5	7.0	6.5	6.3	6.6	4.9	4.4
11:00- -12:45	0	94	16320	8.1	10.2	8.4	8.7	8.6	4.9	3.9
	1	95	16544	8.3	12.2	8.7	12.0	8.7	4.7	4.1
	2	95	15952	5.9	6.2	6.0	5.5	5.9	4.9	4.3
	3	96	15896	6.3	7.2	6.5	6.2	6.6	5.1	4.5
	4	96	15840	6.5	6.8	6.4	6.1	6.5	4.9	4.4
12:45- -13:30	0	92	16232	8.3	10.3	8.9	8.6	8.8	5.0	4.3
	1	92	16632	8.6	12.8	8.7	12.7	9.5	4.8	4.1
	2	91	15984	5.8	6.0	5.9	5.4	6.0	4.6	4.3
	3	90	15952	6.3	6.9	6.3	6.0	6.6	4.8	4.3
	4	91	15888	6.3	6.7	6.3	6.0	6.4	4.9	4.4
13:30- -14:45	0	94	16368	7.7	9.8	8.1	8.3	8.4	4.7	4.0
	1	94	16488	8.0	12.4	8.7	12.3	8.6	4.8	4.2
	2	95	15920	6.0	6.4	6.1	5.6	5.9	4.9	4.6
	3	95	15808	6.4	6.9	6.4	6.0	6.4	5.0	4.4
	4	95	15744	6.4	6.8	6.4	5.9	6.2	5.0	4.7
14:45- -16:00	0	95	16176	7.5	9.5	8.0	8.1	8.3	4.7	4.1
	1	95	16288	7.9	12.8	9.0	13.2	8.4	4.9	4.0
	2	96	15992	5.8	6.1	6.0	5.5	5.9	5.0	4.3
	3	95	15976	6.2	6.6	6.3	5.9	6.2	4.8	4.5
	4	96	15728	6.2	6.8	6.4	5.9	6.2	4.9	4.5