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Development of FWD Procedures Manual

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16. Abstract

In this project, the state-of-practice in FWD testing and analysis procedures were examined by looking at the standard protocols of a number of other highway agencies. The specific needs of NJDOT were also examined and a protocol was developed that encompassed current standard practice in a way most suited to NJDOT operations.
This report documents the development of the FWD Procedures Manual required by NJDOT.

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BACKGROUND AND OBJECTIVES

For rehabilitation design processes, the new Mechanistic-Empirical Pavement Design Guide (MEPDG) relies heavily on the material stiffness backcalculated from the deflection measurements taken from existing pavements. These measurements are typically made using Falling Weight Deflectometer (FWD) or Heavy Weight Deflectometer (HWD) units. In order to provide high quality and consistent material stiffness data for the MEPDG, the New Jersey Department of Transportation (NJDOT) wishes to develop an FWD Procedures Manual that will regulate field testing, analysis, and reporting procedures for FWD and HWD equipment. Adherence to the developed procedures during FWD testing and analysis, whether by State personnel or private contractors, should ensure that good quality material stiffness values are input into the MEPDG processes.

This project sought to examine the state-of-practice in FWD testing and analysis procedures by looking at the standard protocols of a number of other highway agencies. The specific needs of NJDOT were also examined and a protocol was developed that encompassed current standard practice in a way most suited to NJDOT operations. This report documents the development of the FWD Procedures Manual required by NJDOT. The manual itself is prepared as a separate document. The manual contains protocols for FWD testing and analysis for the purpose of project-level rehabilitation design using MEPDG. The developed guidelines clearly define:

- Testing requirements.
- Data analysis approach.
- Reporting requirements.

The protocols are intended to ensure that FWD data is collected and analyzed in a consistent, technically sound, and state-of-practice manner. Appendix A contains FWD Rehabilitation Case Studies to illustrate the methods used to perform rehabilitation analysis using FWD data.

OVERVIEW

This section of the report gives an overview of FWD equipment, the applications in which it can be used, and the benefit of this technology over other data collection methods.

FWD Equipment

The Falling Weight Deflectometer (FWD) is a non-destructive testing device used to complete structural testing for pavement rehabilitation projects, research, and for pavement structural failure detection. It can be used for conventional and deep strength flexible, composite, and rigid pavement structures. The device uses a set of weights that are dropped from preselected heights to generate a loading cycle. The application of the loading cycle is similar in magnitude and duration to a truck moving across the pavement surface. In fact, the loading cycle is designed to simulate the deflection of pavement surfaces caused by fast-moving truck traffic. The deflection generated by the loads is measured by the device's geophones or sensors and the gathered information is used in various analyses to give information on the pavement's structural capacity. There are three versions of FWDs, which are:

- Falling Weight Deflectometer (FWD).
- Heavy Weight Deflectometer (HWD).
- Light Weight Deflectometer (LWD).

The FWD and the HWD are very similar, with the main exception being the maximum loads that they are capable of generating. An FWD can typically generate a maximum load in the range of 24,000 lbs, whereas an HWD can typically generate twice that amount. Usually, HWDs are intended for use on airfield pavements to simulate aircraft loads, which the FWD is not capable of doing. HWDs, however, can be configured to generate loads of lower magnitude, similar to those of the FWD, and therefore the HWD can be used as well as or instead of the FWD for highway pavement testing. The LWD is a handheld device equipped with only one sensor and used mainly during construction. Due to its limited application, the LWD is not included in the scope of this report; the report will instead focus on procedures for use of FWD and HWD equipment and data. Throughout the report, the term 'FWD' can be taken as referring to both devices; the term 'HWD' will only be used when separate considerations apply to that specific device.

Currently, there are four major manufacturers of FWD equipment: Dynatest, KUAB, Foundation Mechanics (JILS) and Carl Brothers. Although all manufacturers use the same overall concepts, technical specifications can noticeably vary between different devices. The majority of FWDs are trailer-mounted, with the exception of one JILS model that is truck-mounted. In general, FWDs have the following components:

- The Load Package, which consists of:
    - Set of Steel Blocks/Plates – raised to preselected heights using a hydraulic cylinder and dropped onto a strike plate.

    - Set of Switches – used to control the heights to which the weight is lifted.
    - Catch – used to lock the weight at the specified height before it is released and dropped.
    - Rubber Springs (Buffers) – fixed to the bottom of the weight package or top of the strike plate and used to modify the shape of the load.
    - Load Plate - circular with radius usually in range of 5.9 in. Placed on pavement surface and transmits the load pulse into the pavement. Load plate may be solid or split into two or more segments. Split plates provide better contact with the pavement surface and more uniform load distribution, especially where ruts exist.
    - Load Cell – measures the load applied to the load plate.
- Deflection Bar – include the deflection sensors (geophones) and the sensor holders that are used to position the sensors at the specified offset distances.
- Data Acquisition System, mainly consisting of:
    - Signal Processor – used to capture load magnitude from the load cell and the deflections with corresponding time measurements.
    - Computer – used to operate the FWD and display/store the data.

Applications for FWD Data

FWD testing and analysis can be used for a range of applications. The most common of these include:

- Determination of the in-situ structural capacity of pavement section.
- Determination of effective pavement layer moduli, including subgrade.
- Detection of voids under the corners of a Portland Cement Concrete (PCC) slab, using certain analysis procedures, such as load versus deflection.
- Determination of Load Transfer Efficiency (LTE) in rigid pavements. LTE
- provides an indication of how well a joint between two PCC slabs transmits loads.
- Evaluation of construction quality under actual field conditions to assess whether each layer meets structural capacity requirements.

Benefits of FWD

Pavement performance has two major components: structural and functional. The structural performance of pavements is related to the number of load repetitions that a pavement section can carry before it develops an unacceptable level of structural related distresses. The functional performance of pavements is related to the users' riding comfort. A pavement section may be structurally adequate, but have functional related problems, such as high roughness, or vice versa. Treatments to meet structural needs are typically much more expensive than treatments designed to rectify functional problems. Therefore, treating a functionally deficient pavement as if it is structurally deficient will result in construction costs that are considerably higher than necessary. Conversely, treating a pavement for functional problems when in fact those problems are structural will not rectify the situation and the pavement will need to be treated again within a relatively short time span to address the structural requirements. Additionally,

during this time, the structural condition may have worsened to a point where more expensive rehabilitation is now required. Therefore, when treating a pavement, it is vital to know whether the problem being addressed is structural or functional in nature. Matching the appropriate treatment to the pavement's needs can lead to significant reductions in pavement construction and life cycle costs. Using FWD analysis to determine pavement structural capacity can therefore result in more cost-effective rehabilitation decisions by providing information that can be used to match the treatment to the cause.

FWD is of course not the only method by which structural capacity could be assessed. Traditionally, it has been assessed through destructive testing (such as coring/boring). However, the coring/boring itself can weaken the pavement and it also gives only point-specific information. The FWD is a non-destructive testing device, i.e. one that causes no damage to the pavement. Although coring would still be necessary, particularly to provide layer thickness information and to obtain samples for laboratory testing, use of the FWD equipment greatly reduces the number of cores needed within a project. Additionally, it gives a much more accurate determination of the pavement's in-situ structural capacity than the traditional destructive method. FWD testing, therefore, does not only provide more accurate structural capacity assessment than traditional methods, leading to more accurate and cost-effective rehabilitation decisions, but it does so without causing further damage to the existing pavement structure.

LITERATURE REVIEW

The first step in the procedure to develop an FWD Procedures Manual for NJDOT, was to examine the current state of practice for FWD testing and analysis. A literature review was conducted that looked at the FWD protocols of the American Society for Testing & Materials (ASTM), the FHWA's Long-Term Pavement Performance (LTPP) study, the FHWA's Central Federal Lands Highway Department (CFLHD), and the Virginia Department of Transportation (VDOT). Additionally, the protocols that were developed on a project-specific basis for the NJDOT Pavement Management System II project, a project that involved statewide FWD data collection and analysis, were examined. Results of this literature review are contained in the following sections.

American Society for Testing and Materials

The American Society for Testing and Materials (ASTM) has a number of standard guides related to deflection testing and analysis. This section gives an overview of some of the most relevant to this study.

Designation D 4695-03: Standard Guide for General Pavement Deflection Measurements

This guide describes procedures that can be applied to various deflection testing devices, of which FWD is included. The information is general and should apply regardless of the type of testing device. However, it is noted that each individual device should be operated according to its own standard procedure. In the case of FWD, this standard is D 4694-96, described below. Designation D 4695-03 is designed to apply for all pavement types.

Planning and Equipment Calibration

Load Cell – Reference calibration of the device's load cell should be performed at least once a year, with the exact procedure being dependent upon the type of device used.

Deflection Sensors – Reference calibration of the deflection sensors should be carried out in accordance with the SHRP Protocol, for devices such as the FWD. A relative calibration check should be conducted once a month during active testing, again using the SHRP Protocol.

Temperature Sensors – Calibration of temperature sensors should be performed at least once a year. For pavement temperature sensors, the calibration should be carried out using a calibrated reference thermometer and two reference surfaces: one hot and one cold. For air temperature sensors, calibration should be carried out using two reference temperatures, e.g., ice water (0°C) and hot water (60°C).

Field Testing

The following are the minimum items that should be recorded during field testing:

- The peak load applied to the pavement surface.
- The location of any cracks and joints between the load and each sensor that are within 6 feet from the center of the load.
- The location and orientation of all sensors from the center of the load.
- The time of test.
- The station number or location of the test point.
- The ambient air temperature and pavement surface temperature at the intervals specified by the engineer.

The taking of deflection measurement should be performed according to the manufacturer's instructions for the particular device. These steps, however, should be taken regardless of the device in question:

- Position device over desired test location.
- Take ambient air and pavement surface temperature measurements.
- Record the following:
  - project location
  - operator name
  - date and time
  - calibration factors
  - start and end stations or physical location
  - culvert locations
  - location of bridges
  - description of surface distresses
  - weather conditions
  - pavement type
- Remove rocks or debris to ensure load plate will be properly seated.
- Set up software for data collection
- Input configuration of device during testing, e.g. size of load plate, number, position, and orientation of deflection sensors.
- Select the required data file format.
- Lower the load plate and sensors to ensure they are properly seated on the pavement surface.
- Raise to the desired height and drop the load. Record data from all test drops and also from any seating drops.

The test location will vary depending on the purpose of testing. However, in general, testing will be conducted in the wheel paths to most accurately reflect the accumulated damage to the pavement. The following are guidelines for different kinds of testing:

- *Network Level* – testing should be performed at intervals of 100 m to 500 m, with a minimum of 7 tests per pavement section. As a minimum, testing for asphalt concrete (AC) and continuously reinforced concrete pavements (CRCP) should

be conducted along the outer wheel path, or, for CRCP slabs, along the centerline. For jointed concrete pavements (JCP), testing should first be conducted at the center of the slab. At least 10 % of the slabs should be tested at the joints for deflection or load transfer efficiency.

- *General Project Level* (for rehabilitation design, etc.) – testing should be performed at intervals of 50 m to 200 m, with a minimum of 15 tests per pavement section. As a minimum, testing for AC or CRCP pavements should be conducted along the outer wheel path, or, for CRCP slabs, along the centerline. For JCP pavements, testing should first be conducted at the center of the slab, followed by the leave side of the nearest joint in line with the slab center, as well as in the outer wheel path. A minimum of 25 % of the slabs should be tested at the joints.

- *Detailed Project Level* (for detailed analysis, identifying localized areas of high deflection, void detection, etc.) – For AC or CRCP pavements, testing should be performed at intervals of 10 m to 100 m as recommended by the engineer, and may be carried out in both wheel paths. For JCP pavements, testing should first be conducted at the center of every slab, followed by the nearest joint or crack, either along the outer wheel path or at the corner of the slab, or both. All slabs should be tested at the joints.

For use in future analysis, it is may also be necessary to determine pavement layer material types and thicknesses, as well as the depth to bedrock or stiff layer.

Data Handling

The following information, as a minimum, should be contained in the field testing reports:

- Date and time of testing
- Operator identification
- Vehicle information
- Weather conditions
- Air and pavement temperatures
- Section Information, such as:
  - Roadway, county and/or district
  - Pavement type
  - Direction of travel
  - Lane being tested and the position within the lane (inner wheel path, mid-lane, outer wheel path, etc.)
- Load and deflection data
  - Type of test, e.g. deflection basin or load transfer.
  - Sensor spacing and orientation
  - Applied load and load frequency
  - Measured deflections

Designation D 4694-96: Standard Test Method for Deflections with a Falling-Weight-Type Impulse Load Device

Planning and Equipment Calibration

Prior to other calibrations, the weight should be dropped at least five times and the relative difference in each loading checked. If loadings vary from each other more than 3%, then the height of the drop, cleanliness of the track and any other relevant parts should be checked. Any part found to be operating incorrectly should be replaced or repaired.

Load calibration should be conducted per the manufacturer's instruction. Deflection sensor calibration should be performed at least once a month or according to the manufacturer's instructions. The procedure for relative deflection calibration requires a sensor holding tower, which should be available from the manufacturer. The tower should hold all sensors above each other along a vertical axis and be stiff enough to allow each sensor to experience the same deflection when the load is applied to the pavement surface. The steps are as follows:

- Position tower (with sensors already mounted) as near to the load plate as possible.
- Use the same load throughout.
- Ensure load plate maintains continuous contact with the pavement surface while gathering calibration data.
- Record five deflections for sensors in current position. Then rotate the sensors and repeat, so that eventually each sensor occupies every level in the tower.
- Manually hold tower in position with a moderate downward pressure while measuring the deflections.
- Determine deflection ratios for each sensor by dividing the average for all the sensors by the average of that individual sensor.
- If any of the resulting ratios are greater than 1.003 or less than 0.997, all the sensor calibration factors should be replaced by the existing calibration factor multiplied by the ratio.
- If any of the calibration factors exceed the limits established by the manufacturer, the device should be repaired and recalibrated according to the manufacturer's recommendations.
- Repeat the procedure at a distance of 1 to 1.5 m from the load plate.
- If any differences in average deflection greater than 0.08 mils are found, the device should be repaired and recalibrated according to the manufacturer's recommendations.

Field Testing

The following steps constitute a basic field testing procedure:

- Position the loading plate over the desired test point. The test location should be cleared of rocks and debris to ensure that the loading plate will be properly seated.
- Lower the loading plate and the sensors and ensure they rest firmly on the pavement surface.
- Apply the required load to the pavement. Record the resulting peak surface deflections and peak load.
- Perform at least two loading sequences and compare the results. If the difference is greater than 3 % for any sensor, note the variability in the report. Additional tests may be run at the same or different loads.

Designation D 5858-96: Standard Guide for Calculating In Situ Equivalent Elastic Moduli of Pavement Materials Using Layered Elastic Theory

The intent of this guide is to outline the general approach for estimating the in-situ elastic moduli of pavement layers using layered elastic theory, which can then be used for pavement evaluation, rehabilitation and overlay design. This guide is predominantly concerned with flexible pavements.

Data Analysis

The following are the main steps in the estimation of in-situ elastic layer moduli using layered elastic theory:

- Delineating Pavement Sections – longitudinal profile graphs of the maximum surface deflection and the deflection furthest from the load should be prepared for the pavement being evaluated. Using these plots, pavement subsections with similar characteristics can be defined.
    - A decision should then be made over whether to analyze all locations or whether to select and analyze only a representative basin.

- Obtain material type and layer thickness information from as-built construction records or, more accurately, from coring. Coring should also highlight the existence of a shallow rigid layer (e.g., bedrock).

- For each basin being considered in the analysis, the following data should be entered into the analysis program:
    - Applied loads
    - Poisson's ratios and thicknesses of the assumed individual layers
    - Deflection values and locations
    - Initial estimates of the layer moduli (seed moduli), when appropriate.

- Elastic moduli often cannot be accurately determined for thin layers (those less than a quarter of the diameter of the loaded area or those thinner than the layer directly above), using most backcalculation methods. If possible, the thin layers should be combined with a similar type of material above or below the thin layer.

Alternatively, the moduli of the thin layers can be estimated and assigned as "known" values.

  - The number of unknown layers (including subgrade, but excluding any fixed apparent stiff layer) to be backcalculated should not exceed five. The number of unknown layers should be equaled or exceeded by the number of known factors, i.e. deflections. Therefore, if four deflection sensors were used, then a maximum of four unknown layers (three pavement layers and the subgrade) could be used in the structural evaluation. Where appropriate, the thicknesses of similar layers may be combined to reduce the number of unknown layers.

- Many backcalculation procedures include an apparent stiff layer at some depth into the subgrade (M_r = 100,000 to 1,000,000 psi), which is intended to simulate bedrock. Research has shown that not including such a layer can lead to significantly inaccurate. However, so too can including the layer but not locating it near its actual depth, particularly if the actual depth is less than 20 ft.

- The accuracy of the backcalculated moduli is affected by the tolerance that the procedure allows when determining a match between the calculated and measured deflections. Two different approaches are commonly employed:

  - Arithmetic Absolute Sum (AASE) of Percent Error – in this approach, the magnitude of tolerance varies with the number of deflection sensors used to define the basin. ASTM recommends that the sum of percent error should not be greater than the following values for any pavement section:
    - 9 to 18 % if nine deflection sensors are used,
    - 7 to 14 % if seven deflection sensors are used, and
    - 5 to 10 % if five deflection sensors are used
    - No less than five sensors should be used

  - Root Mean Square (RMSE) Percent Error – the same minimum of five deflection sensors should also be used in this analysis. ASTM recommends a maximum tolerance limit of 1 to 2 % on the root mean square error.

Reporting Requirements

The following attributes should be included in the report for each pavement section:

- Location of test section, location of test points with section, date and time of testing, original data file name, and the backcalculation program and version used.

- Details of FWD equipment, such as load, sensor spacing, etc.

- Pavement layer information:
  - Thicknesses.

  - Poisson's ratios.
  - Material types.
  - Any layers that were combined into one for analysis purposes.

- Visual characteristics of the test section, such as pavement type, presence of culverts, soil type, and shoulder width, plus type, severity, and extent of pavement distresses.

- Ambient air temperature and pavement surface temperature for each basin measurement.

- The load magnitude and measured and calculated deflections for each basin used in the analysis.

- The equivalent layer elastic moduli of each layer for each backcalculated basin, plus the mean and standard deviation for the design section of each layer.

- For each layer moduli calculation, the arithmetic absolute sum of percent error or the root mean square percent error between the measured and calculated deflection basins.

Federal Highway Administration – Long-Term Pavement Performance Study

The FHWA's LTPP study is nearing the end of its intended 20-year monitoring program of approximately 2,500 flexible and rigid pavement sections across the US and Canada. As part of the program, FWD testing is routinely performed at the sections. The LTPP program has a comprehensive and detailed FWD testing protocol[1], designed to ensure consistent data collection over a vast quantity of sites and during a 20-year testing period. As the data collected in the LTPP study is intended to be used in research, it may be overly detailed for the needs NJDOT hopes to address through development of the FWD Procedures Manual. However, many of its practices could be directly implemented. It should be noted that no analysis was conducted as part of the LTPP program. As such, the protocol does not cover FWD analysis procedures.

Planning and Equipment Calibration

Calibration and Verification

Reference Calibration – LTPP guidelines require that every FWD undergo yearly (400 days) reference calibration, performed at one of the four calibration centers established by the Strategic Highway Research Program (SHRP), or at an equivalent center. In addition to these requirements, if the load cell or signal processor is replaced on the FWD, then the unit must undergo reference calibration before recommencing testing. The replacement of other major components, such as the deflection sensor, multisignal

[1] Long-Term Pavement Performance Program Manual for Falling Weight Deflectometer Measurements, Version 4.1. US Department of Transportation, Federal Highway Administration. Publication No. FHWA-HRT-06-132, 2006.

cable, or trailer printed circuit board (PCB), also necessitates that the FWD should undergo additional reference calibration, but this can be performed at a practical time, and unit can be used for data collection in the meantime. For all reference calibration, the most recent FHWA LTPP FWD Reference and Relative Calibration Manual procedure must be followed.

Relative Calibration – FWD units actively in use in the LTPP program must undergo relative calibration monthly (max. 42 days). Additional relative calibration is required before a unit recommences work after a major component is replaced, such as a deflection sensor, multisignal cable, or trailer PCB board. The most recent version of the FHWA LTPP FWD Reference and Relative Calibration Manual must be followed during relative calibration.

DMI Calibration – LTPP guidelines stipulate that each FWD actively in use must undergo DMI calibration monthly (max. 42 days). Additional DMI calibration is necessary before the unit recommences work if the tow vehicle undergoes maintenance, including replacement of tires.

The DMI calibration method is to drive the vehicle over a known distance of at least 150 meters, across reasonably level ground, which should enable the FWD data collection software to calculate an appropriate calibration factor.

Temperature Sensor Verification – All temperature sensors, both those included in the FWD device and those that are used separately to complement FWD data collection, must undergo accuracy verification on a monthly basis (max. 42 days). If a temperature sensor fails the designated verification procedure, it must be returned to the manufacturer for repair or recalibration, and/or be replaced with a new sensor.

Equipment Set-Up

Geophone Locations – The LTPP guidelines have the following requirements for positioning of geophones (deflection sensors), shown in Table 1. The positions are in millimeters, measured from the center of the load plate.

Table 1. LTPP geophone locations.

	D1	D2	D3	D4	D5	D6	D7	D8	D9
9-Sensor Units	0	203	305	457	610	914	1219	1524	-305
7-Sensor Units	0	-305	305	457	610	914	1524	n/a	n/a

Weight Package – LTPP requires the use of three standard weights and two buffers per side on its standard units, and a configuration that will produce similar results on any other units used for testing under the program.

Load Levels – The four load levels specified for LTPP testing are shown in Table 2. An acceptable load range for each drop height is between 90 percent and 110 percent of the target value. Drop heights may not be adjusted during a test pass.

Table 2. LTPP load levels.

Drop Height	Target Load, kN (kips)
1	26.7 (6.0)
2	40.0 (9.0)
3	53.4 (12.0)
4	71.2 (16.0)

Software Set-Up

The LTPP guidelines have a number of specifications for the set-up of FWD software prior to testing. Firstly, data collected with LTPP FWDs must be in FWDWin MDB format. All FWD data in must be reported in International System (SI) units, with the exception of station units, which must be in feet. Data must be collected with all filters and smoothing turned off. All files should be named according to the file naming convention of:

State_SectionID_SiteVisit_Pass

Test Planning and Testing Locations

LTPP has a number of predetermined test plans that are designed based on the specific experiment being conducted at each test section. Operators select the test plan that is appropriate to the section being tested. There are, however, several general rules that govern each test plan and these are outlined in this section.

Within the LTPP study, each test pass at each section must be performed in the direction of the flow of traffic, with data from each pass stored in a different file. Transverse locations are measured from the outside lane edge (OLE) to the center of the FWD load plate at the relative distances shown in Table 3. These relative positions are midlane (ML), outer wheel path (OWP), pavement edge (PE) and widened lane edge (WLE).

Table 3. LTPP transverse locations.

Relative Position	Offset from OLE	
	3.66 m (12 ft) Nominal Lane Width	4.27 m (14 ft) Nominal Lane Width
Mid-Lane (ML)	1800 mm ± 150 mm	1800 mm ± 150 mm
Outer Wheel Path (OWP)	760 mm ± 75 mm	760 mm ± 75 mm
Pavement Edge (PE)	150 mm ± 75 mm	150 mm ± 75 mm
Widened Lane Edge (WLE)	n/a	150 mm* ± 75 mm

*From outer edge of pavement slab, not from OLE.

FWD testing on rigid pavements is referenced to the effective slab, rather than to absolute longitudinal position. When testing has already been performed at a rigid section at a prior time, the operator should test the same slabs again as those tested previously. If, however, testing is being performed at the rigid pavement section for the first time, the operator must determine the number of slabs to be tested according to the test plan. All slabs selected for testing must be entirely within the section limits and can be bounded either by joints or full-width working transverse cracks. The following are the testing locations for rigid pavements that may be required by the test plans:

- Mid-Panel - the load plate should be as close to the center of the effective slab as possible.

- Joint Approach - the load plate should be tangent to the joint or crack at the approach end of the slab to be tested, but located on the slab immediately before it. The edge of the load plate should be within 50 mm of the joint, but must not bridge it.

- Joint Leave - the load plate should be tangent to the joint or crack defining the leave end of the slab to be tested and located on that slab. The edge of the load plate should be within 50 mm of the joint, but must not bridge it.

- Corner – For jointed concrete pavements (JCP), corner testing should be performed in the same way as joint leave testing except that the load plate should be tangent to both the joint or crack defining the approach end of the slab and the longitudinal joint defining the outside edge of the slab. The edge of the load plate should be no more than 75 mm away from either joint/crack. For continuously reinforced concrete pavements (CRCP), the corner test should be performed with the load plate centered on the transverse crack defining the approach end of the effective slab and tangent to the longitudinal crack defining

the outside edge of the slab. The edge of the load plate should be no more than 75 mm from the longitudinal joint.

Field Testing

The LTPP guidelines give a detailed field testing procedure that must be followed by each operator during FWD testing. The following highlights the key points in that procedure:

- The site should be checked for evidence of recent maintenance activities and the office contacted for advice should any exist.
- Any necessary temperature gradient holes should be prepared.
- 'Before Operations' equipment checks should be made to ensure that the FWD is in good working order.
- The buffer warm-up sequence should be performed. This data is checked to ensure that it is trending the right way and that the load levels are within the accepted limits. If not, adjustments are made and the buffer sequence is repeated until the correct results are achieved. This procedure must be repeated whenever the FWD is idle for more than 15 minutes.
- The load plate should be positioned over the section start and the DMI set to '0'.
- The FWD should then be positioned over the first test point, as per the selected test plan, and a new file opened in the data collection software.
- The first temperature gradient measurement should be taken. These measurements must, for most test sections, be taken every 20-40 minutes.
- The testing sequence is then started. The drop heights for testing are shown below, where C indicates a seating drop from height 3 and H indicates that full-time history should be saved:
  - Flexible pavements: C,C,C,1,1,1,1H,2,2,2,2H,3,3,3,3H,4,4,4,4H
  - Rigid pavements: C,C,C,2,2,2,2H,3,3,3,3H,4,4,4,4H
- Any distresses and defects present on the pavement should be noted in the file.
- For LTE testing, joint/crack widths should be measured.
- Data should be checked for errors and any flagged errors should be resolved in the manner described in the Data Handling below.
- All steps from commencing the test sequence should then be repeated for the next test point.

- Once all test points in the pass have been completed, the file must be closed and a new one opened before commencing the next pass.

- All steps from positioning the load plate over the section start and setting the DMI to '0' should be repeated for the each remaining pass at the section.

- Once all testing is complete, a final temperature gradient measurement should be taken.

- Wherever possible the operator should backup the data and perform initial data processing, as described in the Data Handling section below, before leaving the site.

- As a final step, 'after operation' activities should be performed that ensure that the FWD is in a safe state to commence road travel.

Data Handling

Field Data Quality Checks

During testing, LTPP guidelines require that several data checks be enabled in the FWD data collection software. These are:

- *Roll-off* – this error condition is indicated by the deflection of the pavement surface not returning to near zero within 60 ms of trigger activation. A common cause is poor contact between the deflection sensor and the pavement surface.

- *Non-decreasing Deflections* – this error results when the deflections measured by the deflection sensors do not decrease with increasing distance from the load plate. This condition often indicates poor contact between the flagged sensors and the pavement surface.

- *Overflow* – this condition is triggered when a measured deflection exceeds the range of the deflection sensor. For the FWDs used in the LTPP program, this range is 80 mils. Again, this error is often caused by poor contact between the flagged sensor and the pavement surface.

- *Deflection Variation* – this condition occurs when the load-normalized peak deflections for repeat drops vary by more than the LTPP-specified amount of ± (2 µm + 0.01X). A common cause of this error is uneven pavement surface conditions that result in poor seating of the load plate and/or deflection sensors. It can also be caused by vibrations from nearby heavy equipment, such as trucks traveling in adjacent lanes.

- *Load Variation* – this is an error condition that occurs when the peak load for repeat drops at the same drop height varies by more than a specified amount, which for LTPP is ± (0.18 kN + 0.02X). A cause of this error may be that the load

plate is not seated properly on the pavement surface - possibly because of loose debris or an uneven pavement surface.

All of these conditions can be legitimately caused under certain specific circumstances. For example, non-decreasing deflections can be legitimately caused by a transverse crack or other discontinuity between two sensors, amongst other reasons. The LTPP guidelines give specific instructions for operators to follow in the case of deflection errors (roll-off, non-decreasing deflections, overflow, deflection variation) and in the case of load errors (load variation). However, in general the operator must attempt to identify the source of the errors. If the errors appear to be caused by the FWD equipment, then the test (or entire test pass) should be discarded, the equipment fixed, and testing resumed. If the errors result from localized pavement conditions, the test should be discarded, the FWD repositioned, and the test rerun. If the errors are the result of pavement conditions across the test section as a whole, or are due to factors beyond the operator's control, the error should be accepted and a comment made on the pavement condition.

Field Data Handling

LTPP guidelines require the FWD operator to process all FWD data using FWDConvert and FWDScan before leaving the site whenever it is practical to do so, or at a maximum of 24 hours after data collection. At this point, the operator must resolve any errors generated by FWDScan and note any necessary changes in the file. The operator must make a backup of the Pavement Deflection Data Exchange (PDDX) file on removable media and keep both original and backup in the FWD until the office acknowledges receipt of the copy sent to them.

Office Data Handling

Once the electronic data is received in the office, it should be rerun through FWDScan and any warnings or errors identified should be investigated and resolved. If changes are made, the files should be run through FWDScan again before being uploaded to the Regional Information Management System (RIMS). Any manual temperature measurements should also be entered into RIMS. The PDDX data file and any accompanying forms must then be archived.

Federal Highway Administration Central Federal Lands Highway Division

The CFLHD is a division of the FHWA's Federal Lands Highway Program. CFLHD administers the survey, design, and construction of forest highway system roads, parkways and park roads, Indian reservation roads, defense access roads, and other Federal lands roads within its jurisdiction, which covers the central United States, Hawaii, and American Samoa. The CFLHD recently adopted a new FWD testing and analysis protocol[2], which is summarized below.

[2] MACTEC Engineering and Consulting. FWD Testing and Analysis Guidelines – DRAFT: Guidelines for Falling Weight Deflectometer Testing and Analysis. FHWA Contract No: DTFH65-05-P-00118. 2006.

Planning and Equipment Calibration

Equipment Calibration

FWD equipment employed by the CFLHD for testing is required to have undergone reference calibration within the previous year and relative calibration within the previous month. Both types of calibration must have been performed according to the procedures contained in "SHRP/LTPP FWD Calibration Protocol". The gain values for each sensor entered in the FWD data collection software prior to testing must be consistent with these calibrations.

Equipment Requirements

CFLHD guidelines outline a number of requirements that FWD equipment must meet in order to be eligible to perform testing for the CFLHD. These are:

- Load Plate – must be 12 in. or 300 mm in diameter. An 18 in. or 450 mm load plate may be required for testing on unbound surfaces.

- Loads – the equipment must be capable of producing loads between 6,000 and 16,000 lbs to within 10% of the required level. The load pulse duration must be between 20 and 30 milliseconds.

- Deflection Sensors – a minimum of 9 deflection sensors is required.

- Temperature Sensors – it is preferred that the FWD is equipped with a surface temperature sensor and an air temperature sensor. However, it is permissible to use hand-held instruments to take these measurements instead.

- Data File Format – the equipment should be capable of producing data files compatible with the MODTAG data analysis software.

Equipment Set-Up

For standard testing, the deflection sensors should be placed at these spacings from the center of the load plate:

0", 8", 12", 18", 24", 36", 48", 60", 72"

Where load transfer testing is performed on a section, then the following sensor spacings should be used not only for the load transfer testing, but also for the basin testing:

0", -12", 12", 18", 24", 36", 48", 60", 72"

Test Planning

The CFLHD guidelines require a project to be broken into homogeneous sections if construction history, coring or other available information indicates that the pavement structure varies within the project limits. The resulting sections should, however, be large enough to allow at least fifteen test points in each direction.
For roads with more than one lane per direction, only the outside lanes should be tested. Test sections should be continuous, with intersecting roads, spur roads, access roads, ramps or parking lots treated as separate sections.
The testing interval should be between 100 and 1,000 ft (unless the section itself is less than 1,500 ft.). Ideal testing intervals are shown in Table 4.

Table 4. CFLHD ideal testing intervals.

Section Length (ft)	Testing Interval (ft)	Tests per Direction
1,000	50	21
1,500	100	16
2,000	125	17
5,000	250	21
10,000	500	21

Standard (non-research) FWD testing should only be performed when the air temperature is between 40°F and 90°F and when there is no indication of frozen layers or excessive moisture within the pavement structure. Additionally, load transfer testing should only be performed when the pavement surface temperature is below 85°F.

Field Testing

General Testing Procedures

Prior to commencing testing, CFLHD guidelines require a buffer warm-up sequence to be performed outside the section limits. This should be repeated any time the FWD is idle for more than 60 minutes. The load levels for this sequence are:

6 kip, 9 kip, 12 kip, 16 kip, 16 kip, 16 kip, 16 kip (repeat x 8)

Once testing commences, the required drop sequences are as shown below. In this list, 'S' represents a seating drop at 9 kips which is performed but not reported. The actual load must be within ± 10% of these specified loads.

- Standard: S, 9 kip, 12 kip
- Stiff Pavement (> 8 in. AC or with PCC layer): S, 9 kip, 16 kip
- Soft Pavement (< 2 in. AC): S, 6 kip, 9 kip
- Void Detection or non-linear analysis: S, 6 kip, 9 kip, 12 kip, 16 kip

As a rule, FWD testing should be performed in the outer wheel path (OWP), considered to be 30 in. from the outer lane edge. The operator may test the mid-lane instead if it is a great deal less distressed than the OWP; a note should be made on the file accordingly. The OWP testing rule does not apply to void detection tests, which should be performed at the outside corner of the concrete slab.

The operator should designate the section start limit as station 0, with all other test locations being referenced to that zero point. Station 0 should also be the first test location and the remaining tests should be performed at the specified spacing for that section. A test should be performed at the section end limit regardless of the interval from the previous test location.

After testing is complete in the first direction, the FWD should remain at the section end limit, but be repositioned into the correct path for the second direction. The DMI should be set to the reading recorded at the last test point in the first direction (i.e. the section end limit) and be set for decreasing stations.

The first test point in the second direction will be the section end limit. The second test point should be referenced to the location of the next-to-last test point in the first direction. If the station of the next-to-last test point in the first direction is less than half the specified test interval from the section end limit, then the second test point in the second direction should be at the location of the second test point in the first direction minus one-half of the test interval.

If the station of the next-to-last test point in the first direction is more than half the specified test interval from the section end limit, then the second test point in the second direction should be at the location of the second test point in the first direction plus one-half of the test interval. Subsequent test points shall be at the specified offset, starting from the second test point.

The CFLHD testing guidelines allow the operator to move the FWD forward or backward up to 10% of the specified test interval if the pavement surface at the test location is distressed. If the operator cannot find a sufficiently undistressed area, the test should be carried out at the specified test location and a note made on the file regarding the nature of the distress.

CFLHD requires that an air and pavement surface temperature measurement be taken at each test point. For certain research-related purposes, it may also be required for the operator to take sub-surface measurements. The depth of these measurements, and the time intervals under which they should be taken, would be decided on a case-by-case basis depending on the research requirements.

Throughout the testing, the operator should note any conditions that may be relevant during data analysis, such as weather events and distresses. Note should also be taken of landmarks such as intersecting roads and mile-markers that will help verify that the DMI is working correctly.

A separate FWD data files should be used for testing in each direction at the test section and data in the file should be collected using the same drop sequence. All data files should be compatible with MODTAG.

Rigid Testing Locations

For rigid pavements, basin tests should be performed at the center of the effective slab. Joint approach tests should be performed with the load plate located immediately prior to the selected effective slab, no more than 2 in. from the crack or joint, but not bridging it. Joint leave tests should be performed with the load plate on the selected effective slab, again no more than 2 in. from the joint or crack, but not bridging it.

Void detection testing should be performed on the outside corner of the selected slab. The load plate should be tangent to both the longitudinal and transverse cracks/joints that define the effective slab. Again, the load plate should be no more than two inches from either crack or joint, but must not bridge them.

Field Data Quality Checks

The CFLHD guidelines outline a number of error conditions that should be checked for and resolved at the time of testing. These are:

- *Non-decreasing Deflections* – if this error is triggered, the operator should check for a crack between the two sensors and re-position the FWD if this is found to be the case (without exceeding 10% of the test interval). If this is not the case, then the deflection sensors should be checked for proper seating on the pavement surface and adjusted if necessary.

- *Roll-off* – as this error generally occurs when the deflection sensor does not have good contact with the pavement surface due to debris, the operator should first check for these conditions and, if they are found, try raising and lowering the sensor bar or repositioning the FWD. It may also be necessary to sweep the area underneath the FWD. If the roll-off error is caused by a very weak pavement that is deformed by the FWD test, then the drop sequence may need to be reduced.

- *Overflow* – Overflow errors are most commonly caused by severely distressed pavement surfaces. As such, the operator should reposition the FWD to a less distressed area, if possible, but without exceeding ± 10% of the testing interval. If there is no evidence of pavement distress or thin pavement, the operator should check for equipment problems, such as a deflection sensor that is not securely fastened to its holder. If this error occurs on very thin pavements, the drop sequence may need to be decreased.

- *Deflection Variation* – this error usually indicates that one or more deflection sensors have poor contact with the pavement surface. The operator should attempt to clear the error by raising and lowering the sensor bar. If the pavement being tested is very thin or highly distressed, the error may indicate

that the pavement properties are being modified by the testing process itself. In such cases, the FWD should be repositioned to within ± 10% of the testing interval and the test repeated.

FWD Data Analysis

Layer Thickness Information

The CFLHD guidelines discuss the importance of accurate layer information in FWD data analysis, including number of layers, materials making up each layer, layer thickness, and depth to rigid layer. It discusses the main ways in which layer information can be gathered – through records review, coring/boring, and Ground Penetrating Radar (GPR) testing.

Whilst the document does not make any specific recommendations about which methods should be employed, it is clear that the non-destructive method of GPR testing, which can be performed at highway speeds without traffic control, has a number of advantages over relying entirely on the destructive method of coring/boring.

Pre-Analysis

In the pre-analysis phase, FWD data should undergo quality assurance (QA) checks, have suspect data removed, and be separated into analysis sub-sections. The QA checks are run in MODTAG. These checks should be run as soon as possible after testing to make any errors as easy as possible to resolve. A number of potential errors may be highlighted in the pre-analysis. These are:

- SLIC Warning –triggered when it appears that the sensor spacings listed in the data file do not match the actual sensor spacings
- Non-decreasing Deflections
- Zeros in Data
- Overflow

If these data checks show that data from specific sensors is commonly in error, then the data from these sensors may be removed from analysis for all records for a maximum of two sensors. However, the center sensor may not be removed from analysis.

Any records containing data that trigger one or more of the error conditions should not be used in further analysis. It is not expected that any more than 2% of records should fail these data checks.

Under CFLHD guidelines, any pavement with more than 30 test points in each direction should be analyzed for sub-sections using MODTAG's "cumulative difference of deflections" approach. No resulting sub-section should have fewer than 15 test points in each direction.

Backcalculation Analysis – Standard Procedure

After the pre-analysis data checks and sub-sectioning procedures have been performed, backcalculation analysis can be performed. As a standard, the analysis should be conducted through MODTAG.

Layer material and thickness data for the pavement section, determined by coring, construction history, and other information, should be input into the analysis. Typically, at least three layers will be input: surface (AC or PCC), granular base, and subgrade. Two adjoining layers of the same material type should be input separately if there is a difference in properties or time of construction. However, no input layer should have a thickness less than 2 in. Additionally, if MODTAG's depth-to-hard bottom analysis indicates the presence of a hard layer at less than 300", then a hard bottom layer, with modulus of 1,000,000 psi, should be included in the analysis.

The values shown in Table 5 should be used as default seed moduli and Poisson's ratios within the analysis. These values should be adjusted as required by project-specific information.

All pavement sections with an AC layer must undergo temperature correction prior to analysis. The BELLS3 estimation in MODTAG, with a reference temperature of 68°F, should be used as a default, but the actual measured mid-depth temperature of the AC layer should always be used instead wherever it is available.

Table 5. CFLHD default seed moduli and Poisson's Ratio values.

Material Type	Seed Modulus (psi)	Poisson's Ratio
Portland Cement Concrete	4,000,000	0.15
Asphalt Concrete	400,000	0.35
Asphalt Stabilized Base	300,000	0.35
Cement Stabilized Base	200,000	0.25
Granular Base	40,000	0.35
Granular Subgrade	20,000	0.40
Fine-grained Subgrade	10,000	0.40
Hard Bottom	1,000,000	0.20

After backcalculation analysis has been run, quality assurance checks should be performed on the results. Root mean squared (RMS) errors shall be checked. Sections with RMS errors greater than 3% should be rejected and analysis re-performed. Individual basins with RMS errors greater than 5% should also be rejected. Up to 5% of basins can be removed from a section and the RMS errors recomputed. If the average RMS error remains greater than 3% or the maximum error remains greater than 5%,

then the section should be rejected and analysis re-performed. The minimum and maximum average acceptable average calculated moduli are shown in Table 6. Analysis shall be re-performed where calculated values for any layer exceed these limits.

Table 6. CFLHD acceptable average calculated moduli values.

Material Type	Modulus (psi)	
	Lower Limit	Upper Limit
Portland Cement Concrete	1,000,000	7,000,000
Asphalt Concrete	100,000	1,000,000
Asphalt Stabilized Base	70,000	700,000
Cement Stabilized Base	50,000	500,000
Granular Base	15,000	50,000
Granular Subgrade	10,000	50,000
Fine-grained Subgrade	5,000	50,000

If sections that have been rejected after the above steps fail again after re-performance of the analysis, then the layer structure can be adjusted by:

1. Combining adjacent layers of similar materials into a single layer
2. Using seed modulus as a known value for thin layers (< 2 in. thick)
3. Using seed modulus as a known value for soft layers that lay over stiff layers, e.g. AC overlays on PCC pavements

If sections still fail the quality assurance checks after these steps are taken, then the layer structure information needs to be re-verified or backcalculation analysis run using AASHTO 1993 procedures.

After the quality assurance checks have been passed, the structural layer coefficient should be calculated for each pavement layer, excluding the subgrade. The effective structural number (SN_{eff}) should then be calculated.

CFHLD reporting requirements state that Station, Lane, average load, modulus of each layer, and RMS error should be reported for each deflection basin. For each section and load, the report should contain average load; average, minimum, maximum and standard deviation of the modulus of each layer; and the average and maximum RMS error.

Backcalculation Analysis – AASHTO 1993 Procedure

Although the above describes the standard backcalculation practices, the analysis can instead be performed using the 1993 AASHTO protocols if specifically requested by the Pavement Engineer. MODTAG should also be used to perform the analysis in this instance.

For flexible pavements, only the nominal 9,000 lb drop should be analyzed. As with the standard procedure, temperature correction should be performed, using actual measured mid-depth temperatures if available, or BELLS3 as a default. The subgrade resilient moduli shall be corrected using a factor of 0.33. Reporting requirements for each deflection basin are: station, lane, load, SN_{eff}, pavement modulus (E_p), calculated subgrade resilient modulus (M_r), and corrected subgrade modulus. For each section, the report should record the average load, and the average, minimum, maximum, and standard deviation of SN_{eff} and corrected M_r.

For rigid pavements, again, only the nominal 9,000 lb drop should be analyzed. The "PCC Area/K – Jointed/CRC" option should be used, except where the pavement includes both AC and PCC in which case the "PCC Area/K – Composite" option should be used. Poisson's ratio should be set to 0.15 for either option. Reporting requirements for each deflection basin are: station, lane, load, static K, dynamic K, and modulus of the PCC layer. For each section, the report should record the average load, and average, minimum, maximum, and standard deviation of the static K and modulus of the PCC.

Load Transfer Efficiency

MODTAG should be used to calculate Load Transfer Efficiency (LTE). LTE calculations should be made for all load levels for both joint approach and joint leave tests. Reporting requirements are: station, lane, load, test type (i.e. approach or leave), and LTE. For each section, load, and test type, the report should record the average load, test type, and average, minimum, maximum, and standard deviation of LTE.

Void Detection

MODTAG should be used to perform void detection analysis. The report shall include station, lane, and x-intercept for each void detection test.

Virginia Department of Transportation

The Virginia Department of Transportation (VDOT) has a well defined FWD testing and analysis program[3]. The protocols of that program are outlined below.

[3] Virginia Department of Transportation. Manual of Instructions Materials Division, Section 602 – Falling Weight Deflectometer Testing and Analysis Guidelines. 2006.

Planning and Equipment Calibration

Equipment Set-Up

VDOT guidelines recommend the sensor spacings shown in Table 7 as a standard for basin testing on flexible or rigid pavements. The offset distances from the center of the load plate are shown in inches.

Table 7. VDOT sensor spacings.

	D1	D2	D3	D4	D5	D6	D7	D8	D9
9-Sensor Units	0	8	12	18	24	36	48	60	72
7-Sensor Units	0	8	12	18	24	36	60	n/a	n/a

However, for joint or crack testing on rigid pavements, only two sensors are required, which should be set at:

0 in. and 12 in.

Test Planning and Testing Locations

The guidelines recommend that a project be tested in the direction(s) in which the pavement is to be repaired. Typically, testing should take place in the outside travel lane, but testing on the inside lane should also be conducted if:

1. The pavement structure is different than the outside lane,
2. More load-related distress is present than in the outside lane, or
3. Heavy truck traffic uses the lane (e.g. the lane is prior to a left exit).

Where a project contains multiple intersections, making FWD testing difficult due to traffic, testing should still be conducted at approaches and leaves to an intersection wherever possible.

The recommended test spacing for VDOT flexible or composite pavements is shown in Table 8. The spacing is determined by the project length in terms of directional, rather than centerline, length. A testing day is defined as 200 locations tested. For two- or three-lane bi-directional roadways without a median, the testing should be staggered by one-half the test spacing. This staggered testing pattern is not required for projects that are separated by a median.

For flexible pavements, FWD testing should be conducted in the wheel path closest to the nearest shoulder, i.e. in the right wheel path for outside lanes and the left wheel path for inside lanes. For composite pavements, basin testing should be conducted either in the middle of the lane or near the center of the slab. When joint testing is to be

performed on composite pavements, it should be conducted in the wheel path closest to the free edge of the slab.

Table 8. VDOT test spacing – flexible/composite.

Project Size (miles)	Test Spacing (feet)	Approximate Number of Tests	Testing Days
0 – 0.5	25	75	½ Day
0.5 – 1.0	50	90	½ Day
1.0 – 2.0	50	175	1 Day
2.0 – 4.0	100	175	1 Day
4.0 – 8.0	150	200	1 to 1 ½ Days
> 8.0	200	>200	> 1 ½ Days

The recommended test spacing for jointed concrete pavements (JCP) is shown in Table 9. Spacing is determined by the number and length of jointed concrete slabs in a project. For projects with short slab lengths, it may not be practical to test every slab (basin and joint testing). The directional length of the project also determines the spacing. A testing day is defined as 175 locations tested (joints, corners and basins). Three types of testing are typically conducted on JCP pavements, each with their own specified locations. These are:

- *Basin Testing* – should be conducted near the center of the slab.
- *Joint Testing* – should be conducted in the wheel path closest to the free edge of the slab.
- *Corner Testing* – should be conducted at the slab's free edge corner, i.e. the right edge corner for outside lanes and the left edge corner for inside lanes. The testing should be conducted on the leave side of the joint, where voids are typically located.

Table 9. VDOT test spacing – JCP.

Project Size (miles)	Slab Length	Basin Test Spacing (no. of slabs)	Joint/Corner Spacing (no. of slabs)	Approximate Number of Tests	Testing Days
0 - 0.5	< 20’	Every 6th Slab	Every 2nd J/C	115	1 Day
	20’ – 45’	Every Slab	Every J/C	175	1 Day
	> 45’	Every Slab	Every J/C	120	1 Day
0.5 – 1.0	< 20’	Every 9th Slab	Every 3rd J/C	180	1 Day
	20’ – 45’	Every 2nd Slab	Every 2nd J/C	175	1 Day
	> 45’	Every Slab	Every J/C	300	1 ½ - 2 Days
1.0 – 2.0	< 20’	Every 12th Slab	Every 4th J/C	250	1 – 2 Days
	20’ – 45’	Every 4th Slab	Every 2nd J/C	300	1 ½ - 2 Days
	> 45’	Every 2nd Slab	Every 2nd J/C	270	1 ½ - 2 Days
2.0 – 4.0	< 20’	Every 15th Slab	Every 5th J/C	380	1 ½ - 3 Days
	20’ – 45’	Every 6th Slab	Every 4th J/C	380	1 ½ - 3 Days
	> 45’	Every 4th Slab	Every 2nd J/C	450	2 – 3 ½ Days
4.0 – 8.0	< 20’	Every 20th Slab	Every 10th J/C	220	1 ½ - 3 Days
	20’ – 45’	Every 8th Slab	Every 4th J/C	470	2 ½ - 4 ½ Days
	> 45’	Every 6th Slab	Every 3rd J/C	590	2 ½ - 4 ½ Days
> 8.0	< 20’	Every 20th Slab	Every 10th J/C	450	3 Days
	20’ – 45’	Every 10th Slab	Every 5th J/C	650	3 ½ - 4 Days
	> 45’	Every 8th Slab	Every 4th Slab	500	3 Days

The recommended test spacing for continuously reinforced concrete pavements (CRCP) is shown in Table 10. The directional length of the project will determine the required spacing. A testing day is defined as 175 locations tested (cracks and basins). Two types of testing are typically conducted on CRCP pavements, each with their own specified locations. These are:

- Basin Testing – should be conducted near the center of the panel
- Crack Testing – should be conducted in the wheel path closest to the free edge of the slab

Table 10. VDOT test spacing – CRCP.

Project Size (miles)	Basin Test Spacing (feet)	Crack Spacing (feet)	Approximate Number of Tests	Testing Days
0 – 0.5	25	25	150	1 Days
0.5 – 1.0	50	25	270	1 ½ Days
1.0 – 2.0	100	50	270	1 ½ - 2 Days
2.0 – 4.0	150	50	450	2 – 3 Days
4.0 – 8.0	150	75	650	2 ½ - 5 Days
> 8.0	200	150	680	4 Days

Field Testing

FWD Testing

Regardless of the pavement type being tested, the surface temperature should be taken at each test location, either using the FWD's integral infrared thermometer, or using an external handheld thermometer.

VDOT's recommended drop sequences vary depending on pavement type and the type of information being gathered. The recommended drop sequence for basin testing on any pavement surface, as well as joint and crack testing on composite, JCP or CRCP pavements is:

- Two Seating Drops at 12,000 lbs
- Three Recorded Drops at 6,000 lbs
- Three Recorded Drops at 9,000 lbs
- Three Recorded Drops at 12,000 lbs
- Three Recorded Drops at 16,000 lbs

The recommended drop sequence for corner testing on JCP pavements is:

- Two Seating Drops at 12,000 lbs
- Three Recorded Drops at 9,000 lbs
- Three Recorded Drops at 12,000 lbs
- Three Recorded Drops at 16,000 lbs

Complementary Field Testing Activities

The VDOT guidelines discuss two additional data collection activities that can provide information necessary for FWD data processing: pavement surface condition survey and coring/boring.

VDOT recommends that a detailed pavement condition survey should be conducted at the project site prior to FWD testing. This survey will help the engineer identify possible problem areas and determine an appropriate FWD testing plan. The requirements for the pavement condition survey are to:

- Identify distress type, severity, extent and exact location,
- Identify patched areas and areas that will probably require patching before or during the rehabilitation project, and
- Use same linear referencing system as FWD data collection.

As pavement structure information is vital for FWD data analysis, VDOT requires that pavement coring/boring be carried out at the project site. For materials above the subgrade, the coring and boring crew should record:

- Layer Materials
- Layer Thickness
- Layer Condition
- Material Types

For the subgrade soils, the following material properties should be determined in the lab:

- Soil classifications (gradations and Atterberg Limits)
- Natural moisture content
- Lab CBR
- Resilient modulus (undisturbed or remolded)

New Jersey Department of Transportation (Project-Specific)

The NJDOT Pavement Management System (PMS) II project involved the collection of FWD data from 2,064 test miles of roadway from Interstate, US, and NJ routes. Collection was performed at both the project and network level. Due to the scale of the FWD data collection effort, FWD testing protocols were developed for use within the project. These are detailed in the project's final report[4]. A summary of the key requirements is given in this section. Due to the different objectives and scale involved in project-level and network testing, different requirements were often put in place for each kind of testing. When a requirement is solely intended for one particular type of testing, this is clearly indicated in the text. Requirements where no particular type of testing is indicated can be assumed to apply across the board.

[4] Stantec Consulting (2006). *Pavement Management System II – Final Report.* NJDOT, 2006.

Throughout the testing, composite pavements were tested in the same way as flexible pavements if reflective cracks were not evident on the pavement surface and in the same way as rigid pavements if reflective cracks were visible.

Planning and Equipment Calibration

Calibration and Verification

Before commencing testing, the FWD and HWD units used in the PMS II project were calibrated according to the SHRP-LTPP FWD field manual and the manufacturers' specifications. The deflection sensors went through a relative calibration on a monthly basis to ensure the response is the same regardless of position in the deflection stand. Additionally, FWD operators performed daily checks to ensure the drop height load applied to the pavement was within range and the deflection sensors responded as expected, i.e. that the deflections decreased with distance from the load center.

Equipment Set-Up

Prior to testing, the FWD operating software was loaded on the on-board computer, and the connections from the FWD unit, the Distance Measuring Instrument (DMI), unit and the power supply unit to the computer were all checked to ensure that they were in good working order. The data collection software was also set-up for collection on the appropriate pavement type. The operator could choose various prompts to be displayed to ensure consistency in data collection practices (such as slab ID, test location, pavement surface temperature, etc.). It was mandatory for data validity checks, except the repeatability check, to be enabled.

The required sensor spacing for FWD testing in the PMS II project was as shown in Table 11 below.

Table 11. NJDOT PMSII sensor spacing.

Sensor	D1	D2	D3	D4	D5	D6	D7	D8	D9
Offset from Load Center (in.)	0	12	18	24	36	48	60	72	-12

Pre-Testing Activities

Prior to field testing, the FWD operators were briefed on the testing and reporting protocols. Operators were provided with a checklist to ensure that each step in the testing and reporting procedure was adhered to. The operator also completed a 'check list' of equipment/supplies and operating conditions prior to setting out for the test site.

Testing Planning and Testing Locations

For project-level testing, the projects had no set length; however, test planning involved a number of different rules for testing frequency and location depending on the pavement type. For flexible pavements, 20 tests were performed each mile – approximately every 250 ft – in the right wheel path (RWP) of the slow lane (measured as 3 ft from the lane/shoulder). For rigid pavements, testing was conducted at 20 test points per mile in the RWP of the slow lane to the nearest mid-slab. The mid-slab itself was tested. If necessary, the test point was adjusted so that the mid-slab measurement was always at least 5 ft from the nearest active transverse crack. The approach and leave side of the corresponding joint/crack were also tested, as were the pavement edge/shoulder corners on the approach and leave sides of the crack. The edge of the pavement/shoulder joint on the pavement side adjacent to the mid-slab was also tested every 250 ft.

At the network level, testing on flexible pavement was again conducted in the RWP of the slow lane (3 ft. from the lane/shoulder), but at 10 test points per mile – approximately once every 528 ft. For rigid pavements, testing was conducted at 10 test points per mile in the RWP of the slow lane to the nearest mid slab. The mid-slab itself was tested. If necessary, the test point was adjusted so that the mid-slab measurement was always at least 5 ft from the nearest active transverse crack. The approach and leave side of the corresponding joint/crack were also tested, as were the pavement edge/shoulder corners on the approach and leave sides of the crack. The edge of the pavement/shoulder joint on the pavement side adjacent to the mid-slab was also tested every 528 ft.

Field Testing

Testing Procedures

Target load levels were as shown in Table 12. One drop was made at each of the listed load levels. Buffer warm-ups were also performed at the start of each section.

Table 12. NJDOT PMSII target loads.

Height	Target Load
Seating	9,000 lbs
1	6,500 lbs
2	9,000 lbs
3	12,000 lbs

Tests were conducted in crack- and patch-free areas as much as possible, whilst remaining close to the locations specified in the test plan. Digital photographs and visual notes were taken and added to the file to document any unusual pavement condition close to the test point.

Air, pavement surface, and gradient temperature measurements were taken at various times during the test cycle using either thermistors integral to the FWD equipment or a handheld infrared sensor. Air and pavement surface measurements were taken before commencing FWD testing on each project, or each day, whichever is applicable, and every hour thereafter. When ahead of schedule, mid-depth pavement temperature data was also collected. The aim was to take 2 to 3 mid-depth measurements per data collection shift. The procedure for mid-depth temperature data collection was as follows:

- Find asphalt layer thickness using first core.
- Drill 0.5”-hole near the first core to mid-depth of the asphalt layer.
- Pour oil and insert thermometer into the hole to the drilled depth.
- Wait for a minimum of 20-25 minutes for the temperature to stabilize.
- Record the temperature.

Reporting Protocols

The following file naming convention was followed throughout the PMS II project:

> ddmmyyTS.mdb and ddmmyyTS.f25 for FWD
> ddmmyyTS.f25 for HWD
> dd = day; mm = month; yy = year; T = shift (D for day and N for night); S = Sequence No. for each project – this begins at 1 each day.

Typically, each project was contained in one data file. However, a new file was started if there was a change in pavement type within the project. For rigid pavements, the above protocol was used for testing along the RWP; however, for testing corners and edges, testing along each path was saved a separate file and the following protocol was used:

> ddmmyyTL.mdb and ddmmyyTL.f25 for FWD
> ddmmyyTL.F25 for HWD
> dd = day; mm = month; yy= year; T = shift (D for day and N for night); L = path or location (L for left wheelpath; R for right wheelpath; B for between wheelpaths, E for edge)

A number of comments were required to be entered along with each file: the direction of travel; any unusual features (e.g. patch area, start of different pavement type, change in slab panel size, reason test could not be performed, such as off-ramp, on-ramp, bridge, rest area entrance, etc.); and condition of pavement in terms of distresses. Stations were referenced by milepost, rather than feet, as follows:

mm.nnn
mm = milepost number; nnn = fraction of a mile

For the FWD, electronic and hardcopy data were recorded in US Customary units; for the HWD the electronic data was in metric units but the hardcopy was recorded in US Customary units.

Additional Safety-Related Procedures

The FWD unit was checked for the following items at the start of each working day to ensure proper and safe working condition:

- Sufficient fuel for full day's testing and travel.
- All lights, brakes, and horns in working order.
- The vehicle and trailer is equipped with proper lighting and reflective stripes for night visibility.
- Equipment equipped with an audible back-up signal system.
- All tools and other equipment present that may be required for troubleshooting.

If it was observed that any part of the equipment was not working in a safe manner, this was to be brought immediately to the attention of the Field Manager.

At all times during testing, the FWD operators were required to be wear proper field gear for personal safety and for visibility/recognition, which includes, as a minimum:

- Approved steel toe safety shoes/boots
- Approved hard hats (to be used when outside the vehicle)
- Safety glasses with side shields (when carrying out inspections or maintenance from outside the vehicle)
- Reflective vest or overalls
- Reflective stripes (for night time testing)

To reduce exposure to carbon monoxide, operators were required to stay a safe distance away from exhaust fumes at all times during testing. Safety precautions were also taken with regard to weather conditions – FWD operations were not conducted during severe rainfall, fog or other conditions resulting in poor visibility. Operations were also not conducted during snow storms or squalls.

Traffic Safety – FWD Operator Responsibilities

At all time during FWD operations, specialist traffic control providers were used to provide all necessary warning signs, equipment, Truck Mounted Attenuators (TMA) and traffic control personnel (TCP) to conform with NJ regulations. However, FWD operators were required to adhere to a number of related procedures to ensure work zone safety within the controlled area. This included requirements to:

- Enter designated work area in a convoy formation, with amber rotating lights and 4-way flashers in the functional mode to prevent non-designated vehicles from accidentally entering the work area.

- Pull vehicle as far onto the shoulder as possible, before commencing work.

- Ensure that the immediate work area is cordoned off in such a manner that the FWD activity can be carried out in safety.

- Work as far away as possible from barricades or cones which demarcate the boundary between the work area and the traveling public.

- Never cross the external boundary of the delineator cones or barrels under any circumstances.

- Not pull over onto the lane to be tested without having a TMA-equipped crash truck behind for freeways and expressways, or TCPs for low volume roads.

- Work from the nearest paved or unpaved shoulder for single lane closures. On two-lane closures, work at least 1 m (3 ft) away from the open lane beyond the second closed lane. On one- and two-lane closures, never drive vehicles against the direction of traffic, especially at night.

- Always drive carefully, even in full lane closures as other authorized parties, such as contractors and maintenance crews, may also be conducting work in the area.

- Conduct all FWD testing in the direction of traffic and moving in the direction of traffic.

- Conduct all work within the specified operating hours. The FWD unit should not be present on the work site after the designated road or lane re-opening time.

- Vacate the site immediately if wet, freezing or slippery weather conditions occur. The site should also be vacated if maintenance of the highway pavement and shoulders is scheduled.

- Store equipment in such as way as not to create view obstructions to vehicular or pedestrian traffic.

- Report immediately to the supervisor any circumstances of equipment failure, possible safety shortcomings or unsafe traffic setup practices that the operator feels may result in injury.

Coring/Boring Procedures

Due to the need for accurate pavement structural information as an essential component in FWD backcalculation analysis, coring/boring was performed in the PMS II

project alongside the FWD testing. For both network and project-level testing, cores/bores were taken at the start of each section and at approximate one-mile intervals throughout the section. The following list summarizes the protocol that field staff were asked to follow during coring activities:

1. Identify coring locations upon arrival at site.

2. Complete Core Log Sheet including station location, direction of traffic, and core ID.

3. To ensure high quality cores:
    a. Core barrel sizes must be 6" inside diameter.
    b. Mist or air-cooled drilling is preferred. Water is acceptable
    c. In terms of projections and depressions, and excellent core has < 0.25 mm (0.01"); a good core has 0.25 – 2.5 mm (0.01-0.1").
    d. A good core has skewness from the vertical axis of no more than 0.5 of a degree (1.5 mm in 150 mm or 1/16 of an inch in 6 inches).

4. Use suction cups or wire pulls to extract cores from hole.

5. Mark each core with core ID number. Keep core standing up, inverted with top down, not on its side.

6. Take thickness measurements of each layer at 3 locations; record the average of those measurements on the Core Log Sheet.

7. Photograph each entire core against a scale using a white board as a background.

8. Use a marker to permanently label the core with the site ID and the core ID, e.g. I-295 S, MP 53.

9. Prepare a label for each core with the following information: Section ID, core location number, core ID, coring date, and field set number.

10. Wrap the core prior to transit with saran wrap. Place upright in a box to avoid damage during transportation.

11. Deliver cores to agreed location.

12. Complete sampling report, either on site or later in the day, and send to main office.

13. Remove all water remaining in core holes via vacuum extraction or other acceptable method.

14. Place cold patch in the holes and compact it in lifts of 100 to 150 mm (4 to 6 inches) using a mechanical or hand held tamping rod.

15. On the road surface, create a small hump of the compacted mix to allow for any subsequent settlement of the mix within the cored hole.

16. Clean the core location of any debris or objectionable material, prior to leaving the site.

The following list summarizes the protocol that field staff were asked to follow during boring activities:

1. Carry out boring at the cored locations, unless directed otherwise.

2. To ensure high quality granular and soil samples, auger sizes must be at least 6" inside diameter, and do not drill continuously to the full depth. Drill in 12" lifts. Retract auger and check on type of material

3. Visually classify each material contacted.

4. Take samples of each material type from various points of the auger spiral.

5. Place each material in a zip lock bag and mark it with Site ID, sample ID, location depth, and date.

6. Using a crow bar, scratch the sides of the drilled hole to recheck the depth at which each material type was contacted.

7. Remove all remaining water in drill hole by vacuum extraction or other acceptable method.

8. Fill the drilled hole with the excavated material and compact it. Then use cold patch to fill the hole to the surface as described for the coring operation.

9. Remove debris or objectionable material from the drilled location prior to leaving the site.

10. Return samples to agreed location; log and recheck to confirm the aggregate and soil description.

11. Complete sampling report, either on site or later in the day, and send to main office.

Data Quality Checks

Field Data Quality Checks

The software on the FWD equipment used in the PMS II project performed a number of quality control checks on the collected data prior to the removal of traffic control from the test site (in case of a need to re-test), which included:

- Decreasing deflection with distance from the load plate.
- Proper contact between sensors and pavement (Roll Off).
- Overflow – Deflections are within range of the sensitivity of the sensors (up to 80mils).
- File format checks to ensure that the raw data is formatted correctly and is complete (testing location, measured temperatures, sensor spacing, number of load drops, load levels, etc.)
- Reasonableness of collected data (e.g. maximum and minimum temperatures among sections tested, number of setup drops versus actual number of drops, if load levels are increasing at each station, limits of load levels, reasonableness of deflection 1 (D1) and the ratio between load and deflection D1).

Field Data Handling

FWD operators were required to adhere to the following requirements for field data handling:

- Hard copies of the FWD data had to be printed on a daily basis (if required).
- The FWD data files had to be copied onto disc and correctly labeled.
- A backup copy of the FWD data had to be made in case of loss in transit to office.
- Field logs had to be checked for completeness and readability.
- Field data transmittals (hard copies, floppies, field logs, etc.) had to be organized and sent to the office without undue delay.

Office Data Processing

Once the field data was received by office staff, the first step was to organize and check the field data transmittal. A checklist was complete to ensure that all the required documentation had arrived and that all the right documentation was attached to the right data. The files were then scanned for viruses, transferred to the designated directory,

and the original data archived. Two copies of the transmitted data were made: one for review by the Quality Assurance Manager and the other as office backup.

Data files were then checked for completeness and accuracy of data, particularly the following:

- Correct file naming and numbering for each project and each FWD test location.
- Proper highway definition and project identification.
- Target loads and testing locations, etc.
- Testing patterns.
- Reasonableness of data.

If anomalies in the collected data were identified, the field office was contacted for clarification. A completed *Data Completeness Form* was passed on to the Quality Assurance Manager who performed a secondary review. Any remaining anomalies in the processed data were resolved at this stage, up to and including manual upgrade of FWD data, if required. After the upgrade was completed, the output was re-reviewed to confirm it now met all reasonableness checks. Data could then be considered ready for analysis.

FWD Data Analysis

Flexible Pavement

In this project, the 1993 AASHTO Pavement Design backcalculation procedure was used to estimate the effective pavement and subgrade moduli for flexible pavements. The first step in the process was to normalize the collected FWD data to a 9000-lb load level. The 1993 AASHTO procedure was then applied to account for the normalized deflection basins to bring the tests performed at different temperatures to a standard temperature of 70°F. Backcalculation analysis (using Boussinesq's Theory and O'dmark's Transformation approach – similar to that outlined in the 1993 AASHTO Guide) was performed on each deflection basin to determine the effective pavement modulus, as well as the asphalt, aggregate and subgrade moduli.

The Structural Number required to support future traffic (SN_{req}), which accounts for both the effective pavement and subgrade moduli, was used in this project as a measure of the pavement's in-situ structural capacity. As the ability to support future traffic depends on the amount of that future traffic, the traffic classes shown in Table 13, based on roadway functional class, were used to calculate the SN_{req}.

Table 13. NJDOT PMSII future traffic classes.

Functional Class	Assumed Future Traffic (in 10 years)
Urban – Interstate	100 million ESAL
Rural – Interstate	50 million ESAL
Urban – Non-Interstate	30 million ESAL
Rural – Non-Interstate	10 million ESAL

Rigid Pavement

In this project, the 1993 AASHTO Pavement Design backcalculation procedure was used to estimate the effective modulus of elasticity of the PCC slabs (E_{pcc}) and the modulus of subgrade reaction (k) of the foundation for rigid pavements. Equation 1 below was used to calculate the area of the deflection basin from mid-slab deflections.

$$Area = 6 * [1 + 2(d_{12}/d_0) + 2(d_{24}/d_0) + (d_{36}/d_0)] \quad (1)$$

Where, d_0, d_{12}, d_{24} and d_{36} are the normalized deflections at 0, 12, 24 and 36 inches from the center of the load plate.

The PCC thickness required to support future traffic (D_{req}), which accounts for both the effective modulus of elasticity of the PCC slabs (E_{pcc}) and the modulus of subgrade reaction (k), was used in this project as a measure of the pavement's in-situ structural capacity. As the ability to support future traffic depends on the amount of that future traffic, the traffic classes shown in Table 13, based on roadway functional class, were used to calculate the D_{req}.

Using data from joint testing (approach and leave locations), Load Transfer Efficiencies (LTEs) were calculated as the ratio of the unloaded slab deflection to that of the loaded slab.

Composite Pavement

In the PMS II project, composite pavement sections were analyzed twice: once in the same way as flexible pavements and once in the same way as rigid pavements. The two sets of results were then evaluated and the most reasonable set of results was selected for the pavement section.

In the 'rigid pavement' round of analysis, the following equation was used to calculate the area of the deflection basin:

$$Area_{pcc} = 6 * [1 + 2(d_{12}/ d_{0pcc}) + 2(d_{24}/d_{0pcc}) + (d_{36}/ d_{0pcc})] \quad (2)$$

Where,

d_{0pcc} = PCC deflection in center of the load plate, and

$$= d_0 - d_{0ac} \quad (3)$$

$$d_{0ac} = -0.0000328 + 121.5006 * (d_{0ac}/E_{ac})^{1.0798} \quad (4)$$

$$E_{ac} = 6.451235 - 0.000164671t_p^{1.92544} \quad (5)$$

t_p = AC mix temperature

d_{12}, d_{24} and d_{36} are the normalized deflections at 12, 24 and 36 inches from the center of the load plate. With this exception, all other analyses were ostensibly the same as described for flexible and rigid pavements.

FWD TESTING – RECOMMENDATIONS FOR NJDOT

After examination of the current state-of-practice for FWD testing and analysis procedures and discussions with NJDOT concerning its specific needs, the following recommendations are made regarding protocols for FWD testing and analysis in the state of New Jersey.

Planning and Equipment Calibration

Calibration and Verification

Reference Calibration – All FWD equipment to be used for testing in New Jersey must be reference calibrated within the last year. Reference calibration must be performed according to the most recent FHWA LTPP protocols. Should the load cell or signal processor be replaced, then the unit must undergo reference calibration before recommencing testing. Reference calibration will also be required if other major components, such as the deflection sensor, multi-signal cable, or trailer Printed Circuit Board (PCB), are replaced, but the unit can be used for data collection in the meantime.

Relative Calibration – All FWD units that are actively testing in New Jersey must be relative calibrated in the last month and must continue to undergo relative calibration on a monthly basis throughout the testing period. Relative calibration must be performed according to the most recent FHWA LTPP protocols. Additional relative calibration will also be required prior to a unit recommencing work after the replacement of a major component, such as a deflection sensor, multi-signal cable, or trailer PCB board.

DMI Calibration – All FWD units that are actively testing in New Jersey must have had the DMI calibrated in the last month and must continue to undergo DMI calibration on a monthly basis throughout the testing period. DMI calibration must also be performed before the unit recommences work if the tow vehicle undergoes maintenance, including replacement of tires. To calibrate the DMI, the FWD unit should be driven across a straight and reasonably level pavement section of a known distance of at least 500 ft.

Temperature Sensor Verification – All temperature sensors, both those included in the FWD device and those that are used separately to complement FWD data collection, must undergo accuracy verification on a monthly basis. If a temperature sensor fails the designated verification procedure, it must be returned to the manufacturer for repair or recalibration, and/or be replaced with a new sensor.

Equipment Set-Up

Prior to commencing FWD testing operations, the FWD equipment should be set up to comply with the following requirements.

Deflection Sensor Spacing – Deflection sensors should be set at the recommended offset distances shown in Table 14. The positions are in inches, measured from the center of the load plate.

Table 14. Recommended sensor locations.

Sensor	D1	D2	D3	D4	D5	D6	D7	D8	D9
9-Sensor Configuration	0	12	18	24	36	48	60	72	-12
7-Sensor Configuration	0	-12	12	24	36	48	60	n/a	n/a

Weight Package – Three standard weights and two buffers should be used on each side and configured in such a way as to generate the recommended load levels.

Load Levels – The recommended target load levels for New Jersey are shown in Table 15. To be acceptable, equipment must be configured in such a way that the actual load applied is within 10% of the target load. During testing, one seating drop should be performed, followed by one drop at each of the recommended load levels.

Table 15. Recommended target loads.

Height	Target Load
Seating	9,000 lbs
1	6,500 lbs
2	9,000 lbs
3	12,000 lbs

Test Planning and Testing Locations

It is recommended that a project be tested in the direction(s) in which the pavement is to be repaired. Typically, testing should take place in the outside travel lane. However, NJDOT engineers may require that the inside lane be tested if one of more of these conditions exist:

- The pavement structure of the inside lane is different than the outside lane.
- More load-related distress is present in the inside lane than in the outside lane.
- Heavy truck traffic uses the inside lane (e.g. the lane is prior to a left exit).

Where a project contains multiple intersections, making FWD testing difficult due to traffic, testing should still be conducted at approaches and leaves to an intersection wherever possible.

The testing frequency depends on the project length – in terms of directional, rather than centerline length. For projects that are 3 miles or more in length, 20 tests should

be conducted per mile – approximately one test every 250 ft – in the right wheel path (RWP) of the slow lane (measured as 3 ft from the lane/shoulder). For projects of less than 3 miles, the recommended test spacing is shown in Table 16.

Table 16. Recommended project-level test spacing.

Project Size (miles)	Test Spacing (feet)	Minimum Number of Tests
0 – 0.5	50-100	25
0.5 – 1.0	100-150	30
1.0 – 3.0	150-200	40

For flexible pavements, FWD testing should be conducted in the wheel path closest to the nearest shoulder, i.e. in the right wheel path for outside lanes and the left wheel path for inside lanes.

Three types of testing may be required for rigid pavements. These locations should be:

- *Basin Testing* – should be conducted near the middle of the slab (i.e. mid-point between two joints) in wheel path closest to the nearest shoulder. If necessary, the test point can be moved slightly to be at least 5 ft from nearest active transverse crack.

- *Joint/Crack Testing* – should be conducted in the wheel path closest to the free edge of the slab

- *Corner Testing* - should be conducted at the slab's free edge corner, i.e. the right edge corner for outside lanes and the left edge corner for inside lanes. The testing should be conducted on the leave side of the joint, where voids are typically located.

Field Testing

Pre-Testing Activities

Equipment Checks

The following equipment checks should be made each day before leaving to go to the testing site:

- The vehicle's lights, brakes, and horns are in good working order.

- Vehicle and trailer are equipped with a 360 degree rotating beacon and/or strobe lights and reflective stripes for night visibility.

- Fuel levels are sufficient for the day's planned activities.

- All required tools and other equipment, such as equipment required for temperature measurements, are on board.

Software Set-Up & File Naming Conventions

Prior to commencing FWD field operations, the FWD data collection software must be set up as follows:

- Testing units set to US customary units.
- All filters turned off.
- Smoothing turned off.
- Data checks should be enabled.

The following file naming convention will be used to maintain consistency with previous data collection efforts in New Jersey:

ddmmyyTS. mdb and ddmmyyTS.f25 for FWD

ddmmyyTS.f25 for HWD

dd = day; mm = month; yy = year; T = shift (D for day and N for night); S = Sequence No. for each project – this begins at 1 each day.

A new data file must be started for each project and data for the entire project should be contained in that file. An exception will be made if there is a change in pavement type within the project, in which case a new file will be started for the new pavement type.

For testing corners and edges on rigid pavements, the following naming protocol should be used. Testing along each path must be saved a separate file:

ddmmyyTL.mdb and ddmmyyTL.f25 for FWD

ddmmyyTL.F25 for HWD

dd = day; mm = month; yy= year; T = shift (D for day and N for night); L = path or location (L for left wheel path; R for right wheel path; B for between wheel paths, E for edge)

For all testing, stations will be referenced by milepost as follows:

mm.nnn

mm = milepost number; nnn = fraction of a mile

Field Testing

The following will be the recommended FWD field testing procedure for NJDOT:

1. Upon arriving at site, operator should check for evidence of recent maintenance activities and contact field office for advice should any exist.

2. Holes should be prepared for mid-depth pavement temperature measurements, if required.

3. The buffer warm-up sequence should be performed. The operator should then check that the data is not all trending in the same direction, i.e. consistently increasing or decreasing. If so, the buffer sequence should be repeated until the load levels stabilize.

4. The operator must ensure that the actual load applied to the pavement is within 10% of the target load and that the deflection sensors are responding appropriately, i.e. deflections decreasing with distance from the center of the load.

5. Steps 3 & 4 must be repeated whenever the FWD is idle for more than 15 minutes.

6. The operator should position the load plate over the section start point and set the DMI to '0'.

7. The FWD should then be positioned over the first test point, as per the selected test plan, and a new file opened in the data collection software.

8. The first air and pavement surface temperature measurements should be taken. These measurements must be taken approximately every hour throughout testing.

9. The testing procedure should be started, comprising one drop at each of the loads shown in Table 15.

10. Data should be checked for errors using the procedure outlined in the Field Data Quality Checks section below.

11. Steps 9 & 10 should then be repeated for the next test point along the path.

12. Throughout testing, the following comments should be added to the datafile: the direction of travel; any unusual features (e.g. patch area, start of different pavement type, change in slab panel size, reason test couldn't be performed, such as off ramp, on-ramp, bridge, rest area entrance, etc.); and condition of pavement in terms of distresses. For LTE testing, joint/crack widths should be measured.

13. If another path is to be tested, all steps from 6-12 should be repeated for the second path.

14. Once all testing is complete, final air and pavement surface temperatures should be taken.

15. The operator should backup the data and perform initial data processing, as described in Section 4.1.3.2 below, before leaving the site. If not possible, this should be done within 24 hours of testing completion.

16. Prior to leaving the site, 'post-testing' checks should be performed on the vehicle and equipment to ensure that are in a safe state to commence road travel.

Field Data Quality Checks & Data Handling

Field Data Quality Checks

During testing, the following data checks be enabled in the FWD data collection software. These are:

- Roll-off – this error condition is indicated by the deflection of the pavement surface not returning to near zero within 60 ms of trigger activation. A common cause is poor contact between the deflection sensor and the pavement surface.

- Non-decreasing Deflections – this error results when the deflections measured by the deflection sensors do not decrease with increasing distance from the load plate. This condition often indicates poor contact between the flagged sensors and the pavement surface.

- Overflow – this condition is triggered when a measured deflection exceeds the range of the deflection sensor. Again, this error is often caused by poor contact between the flagged sensor and the pavement surface.

- Deflection Variation – this condition occurs when the load-normalized peak deflections for repeat drops vary by more than the specified amount. A common cause of this error is uneven pavement surface conditions that result in poor seating of the load plate and/or deflection sensors. It can also be caused by vibrations from nearby heavy equipment, such as trucks traveling in adjacent lanes.

- Load Variation – this is an error condition that occurs when the peak load for repeat drops at the same drop height varies by more than the specified amount. A cause of this error may be that the load plate is not seated properly on the pavement surface - possibly because of loose debris or an uneven pavement surface.

All of these conditions can be legitimately caused under certain specific circumstances. For example, non-decreasing deflections can be legitimately caused by a transverse

crack or other discontinuity between two sensors, amongst other reasons. The operator must attempt to identify the source of the errors. If the errors appear to be caused by the FWD equipment, then the test (or entire test pass) should be discarded, the equipment fixed, and testing resumed. If the errors result from localized pavement conditions, the test should be discarded, the FWD repositioned, and the test rerun. If the errors are the result of pavement conditions across the test section as a whole, or are due to factors beyond the operator's control, the error should be accepted and a comment made on the pavement condition.

Field Data Handling

Operators must perform the following data handling tasks:

- Print hard copies of FWD data on daily basis, if required by NJDOT engineer.
- Copy FWD data files onto disc and label properly.
- Make additional back-up copy of above disc.
- Check field logs for completeness; fill-in any missing information.
- Send all above data to office on regular basis, as required by NJDOT engineer. The back-up disc should not be sent, it should be kept with vehicle in case of loss during transit.

Office Data Processing

Once received by the office, transmittals should be checked for inclusion of all required documentation. The raw data files should be loaded to the designated directory in two copies – one as raw data back up and the other for review and analysis. The original disc should be archived.

Data files should then be checked for completeness and accuracy of data, including:

- Correct file naming and numbering for each project and each FWD test location.
- Proper highway definition and project identification.
- Target loads and testing locations, etc.
- Testing patterns.
- Reasonableness of data.

If anomalies are identified, the operator should be contacted immediately for clarification and corrective action (where appropriate). Any anomalies that cannot be resolved should be reviewed by the Quality Assurance Manager, who should take all necessary measures to resolve them, including manual upgrade of FWD data, if required. The file should then be re-reviewed to confirm it that it meets all data reasonableness checks. At this point, data will be considered ready for analysis.

FWD ANALYSIS

Recommendations for Analysis Procedures

A large number of factors related to pavement performance and/or to decisions regarding pavement maintenance and rehabilitation (M&R) options can be added or enhanced within the FWD analysis to provide more accurate results and therefore more cost-effective M&R decisions. Some of the most important factors are addressed in the sections below.

Pavement Sectioning

Pavements are intrinsically non-homogeneous structures. To begin with, they are extended over miles of natural soils that vary in type, gradation, moisture content, ground water table, depth to rigid layer (such as bed rock), etc. In addition, pavement materials themselves are not particularly homogeneous – particularly true of the unbound layers – and construction specifications typically allow for the thickness of different layers to vary within certain tolerance levels. Finally, pavements receive multiple overlays during the course of their service lives resulting in an increased variation in layer thickness and materials' strength over time. This non-homogeneity means that by the time the rehabilitation design process is begun, a pavement's structural capacity will inevitably vary along its length.

Despite this recognized non-homogeneity, a common practice when analyzing FWD data for the purposes of determining the appropriate rehabilitation design is to treat the entire project length as one unit and select one rehabilitation treatment for the entirety. Yet, as a pavement's structural capacity is expected to vary along its length, due to the reasons laid out above, the selection of single treatment is likely to result in areas with surplus or insufficient overlay thickness, i.e. under- and over-designed sections. Prior studies, including one performed for NJDOT, have shown that a more cost-effective approach to such analysis, is to divide the project into homogeneous sections and select an appropriate rehabilitation treatment for each individual section. Two example cases are discussed below.

An FWD pilot program was performed on approximately 330 centerline miles of the National Highway System (NHS) highways in New Jersey[5]. One illustrative example from within this study was a project between mileposts 5.87 and 10.00 on Route 38 East. Analyses were performed to determine rehabilitation needed to extend the service life of this project by 10 years. In the first round of analysis, the entire project length was treated as one section. An overlay thickness of 1.6 in. was selected for the entire project using this approach. In the second round of analysis, deflection data was used to identify the limits of homogeneous sections within the project. The project was found to have 4 homogeneous sections with required overlay thicknesses of 0.8 in., 3.5 in., 2.5 in., and 0 in. (i.e. a structurally sound section). Under the first approach, then, two sections would have been over-designed (receiving more overlay thickness than

[5] Zaghloul, S., He, Z.W. and Vitillo, N. *Project Scoping Using FWD Testing - New Jersey Experience*. Transportation Research Record No. 1643, Washington, DC, 1998, pp. 34-38.

required) and two sections would be under-designed (receiving less overlay thickness than required). The under-designed section would be expected to last only 3 and 6 years before requiring rehabilitation again. Results of a limited life cycle cost analysis (LCCA) indicated that the direct agency costs could be reduced by 26% by selecting rehabilitation treatments based on homogeneous sections.

A second good example of homogeneous sectioning is a 160-lane mile project on I-85 Virginia[6]. In this case study, it was originally intended that the entire project would be treated as one section and a 3-in. overlay had been selected as the rehabilitation treatment. A second approach was then implemented in which the project was divided into structurally homogeneous sections. The in-situ structural capacity and appropriate rehabilitation treatment was then selected for each section individually. Results from this second round of analysis showed that the application of a 3-in. overlay would result in 18 over- and 2 under-designed sections, and in only one adequately designed section. LCCA was performed to quantify the impact of considering homogeneous sections in this project over a 30-year period. It was found that for both the under-designed and over-designed sections, an approximate 26% saving could be made in direct agency costs as a result of considering homogeneous sections.

It can be seen, that FWD analysis for rehabilitation design should be performed on structurally homogeneous sections and it is recommended that NJDOT adopt sectionalization as part of their FWD analysis procedure. Sectionalization can be added to the analysis procedure in two ways.
In the FWD pilot study performed for NJDOT, the procedure developed for sectionalization was to process FWD data, pavement temperature measurements and cores to determine the limits of the homogeneous sections. A representative deflection basin was then determined for each section. Backcalculation analysis, using the representative deflection basin, plus cores and as-built documents to provide layer thickness information, was the performed to determine the effective pavement and subgrade moduli for each section. These moduli were then adjusted for temperature variation and used, together with distress data and expected future traffic, in the rehabilitation analysis.

An alternative to this approach is to use Ground Penetrating Radar (GPR) data to gather layer profile data. A pre-processing of GPR data can be performed to determine the initial limits of homogeneous sections, which can then be used in the analysis of FWD data. The benefits of GPR technology (such as its non-destructive nature and operation at regular traffic speeds) are discussed in more detail in the following section. Since it is recommended that NJDOT use GPR data to provide the layer profile information needed for backcalculation analysis, it is also recommended that the pre-processing of GPR data be used to determine homogeneous sections prior to the FWD analysis.

[6] Zaghloul, S. and Elfino, M. *Pavement Rehabilitation Selection Based on FWD Data Mechanistic Analysis and Field Diagnosis - Virginia Experience*. Transportation Research Record No. 1730, Washington, DC, 2000, pp. 177-186.

Layer Thickness Data

Dividing a project into structurally homogeneous pavement sections, as described above, deals with differences in pavement layer characteristics in a larger sense. Once divided into homogeneous sections, pavement layer thickness can still vary considerably along the length of a section. One common cause is the thickness tolerance allowed for each layer during initial construction. Layer thickness information is known to be an important input into backcalculation analysis. In the FWD pilot study performed for NJDOT[7], sensitivity analyses was used to assess the extent to which inaccurate layer thickness data could affect backcalculation results and rehabilitation selection. Results from these analyses showed that the effect on backcalculation results could be significant and could, in some cases, lead to serious error in the selection of an appropriate rehabilitation treatment.

Typical practice within backcalculation analysis is to gather layer thickness information from as-built records/plans or through destructive testing, such as coring/boring. However, as-built documents, as well as often being difficult to locate, provide only general layer thickness information that is in many cases different than what is actually built. Cores/bores provide extremely accurate layer thickness data, but it is point specific and valid only for the area close to the core's location. Due to their destructive nature, only a certain number of cores can be extracted from the pavement, meaning that cores can only provide layer thickness data for a certain number of given points along the pavement's length. Using layer thickness information from as-built documents or cores in backcalculation analysis, then, necessitates the assumption that pavement layer thickness is constant throughout the section's length. However, studies have shown that this is not the case, even within homogeneous pavement sections. Another study performed for the NJDOT[8] used GPR technology to collect continuous layer thickness information from over 1,000 miles of different pavement types. The study concluded that thickness variability exists in all pavement types and functional classes. Taking one of many similar examples, the asphalt layer of one interstate section, from which the extracted core showed thickness of around 10.2 in., was found to vary from 9 in. to 11 in. along the section length, with an average of 9.9 in., i.e. a variation of around ± 11%.

Typical practice is to extract only one core/bore from each homogeneous section. Taking the above example as an illustration, it can be seen that using this one core to represent the section would introduce an error into the backcalculation process. Although the magnitude of the error will depend on factors such as pavement type, the degree of thickness variability, the overall pavement thickness, and the stiffness of the pavement layers, it has previously been noted that inaccurate layer thickness data can have significant effects on backcalculation results and rehabilitation selection[9].

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[7] Zaghloul, S., He, Z.W. and Vitillo, N. *Project Scoping Using FWD Testing - New Jersey Experience*. Transportation Research Record No. 1643, Washington, D.C., 1998, pp. 34-38.

[8] Zaghloul, S., Hoover, T., Swan, DJ, Vitillo, N., Sauber, R., and Jumikis, A. *Enhancing Backcalculation Procedures through Consideration of Thickness Variability*. Transportation Research Record No. 1869, Washington, DC, 2004, pp. 80-87.

[9] Zaghloul, S., He, Z.W. and Vitillo, N. *Project Scoping Using FWD Testing - New Jersey Experience*. Transportation Research Record No. 1643, Washington, D.C., 1998, pp. 34-38.

The GPR study performed for NJDOT looked at the difference made in rehabilitation selection when GPR data was used in backcalculation analysis rather than core data. For the FHWA Long-Term Pavement Performance sections SPS-5 and SPS-9 (sites that are built with extremely tight QC/QA protocols during construction, which might therefore be expected to have very consistent layer thickness) the overlay thicknesses selected under the different approaches differed by up to 3 in. for some sections. A limited life cycle cost analysis (LCCA) was performed to quantify the difference between the two scenarios. Results indicated that a saving in direct agency costs of between 15% and 20% could be achieved when GPR data is used in the analysis[10].

A valuable alternative, then, to the use of as-built documents and/or cores to provide layer thickness information for backcalculation analysis is GPR. GPR vehicles collect continuous layer profile information while traveling at highway traffic speeds, thereby having no need for traffic control. This is a non-destructive pavement testing method that will not affect the integrity of the pavement structure. However, it is important to note that GPR data needs to be calibrated using core data. Although this means that cores still need to be taken, their number can be significantly fewer than if they are used as the sole indicator of layer thickness. It is recommended that NJDOT use GPR data to provide layer thickness information for backcalculation analysis.

An approach has previously been developed to incorporate GPR data into backcalculation analysis[11], and this approach is recommended for implementation by NJDOT.

Temperature Correction

Pavement performance is highly influenced by environmental factors, most particularly by temperature and moisture. Temperature and moisture conditions vary with time (daily, seasonal, and longer cycles), meaning that deflection testing can be performed at the same pavement section, but yield very different results depending on the climatic conditions at the time of the test. For example, deflections from a pavement section measured during particularly cold temperatures when the pavement materials are stiff would indicate a higher than expected structural performance, with the converse also being true: if the pavement was measured during particularly high temperatures, the deflections would indicate a lower than expected structural performance. Therefore, to gain an accurate picture of the pavement's structural performance, and therefore an accurate picture of its rehabilitation needs, seasonal factors, such as temperature and moisture need to be accounted for during FWD analysis. This requires the use of adjustment models that can be applied to the measured deflections prior to analysis to account to bring pavement response parameters measured at different times of the day and year to the same standard environmental conditions.

The 1993 AASHTO Pavement Design Guide backcalculation procedure, which has been recommended for use by NJDOT, contains temperature correction models that

[10] Zaghloul, S., & Elfino, M. *Applying Value Engineering Techniques to Pavement Rehabilitation Design Procedures*. 5th Intl Conference on Maintenance & Rehabilitation of Pavements & Technological Control, Park City, UT, 2007.
[11] Zaghloul, S., Jumikis, A., Vitillo, N., Sauber, R. and Swan, DJ. *Incorporating Reliability Factors in Backcalculation Analysis for New Jersey Pavements*. 17th ASCE Engineering Mechanics Conference, Newark, DE, 2004.

can be applied to FWD data. However, some deficiencies have been observed in these models. For example, when backcalculation was performed on deflection data from some LTPP-SPS sections in New Jersey, the pavement structural performance showed reversed trends, i.e. that structural performance would improve over time[12]. The reason for this reversed trend was found to be that the 1993 AASHTO temperature correction models had not adequately accounted for the impact of seasonal and temperature variations in the FWD data, which had been collected at different times of the year. A further point to consider in the use of the AASHTO models is that they cover only pavement temperature, whereas a previous study found that moisture content, ground water table and rainfall also have significant impact on FWD deflections[13].

The recommended alternative to the 1993 AASHTO temperature correction models is to use the seasonal and temperature correction factors previously developed specifically for New Jersey conditions in the New Jersey Seasonal Study[14]. These factors were developed after extensive climatic and deflection testing of twenty-four New Jersey test sites over a period of 2 years and are expected to more accurately account for environmental conditions within the state. They were also validated using LTPP data. The temperature correction factor, which should be applied to the measured deflections (or backcalculated moduli) is:

$$TCF_i = \frac{a_i * T_m + b_i * t_{ac} + c_i}{a_i * T_s + b_i * t_{ac} + c_i} \quad [6\text{-}1]$$

Where,
TCF_i = Temperature Correction Factor for the deflection of sensors 1 to 8, M_r and E_p
T_s = Standard temperature, 20°C
T_m = Mid-depth AC Temperature, °C
t_{ac} = Thickness of AC layers, inch
a_i, b_i and c_i = Regression Coefficients

The regression coefficients for this equation can be found in the "Material Characterization and Seasonal Variation in Material Properties", Final Report (NJDOT 2005) [15].
After correcting for temperature, deflection should be adjusted for other seasonal factors, using the following equation:

*Standard Deflection = Temperature Corrected Deflection * SDCF* [6-2]

Where,
SDCF is the appropriate Seasonal Deflection Correction Factor based on the thickness class, region and testing date

[12] Zaghloul, S., Meyer, F., Ayed, A., Abd El Halim, A., Springer, J. and Vitillo, N. *Adjustment of New Jersey LTPP Deflection Data for Seasonal Variation*. Proceedings of 84th Annual Meeting of the Transportation Research Board (TRB), Washington, D.C., 2005.
[13] Zaghloul, S., Meyer, F., Ayed, A., Abd El Halim, A., Springer, J. and Vitillo, N. *Adjustment of New Jersey LTPP Deflection Data for Seasonal Variation*. Proceedings of 84th Annual Meeting of the Transportation Research Board (TRB), Washington, D.C., 2005.
[14] Stantec Consulting. Material Characterization and Seasonal Variation in Material Properties. Final Report. NJDOT, 2005.
[15] Stantec Consulting. Material Characterization and Seasonal Variation in Material Properties. Final Report. NJDOT, 2005.

These SDCFs can be found in the study report listed above.

A study compared the cost-effectiveness of rehabilitation solutions performed using these models compared to the AASHTO models by performing backcalculation analysis, followed by rehabilitation analysis, on deflection data from more than 1,000 miles of New Jersey roadway[16]. In the first round of analysis, the AASHTO models were used. In the second round, the seasonal and temperature models developed for NJDOT were used instead. Results indicated that use of the AASHTO models resulted in 126 miles of over-designed sections and 946 miles of under-designed sections. A limited LCCA indicated that a reduction in rehabilitation cost in the range of $70,000 per lane mile was achieved by using the NJ-specific models.

Considerations for PCC Pavement

Load Transfer Efficiency

Void Detection

For rigid pavements, FWD analysis can also be conducted to determine the presence of voids underneath concrete slabs. As the New Jersey Seasonal Study[17] showed that the phenomenon of slab curling/warping can be misidentified as a void, special testing procedures were specified for concrete pavement in the Field Data Quality Checks section that should help to minimize these erroneous results.
Three methods are commonly used under the 1993 AASHTO Design Guide for the detection of voids. These are: corner deflection profile, variable load corner deflection analysis, and void size estimation procedure.

- Corner Deflection Profile – this method can only be used if corner deflection measurements at a constant load (preferably 9,000 lbs) are available. Approach and leave corner deflections are plotted on a profile and the corners with the lowest deflections (i.e. those likely to have full support) are identified. By examining these plots, a reasonable maximum allowable deflection value can be selected. Corners with deflections above this value would be selected for subsealing.

  Once a corner is subsealed, the deflection at that location should be measured again, preferably at a similar temperature to the prior test. Corners with deflections still above the maximum allowable value should be subsealed again. The AASHTO 1993 Guide does, however, note that this should be considered only an approximate approach for void detection that may not identify voids accurately if load transfer varies greatly from joint to joint. Also, it does estimate the size of the identified voids.

[16] Zaghloul, S., & Elfino, M. *Applying Value Engineering Techniques to Pavement Rehabilitation Design Procedures*. 5th Intl Conference on Maintenance & Rehabilitation of Pavements & Technological Control, Park City, UT, 2007.
[17] Stantec Consulting. Material Characterization and Seasonal Variation in Material Properties. Final Report. NJDOT, 2005.

- Variable Load Corner Deflection Analysis – in this method, corner deflections need to have been measured at three different load levels. Load vs. deflection response can then be plotted for each test location. Locations without voids typically cross the deflection axis (where load = 0 lbs) close to zero (i.e. ≤ 0.002 in.). Voids are indicated for sections that cross the deflection axis at higher points than this value. The AASHTO 1993 Guide again notes that this method cannot be used to estimate the size of the voids present.

- Void Size Estimation Procedure – for this procedure, deflection measurements are needed from the slab center and slab corner; the calculated transverse joint load transfer is also necessary. The center slab deflections are used to standardize the corner deflections and load transfer. The standardized corner deflections are then plotted against the adjusted load transfer. A 'zero voids band' is plotted, and deflections falling within this band indicate 'no voids'. Deflections falling outside the band are used to determine the approximate size and location of the voids at each joint.

Traffic Data

A pavement's structural capacity refers to its ability to support the traffic loads applied to it. As such, to calculate a pavement's remaining service life in FWD analysis, it is important to know how much traffic it is expected to hold in future years. If the pavement is in need, a key factor during rehabilitation design is to ensure that the pavement's rehabilitated structural capacity will be sufficient to carry the traffic expected during its service life. It stands to reason that the more accurate the expected future traffic input into rehabilitation analysis, the more cost-effective design will result. In fact, a sensitivity analysis performed as part of the FWD pilot study for NJDOT[18] showed that the amount of expected future traffic input into the analysis had a significant effect on the selected overlay thickness, although it did not appear to affect the selection of the treatment type.

At the project-level, accurate traffic load data can be obtained using portable Weigh-in-Motion (WIM) stations. For this purpose, the project should be divided into sections that are expected to receive similar traffic, e.g. sections that are not interrupted by any major intersections would be expected to receive similar traffic. Ideally, portable WIM data should be collected from each traffic section. The traffic load data collected by these devices should be converted in Equivalent Single Axle Loads (ESALs) and a growth factor applied to calculate the expected future traffic at the pavement section. This data can then be used in the rehabilitation analysis to ensure that an adequate treatment is selected for section's expected traffic.

For network level analysis, where widespread portable WIM testing may not be practical, the approach used in the Interstate Study performed for NJDOT could be

[18] Zaghloul, S., He, Z.W. and Vitillo, N. *Project Scoping Using FWD Testing - New Jersey Experience*. Transportation Research Record No. 1643, Washington, D.C., 1998, pp. 34-38.

used[19]. In this study, traffic volumes and ESAL factors were obtained from the Bureau of Traffic Data Development (TDD), as well as default truck percentage factors for different roadway functional classes (as opposed to actual measured truck percentages). Pavement type data was obtained from the NJ Pavement Management System (NJPMS). The number of lanes was obtained from the Straight-Line Diagram (SLD) database. As traffic needed to be calculated by direction, and the number of lanes could not always be equally split, an algorithm was developed that divided the pavement width by 12-ft multiples. A computer application was developed that used all the above data to divide the Interstate network into homogeneous traffic sections. The ESAL values for the current year were then calculated using the 2002 Annual Average Daily Traffic (AADT), directional split, lane distribution factor (LDF), ESAL factor, light/heavy vehicle percentage at each location, and traffic days by using the following formula:

ESAL=AADT*directional%*LDF*(light vehicle%*light ESAL factor+heavy vehicle%*heavy ESAL factor)* traffic days
Where, traffic days = 365 and LDF = 75%

The ESALs calculated for the current year were then extrapolated for each year in the analysis period to give a total accumulated ESAL value for that period. The growth factor was calculated based on the annual Vehicle Mile Traveled (VMT) data.

Unit Costs

Another important factor for analyzing the cost-effectiveness of rehabilitation treatments is the unit cost of those treatments. The more up-to-date the unit costs, the better indication will be given of the treatment's cost-effectiveness. In the Interstate Study performed for NJDOT in 2002, a procedure was implemented to update NJ unit costs[20]. Most rehabilitation treatments are composed of one or more components. For example, the main components of a Mill 2" Overlay 2" treatment are: milling to a depth of 2", overlaying with 2" of asphalt concrete. The first step in this cost analysis was to extract unit costs for each of these individual components from the NJPMS, Capital Program Management (CPM) projects, M&R engineering estimates, and M&R low bid prices. These extracted unit costs were compared and analyzed to estimate a unit cost for each treatment component. As the different sources sometimes gave different unit costs for the same component, as system of hierarchy and priority was implemented to result in one final unit cost that could be used for the component.

The second step was to use the costs of these components to determine unit costs for the complete rehabilitation treatment. To this end, a set of equations was developed, which allow for incorporation of the actual design thickness and also eliminate

[19] Zaghloul, S., Helali, K., Ahmed, Z., Sauber, R. and Jumikis, A. *Cash Flow Control of New Jersey Interstate Needs*. Transportation Research Record No. 1974, Washington, D.C., 2006, pp. 54-62.
[20] Zaghloul, S., Helali, K., Ahmed, Z., Sauber, R. and Jumikis, A. *Cash Flow Control of New Jersey Interstate Needs*. Transportation Research Record No. 1974, Washington, D.C., 2006, pp. 54-62.

assumptions about the components of the treatments. The developed equations, by pavement type, are reproduced below[21].

Rigid pavement – unit costs per sq.yd.:

- AC Overlay: 7.0 T_{ac} + 71.90 P_j + 350.73 P_s + 21.54
- Reconstruction: 64.29 + 23.38 D

Flexible Pavement - unit costs per sq.yd.:

- Mill+Overlay: 3.98 M + 7.0 T_{ac}
- Partial Reconstruction: 17.53 + 7.0 T_{ac}
- Full Reconstruction: 65.71 + 7.0 T_{ac}
- Full Depth AC Reconstruction: 42.33 + 7.0 T_{ac}

Composite Pavement - unit costs per sq.yd.:

- Mill+Overlay: 3.98M + 7.01 T_{ac}
- Mill+Joint Repair+Slab Repair+Overlay: 3.98 M + 7.0 T_{ac} + 71.90 P_j + 350.73 P_s +21.54
- Partial Reconstruction: 7.0 T_{ac} + 71.90 P_j + 350.73 P_s +39.05
- Full Reconstruction 1: 81.8 + 23.38 D
- Full Reconstruction 2: 81.8+ 7.0 T_{ac}

AC Shoulders - unit costs per sq.yd.:

- Full Reconstruction: 72.31 +7.0 T_{ac}
- Full Depth Reconstruction: 48.93 +7.00 T_{ac}

In these equations:

- M = Thickness of milling in inches
- T_{ac} = Thickness of AC overlay in inches
- P_j = Percent of poor joints (e.g. 0.1 for ten percent)
- P_s = Percent of poor slabs
- D = Thickness of concrete slab in inches

However, the treatment itself does not constitute the entire expense for rehabilitation – factors such as preliminary engineering, construction engineering, traffic control, etc. add to this unit rate. A prior study performed for NJDOT that had compared total treatment cost versus material cost[22] had determined that a factor of 3.1 could be used to account for these additional expenses. This factor was applied to the material costs to give a complete cost for the treatment.

Using FWD Data to Evaluate Construction Quality

A use for FWD data collection and analysis that has not yet been discussed is in construction quality control. Traditional QC methods focus on laboratory tests of the

[21] Zaghloul, S., Helali, K., Ahmed, Z., Sauber, R. and Jumikis, A. *Cash Flow Control of New Jersey Interstate Needs.* Transportation Research Record No. 1974, Washington, D.C., 2006, pp. 54-62.
[22] NJDOT Pavement Management System I. Pavement Management Program Documentation Volume 1, New Jersey State Department of Transportation, 2000.

materials and evaluation of the functional side of pavement performance, i.e. smoothness acceptance testing. However, even if pavements meet the criteria specified for laboratory tests and smoothness, it does not dictate that the pavement will also have acceptable structural capacity – many pavements have failed prematurely having passed these QC requirements. Also, QC testing is performed after construction of the pavement is complete, meaning that a defect originating in a lower layer is harder to detect and also to rectify.

A procedure has previously been developed for using FWD data in the evaluation of construction quality[23]. The basic steps in this procedure are outlined below. These steps should be conducted after the construction of each layer, including the compacted subgrade.

1. Divide the pavement section into homogeneous sections – the following factors would mark the boundaries of a section:
    a. Width of the traffic lane.
    b. End of each day of construction.
    c. Change in construction equipment.
    d. Change in operator.
    e. Change of source material.

2. Perform FWD testing – the target load is recommended to be in the 45KN range, except if lower loads are needed to test soft subgrades. Tests should be performed at short intervals to given the best picture of construction quality. Although the frequency of testing should be determined based on the length of the project, a frequency of every 10 to 20 m would be recommended.

3. Determine the target deflection – a key part of the analysis is to compare the measured deflections with target deflections. Target deflections can be determined in two ways: using an empirical approach or using three-dimensional dynamic finite element analysis (3D-DFEA). However, use of the 3D-DFEA approach requires complicated analysis and additional material testing, therefore use of the empirical approach is recommended. The recommended approach for the empirical method is to test pavement sections that have previously shown acceptable in-situ density levels during routine FWD testing. Results of these tests can be used to determine the target loads.

4. Conduct analysis of FWD data.

5. Satisfactory sections can be approved and construction begun on the next layer.

6. For sections that show unsatisfactory analysis results, the FWD testing and analysis should be repeated.

[23] Zaghloul, S. & Saeed, N. *The Use of Falling Weight Deflectometer in Asphalt Pavement Construction Quality Control*. Quality Management of Hot Mix Asphalt, ASTM STP 1299, Dale S. Decker, Ed., American Society for Testing and Materials, 1996.

7. Sections that now have satisfactory results can be approved and construction begun on the next layer.

8. Sections that remain unsatisfactory should be investigated for the cause of the issue and corrective action should be taken.

The advantages of this QC method are that pavements are tested under actual field conditions and the interaction between each of the individual layers is considered. Testing after construction of each layer allows potential weak spots to be identified and rectified early, resulting in savings in future M&R work. This method also allows for much more frequent testing along the project than is the case for laboratory sampling – meaning that there is a greater chance of identifying potential problem areas.

Summary, Conclusions, and Recommendations

Pavement performance has two major components: structural and functional. The structural performance of pavements is related to the number of load repetitions that a pavement section can carry before it develops an unacceptable level of structural related distresses. Treatments to meet structural needs are typically much more expensive than treatments designed to rectify functional problems. Therefore, treating a functionally deficient pavement as if it is structurally deficient will result in construction costs that are considerably higher than necessary. inversely, treating a pavement for functional problems when in fact those problems are structural will not rectify the situation and the pavement will need to be treated again within a relatively short time span to address the structural requirements. Additionally, during this time, the structural condition may have worsened to a point where more expensive rehabilitation is now required. Therefore, when treating a pavement, it is vital to know whether the problem being addressed is structural or functional in nature. Matching the appropriate treatment to the pavement's needs can lead to significant reductions in pavement construction and life cycle costs. Using FWD analysis to determine pavement structural capacity can therefore result in more cost-effective rehabilitation decisions by providing information that can be used to match the treatment to the cause.

In addition, the new Mechanistic-Empirical Pavement Design Guide (MEPDG) relies heavily on the material stiffness backcalculated from the deflection measurements taken from existing pavements. These measurements are typically made using FWD.
In order to ensure the selection of the appropriate treatments, structural or functional, and to provide high quality and consistent material stiffness data for the MEPDG, the New Jersey Department of Transportation (NJDOT) initiated the effort to develop an FWD Procedures Manual that will regulate field testing, analysis, and reporting procedures in New Jersey. Adherence to the developed procedures during FWD testing and analysis, whether by State personnel or private contractors, will ensure the consistency of the process for rehabilitation analysis and also the quality of the material stiffness values required for input into the MEPDG processes.

In this project, the state-of-practice in FWD testing and analysis procedures were examined by looking at the standard protocols of a number of other highway agencies.

The specific needs of NJDOT were also examined and a protocol was developed that encompassed current standard practice in a way most suited to NJDOT operations. This report documents the development of the FWD Procedures Manual required by NJDOT. The manual itself is presented in a separate document. The manual contains protocols for FWD testing and analysis for the purpose of project-level rehabilitation design using MEPDG. The developed guidelines clearly define:

- testing requirements.
- data analysis approach.
- reporting requirements.

The protocols are intended to ensure that FWD data is collected and analyzed in a consistent, technically sound, and state-of-practice manner.

Appendix A: FWD Rehabilitation Case Studies

TYPICAL PAVEMENT REHABILITATION PROCEDURE

Overview

This pavement rehabilitation approach has been successfully implemented in many states, including New Jersey, and is built around the use of non-destructive testing (NDT) techniques, along with some other tools. One of the basic goals of this approach is to diagnose the problems that have resulted in the need for rehabilitation, and whether or not these problems are structural or functional. The structural performance of pavements is related to the traffic loads that a pavement section can carry before it develops an unacceptable level of structural distresses. The functional performance of pavements is related to user riding comfort. A pavement section may be structurally adequate, but have functional problems, or vice versa. Poor structural and functional performances are both reflected on the pavement surface in the form of distresses, such as cracking. Once the problem is diagnosed, alternative fixes are chosen that are appropriate to the cause of the problem.

Figure 1 shows the main steps recommended for any pavement rehabilitation project. The first step is the investigations and data gathering step. It is highly recommend not to cut this step short because the more information available to the designer, the more cost-effective the design will be. The gathered data is processed and analyzed in the second step. The results of this analysis are then used to select candidate rehabilitation strategies. The final selection from these strategies is then made based on the project performance and financial constraints. It is recommended to use limited Life Cycle Cost Analysis (LCCA) or Benefit-Cost (BC) approaches in the final selection in order to select the optimum rehabilitation strategy, i.e. the strategy that satisfies all the constraints (performance, budget, and cash flow) at the lowest cost.

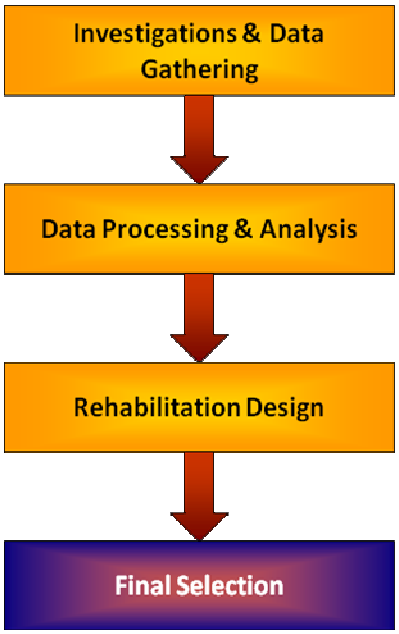

Figure 1. Steps of typical pavement rehabilitation design approach.

Data Collection

A number of inputs are required for pavement rehabilitation design. These would be collected through a customized pavement evaluation program, comprising office and field data collection components.

Office Data Collection

The first step in the rehabilitation design process would be an office data collection task to collect inputs such as traffic data and projections, as-built information, cost information, etc. In addition, maintenance and construction histories, along with any records of past performance, can be very helpful in assisting the identification of problem areas and providing information about what has and has not worked in the past. NJDOT PMS is a good starting point to gather all these data attributes. The data available from NJDOT PMS is very valuable and provides the designer a direction to follow in the field data collection program.

Field Data Collection

The field data collection program can include several tasks, as appropriate for the specific project. These tasks may include:

- Deflection testing to evaluate the in-situ structural capacity of the existing pavement and the condition of the subgrade, using a Falling Weight Deflectometer (FWD).

- Detailed pavement distress survey (all lanes in each direction) to supplement the NJDOT PMS condition data. This data is essential for rehabilitation design and can be collected during the FWD/coring operation with minimal additional effort.

- Site characterization, such as geometric condition (e.g. horizontal curve, upgrade, etc), substructure (embankment, cut/fill, etc), shoulder information (type) and drainage (type, condition). This too can be collected during the FWD/coring operation with minimal additional effort.

- Ground Penetrating Radar (GPR) survey to provide continuous layer thickness information.

- Pavement coring for GPR calibration.

- Dynamic Cone Penetrometer (DCP) testing.

- Axle weight data collection using portable Weigh-In-Motion (WIM) stations.

- Overview digital images collected during the FWD/coring operation.Laboratory tests (may be needed for special cases)

- Roughness (IRI) survey (available from PMS)

- Subsurface drainage video investigations (as needed)

The sequence of the data collection is very important and can save a lot of money. The recommended sequence is as follows:

- Office data collection, including extraction of data from PMS.

- GPR testing (no traffic control is required).

- Preliminary analysis of GPR data to identify significant changes in the pavement structure, an example is shown in Figure 2.

- Selection of core locations, and FWD testing locations and frequencies based on the results of the preliminary analysis of the GPR data.

- Coordination of traffic control whilst some or all of the following tasks are performed, as applicable:
  - FWD
  - Core/bore
  - DCP
  - Detailed distress survey
  - Site characterization
  - Limited WIM at distance far enough from the lane closure, but close enough to represent the project conditions
  - Digital images
  - Subsurface drainage video investigations can be performed separately since it is a shoulder activity and does not require lane closure.

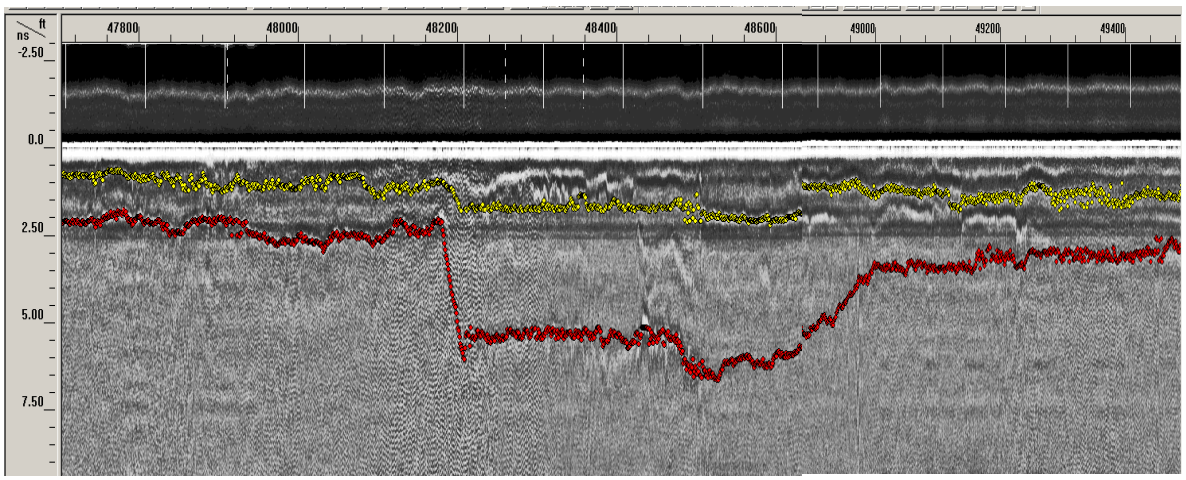

Figure 2. Preliminary analysis of GPR data.

It is very important to have a common referencing system among all the collected data to be able to accurately overlay the data. GPS coordinates, along with calibrated DMI mile post, may be a good approach.

Analysis and Rehabilitation Design

Once all appropriate data has been collected, analyses are performed to assess the structural and functional condition of the pavement. The following is a list of the analysis tasks that are typically performed:

- **Backcalculation**
- **Sectioning**
- **Traffic Analysis**
- **Rehabilitation Design**

- **Backcalcualtion**

The in-situ structural capacity of pavements is evaluated using FWD deflection data. Backcalculation analysis is performed on the measured deflections to estimate the in-situ pavement layer moduli. NJDOT adopted the use of the procedure described in the 1993 AASHTO Pavement Design Guide. Typical backcalculation analysis outcomes include:

- Identification of the limits of homogeneous sections that have similar structural capacity and are therefore candidate to receive the same rehabilitation treatment.
- Assessment of the pavement's overall structural capacity, as well as of the structural capacity of individual layers, including the subgrade.
- Estimation of the pavement's remaining service life.
- Identification of the rehabilitation needs of each homogeneous section.

Layer thickness is an essential input for backcalculation analysis. Consequently, the accuracy of the layer thicknesses used in the backcalculation analysis has significant impact on the accuracy of the analysis results. Layer thickness information has traditionally been obtained from as-built records or from cores/bores. Typically, accurate as-built records are difficult to obtain and even when they are available, contain only general layer thickness information. Cores/bores provide more accurate layer thickness information. However, the number of cores that can be obtained per pavement section is limited because of their destructive nature. Also, cores/bores provide only point-specific information about the in-situ layer thickness. Calibrated / validated GPR measurements, however, provide continuous layer thickness information along the length of the project and represent the best source of layer thickness information (although a small number of cores are still required to calibrate/validate the GPR measurements).

To demonstrate the impact of using core versus GPR data in backcalculation analysis, an analysis was performed on 17 test sections in New Jersey (SPS-5 and SPS-9 sections) to calculate the required overlay thickness for both cases. The analysis was performed twice: firstly using core data to provide layer thickness information and

secondly using calibrated/validated GPR data. Although in some cases the difference between the results was not significant, in other cases the difference in the required overlay thickness calculated in the two analyses was as high as +/- 3".

- **Sectioning**
  The first step in the analysis is to identify the limits of the homogeneous sections within the project. Homogenous sections are defined with respect to future rehabilitation needs. Each section should be qualified to receive the same rehabilitation treatment. In this step, it is very important to keep practically issues, minimum section length, as one of the major decision making criteria to ensure that the selected rehabilitation strategies can be implemented with no major increase in cost or low initial rideability. Short sections are not desired because of these reasons.
  One of the key issues in this step is looking at the project data as one project. In some cases and for long projects, some data attributes are collected in more than one day, such as FWD data. In reality the entire project should be treated as one unit, regardless if data was collected in one or more sessions (files). Therefore, it is recommended to append all the project data to a one set and treat this set as one unit.

  GPR data provides an excellent starting point for sectioning and more accurate determination would result from the backcalculation analysis. Factors that may consider in selecting the limits of homogeneous sections include:

  - As-built documents and maintenance and rehabilitation histories
  - In-situ pavement structure (GPR and/or core/bore)
  - Traffic
  - Roughness
  - Deflection or backcalcualtion results
  - Distresses or distress index

  Depending on the data availability some of these parameters may not be used. Also, common referencing system is vital in this task.

- **Traffic Analysis**

Pavements deteriorate because of environmental impacts and truck traffic. Therefore, another key input parameter in pavement analysis is truck traffic data. Adequately estimating the future traffic loads for pavements can often be a challenge. Typically, DOTs collect actual axle weight data from only a limited number of locations and classified data from many more locations. The classified traffic is then used to estimate the Average Annual Daily Traffic (AADT) and %Trucks for the rest of the network, and in some cases truck factors as well.

With only a limited number of weigh stations in each state, the accuracy of estimated axle loads is not expected to be high. Although classified traffic counts may be more

available, collection of axle weight data using portable WIM stations can provide substantial benefits, including more accurate assessment of the pavement remaining service life and more accurate rehabilitation design at the project level.

- **Rehabilitation Design**

The outcomes of the rehabilitation design can be grouped into two main categories, which are:

1. Diagnoses of existing problems:
   - Structural deficiency/adequacy.
   - Issues with the unbound layers (flexible).
   - Issues with Load Transfer Efficiency (LTE) and voids (rigid).
   - Localized (weak spots) versus general failures.
   - Effectiveness of subsurface drainage system and need for improvements.

2. Candidate rehabilitation strategies:
   - Pre-rehabilitation repairs.
   - Design life and staging.
   - Future structural needs.
   - Overlay feasibility.
   - Constraints, such as elevation, use of specific treatments.

The final outcome of the rehabilitation analysis is a set of candidate rehabilitation strategies. Each strategy should include a list of pre-rehabilitation repairs and the proposed rehabilitation activities for different sections, and in some cases future rehabilitation activities, i.e. 30-year program that may include 2 overlays.
These strategies are then evaluated with respect to their economic benefits to select the most cost-effective strategy that satisfies the project financial and performance constraints.

Case Study 1 – Asphalt Pavement

Location:
- I-195 E From MP 0 – To MP 20.1

Available Data
- FWD
- Core/bore
- Traffic
- GPR
- Distress and distress index (from NJDOT PMS)
- IRI (from NJDOT PMS)

Appendix B has the following tables:

- Table 1 shows the collected deflection data (metric units).
- Table 2 shows the collected deflection data (English units).
- Table 3 shows the normalized (9000 lb) deflection data (English units).
- Table 4 shows the average normalized deflection data (English units).
- Table 5 shows the core/bore data.

Backcalculation Analysis:

- Backcalculation of the effective pavement and subgrade moduli (E_p and M_r) and the effective Structural Number (SN_{eff}) using the 1993 AASHTO Pavement Design Procedure. These results are shown in Appendix B as Table 6. It should be noted that the core/bore data was used in the backcalcualtion analysis because the GPR data wasn't complete (many missing base/subbase data .
- M_r subgrade modulus profile from backcalculation results, shown in Figure 3.
- SN_{eff} profile from backcalculation results, shown in Figure 4.
-

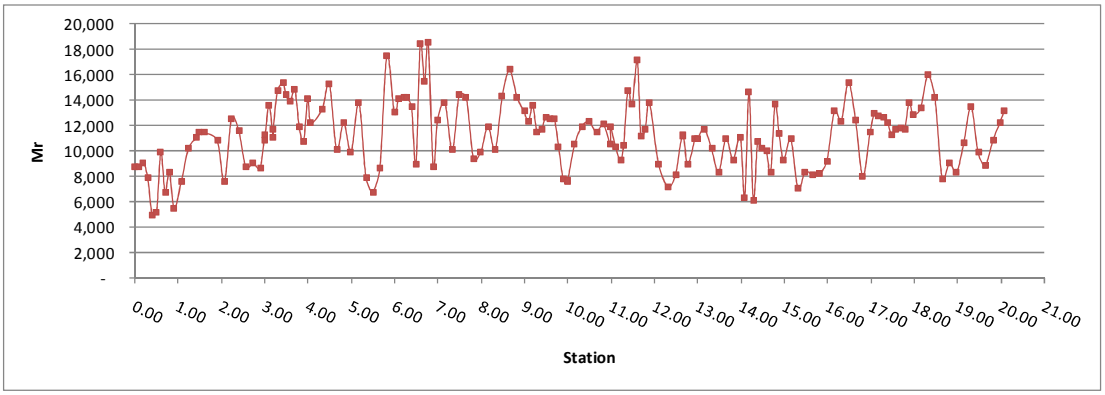

Figure 3. M_r profile.

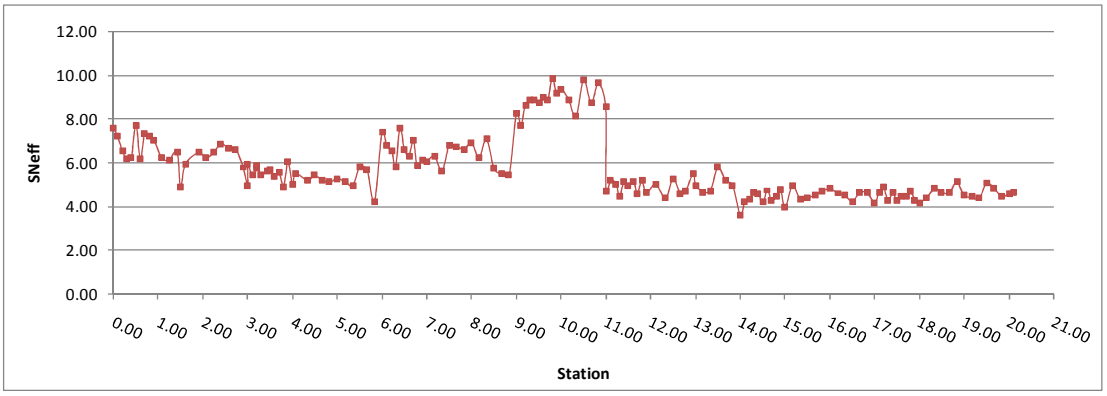

Figure 4. SN_{eff} profile.

Pavement Sectioning

- GPR
  GPR data is complete only for the AC layers, therefore sectioning was performed based on AC thickness only. Figure 5a shows the AC thickness obtained from GPR and Cores. Based on this figure, the project can be divided into the following sections:
  - 0.000 – 4.500
  - 4.510 – 7.000
  - 7.100 – 20.000

  It should be noted that there is a short section at the beginning of the project that show thinner AC thickness, however the length of this section is not long enough to be considered as a standalone section. The same case is repeated @ MP 9.000, however the GPR data from MP 9.000 to 12.000 is not completed, therefore this part was ignored.

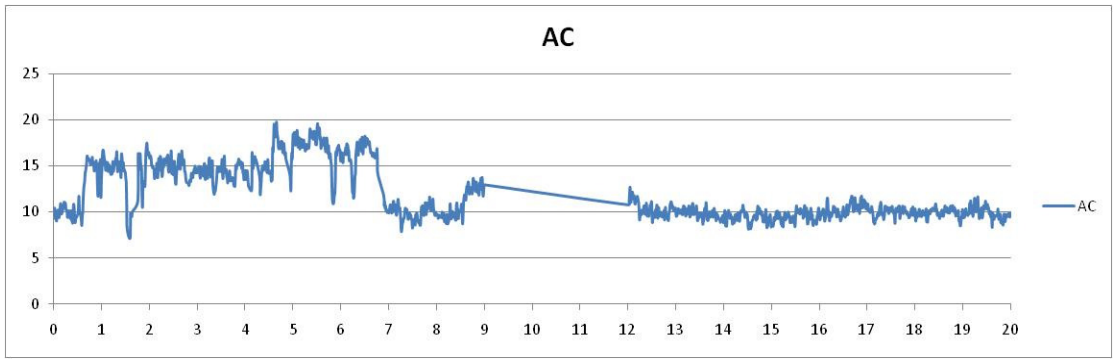

Figure 5a. Pavement layer profile – AC only - GPR.

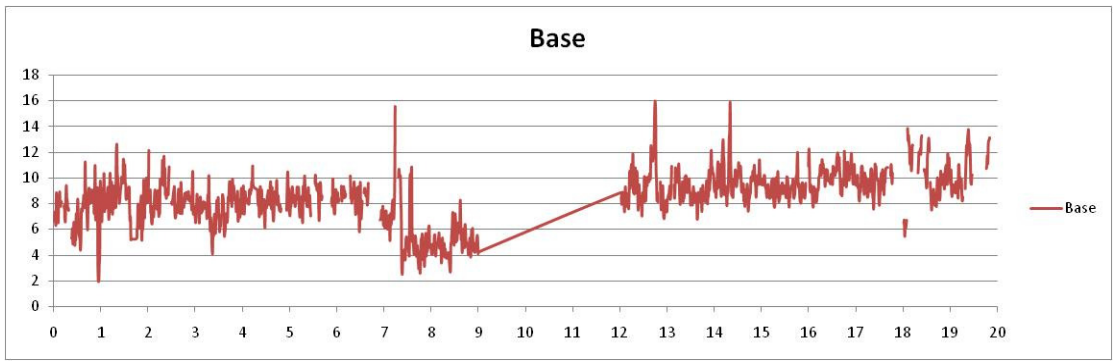

Figure 5b. Pavement layer profile – Base Course only - GPR.

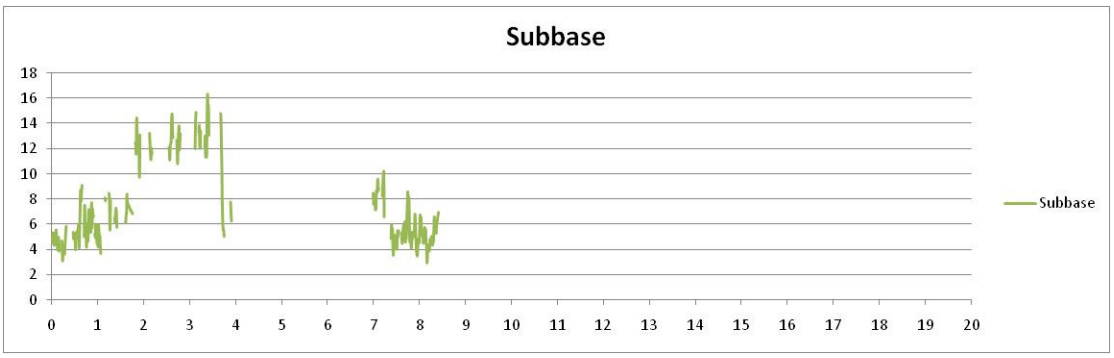

Figure 5c. Pavement layer profile – Subbase Course only - GPR.

- Deflection
  - Sensor D1 profile (Figure 6) examined first. No clear section limits are shown.
  - SN_{eff} profile (Figure 4) examined. Indicates five distinct sections. These are shown in Table 7, together with their respective M_r, E_p, and SN_{eff} values.

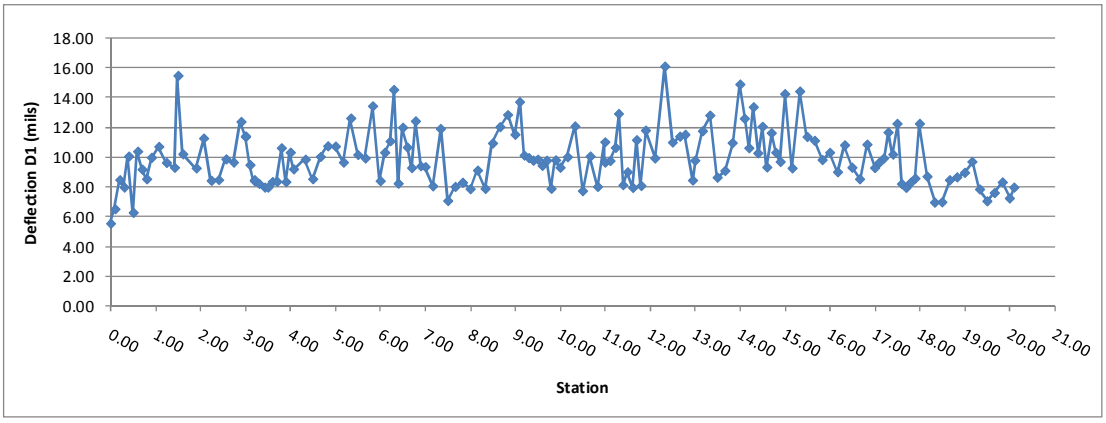

Figure 6. Sensor D1 profile.

Table 7. Sections identified from SN_{eff} profile.

Section	From Station	To Station	Length (mile)	M_R	E_p	SN_{eff}
1	0.00	2.99	2.99	8,931	211,042	6.55
2	3.00	5.80	2.80	12,144	215,819	5.43
3	5.83	8.99	3.16	13,400	141,050	6.32
4	9.00	11.00	2.00	11,454	113,677	8.90
5	11.01	20.10	9.09	11,040	131,968	4.65

- Core/Bore Data
  Pavement layer profile obtained from cores/bores (Figure 7) examined and indicates three distinct sections, as shown in Table 8.

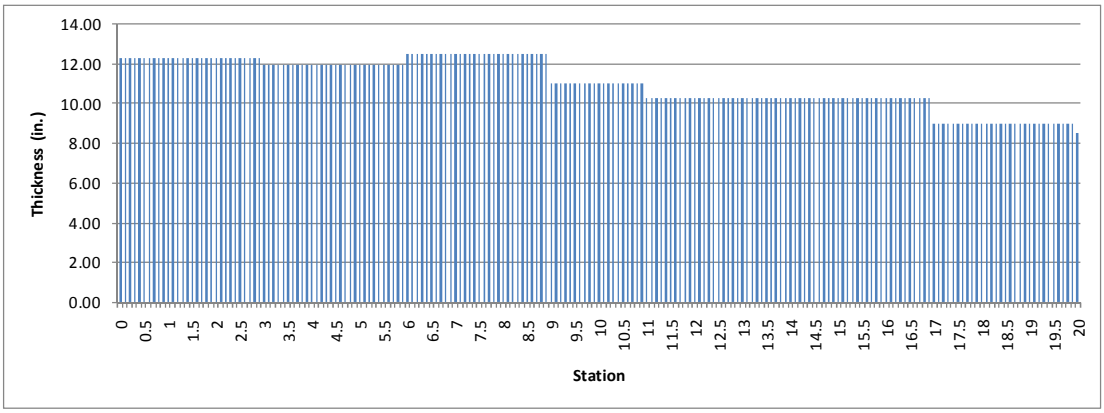

Figure 7a. Pavement layer profile – AC only.

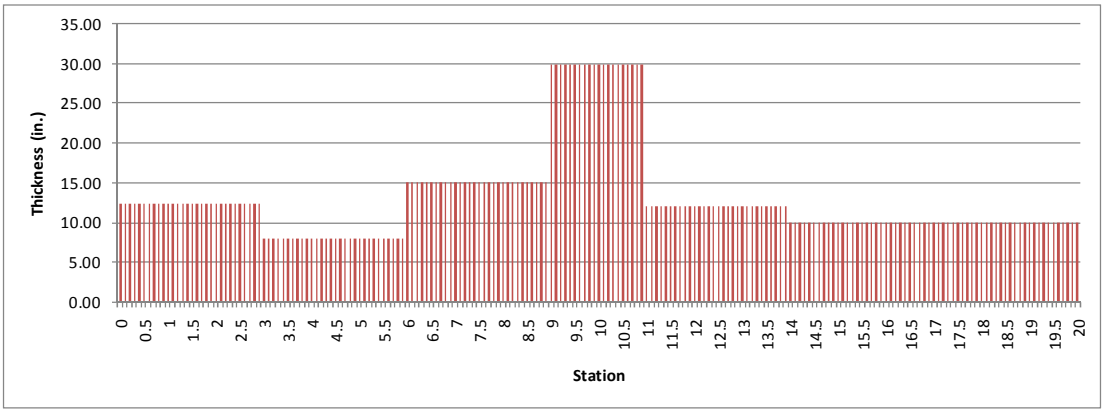

Figure 7b. Pavement layer profile – aggregate only.

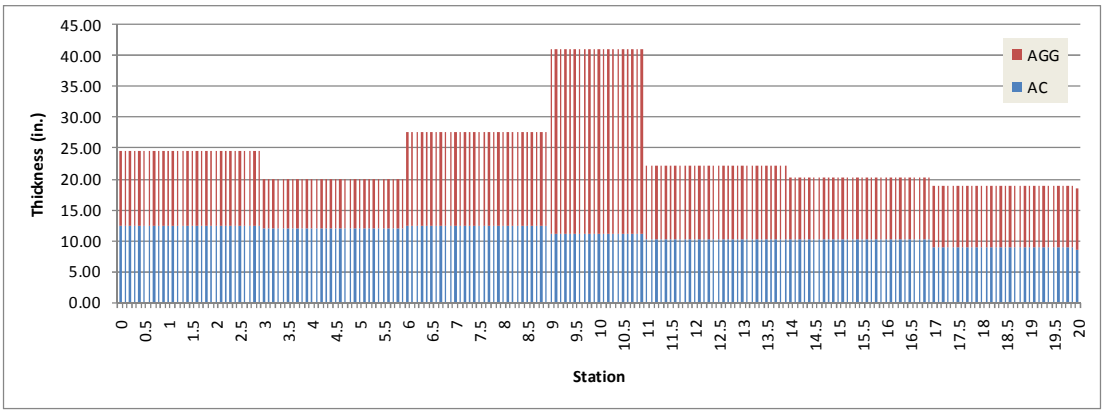

Figure 7c. Pavement layer profile – complete.

Table 8. Sections identified from pavement layer profile.

Section	From Station	To Station
1	0.00	8.99
2	9.00	11.00
3	11.01	20.10

- Distresses
  As can be seen from Figure 8, based on SDI the project can be divided to the sections shown in Table 9.

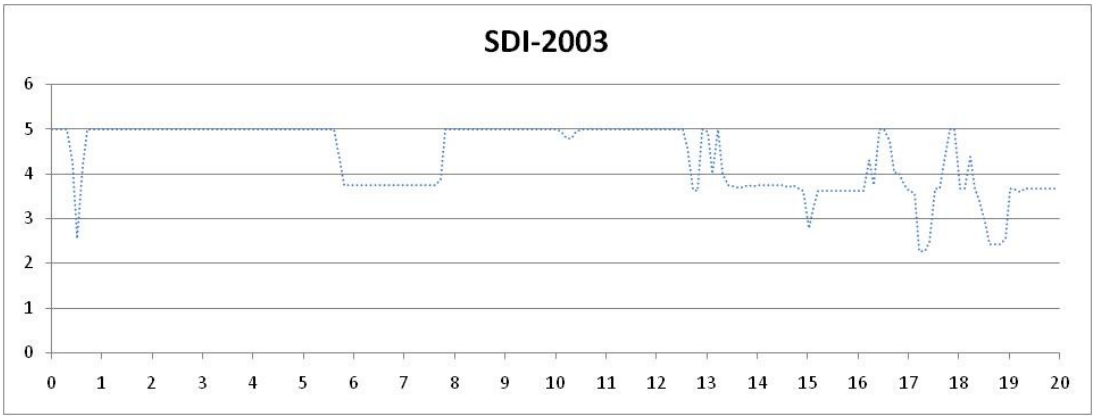

Figure 8. SDI profile.

Table 9. Sections identified from SDI.

Section	From Station	To Station
1	0.00	5.70
2	5.8	7.8
3	7.9	12.6
4	12.7	20.00

- Roughness
  As can be seen from Figure 9, based on IRI the project can be divided to the sections shown in Table 10.

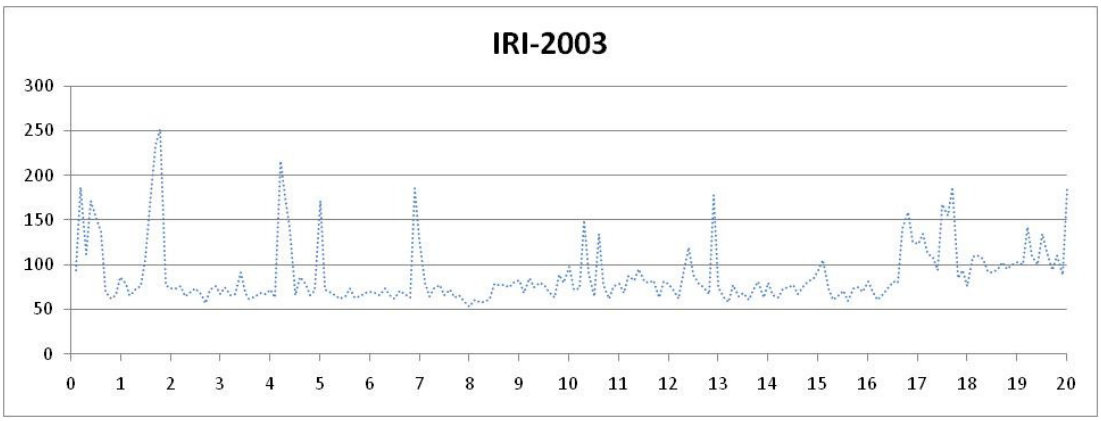

Figure 9. IRI profile.

Table 10. Sections identified from IRI.

Section	From Station	To Station
1	0.00	16.6
2	16.7	20.00

- **Final Sectioning**
  - It is evident that referencing of all data attributes has some issues. It is very important to make sure that a common accurate referencing is used for all data attributes, such as GPS in addition to calibrated DMI.
  - Table 11 shows the final sectioning for the project. The 20-mile segment was divided into 5 homogenous sections. The length of these sections ranges from 2.4 miles to 9.09 miles.

Table 11. Final Sectioning

Section	From Station	To Station	Length (mile)
1	0.00	2.99	2.99
2	3.00	5.80	2.80
3	5.83	8.99	3.16
4	9.00	11.00	2.00
5	11.01	20.10	9.09

3. Check overlay feasibility:
   - Overlay is not a feasible option if:
     - The subgrade modulus (M_r) is lower than a minimum value (3,000 to 4,500 psi).
     - The strength of the asphalt layer is very low. This can be checked by calculating a minimum SN_{eff} using the following equation:

$$SN_{min} = 0.2 * \text{AC Thickness (in)} + 0.11* \text{Agg Thickness (in)}$$

- As shown in Figure 3, for this project, the subgrade modulus (M_r) is always higher than the minimum value of 3,000 to 4,500 psi.

- Figure 10, below, shows the SN_{eff} profile compared with the SN_{min} calculated using the above equation.

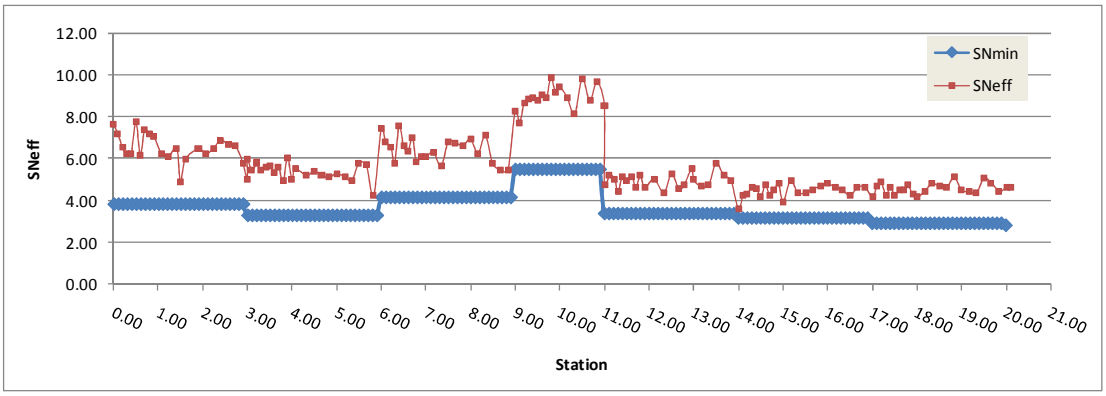

Figure 10. SN_{eff} and SN_{min}.

- As can be seen from this figure, for this project, the SN_{eff} is always higher than the calculated minimum SN_{eff} (SN_{min}).

- Therefore, overlay is a feasible option for this project.

- Traffic records indicate that the 20-year design traffic for this project is about 20 million ESALs. This is based on NJDOT PMS estimated annual ESALs. A more accurate estimate can be obtained if a limited axle survey is performed using a calibrated portable WIM.

4. Calculate required overlay thickness (additional thickness):
   - Table 12 shows, for each of the five homogeneous sections in this project, the required additional thickness for different traffic levels under the 1993 AASHTO Pavement Design procedure:

Table 12. Required additional thickness by traffic level.

Section	From Station	To Station	Length (mile)	AC Overlay			
				10M_ESAL	20M_ESAL	30M_ESAL	50M_ESAL
1	0.00	2.99	2.99	-	-	-	-
2	3.00	5.80	2.80	-	-	-	1"
3	5.83	8.99	3.16	-	-	-	-
4	11.70	14.10	2.40	-	-	-	-
5	11.01	20.10	9.09	-	1"	2"	3"

- Distress data indicated the existence of some non-load related cracks, therefore milling is recommended.

- Localized repairs may be required based on the results of a detailed distress survey.
- In general, IRI numbers are reasonable for the pavement. Milling will help to achieve a low initial IRI after constructing the selected rehabilitation activity.
- Therefore, if the design traffic is assumed to be 20 million ESALs, then the rehabilitation activity for each of the five homogeneous sections would be as shown in Table 13 below.
- The required additional thickness, as can be seen from Table 9, for different traffic levels shows low sensitivity.
- Distress data should be used to identify any pre-rehabilitation repair. However, the available network level distress data is not suitable for this purpose.

Table 13. Selected rehabilitation activities

Section	From Station	To Station	Activity
1	0.00	2.99	Mill 2" Overlay 2"
2	3.00	5.80	Mill 2" Overlay2"
3	5.83	8.99	Mill 2" Overlay 2"
4	11.70	14.10	Mill 2" Overlay 2"
5	11.01	20.10	Mill 2" Overlay 3"

The above case study presented an approach that can be followed to perform rehabilitation analysis based on FWD. This case study highlighted the importance of having a common and accurate referencing system to allow the accurate overlaying different data attributes.

Case Study 2 – PCC Pavement

Location:
- I78 E From MP 1.30 – To MP 4.68

Available Data
- FWD
- Core/bore
- Traffic (from NJDOT PMS)
- GPR
- Distress and distress index (from NJDOT PMS)
- IRI (from NJDOT PMS)

Appendix B has the following tables:
- Table 7 shows the collected deflection data (metric units).
- Table 8 shows the collected deflection data (English units).
- Table 9 shows the normalized (9000 lb) deflection data (English units).
- Table 10 shows the average normalized deflection data (English units).

Backcalculation Analysis:

- Backcalculation of the effective PCC modulus (Epcc), Modulus of Subgrade Reaction (Kstatic) and Load Transfer Efficiency of the approach and leave sides of joints (LTE) using the 1993 AASHTO Pavement Design Procedure. These results are shown in Appendix B as Tables 11 and 12. It is worth mentioning that the mid-slab deflections of three locations did not pass the quality checks, and therefore were excluded from the analysis results shown in Table 12. These locations are highlighted in "**red**" in Tables 7 to 10 of Appendix B.
- Kstatic profile from backcalculation results, shown in Figure 11.
- Epcc profile from backcalculation results, shown in Figure 12.
-

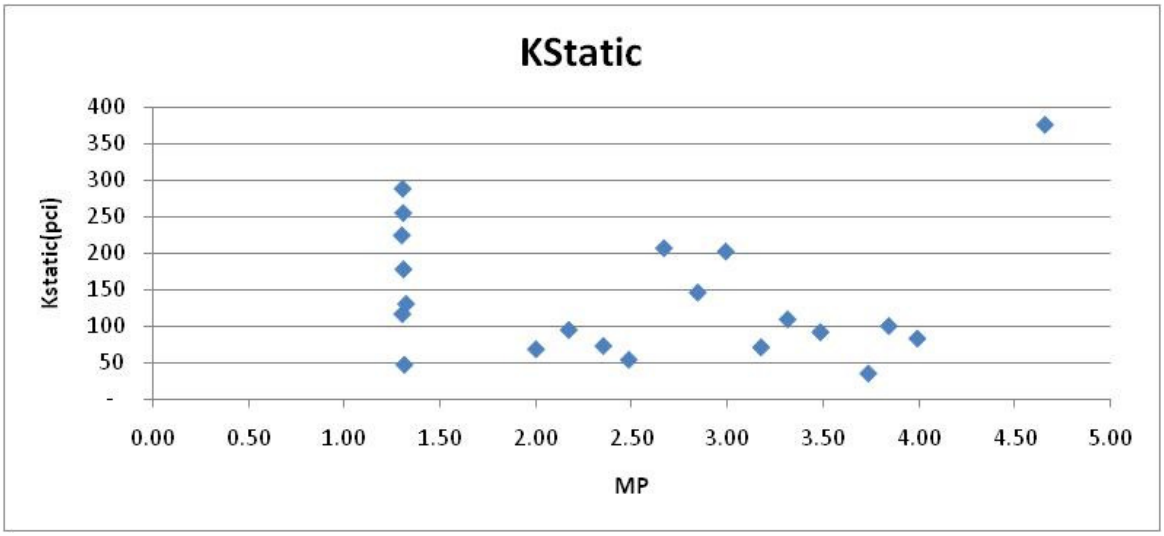

Figure 11. Kstatic profile.

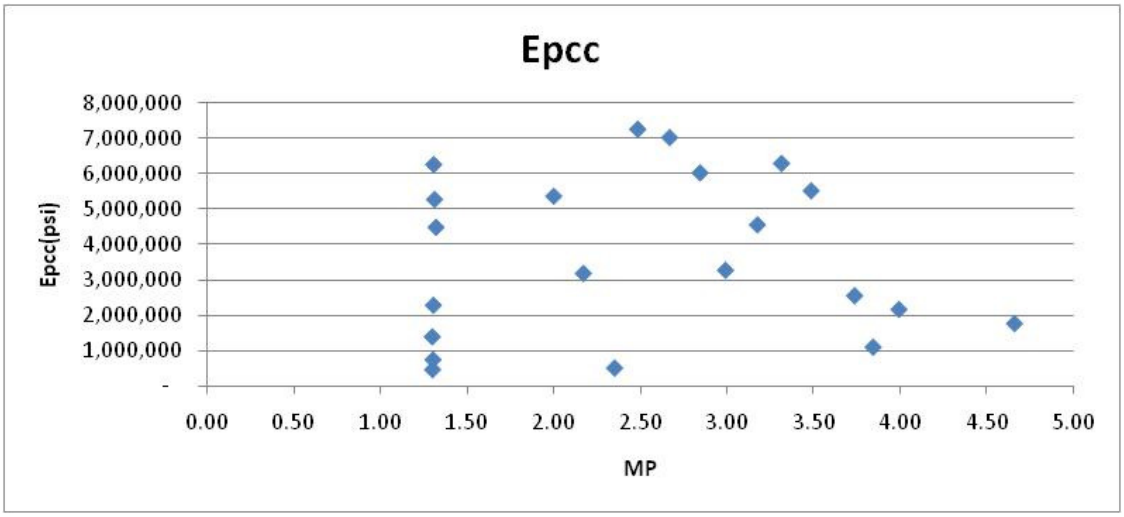

Figure 12. Epcc profile.

Pavement Sectioning

- GPR
  GPR data is complete only for the PCC layer, therefore sectioning was performed based on PCC thickness only. Figure 13 shows the PCC thickness obtained from GPR and Cores. Based on this figure, the project can be treated as one section

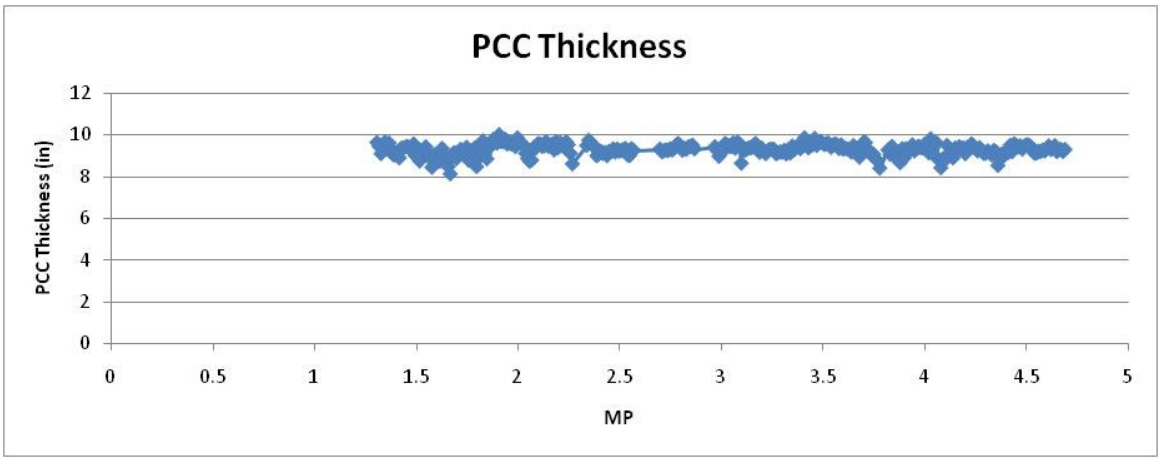

Figure 13. PCC Thickness - GPR.

- Deflection
  - Sensor D1- mid slab profile (Figure 14) examined first. No clear section limits are shown.
  - Epcc profile (Figure 12) examined indicates no distinct section limits.

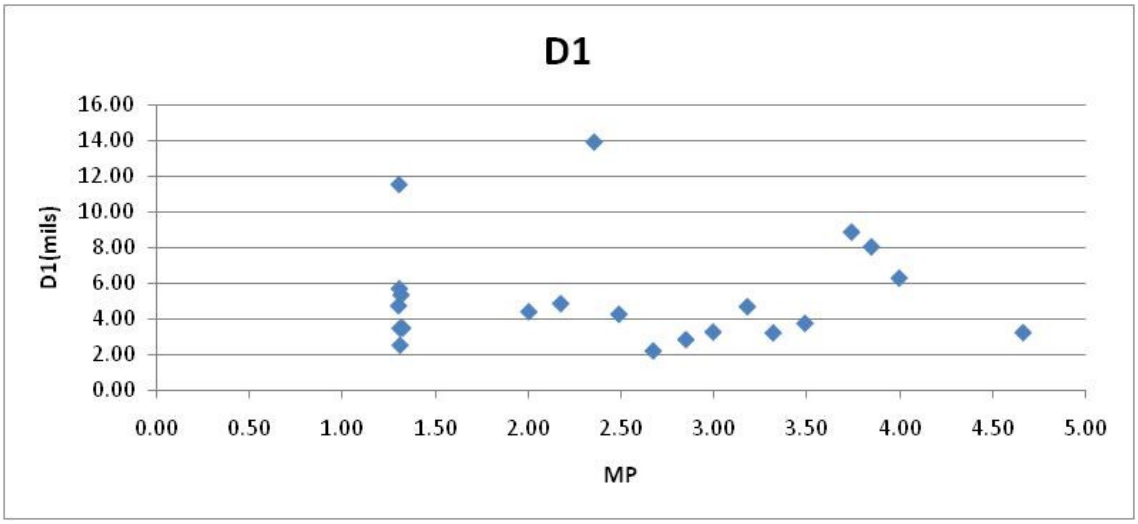

Figure 14. Sensor D1 profile.

- Core/Bore Data
  Only one core is available showing a PCC thickness of 10 in.

- Distresses
  As can be seen from Figure 15, based on SDI the project can be divided to the sections shown in Table 9.

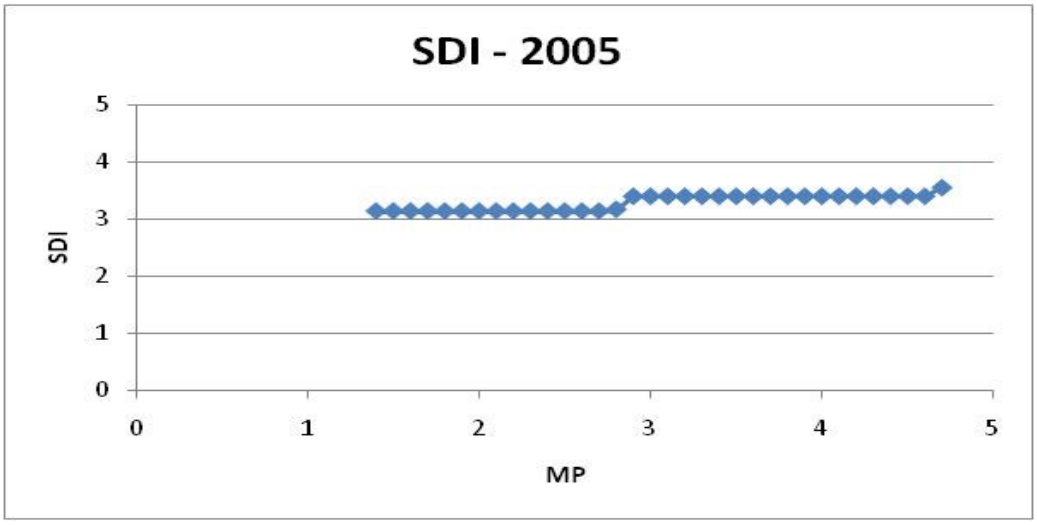

Figure 15. SDI profile.

- Roughness
  As can be seen from Figure 16, based on IRI the project can be divided to the sections shown in Table 10.

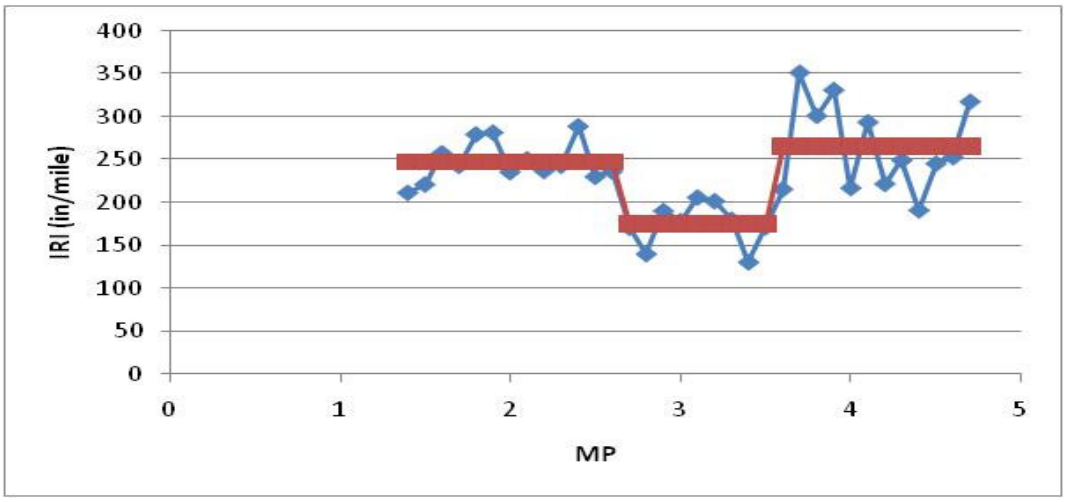

Figure 16. IRI profile.

Table 10. Sections identified from IRI.

Section	From MP	To MP
1	1.3	2.6
2	2.61	3.6
3	3.61	4.68

- Final Sectioning

  Table 11 shows the final sectioning for the project. The project can be divided into 3 homogenous sections. The length of these sections ranges from 0.99 to 1.30 miles.

Table 11. Final Sectioning

Section	From Station	To Station	Length (mile)
1	1.30	2.60	1.30
2	2.61	3.60	0.99
3	3.61	4.68	1.07

- **Repairs**
  - Slab replacement – Any slab with Epcc less than 1,000,000 psi need to be replaced. Twenty one slabs were tested and 3 of them have backcalcualted Epcc < 1,000,000 psi, i.e. 15% of the slabs require slab repair. The detailed condition survey should help in identifying the slabs that require repair.
  - Joint repair/replacement – Any joints with Load Transfer Efficiency (LTE) < 70% and excessive deflections need to be fixed. All tested joints have LTE > 70%.

- **Void Detection and Sub-sealing Requirements**

Typically, voids are detected based on corner testing. The most common procedure adopted by the 1993 AASHTO Pavement Design Guide is based on the estimated deflection when the applied load is set to zero. This deflection is estimated by plotting the load versus deflection and extending the line and evaluate the intercept magnitude. Since the available FWD data includes mid-slab and joint tests only, the joint data has been used to demonstrate this procedure, as shown in Figure 17.

As can be seen from this figure, the deflection @ zero load level is small, therefore the potential of these 2 joints to have voids is small. However, it should be noted that this approach is based on corner testing, not joint testing. Therefore, this conclusion may not be valid.

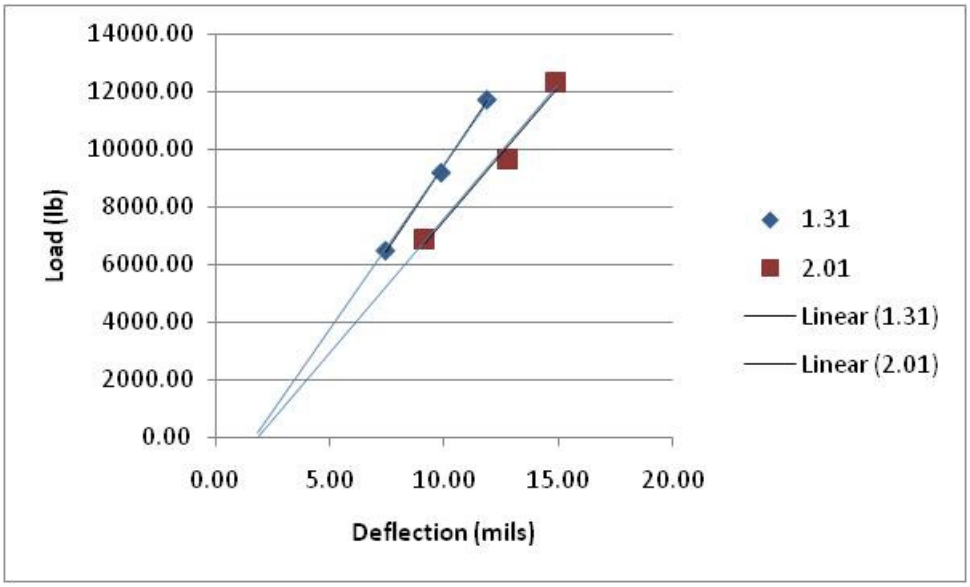

Figure 17. 1993 AASHTO void detection procedure

Another approach to detect voids based on joint testing is based on comparing joint deflections with mid-slab deflections. Based on mechanistic analysis, it is expected that a fully supported joint to have a deflection 2 to 3 times of that of a fully supported mid-slab subjected to the same load level. The main reason for the higher joint deflection is this case will be only because of the discontinuity due to the joint. Therefore, if the ratio of joint deflection to the same slab, mid-slab deflection (M-Ratio) is much higher than 3, then the potential of having a void is high. Figure 18 shows the calculated M-Ratio for joint tests (approach and leave). As can be seen, some of the joints have very high M-Ratio, such as the leave joint @ St 3.18 (M_Ratio > 12). The load-deflection plot of this joint is presented in Figure 19. The estimated deflection @ zero load level is close to 10 mils, which is high, indicating the high potential of having a void under this joint.

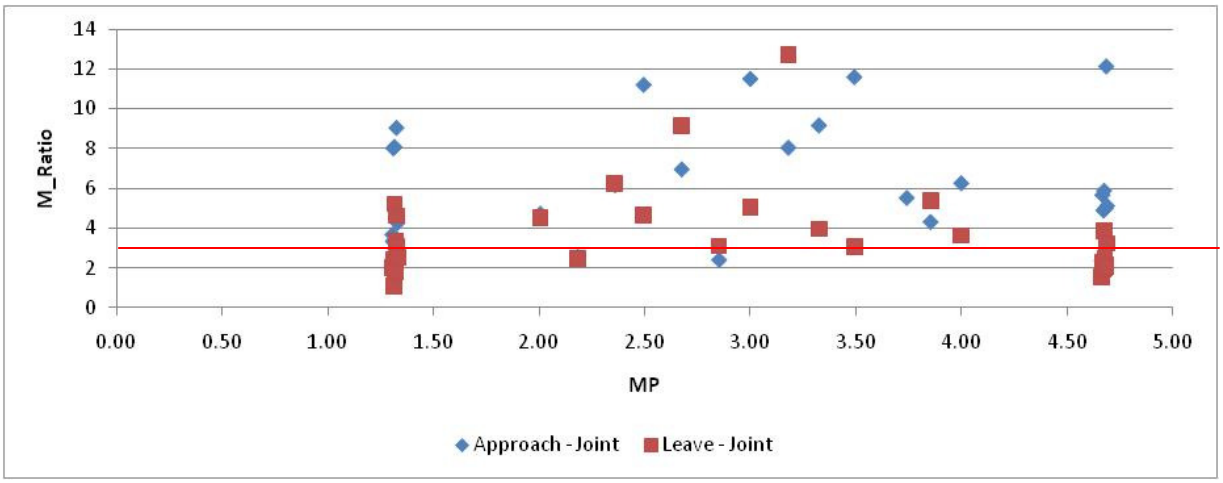

Figure 18. Calculated M-Ration

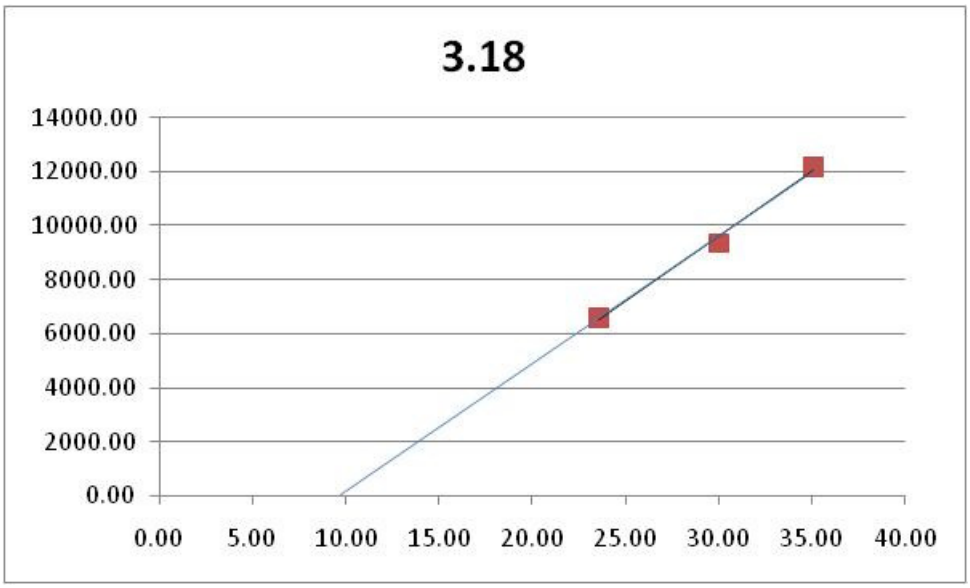

Figure 19. Load-deflection of joint @ Station 3.18

- **Check overlay feasibility**
  - AC overlay is not a feasible option if the cost of repairing joints and slabs (pre-overlay repair) + the overlay cost is greater than reconstructing the pavement.
  - Traffic records indicate that the 20-year design traffic for this project is about 36 million ESALs. This is based on NJDOT PMS estimated annual ESALs. A more accurate estimate can be obtained if a limited axle survey is performed using a calibrated portable WIM.
  - Calculate AC overlay thickness using the procedure described in the 1993 AASHTO Pavement Design Guide
  - Select an appropriate reflective crack control technique

Appendix B

Available FWD & Core/Bore Data for Case Study 1

Table 1. Deflection data – I-195 (metric units).

Station	LoadSize (KPa)	Deflect 1	Deflect 2	Deflect 3	Deflect 4	Deflect 5	Deflect 6	Deflect 7	Deflect 8	Deflect 9
0.00	395.00	97.00	72.00	75.00	65.00	55.00	39.00	28.00	21.00	15.00
0.00	558.00	137.00	101.00	105.00	91.00	78.00	57.00	40.00	28.00	20.00
0.00	701.00	176.00	131.00	137.00	120.00	105.00	76.00	55.00	41.00	29.00
0.10	417.00	108.00	83.00	79.00	68.00	58.00	41.00	30.00	22.00	17.00
0.10	585.00	155.00	120.00	115.00	101.00	85.00	61.00	45.00	35.00	25.00
0.10	741.00	195.00	153.00	148.00	127.00	109.00	79.00	57.00	43.00	31.00
0.20	447.00	134.00	94.00	93.00	77.00	63.00	43.00	30.00	23.00	17.00
0.20	617.00	190.00	133.00	132.00	109.00	91.00	62.00	44.00	33.00	25.00
0.20	782.00	240.00	170.00	168.00	139.00	117.00	81.00	58.00	43.00	33.00
0.30	393.00	140.00	101.00	99.00	81.00	66.00	44.00	32.00	20.00	19.00
0.30	553.00	198.00	143.00	141.00	117.00	96.00	64.00	44.00	33.00	25.00
0.30	709.00	252.00	185.00	182.00	151.00	125.00	85.00	59.00	45.00	35.00
0.40	412.00	174.00	145.00	148.00	129.00	103.00	72.00	52.00	39.00	30.00
0.40	576.00	245.00	203.00	209.00	185.00	151.00	105.00	77.00	58.00	44.00
0.40	726.00	303.00	251.00	259.00	230.00	188.00	133.00	96.00	72.00	56.00
0.50	390.00	110.00	87.00	86.00	80.00	73.00	61.00	51.00	43.00	35.00
0.50	552.00	157.00	126.00	124.00	115.00	107.00	89.00	75.00	62.00	51.00
0.50	704.00	199.00	159.00	158.00	147.00	135.00	114.00	95.00	78.00	64.00
0.60	467.00	148.00	96.00	94.00	73.00	59.00	40.00	29.00	24.00	20.00
0.60	663.00	215.00	139.00	136.00	108.00	88.00	60.00	45.00	36.00	30.00
0.60	845.00	279.00	182.00	180.00	145.00	118.00	80.00	59.00	48.00	40.00
0.70	486.00	132.00	89.00	91.00	83.00	75.00	60.00	49.00	39.00	32.00
0.70	686.00	186.00	126.00	130.00	119.00	108.00	86.00	71.00	58.00	46.00
0.70	875.00	232.00	160.00	165.00	150.00	136.00	110.00	90.00	73.00	59.00
0.80	480.00	122.00	83.00	82.00	72.00	63.00	48.00	38.00	30.00	24.00
0.80	676.00	175.00	121.00	119.00	104.00	92.00	71.00	56.00	44.00	35.00
0.80	864.00	220.00	155.00	152.00	134.00	118.00	91.00	70.00	56.00	44.00
0.91	455.00	150.00	113.00	114.00	104.00	91.00	70.00	55.00	42.00	32.00
0.91	643.00	215.00	163.00	164.00	148.00	132.00	103.00	81.00	62.00	47.00
0.91	825.00	270.00	205.00	206.00	185.00	167.00	131.00	102.00	78.00	59.00
1.08	456.00	160.00	102.00	103.00	86.00	73.00	52.00	39.00	31.00	25.00
1.08	651.00	229.00	150.00	151.00	127.00	107.00	76.00	57.00	44.00	35.00
1.08	828.00	289.00	192.00	193.00	163.00	139.00	99.00	73.00	57.00	46.00
1.24	450.00	146.00	87.00	90.00	70.00	55.00	37.00	28.00	23.00	19.00
1.24	638.00	207.00	128.00	132.00	104.00	83.00	57.00	41.00	33.00	27.00
1.24	814.00	266.00	167.00	171.00	136.00	110.00	75.00	54.00	43.00	34.00
1.42	480.00	132.00	77.00	77.00	63.00	53.00	36.00	28.00	23.00	18.00
1.42	678.00	188.00	113.00	114.00	92.00	78.00	55.00	41.00	33.00	25.00
1.42	865.00	242.00	148.00	148.00	120.00	102.00	72.00	54.00	43.00	34.00
1.50	461.00	242.00	155.00	146.00	102.00	70.00	37.00	24.00	20.00	16.00
1.50	649.00	333.00	217.00	209.00	148.00	105.00	55.00	35.00	25.00	22.00
1.50	822.00	413.00	273.00	265.00	192.00	138.00	73.00	45.00	34.00	28.00
1.61	460.00	154.00	105.00	103.00	79.00	61.00	36.00	25.00	20.00	15.00
1.61	648.00	216.00	148.00	147.00	114.00	88.00	53.00	35.00	27.00	22.00

Station	LoadSize (KPa)	Deflect 1	Deflect 2	Deflect 3	Deflect 4	Deflect 5	Deflect 6	Deflect 7	Deflect 8	Deflect 9
1.61	828.00	276.00	189.00	188.00	148.00	116.00	71.00	47.00	36.00	29.00
1.90	471.00	134.00	85.00	85.00	69.00	57.00	39.00	27.00	21.00	17.00
1.90	665.00	190.00	122.00	123.00	101.00	84.00	57.00	39.00	31.00	24.00
1.90	854.00	245.00	158.00	160.00	133.00	110.00	75.00	52.00	39.00	31.00
2.07	473.00	162.00	106.00	105.00	87.00	73.00	52.00	40.00	33.00	25.00
2.07	668.00	231.00	154.00	154.00	129.00	110.00	79.00	59.00	47.00	38.00
2.07	860.00	296.00	198.00	197.00	166.00	142.00	103.00	77.00	61.00	49.00
2.24	466.00	128.00	82.00	84.00	68.00	55.00	34.00	23.00	18.00	14.00
2.24	658.00	174.00	115.00	117.00	96.00	79.00	49.00	33.00	25.00	19.00
2.24	842.00	224.00	145.00	148.00	123.00	101.00	64.00	43.00	32.00	25.00
2.40	487.00	121.00	77.00	77.00	64.00	54.00	37.00	26.00	20.00	15.00
2.40	685.00	169.00	108.00	108.00	92.00	78.00	54.00	38.00	29.00	22.00
2.40	876.00	217.00	140.00	141.00	120.00	102.00	72.00	50.00	37.00	28.00
2.57	483.00	138.00	95.00	93.00	78.00	65.00	46.00	34.00	27.00	21.00
2.57	681.00	200.00	141.00	139.00	119.00	100.00	71.00	53.00	40.00	31.00
2.57	871.00	255.00	182.00	180.00	154.00	131.00	94.00	69.00	53.00	41.00
2.74	473.00	135.00	89.00	88.00	74.00	62.00	43.00	32.00	24.00	18.00
2.74	669.00	197.00	135.00	134.00	115.00	97.00	68.00	49.00	37.00	28.00
2.74	859.00	256.00	177.00	176.00	151.00	129.00	91.00	66.00	50.00	38.00
2.90	468.00	178.00	123.00	119.00	94.00	75.00	48.00	32.00	24.00	18.00
2.90	663.00	256.00	178.00	174.00	139.00	112.00	72.00	48.00	35.00	26.00
2.90	848.00	331.00	232.00	227.00	183.00	150.00	97.00	65.00	47.00	35.00
3.00	479.00	166.00	105.00	111.00	87.00	67.00	40.00	27.00	21.00	18.00
3.00	677.00	233.00	148.00	157.00	124.00	96.00	59.00	39.00	30.00	25.00
3.00	864.00	294.00	191.00	202.00	161.00	126.00	78.00	51.00	39.00	32.00
3.00	481.00	166.00	108.00	107.00	83.00	63.00	38.00	26.00	21.00	17.00
3.00	680.00	231.00	151.00	152.00	119.00	91.00	56.00	38.00	28.00	25.00
3.00	866.00	292.00	196.00	197.00	156.00	120.00	75.00	50.00	39.00	32.00
3.10	493.00	132.00	81.00	82.00	62.00	48.00	30.00	23.00	20.00	17.00
3.10	699.00	185.00	116.00	118.00	92.00	73.00	46.00	34.00	28.00	24.00
3.10	891.00	240.00	153.00	156.00	123.00	98.00	63.00	46.00	37.00	32.00
3.20	472.00	121.00	77.00	76.00	63.00	54.00	36.00	27.00	23.00	18.00
3.20	669.00	173.00	113.00	110.00	93.00	77.00	54.00	40.00	32.00	26.00
3.20	863.00	222.00	145.00	144.00	122.00	103.00	72.00	53.00	41.00	34.00
3.20	480.00	119.00	76.00	74.00	61.00	51.00	35.00	26.00	21.00	18.00
3.20	679.00	170.00	111.00	109.00	91.00	75.00	52.00	38.00	30.00	25.00
3.20	868.00	218.00	144.00	141.00	118.00	99.00	69.00	51.00	39.00	33.00
3.30	468.00	120.00	75.00	72.00	57.00	45.00	27.00	19.00	16.00	13.00
3.30	665.00	169.00	107.00	103.00	83.00	67.00	42.00	29.00	23.00	20.00
3.30	853.00	217.00	139.00	135.00	109.00	90.00	57.00	40.00	31.00	27.00
3.43	480.00	117.00	72.00	71.00	55.00	43.00	27.00	20.00	18.00	14.00
3.43	678.00	163.00	101.00	100.00	79.00	63.00	40.00	29.00	23.00	19.00
3.43	867.00	203.00	126.00	126.00	101.00	80.00	53.00	37.00	31.00	24.00
3.50	481.00	116.00	70.00	71.00	57.00	46.00	30.00	20.00	15.00	11.00
3.50	673.00	161.00	100.00	101.00	82.00	67.00	44.00	30.00	23.00	16.00
3.50	863.00	207.00	128.00	130.00	106.00	87.00	58.00	39.00	29.00	22.00

Station	LoadSize (KPa)	Deflect 1	Deflect 2	Deflect 3	Deflect 4	Deflect 5	Deflect 6	Deflect 7	Deflect 8	Deflect 9
3.60	463.00	123.00	77.00	76.00	59.00	47.00	30.00	20.00	16.00	12.00
3.60	654.00	175.00	109.00	107.00	85.00	68.00	44.00	30.00	23.00	17.00
3.60	835.00	225.00	141.00	138.00	110.00	89.00	58.00	40.00	30.00	23.00
3.70	489.00	122.00	74.00	76.00	60.00	48.00	30.00	20.00	15.00	12.00
3.70	685.00	168.00	105.00	106.00	84.00	68.00	44.00	29.00	23.00	16.00
3.70	879.00	210.00	133.00	134.00	108.00	88.00	57.00	38.00	28.00	22.00
3.80	468.00	167.00	108.00	106.00	79.00	60.00	35.00	24.00	19.00	16.00
3.80	663.00	222.00	147.00	145.00	112.00	86.00	52.00	36.00	28.00	24.00
3.80	845.00	274.00	183.00	180.00	141.00	110.00	67.00	46.00	37.00	30.00
3.90	486.00	117.00	78.00	77.00	65.00	55.00	39.00	29.00	24.00	20.00
3.90	687.00	167.00	113.00	112.00	96.00	81.00	58.00	43.00	34.00	28.00
3.90	883.00	212.00	145.00	143.00	124.00	105.00	75.00	55.00	44.00	36.00
4.00	485.00	152.00	99.00	95.00	70.00	54.00	32.00	20.00	15.00	11.00
4.00	682.00	209.00	138.00	134.00	101.00	78.00	47.00	30.00	22.00	17.00
4.00	871.00	262.00	172.00	168.00	129.00	101.00	62.00	39.00	29.00	22.00
4.07	485.00	135.00	93.00	91.00	73.00	59.00	37.00	24.00	19.00	13.00
4.07	691.00	186.00	129.00	127.00	103.00	84.00	54.00	36.00	26.00	19.00
4.07	885.00	228.00	160.00	158.00	129.00	106.00	69.00	45.00	35.00	25.00
4.33	485.00	144.00	89.00	89.00	67.00	53.00	33.00	22.00	17.00	13.00
4.33	681.00	198.00	125.00	125.00	96.00	76.00	48.00	32.00	25.00	19.00
4.33	871.00	252.00	161.00	158.00	124.00	99.00	64.00	43.00	33.00	25.00
4.50	483.00	124.00	80.00	81.00	63.00	49.00	30.00	19.00	14.00	11.00
4.50	683.00	173.00	113.00	114.00	90.00	71.00	44.00	27.00	20.00	15.00
4.50	873.00	217.00	143.00	144.00	116.00	91.00	57.00	35.00	25.00	18.00
4.66	466.00	148.00	101.00	98.00	81.00	66.00	42.00	28.00	22.00	17.00
4.66	658.00	210.00	144.00	140.00	115.00	94.00	61.00	41.00	31.00	24.00
4.66	838.00	268.00	184.00	180.00	148.00	122.00	80.00	53.00	40.00	31.00
4.83	493.00	159.00	101.00	100.00	79.00	63.00	39.00	25.00	19.00	13.00
4.83	696.00	214.00	138.00	136.00	108.00	87.00	55.00	35.00	24.00	17.00
4.83	888.00	265.00	172.00	169.00	136.00	110.00	69.00	44.00	31.00	22.00
5.00	486.00	151.00	102.00	102.00	83.00	68.00	45.00	30.00	23.00	17.00
5.00	685.00	216.00	144.00	145.00	119.00	98.00	65.00	44.00	33.00	25.00
5.00	877.00	274.00	185.00	185.00	152.00	126.00	84.00	56.00	42.00	30.00
5.18	487.00	142.00	94.00	92.00	73.00	57.00	34.00	21.00	16.00	12.00
5.18	680.00	194.00	130.00	128.00	102.00	80.00	49.00	30.00	22.00	16.00
5.18	868.00	247.00	164.00	161.00	128.00	102.00	63.00	38.00	28.00	21.00
5.34	480.00	180.00	122.00	119.00	96.00	77.00	53.00	39.00	31.00	26.00
5.34	676.00	258.00	177.00	174.00	140.00	114.00	77.00	55.00	44.00	37.00
5.34	861.00	328.00	229.00	223.00	183.00	149.00	101.00	71.00	56.00	46.00
5.50	476.00	148.00	107.00	106.00	94.00	81.00	61.00	46.00	35.00	26.00
5.50	668.00	208.00	151.00	151.00	133.00	116.00	87.00	66.00	50.00	37.00
5.50	860.00	265.00	195.00	194.00	171.00	151.00	114.00	85.00	63.00	47.00
5.66	490.00	140.00	95.00	95.00	81.00	70.00	49.00	37.00	30.00	25.00
5.66	691.00	198.00	136.00	136.00	116.00	99.00	72.00	53.00	43.00	35.00
5.66	882.00	252.00	173.00	173.00	148.00	127.00	92.00	68.00	54.00	44.00
5.83	477.00	204.00	117.00	122.00	82.00	56.00	26.00	16.00	14.00	12.00

Station	LoadSize (KPa)	Deflect 1	Deflect 2	Deflect 3	Deflect 4	Deflect 5	Deflect 6	Deflect 7	Deflect 8	Deflect 9
5.83	679.00	276.00	163.00	167.00	115.00	80.00	38.00	23.00	19.00	18.00
5.83	872.00	337.00	202.00	206.00	144.00	102.00	50.00	32.00	28.00	23.00
6.00	488.00	115.00	76.00	73.00	58.00	47.00	31.00	23.00	19.00	16.00
6.00	690.00	167.00	110.00	108.00	88.00	72.00	49.00	35.00	28.00	22.00
6.00	878.00	217.00	145.00	142.00	116.00	96.00	66.00	46.00	35.00	28.00
6.10	503.00	147.00	92.00	92.00	69.00	53.00	31.00	22.00	17.00	14.00
6.10	707.00	200.00	126.00	126.00	97.00	77.00	47.00	32.00	25.00	20.00
6.10	904.00	253.00	161.00	160.00	126.00	99.00	62.00	42.00	33.00	27.00
6.22	502.00	161.00	105.00	105.00	80.00	62.00	35.00	21.00	15.00	10.00
6.22	701.00	219.00	145.00	144.00	111.00	86.00	50.00	29.00	21.00	14.00
6.22	896.00	271.00	180.00	179.00	139.00	109.00	64.00	38.00	26.00	18.00
6.30	502.00	217.00	133.00	134.00	97.00	70.00	36.00	20.00	15.00	12.00
6.30	705.00	287.00	179.00	180.00	132.00	99.00	52.00	29.00	21.00	16.00
6.30	901.00	350.00	220.00	221.00	163.00	121.00	66.00	38.00	26.00	20.00
6.40	501.00	116.00	74.00	74.00	60.00	50.00	33.00	23.00	17.00	13.00
6.40	699.00	161.00	103.00	103.00	85.00	71.00	48.00	33.00	24.00	19.00
6.40	888.00	207.00	135.00	134.00	112.00	93.00	64.00	44.00	32.00	24.00
6.50	490.00	168.00	116.00	116.00	93.00	75.00	48.00	33.00	24.00	18.00
6.50	689.00	242.00	169.00	168.00	137.00	112.00	72.00	49.00	36.00	27.00
6.50	877.00	305.00	216.00	216.00	178.00	146.00	96.00	65.00	47.00	35.00
6.60	496.00	161.00	94.00	91.00	66.00	49.00	27.00	16.00	11.00	9.00
6.60	692.00	217.00	127.00	124.00	91.00	70.00	38.00	22.00	15.00	12.00
6.60	869.00	264.00	156.00	153.00	114.00	86.00	48.00	28.00	20.00	15.00
6.70	502.00	134.00	90.00	86.00	67.00	53.00	31.00	19.00	14.00	11.00
6.70	703.00	183.00	124.00	119.00	95.00	75.00	45.00	28.00	20.00	15.00
6.70	896.00	227.00	155.00	149.00	120.00	95.00	58.00	36.00	26.00	19.00
6.78	479.00	190.00	117.00	117.00	81.00	54.00	25.00	15.00	12.00	10.00
6.78	678.00	256.00	160.00	159.00	112.00	77.00	38.00	22.00	18.00	14.00
6.78	867.00	312.00	196.00	195.00	138.00	96.00	48.00	28.00	22.00	17.00
6.90	393.00	163.00	109.00	107.00	81.00	63.00	39.00	26.00	19.00	14.00
6.90	553.00	235.00	159.00	158.00	122.00	97.00	60.00	40.00	29.00	21.00
6.90	707.00	298.00	207.00	203.00	159.00	127.00	81.00	53.00	39.00	28.00
7.00	411.00	161.00	97.00	96.00	70.00	52.00	29.00	19.00	15.00	12.00
7.00	574.00	225.00	139.00	139.00	104.00	79.00	45.00	29.00	22.00	17.00
7.00	731.00	283.00	178.00	178.00	135.00	103.00	60.00	39.00	29.00	23.00
7.17	404.00	140.00	85.00	86.00	62.00	45.00	26.00	17.00	15.00	12.00
7.17	569.00	196.00	123.00	123.00	90.00	67.00	40.00	26.00	21.00	17.00
7.17	724.00	247.00	157.00	156.00	116.00	88.00	52.00	35.00	27.00	23.00
7.34	420.00	200.00	114.00	113.00	81.00	60.00	36.00	25.00	20.00	16.00
7.34	586.00	283.00	168.00	165.00	121.00	90.00	54.00	38.00	30.00	24.00
7.34	743.00	354.00	215.00	212.00	158.00	119.00	72.00	49.00	38.00	32.00
7.50	414.00	119.00	77.00	78.00	59.00	45.00	26.00	16.00	13.00	10.00
7.50	578.00	169.00	111.00	111.00	87.00	66.00	39.00	25.00	18.00	15.00
7.50	734.00	214.00	143.00	143.00	113.00	87.00	52.00	34.00	24.00	19.00
7.66	439.00	128.00	75.00	75.00	58.00	46.00	28.00	18.00	14.00	11.00
7.66	616.00	181.00	110.00	109.00	86.00	67.00	41.00	27.00	21.00	17.00

Station	LoadSize (KPa)	Deflect 1	Deflect 2	Deflect 3	Deflect 4	Deflect 5	Deflect 6	Deflect 7	Deflect 8	Deflect 9
7.66	777.00	228.00	140.00	140.00	111.00	87.00	55.00	36.00	27.00	22.00
7.83	412.00	138.00	88.00	88.00	70.00	57.00	37.00	27.00	21.00	16.00
7.83	575.00	199.00	131.00	132.00	105.00	85.00	57.00	40.00	31.00	25.00
7.83	734.00	253.00	169.00	170.00	138.00	113.00	76.00	53.00	41.00	32.00
8.00	424.00	130.00	89.00	88.00	72.00	59.00	38.00	26.00	19.00	16.00
8.00	587.00	185.00	129.00	127.00	105.00	86.00	56.00	37.00	28.00	21.00
8.00	743.00	235.00	166.00	163.00	135.00	112.00	73.00	49.00	38.00	28.00
8.17	421.00	152.00	92.00	95.00	72.00	55.00	32.00	20.00	15.00	11.00
8.17	585.00	217.00	135.00	139.00	107.00	82.00	48.00	30.00	22.00	17.00
8.17	735.00	274.00	175.00	179.00	138.00	108.00	64.00	40.00	29.00	22.00
8.33	435.00	123.00	81.00	80.00	66.00	53.00	37.00	26.00	21.00	17.00
8.33	607.00	179.00	121.00	119.00	100.00	81.00	56.00	39.00	30.00	24.00
8.33	772.00	229.00	157.00	154.00	129.00	106.00	73.00	52.00	39.00	31.00
8.50	429.00	176.00	101.00	99.00	72.00	49.00	27.00	18.00	15.00	11.00
8.50	602.00	251.00	147.00	143.00	105.00	74.00	41.00	25.00	20.00	15.00
8.50	759.00	322.00	190.00	186.00	138.00	99.00	55.00	34.00	27.00	21.00
8.66	429.00	201.00	105.00	108.00	70.00	48.00	23.00	15.00	12.00	11.00
8.66	602.00	279.00	149.00	151.00	101.00	70.00	36.00	23.00	18.00	16.00
8.66	765.00	345.00	189.00	190.00	128.00	91.00	48.00	31.00	25.00	21.00
8.84	433.00	209.00	102.00	106.00	69.00	48.00	28.00	18.00	14.00	10.00
8.84	605.00	296.00	151.00	154.00	103.00	73.00	41.00	26.00	19.00	14.00
8.84	767.00	370.00	195.00	195.00	133.00	95.00	55.00	34.00	25.00	18.00
9.70	786.00	282.00	170.00	174.00	106.00	66.00	49.00	23.00	0.00	0.00
9.80	433.00	125.00	84.00	83.00	56.00	38.00	29.00	25.00	0.00	0.00
9.80	589.00	172.00	119.00	119.00	78.00	52.00	38.00	28.00	0.00	0.00
9.80	784.00	235.00	161.00	163.00	109.00	70.00	52.00	36.00	0.00	0.00
9.90	430.00	161.00	107.00	105.00	68.00	47.00	37.00	31.00	0.00	0.00
9.90	593.00	216.00	146.00	148.00	96.00	65.00	49.00	41.00	0.00	0.00
9.90	783.00	287.00	197.00	200.00	131.00	85.00	63.00	51.00	0.00	0.00
10.00	427.00	149.00	105.00	101.00	68.00	48.00	38.00	30.00	0.00	0.00
10.00	591.00	207.00	144.00	147.00	95.00	67.00	52.00	41.00	0.00	0.00
10.00	777.00	276.00	194.00	198.00	129.00	89.00	67.00	51.00	0.00	0.00
10.17	430.00	165.00	98.00	92.00	55.00	36.00	29.00	24.00	0.00	0.00
10.17	592.00	221.00	134.00	129.00	77.00	51.00	36.00	30.00	0.00	0.00
10.17	788.00	291.00	181.00	173.00	105.00	68.00	48.00	37.00	0.00	0.00
10.33	429.00	197.00	107.00	105.00	49.00	31.00	24.00	23.00	0.00	0.00
10.33	583.00	271.00	151.00	149.00	71.00	43.00	33.00	25.00	0.00	0.00
10.33	777.00	358.00	202.00	204.00	100.00	58.00	41.00	32.00	0.00	0.00
10.50	433.00	123.00	79.00	80.00	52.00	35.00	25.00	18.00	0.00	0.00
10.50	595.00	170.00	112.00	113.00	75.00	51.00	35.00	25.00	0.00	0.00
10.50	785.00	227.00	150.00	152.00	102.00	67.00	46.00	29.00	0.00	0.00
10.67	430.00	166.00	99.00	100.00	58.00	35.00	27.00	22.00	0.00	0.00
10.67	584.00	222.00	138.00	140.00	80.00	47.00	34.00	25.00	0.00	0.00
10.67	778.00	298.00	186.00	192.00	113.00	66.00	46.00	32.00	0.00	0.00
10.84	437.00	128.00	85.00	84.00	52.00	35.00	25.00	19.00	0.00	0.00
10.84	594.00	177.00	118.00	119.00	75.00	49.00	34.00	24.00	0.00	0.00

Station	LoadSize (KPa)	Deflect 1	Deflect 2	Deflect 3	Deflect 4	Deflect 5	Deflect 6	Deflect 7	Deflect 8	Deflect 9
10.84	783.00	235.00	158.00	159.00	103.00	68.00	46.00	33.00	0.00	0.00
11.00	431.00	179.00	113.00	108.00	61.00	38.00	27.00	23.00	0.00	0.00
11.00	593.00	244.00	155.00	151.00	87.00	53.00	37.00	30.00	0.00	0.00
11.00	782.00	323.00	207.00	203.00	118.00	71.00	49.00	38.00	0.00	0.00
11.00	387.00	172.00	92.00	89.00	63.00	46.00	28.00	20.00	16.00	15.00
11.00	549.00	243.00	136.00	132.00	95.00	71.00	43.00	29.00	24.00	20.00
11.00	697.00	309.00	176.00	174.00	127.00	96.00	58.00	39.00	31.00	26.00
11.11	428.00	158.00	87.00	91.00	68.00	53.00	34.00	25.00	20.00	16.00
11.11	600.00	226.00	128.00	134.00	103.00	82.00	53.00	38.00	29.00	23.00
11.11	754.00	288.00	168.00	176.00	137.00	109.00	72.00	50.00	38.00	29.00
11.23	421.00	175.00	98.00	96.00	72.00	56.00	37.00	28.00	23.00	19.00
11.23	592.00	249.00	147.00	142.00	109.00	86.00	58.00	43.00	34.00	27.00
11.23	753.00	315.00	191.00	185.00	144.00	114.00	77.00	57.00	45.00	36.00
11.30	421.00	212.00	110.00	110.00	76.00	55.00	34.00	24.00	20.00	16.00
9.00	430.00	207.00	114.00	112.00	58.00	35.00	26.00	21.00	0.00	0.00
9.00	582.00	277.00	155.00	152.00	78.00	48.00	34.00	28.00	0.00	0.00
9.00	770.00	370.00	205.00	203.00	104.00	63.00	45.00	36.00	0.00	0.00
9.00	437.00	174.00	89.00	94.00	48.00	29.00	22.00	14.00	0.00	0.00
9.00	596.00	236.00	126.00	132.00	69.00	40.00	29.00	19.00	0.00	0.00
9.00	783.00	307.00	166.00	178.00	95.00	52.00	38.00	25.00	0.00	0.00
9.10	433.00	232.00	113.00	109.00	49.00	31.00	24.00	21.00	0.00	0.00
9.10	590.00	307.00	156.00	152.00	68.00	41.00	32.00	25.00	0.00	0.00
9.10	776.00	399.00	205.00	205.00	93.00	55.00	43.00	29.00	0.00	0.00
9.20	433.00	171.00	98.00	98.00	51.00	30.00	22.00	19.00	0.00	0.00
9.20	594.00	228.00	132.00	134.00	70.00	40.00	30.00	22.00	0.00	0.00
9.20	780.00	290.00	170.00	173.00	93.00	52.00	35.00	30.00	0.00	0.00
9.30	434.00	164.00	101.00	100.00	57.00	35.00	25.00	22.00	0.00	0.00
11.30	589.00	303.00	166.00	162.00	116.00	87.00	52.00	37.00	31.00	23.00
11.30	749.00	386.00	217.00	212.00	155.00	118.00	72.00	50.00	41.00	31.00
11.40	407.00	138.00	83.00	80.00	58.00	43.00	25.00	16.00	13.00	11.00
11.40	571.00	197.00	119.00	115.00	86.00	65.00	37.00	24.00	19.00	15.00
11.40	725.00	250.00	154.00	149.00	112.00	85.00	51.00	32.00	24.00	20.00
11.50	415.00	153.00	92.00	88.00	66.00	50.00	27.00	17.00	13.00	10.00
11.50	580.00	217.00	135.00	129.00	98.00	76.00	43.00	26.00	20.00	15.00
11.50	732.00	271.00	172.00	165.00	126.00	98.00	57.00	35.00	25.00	20.00
11.62	420.00	136.00	77.00	77.00	54.00	40.00	22.00	14.00	11.00	9.00
11.62	587.00	189.00	110.00	110.00	80.00	59.00	33.00	21.00	16.00	13.00
11.62	741.00	235.00	140.00	139.00	103.00	77.00	45.00	29.00	21.00	17.00
11.70	414.00	188.00	106.00	101.00	70.00	52.00	31.00	22.00	19.00	15.00
12.33	614.00	364.00	219.00	213.00	161.00	125.00	78.00	56.00	44.00	35.00
12.33	772.00	462.00	282.00	274.00	208.00	163.00	102.00	72.00	57.00	46.00
12.50	444.00	163.00	98.00	97.00	78.00	63.00	45.00	34.00	27.00	21.00
12.50	624.00	244.00	152.00	150.00	122.00	100.00	70.00	51.00	39.00	32.00
12.50	785.00	317.00	202.00	199.00	163.00	133.00	93.00	67.00	51.00	41.00
12.66	417.00	188.00	114.00	115.00	86.00	63.00	35.00	21.00	15.00	12.00
12.66	582.00	272.00	167.00	168.00	125.00	94.00	52.00	31.00	22.00	17.00

Station	LoadSize (KPa)	Deflect 1	Deflect 2	Deflect 3	Deflect 4	Deflect 5	Deflect 6	Deflect 7	Deflect 8	Deflect 9
12.66	732.00	347.00	218.00	219.00	164.00	124.00	69.00	41.00	28.00	23.00
12.78	421.00	182.00	119.00	114.00	87.00	66.00	41.00	26.00	20.00	14.00
12.78	579.00	274.00	183.00	176.00	135.00	105.00	64.00	41.00	29.00	23.00
12.78	735.00	355.00	242.00	235.00	182.00	141.00	86.00	54.00	38.00	29.00
12.95	437.00	133.00	76.00	76.00	60.00	49.00	33.00	25.00	21.00	17.00
13.50	609.00	195.00	142.00	142.00	121.00	100.00	69.00	47.00	34.00	25.00
13.50	774.00	253.00	187.00	187.00	158.00	133.00	91.00	62.00	45.00	32.00
13.67	428.00	146.00	102.00	102.00	79.00	62.00	37.00	23.00	16.00	11.00
13.67	597.00	211.00	147.00	147.00	116.00	90.00	54.00	33.00	22.00	16.00
13.67	754.00	269.00	187.00	186.00	146.00	115.00	69.00	42.00	28.00	20.00
13.83	436.00	174.00	104.00	101.00	78.00	61.00	40.00	28.00	22.00	18.00
13.83	606.00	252.00	154.00	151.00	117.00	92.00	60.00	42.00	33.00	26.00
13.83	757.00	322.00	201.00	197.00	154.00	122.00	80.00	55.00	42.00	33.00
14.00	400.00	257.00	153.00	151.00	106.00	73.00	36.00	20.00	15.00	12.00
14.00	558.00	368.00	224.00	221.00	155.00	108.00	54.00	29.00	21.00	18.00
14.00	718.00	465.00	288.00	282.00	200.00	140.00	70.00	38.00	28.00	23.00
14.10	400.00	212.00	143.00	142.00	111.00	88.00	56.00	38.00	23.00	18.00
14.10	557.00	312.00	213.00	211.00	168.00	134.00	85.00	55.00	38.00	26.00
14.10	711.00	400.00	276.00	274.00	219.00	176.00	112.00	72.00	50.00	34.00
14.20	439.00	178.00	111.00	111.00	81.00	59.00	32.00	17.00	12.00	8.00
14.20	609.00	244.00	152.00	153.00	113.00	84.00	44.00	24.00	15.00	11.00
14.20	771.00	299.00	188.00	187.00	138.00	103.00	56.00	30.00	19.00	14.00
14.30	443.00	206.00	141.00	139.00	113.00	92.00	63.00	44.00	33.00	25.00
14.30	619.00	299.00	206.00	204.00	166.00	137.00	93.00	65.00	47.00	35.00
14.30	783.00	383.00	267.00	265.00	217.00	179.00	123.00	85.00	61.00	46.00
14.40	429.00	162.00	105.00	107.00	83.00	65.00	37.00	23.00	19.00	12.00
14.40	600.00	238.00	153.00	155.00	120.00	95.00	55.00	34.00	24.00	19.00
14.40	752.00	306.00	198.00	202.00	157.00	124.00	72.00	44.00	32.00	24.00
14.50	424.00	195.00	131.00	130.00	99.00	75.00	42.00	23.00	16.00	11.00
17.30	670.00	242.00	152.00	150.00	114.00	87.00	52.00	33.00	25.00	19.00
17.30	849.00	303.00	192.00	189.00	146.00	113.00	68.00	43.00	32.00	24.00
17.40	483.00	148.00	101.00	98.00	77.00	61.00	35.00	23.00	17.00	13.00
17.40	676.00	209.00	144.00	140.00	113.00	90.00	54.00	35.00	24.00	18.00
17.40	862.00	262.00	181.00	178.00	146.00	117.00	72.00	45.00	31.00	23.00
17.50	482.00	180.00	119.00	119.00	91.00	69.00	39.00	25.00	19.00	15.00
17.50	676.00	253.00	171.00	172.00	134.00	104.00	59.00	37.00	28.00	21.00
17.50	860.00	314.00	216.00	216.00	170.00	134.00	78.00	49.00	36.00	28.00
17.60	415.00	138.00	88.00	88.00	67.00	51.00	31.00	22.00	19.00	14.00
17.60	581.00	195.00	127.00	126.00	97.00	75.00	46.00	32.00	25.00	20.00
17.60	741.00	246.00	162.00	161.00	125.00	97.00	61.00	42.00	32.00	26.00
17.70	407.00	133.00	83.00	82.00	62.00	48.00	30.00	21.00	16.00	13.00
18.17	607.00	201.00	117.00	119.00	86.00	65.00	41.00	30.00	24.00	22.00
18.17	762.00	250.00	148.00	151.00	113.00	84.00	53.00	39.00	32.00	27.00
18.33	450.00	111.00	74.00	71.00	53.00	40.00	25.00	17.00	14.00	11.00
18.33	603.00	157.00	102.00	98.00	73.00	57.00	35.00	24.00	19.00	15.00
18.33	767.00	202.00	131.00	128.00	98.00	75.00	47.00	32.00	25.00	20.00

Station	LoadSize (KPa)	Deflect 1	Deflect 2	Deflect 3	Deflect 4	Deflect 5	Deflect 6	Deflect 7	Deflect 8	Deflect 9
18.50	414.00	119.00	68.00	69.00	50.00	38.00	24.00	18.00	15.00	12.00
18.50	577.00	167.00	99.00	100.00	73.00	56.00	37.00	27.00	22.00	18.00
18.50	734.00	211.00	127.00	127.00	94.00	73.00	49.00	36.00	30.00	23.00
18.67	400.00	143.00	95.00	97.00	80.00	64.00	43.00	31.00	25.00	19.00
18.67	561.00	208.00	142.00	144.00	118.00	98.00	66.00	47.00	36.00	28.00
18.67	716.00	266.00	184.00	186.00	153.00	127.00	87.00	62.00	47.00	36.00
18.83	461.00	131.00	96.00	93.00	77.00	63.00	43.00	32.00	25.00	20.00
9.30	595.00	222.00	140.00	140.00	81.00	48.00	35.00	29.00	0.00	0.00
9.30	780.00	289.00	182.00	183.00	108.00	65.00	45.00	32.00	0.00	0.00
9.40	432.00	164.00	94.00	94.00	54.00	32.00	25.00	23.00	0.00	0.00
9.40	593.00	217.00	126.00	129.00	73.00	42.00	31.00	26.00	0.00	0.00
9.40	782.00	283.00	168.00	173.00	99.00	58.00	42.00	36.00	0.00	0.00
9.50	432.00	167.00	92.00	96.00	50.00	30.00	25.00	22.00	0.00	0.00
9.50	592.00	221.00	123.00	132.00	70.00	37.00	31.00	25.00	0.00	0.00
9.50	782.00	283.00	157.00	170.00	94.00	46.00	37.00	28.00	0.00	0.00
9.60	433.00	155.00	96.00	95.00	58.00	35.00	25.00	18.00	0.00	0.00
9.60	594.00	209.00	130.00	132.00	81.00	46.00	32.00	23.00	0.00	0.00
9.60	786.00	273.00	176.00	173.00	108.00	67.00	45.00	32.00	0.00	0.00
9.70	435.00	163.00	95.00	95.00	58.00	36.00	29.00	21.00	0.00	0.00
9.70	593.00	216.00	128.00	131.00	79.00	49.00	36.00	22.00	0.00	0.00
11.70	579.00	270.00	155.00	147.00	105.00	81.00	48.00	34.00	27.00	23.00
11.70	724.00	340.00	200.00	189.00	137.00	104.00	64.00	45.00	37.00	30.00
11.80	395.00	139.00	84.00	85.00	62.00	48.00	29.00	20.00	17.00	13.00
11.80	557.00	200.00	125.00	125.00	95.00	72.00	45.00	31.00	25.00	19.00
11.80	711.00	255.00	162.00	162.00	124.00	96.00	61.00	40.00	33.00	26.00
11.90	439.00	186.00	102.00	98.00	67.00	49.00	28.00	19.00	15.00	11.00
11.90	615.00	267.00	149.00	142.00	98.00	73.00	43.00	28.00	22.00	17.00
11.90	779.00	337.00	193.00	184.00	129.00	96.00	57.00	37.00	29.00	22.00
12.11	413.00	166.00	86.00	88.00	67.00	54.00	38.00	28.00	21.00	17.00
12.11	578.00	238.00	130.00	132.00	102.00	83.00	59.00	43.00	33.00	25.00
12.11	731.00	303.00	171.00	171.00	135.00	111.00	77.00	56.00	43.00	33.00
12.33	443.00	257.00	151.00	147.00	109.00	85.00	54.00	38.00	30.00	24.00
12.95	608.00	192.00	113.00	114.00	91.00	74.00	50.00	37.00	31.00	24.00
12.95	771.00	245.00	148.00	148.00	120.00	98.00	67.00	49.00	40.00	31.00
13.00	422.00	156.00	92.00	94.00	71.00	54.00	33.00	23.00	19.00	15.00
13.00	589.00	229.00	142.00	142.00	108.00	84.00	51.00	35.00	27.00	21.00
13.00	743.00	296.00	186.00	187.00	145.00	112.00	68.00	45.00	34.00	28.00
13.17	436.00	184.00	111.00	111.00	83.00	62.00	35.00	22.00	16.00	13.00
13.17	609.00	267.00	163.00	163.00	122.00	92.00	52.00	30.00	23.00	19.00
13.17	767.00	344.00	215.00	213.00	160.00	121.00	68.00	41.00	29.00	24.00
13.33	451.00	196.00	127.00	129.00	98.00	74.00	42.00	25.00	20.00	14.00
13.33	626.00	282.00	182.00	184.00	141.00	108.00	62.00	37.00	26.00	21.00
13.33	790.00	363.00	235.00	237.00	182.00	140.00	80.00	49.00	35.00	27.00
13.50	439.00	130.00	93.00	94.00	79.00	66.00	45.00	31.00	23.00	17.00
14.50	592.00	283.00	189.00	187.00	144.00	110.00	61.00	33.00	22.00	16.00
14.50	743.00	362.00	244.00	242.00	186.00	143.00	79.00	44.00	29.00	21.00

Station	LoadSize (KPa)	Deflect 1	Deflect 2	Deflect 3	Deflect 4	Deflect 5	Deflect 6	Deflect 7	Deflect 8	Deflect 9
14.60	421.00	148.00	98.00	96.00	76.00	61.00	38.00	24.00	17.00	12.00
14.60	583.00	221.00	147.00	145.00	115.00	91.00	57.00	36.00	25.00	17.00
14.60	732.00	287.00	194.00	191.00	152.00	122.00	76.00	48.00	33.00	21.00
14.70	404.00	195.00	139.00	131.00	101.00	78.00	47.00	28.00	18.00	12.00
14.70	562.00	283.00	203.00	191.00	148.00	114.00	69.00	40.00	25.00	17.00
14.70	726.00	362.00	262.00	248.00	193.00	149.00	89.00	52.00	33.00	21.00
14.80	443.00	157.00	99.00	98.00	71.00	53.00	30.00	18.00	14.00	10.00
14.80	618.00	231.00	147.00	144.00	106.00	79.00	45.00	27.00	20.00	15.00
14.80	782.00	296.00	191.00	189.00	140.00	106.00	60.00	37.00	27.00	21.00
14.90	445.00	145.00	85.00	85.00	65.00	50.00	32.00	23.00	18.00	15.00
14.90	618.00	217.00	130.00	130.00	100.00	78.00	51.00	36.00	28.00	22.00
14.90	781.00	280.00	173.00	172.00	133.00	105.00	69.00	48.00	37.00	29.00
15.00	429.00	231.00	147.00	141.00	104.00	78.00	43.00	27.00	20.00	16.00
15.00	595.00	332.00	211.00	203.00	151.00	113.00	63.00	39.00	28.00	23.00
15.00	752.00	422.00	271.00	263.00	196.00	148.00	83.00	50.00	37.00	30.00
15.17	448.00	141.00	97.00	95.00	75.00	60.00	38.00	24.00	18.00	13.00
15.17	619.00	204.00	139.00	136.00	109.00	87.00	55.00	35.00	27.00	18.00
15.17	787.00	266.00	180.00	176.00	141.00	113.00	72.00	46.00	34.00	23.00
15.33	454.00	220.00	142.00	145.00	113.00	89.00	57.00	39.00	30.00	22.00
15.33	636.00	315.00	204.00	208.00	164.00	130.00	84.00	57.00	43.00	32.00
15.33	802.00	401.00	264.00	268.00	212.00	168.00	110.00	75.00	57.00	42.00
15.50	425.00	188.00	119.00	120.00	93.00	73.00	45.00	31.00	24.00	19.00
15.50	591.00	267.00	173.00	174.00	135.00	106.00	66.00	44.00	34.00	27.00
15.50	743.00	339.00	224.00	225.00	176.00	138.00	86.00	59.00	44.00	35.00
15.66	428.00	178.00	115.00	118.00	93.00	72.00	46.00	32.00	24.00	20.00
15.66	597.00	259.00	170.00	172.00	136.00	107.00	67.00	48.00	35.00	29.00
15.66	752.00	330.00	221.00	221.00	176.00	138.00	88.00	61.00	46.00	38.00
15.83	419.00	159.00	107.00	106.00	84.00	68.00	44.00	30.00	22.00	17.00
15.83	583.00	232.00	159.00	158.00	127.00	102.00	67.00	46.00	32.00	25.00
15.83	734.00	301.00	209.00	207.00	167.00	136.00	88.00	59.00	42.00	31.00
16.00	443.00	157.00	110.00	108.00	88.00	71.00	45.00	28.00	19.00	13.00
16.00	627.00	229.00	161.00	158.00	129.00	104.00	66.00	42.00	25.00	18.00
16.00	793.00	291.00	207.00	205.00	168.00	136.00	87.00	54.00	35.00	23.00
16.18	430.00	151.00	89.00	86.00	65.00	49.00	29.00	20.00	16.00	13.00
16.18	591.00	211.00	126.00	123.00	93.00	71.00	42.00	29.00	23.00	18.00
16.18	747.00	265.00	160.00	156.00	119.00	91.00	54.00	37.00	30.00	23.00
16.33	449.00	166.00	105.00	105.00	80.00	61.00	34.00	21.00	16.00	13.00
16.33	625.00	239.00	153.00	152.00	117.00	88.00	50.00	30.00	23.00	18.00
16.33	793.00	305.00	199.00	198.00	152.00	118.00	67.00	41.00	30.00	24.00
16.50	393.00	160.00	93.00	92.00	64.00	45.00	23.00	15.00	12.00	10.00
16.50	552.00	230.00	137.00	136.00	95.00	67.00	35.00	22.00	17.00	14.00
16.50	714.00	295.00	180.00	178.00	126.00	90.00	47.00	30.00	23.00	18.00
16.66	400.00	148.00	84.00	85.00	61.00	46.00	28.00	20.00	17.00	14.00
16.66	560.00	209.00	123.00	123.00	90.00	67.00	41.00	30.00	24.00	19.00
16.66	717.00	266.00	160.00	159.00	119.00	89.00	54.00	39.00	32.00	26.00
16.83	426.00	175.00	111.00	113.00	88.00	69.00	45.00	33.00	26.00	22.00

Station	LoadSize (KPa)	Deflect 1	Deflect 2	Deflect 3	Deflect 4	Deflect 5	Deflect 6	Deflect 7	Deflect 8	Deflect 9
16.83	594.00	253.00	166.00	168.00	132.00	105.00	68.00	49.00	38.00	31.00
16.83	752.00	323.00	217.00	217.00	172.00	138.00	91.00	61.00	49.00	39.00
17.00	402.00	158.00	96.00	95.00	68.00	51.00	30.00	22.00	16.00	15.00
17.00	569.00	225.00	140.00	138.00	101.00	76.00	46.00	32.00	25.00	22.00
17.00	731.00	285.00	180.00	178.00	133.00	100.00	61.00	42.00	33.00	28.00
17.10	477.00	144.00	96.00	99.00	75.00	58.00	33.00	22.00	17.00	13.00
17.10	662.00	198.00	134.00	137.00	105.00	82.00	49.00	32.00	24.00	18.00
17.10	851.00	253.00	169.00	174.00	135.00	106.00	65.00	42.00	32.00	24.00
17.20	505.00	138.00	92.00	89.00	69.00	54.00	34.00	23.00	18.00	13.00
17.20	705.00	195.00	133.00	130.00	103.00	81.00	52.00	35.00	27.00	20.00
17.20	893.00	247.00	172.00	168.00	136.00	107.00	70.00	48.00	35.00	27.00
17.30	480.00	173.00	104.00	104.00	77.00	58.00	34.00	22.00	18.00	13.00
17.70	571.00	192.00	124.00	122.00	94.00	73.00	45.00	31.00	23.00	19.00
17.70	729.00	245.00	161.00	158.00	124.00	96.00	61.00	41.00	31.00	25.00
17.80	447.00	129.00	83.00	83.00	65.00	51.00	32.00	22.00	17.00	14.00
17.80	614.00	185.00	124.00	123.00	97.00	77.00	50.00	34.00	26.00	20.00
17.80	781.00	238.00	161.00	160.00	127.00	102.00	67.00	46.00	33.00	26.00
17.90	415.00	141.00	82.00	82.00	59.00	44.00	26.00	18.00	15.00	11.00
17.90	582.00	203.00	122.00	122.00	89.00	67.00	40.00	27.00	21.00	16.00
17.90	748.00	257.00	158.00	159.00	118.00	90.00	54.00	36.00	28.00	22.00
18.00	488.00	187.00	116.00	117.00	85.00	61.00	35.00	23.00	18.00	13.00
18.00	676.00	252.00	160.00	161.00	119.00	85.00	50.00	33.00	25.00	19.00
18.00	862.00	309.00	199.00	200.00	149.00	109.00	65.00	43.00	32.00	25.00
18.17	435.00	143.00	80.00	81.00	58.00	43.00	27.00	21.00	18.00	15.00
18.83	641.00	186.00	139.00	135.00	112.00	93.00	65.00	47.00	35.00	28.00
18.83	814.00	237.00	177.00	174.00	145.00	121.00	84.00	60.00	46.00	36.00
19.00	407.00	145.00	98.00	98.00	77.00	61.00	40.00	30.00	24.00	20.00
19.00	572.00	215.00	150.00	149.00	119.00	96.00	63.00	45.00	36.00	29.00
19.00	730.00	279.00	197.00	195.00	158.00	129.00	85.00	60.00	47.00	38.00
19.17	443.00	151.00	98.00	97.00	74.00	58.00	36.00	25.00	20.00	17.00
19.17	619.00	216.00	142.00	142.00	111.00	86.00	54.00	37.00	30.00	25.00
19.17	781.00	278.00	185.00	184.00	145.00	114.00	72.00	50.00	38.00	31.00
19.33	401.00	130.00	76.00	77.00	56.00	42.00	25.00	18.00	14.00	10.00
19.33	568.00	190.00	116.00	116.00	87.00	65.00	40.00	27.00	21.00	16.00
19.33	729.00	243.00	152.00	151.00	114.00	88.00	54.00	36.00	27.00	21.00
19.50	413.00	112.00	76.00	78.00	63.00	51.00	34.00	26.00	21.00	17.00
19.50	580.00	167.00	117.00	118.00	97.00	79.00	54.00	40.00	32.00	26.00
19.50	742.00	216.00	153.00	155.00	127.00	105.00	72.00	51.00	39.00	32.00
19.66	399.00	124.00	82.00	80.00	64.00	51.00	36.00	28.00	24.00	20.00
19.66	562.00	186.00	127.00	123.00	98.00	81.00	56.00	43.00	35.00	29.00
19.66	720.00	240.00	168.00	163.00	132.00	109.00	77.00	58.00	46.00	39.00
19.84	416.00	143.00	92.00	94.00	70.00	53.00	33.00	24.00	20.00	17.00
19.84	579.00	200.00	131.00	133.00	102.00	77.00	49.00	35.00	29.00	23.00
19.84	734.00	249.00	165.00	166.00	127.00	99.00	63.00	45.00	37.00	30.00
20.00	408.00	122.00	80.00	80.00	61.00	48.00	30.00	20.00	16.00	12.00
20.00	573.00	174.00	117.00	117.00	91.00	72.00	44.00	30.00	23.00	17.00

Station	LoadSize (KPa)	Deflect 1	Deflect 2	Deflect 3	Deflect 4	Deflect 5	Deflect 6	Deflect 7	Deflect 8	Deflect 9
20.00	732.00	221.00	150.00	149.00	117.00	93.00	58.00	39.00	29.00	22.00
20.10	446.00	124.00	79.00	80.00	60.00	46.00	28.00	20.00	17.00	13.00
20.10	617.00	177.00	117.00	117.00	90.00	70.00	44.00	31.00	23.00	18.00
20.10	782.00	228.00	152.00	153.00	119.00	93.00	59.00	40.00	31.00	23.00

Table 2. Deflection data – I-195(English units).

Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
6,265	3.82	2.83	2.95	2.56	2.17	1.54	1.10	0.83	0.59
8,850	5.39	3.98	4.13	3.58	3.07	2.24	1.57	1.10	0.79
11,119	6.93	5.16	5.39	4.72	4.13	2.99	2.17	1.61	1.14
6,614	4.25	3.27	3.11	2.68	2.28	1.61	1.18	0.87	0.67
9,279	6.10	4.72	4.53	3.98	3.35	2.40	1.77	1.38	0.98
11,753	7.68	6.02	5.83	5.00	4.29	3.11	2.24	1.69	1.22
7,090	5.28	3.70	3.66	3.03	2.48	1.69	1.18	0.91	0.67
9,786	7.48	5.24	5.20	4.29	3.58	2.44	1.73	1.30	0.98
12,403	9.45	6.69	6.61	5.47	4.61	3.19	2.28	1.69	1.30
6,233	5.51	3.98	3.90	3.19	2.60	1.73	1.26	0.79	0.75
8,771	7.80	5.63	5.55	4.61	3.78	2.52	1.73	1.30	0.98
11,245	9.92	7.28	7.17	5.94	4.92	3.35	2.32	1.77	1.38
6,535	6.85	5.71	5.83	5.08	4.06	2.83	2.05	1.54	1.18
9,136	9.65	7.99	8.23	7.28	5.94	4.13	3.03	2.28	1.73
11,515	11.93	9.88	10.20	9.06	7.40	5.24	3.78	2.83	2.20
6,186	4.33	3.43	3.39	3.15	2.87	2.40	2.01	1.69	1.38
8,755	6.18	4.96	4.88	4.53	4.21	3.50	2.95	2.44	2.01
11,166	7.83	6.26	6.22	5.79	5.31	4.49	3.74	3.07	2.52
7,407	5.83	3.78	3.70	2.87	2.32	1.57	1.14	0.94	0.79
10,516	8.46	5.47	5.35	4.25	3.46	2.36	1.77	1.42	1.18
13,403	10.98	7.17	7.09	5.71	4.65	3.15	2.32	1.89	1.57
7,708	5.20	3.50	3.58	3.27	2.95	2.36	1.93	1.54	1.26
10,881	7.32	4.96	5.12	4.69	4.25	3.39	2.80	2.28	1.81
13,878	9.13	6.30	6.50	5.91	5.35	4.33	3.54	2.87	2.32
7,613	4.80	3.27	3.23	2.83	2.48	1.89	1.50	1.18	0.94
10,722	6.89	4.76	4.69	4.09	3.62	2.80	2.20	1.73	1.38
13,704	8.66	6.10	5.98	5.28	4.65	3.58	2.76	2.20	1.73
7,217	5.91	4.45	4.49	4.09	3.58	2.76	2.17	1.65	1.26
10,199	8.46	6.42	6.46	5.83	5.20	4.06	3.19	2.44	1.85
13,085	10.63	8.07	8.11	7.28	6.57	5.16	4.02	3.07	2.32
7,233	6.30	4.02	4.06	3.39	2.87	2.05	1.54	1.22	0.98
10,326	9.02	5.91	5.94	5.00	4.21	2.99	2.24	1.73	1.38
13,133	11.38	7.56	7.60	6.42	5.47	3.90	2.87	2.24	1.81
7,137	5.75	3.43	3.54	2.76	2.17	1.46	1.10	0.91	0.75
10,119	8.15	5.04	5.20	4.09	3.27	2.24	1.61	1.30	1.06
12,911	10.47	6.57	6.73	5.35	4.33	2.95	2.13	1.69	1.34
7,613	5.20	3.03	3.03	2.48	2.09	1.42	1.10	0.91	0.71
10,754	7.40	4.45	4.49	3.62	3.07	2.17	1.61	1.30	0.98
13,720	9.53	5.83	5.83	4.72	4.02	2.83	2.13	1.69	1.34
7,312	9.53	6.10	5.75	4.02	2.76	1.46	0.94	0.79	0.63
10,294	13.11	8.54	8.23	5.83	4.13	2.17	1.38	0.98	0.87
13,038	16.26	10.75	10.43	7.56	5.43	2.87	1.77	1.34	1.10
7,296	6.06	4.13	4.06	3.11	2.40	1.42	0.98	0.79	0.59
10,278	8.50	5.83	5.79	4.49	3.46	2.09	1.38	1.06	0.87

Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
13,133	10.87	7.44	7.40	5.83	4.57	2.80	1.85	1.42	1.14
7,471	5.28	3.35	3.35	2.72	2.24	1.54	1.06	0.83	0.67
10,548	7.48	4.80	4.84	3.98	3.31	2.24	1.54	1.22	0.94
13,545	9.65	6.22	6.30	5.24	4.33	2.95	2.05	1.54	1.22
7,502	6.38	4.17	4.13	3.43	2.87	2.05	1.57	1.30	0.98
10,595	9.09	6.06	6.06	5.08	4.33	3.11	2.32	1.85	1.50
13,640	11.65	7.80	7.76	6.54	5.59	4.06	3.03	2.40	1.93
7,391	5.04	3.23	3.31	2.68	2.17	1.34	0.91	0.71	0.55
10,437	6.85	4.53	4.61	3.78	3.11	1.93	1.30	0.98	0.75
13,355	8.82	5.71	5.83	4.84	3.98	2.52	1.69	1.26	0.98
7,724	4.76	3.03	3.03	2.52	2.13	1.46	1.02	0.79	0.59
10,865	6.65	4.25	4.25	3.62	3.07	2.13	1.50	1.14	0.87
13,894	8.54	5.51	5.55	4.72	4.02	2.83	1.97	1.46	1.10
7,661	5.43	3.74	3.66	3.07	2.56	1.81	1.34	1.06	0.83
10,801	7.87	5.55	5.47	4.69	3.94	2.80	2.09	1.57	1.22
13,815	10.04	7.17	7.09	6.06	5.16	3.70	2.72	2.09	1.61
7,502	5.31	3.50	3.46	2.91	2.44	1.69	1.26	0.94	0.71
10,611	7.76	5.31	5.28	4.53	3.82	2.68	1.93	1.46	1.10
13,625	10.08	6.97	6.93	5.94	5.08	3.58	2.60	1.97	1.50
7,423	7.01	4.84	4.69	3.70	2.95	1.89	1.26	0.94	0.71
10,516	10.08	7.01	6.85	5.47	4.41	2.83	1.89	1.38	1.02
13,450	13.03	9.13	8.94	7.20	5.91	3.82	2.56	1.85	1.38
7,597	6.54	4.13	4.37	3.43	2.64	1.57	1.06	0.83	0.71
10,738	9.17	5.83	6.18	4.88	3.78	2.32	1.54	1.18	0.98
13,704	11.57	7.52	7.95	6.34	4.96	3.07	2.01	1.54	1.26
7,629	6.54	4.25	4.21	3.27	2.48	1.50	1.02	0.83	0.67
10,785	9.09	5.94	5.98	4.69	3.58	2.20	1.50	1.10	0.98
13,736	11.50	7.72	7.76	6.14	4.72	2.95	1.97	1.54	1.26
7,819	5.20	3.19	3.23	2.44	1.89	1.18	0.91	0.79	0.67
11,087	7.28	4.57	4.65	3.62	2.87	1.81	1.34	1.10	0.94
14,132	9.45	6.02	6.14	4.84	3.86	2.48	1.81	1.46	1.26
7,486	4.76	3.03	2.99	2.48	2.13	1.42	1.06	0.91	0.71
10,611	6.81	4.45	4.33	3.66	3.03	2.13	1.57	1.26	1.02
13,688	8.74	5.71	5.67	4.80	4.06	2.83	2.09	1.61	1.34
7,613	4.69	2.99	2.91	2.40	2.01	1.38	1.02	0.83	0.71
10,770	6.69	4.37	4.29	3.58	2.95	2.05	1.50	1.18	0.98
13,767	8.58	5.67	5.55	4.65	3.90	2.72	2.01	1.54	1.30
7,423	4.72	2.95	2.83	2.24	1.77	1.06	0.75	0.63	0.51
10,548	6.65	4.21	4.06	3.27	2.64	1.65	1.14	0.91	0.79
13,529	8.54	5.47	5.31	4.29	3.54	2.24	1.57	1.22	1.06
7,613	4.61	2.83	2.80	2.17	1.69	1.06	0.79	0.71	0.55
10,754	6.42	3.98	3.94	3.11	2.48	1.57	1.14	0.91	0.75
13,751	7.99	4.96	4.96	3.98	3.15	2.09	1.46	1.22	0.94
7,629	4.57	2.76	2.80	2.24	1.81	1.18	0.79	0.59	0.43
10,674	6.34	3.94	3.98	3.23	2.64	1.73	1.18	0.91	0.63
13,688	8.15	5.04	5.12	4.17	3.43	2.28	1.54	1.14	0.87

Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
7,344	4.84	3.03	2.99	2.32	1.85	1.18	0.79	0.63	0.47
10,373	6.89	4.29	4.21	3.35	2.68	1.73	1.18	0.91	0.67
13,244	8.86	5.55	5.43	4.33	3.50	2.28	1.57	1.18	0.91
7,756	4.80	2.91	2.99	2.36	1.89	1.18	0.79	0.59	0.47
10,865	6.61	4.13	4.17	3.31	2.68	1.73	1.14	0.91	0.63
13,942	8.27	5.24	5.28	4.25	3.46	2.24	1.50	1.10	0.87
7,423	6.57	4.25	4.17	3.11	2.36	1.38	0.94	0.75	0.63
10,516	8.74	5.79	5.71	4.41	3.39	2.05	1.42	1.10	0.94
13,403	10.79	7.20	7.09	5.55	4.33	2.64	1.81	1.46	1.18
7,708	4.61	3.07	3.03	2.56	2.17	1.54	1.14	0.94	0.79
10,897	6.57	4.45	4.41	3.78	3.19	2.28	1.69	1.34	1.10
14,005	8.35	5.71	5.63	4.88	4.13	2.95	2.17	1.73	1.42
7,693	5.98	3.90	3.74	2.76	2.13	1.26	0.79	0.59	0.43
10,817	8.23	5.43	5.28	3.98	3.07	1.85	1.18	0.87	0.67
13,815	10.31	6.77	6.61	5.08	3.98	2.44	1.54	1.14	0.87
7,693	5.31	3.66	3.58	2.87	2.32	1.46	0.94	0.75	0.51
10,960	7.32	5.08	5.00	4.06	3.31	2.13	1.42	1.02	0.75
14,037	8.98	6.30	6.22	5.08	4.17	2.72	1.77	1.38	0.98
7,693	5.67	3.50	3.50	2.64	2.09	1.30	0.87	0.67	0.51
10,801	7.80	4.92	4.92	3.78	2.99	1.89	1.26	0.98	0.75
13,815	9.92	6.34	6.22	4.88	3.90	2.52	1.69	1.30	0.98
7,661	4.88	3.15	3.19	2.48	1.93	1.18	0.75	0.55	0.43
10,833	6.81	4.45	4.49	3.54	2.80	1.73	1.06	0.79	0.59
13,847	8.54	5.63	5.67	4.57	3.58	2.24	1.38	0.98	0.71
7,391	5.83	3.98	3.86	3.19	2.60	1.65	1.10	0.87	0.67
10,437	8.27	5.67	5.51	4.53	3.70	2.40	1.61	1.22	0.94
13,292	10.55	7.24	7.09	5.83	4.80	3.15	2.09	1.57	1.22
7,819	6.26	3.98	3.94	3.11	2.48	1.54	0.98	0.75	0.51
11,039	8.43	5.43	5.35	4.25	3.43	2.17	1.38	0.94	0.67
14,085	10.43	6.77	6.65	5.35	4.33	2.72	1.73	1.22	0.87
7,708	5.94	4.02	4.02	3.27	2.68	1.77	1.18	0.91	0.67
10,865	8.50	5.67	5.71	4.69	3.86	2.56	1.73	1.30	0.98
13,910	10.79	7.28	7.28	5.98	4.96	3.31	2.20	1.65	1.18
7,724	5.59	3.70	3.62	2.87	2.24	1.34	0.83	0.63	0.47
10,785	7.64	5.12	5.04	4.02	3.15	1.93	1.18	0.87	0.63
13,767	9.72	6.46	6.34	5.04	4.02	2.48	1.50	1.10	0.83
7,613	7.09	4.80	4.69	3.78	3.03	2.09	1.54	1.22	1.02
10,722	10.16	6.97	6.85	5.51	4.49	3.03	2.17	1.73	1.46
13,656	12.91	9.02	8.78	7.20	5.87	3.98	2.80	2.20	1.81
7,550	5.83	4.21	4.17	3.70	3.19	2.40	1.81	1.38	1.02
10,595	8.19	5.94	5.94	5.24	4.57	3.43	2.60	1.97	1.46
13,640	10.43	7.68	7.64	6.73	5.94	4.49	3.35	2.48	1.85
7,772	5.51	3.74	3.74	3.19	2.76	1.93	1.46	1.18	0.98
10,960	7.80	5.35	5.35	4.57	3.90	2.83	2.09	1.69	1.38
13,989	9.92	6.81	6.81	5.83	5.00	3.62	2.68	2.13	1.73
7,566	8.03	4.61	4.80	3.23	2.20	1.02	0.63	0.55	0.47

Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
10,770	10.87	6.42	6.57	4.53	3.15	1.50	0.91	0.75	0.71
13,831	13.27	7.95	8.11	5.67	4.02	1.97	1.26	1.10	0.91
7,740	4.53	2.99	2.87	2.28	1.85	1.22	0.91	0.75	0.63
10,944	6.57	4.33	4.25	3.46	2.83	1.93	1.38	1.10	0.87
13,926	8.54	5.71	5.59	4.57	3.78	2.60	1.81	1.38	1.10
7,978	5.79	3.62	3.62	2.72	2.09	1.22	0.87	0.67	0.55
11,214	7.87	4.96	4.96	3.82	3.03	1.85	1.26	0.98	0.79
14,338	9.96	6.34	6.30	4.96	3.90	2.44	1.65	1.30	1.06
7,962	6.34	4.13	4.13	3.15	2.44	1.38	0.83	0.59	0.39
11,119	8.62	5.71	5.67	4.37	3.39	1.97	1.14	0.83	0.55
14,211	10.67	7.09	7.05	5.47	4.29	2.52	1.50	1.02	0.71
7,962	8.54	5.24	5.28	3.82	2.76	1.42	0.79	0.59	0.47
11,182	11.30	7.05	7.09	5.20	3.90	2.05	1.14	0.83	0.63
14,291	13.78	8.66	8.70	6.42	4.76	2.60	1.50	1.02	0.79
7,946	4.57	2.91	2.91	2.36	1.97	1.30	0.91	0.67	0.51
11,087	6.34	4.06	4.06	3.35	2.80	1.89	1.30	0.94	0.75
14,085	8.15	5.31	5.28	4.41	3.66	2.52	1.73	1.26	0.94
7,772	6.61	4.57	4.57	3.66	2.95	1.89	1.30	0.94	0.71
10,928	9.53	6.65	6.61	5.39	4.41	2.83	1.93	1.42	1.06
13,910	12.01	8.50	8.50	7.01	5.75	3.78	2.56	1.85	1.38
7,867	6.34	3.70	3.58	2.60	1.93	1.06	0.63	0.43	0.35
10,976	8.54	5.00	4.88	3.58	2.76	1.50	0.87	0.59	0.47
13,783	10.39	6.14	6.02	4.49	3.39	1.89	1.10	0.79	0.59
7,962	5.28	3.54	3.39	2.64	2.09	1.22	0.75	0.55	0.43
11,150	7.20	4.88	4.69	3.74	2.95	1.77	1.10	0.79	0.59
14,211	8.94	6.10	5.87	4.72	3.74	2.28	1.42	1.02	0.75
7,597	7.48	4.61	4.61	3.19	2.13	0.98	0.59	0.47	0.39
10,754	10.08	6.30	6.26	4.41	3.03	1.50	0.87	0.71	0.55
13,751	12.28	7.72	7.68	5.43	3.78	1.89	1.10	0.87	0.67
6,233	6.42	4.29	4.21	3.19	2.48	1.54	1.02	0.75	0.55
8,771	9.25	6.26	6.22	4.80	3.82	2.36	1.57	1.14	0.83
11,214	11.73	8.15	7.99	6.26	5.00	3.19	2.09	1.54	1.10
6,519	6.34	3.82	3.78	2.76	2.05	1.14	0.75	0.59	0.47
9,104	8.86	5.47	5.47	4.09	3.11	1.77	1.14	0.87	0.67
11,594	11.14	7.01	7.01	5.31	4.06	2.36	1.54	1.14	0.91
6,408	5.51	3.35	3.39	2.44	1.77	1.02	0.67	0.59	0.47
9,025	7.72	4.84	4.84	3.54	2.64	1.57	1.02	0.83	0.67
11,483	9.72	6.18	6.14	4.57	3.46	2.05	1.38	1.06	0.91
6,662	7.87	4.49	4.45	3.19	2.36	1.42	0.98	0.79	0.63
9,295	11.14	6.61	6.50	4.76	3.54	2.13	1.50	1.18	0.94
11,785	13.94	8.46	8.35	6.22	4.69	2.83	1.93	1.50	1.26
6,566	4.69	3.03	3.07	2.32	1.77	1.02	0.63	0.51	0.39
9,168	6.65	4.37	4.37	3.43	2.60	1.54	0.98	0.71	0.59
11,642	8.43	5.63	5.63	4.45	3.43	2.05	1.34	0.94	0.75
6,963	5.04	2.95	2.95	2.28	1.81	1.10	0.71	0.55	0.43
9,770	7.13	4.33	4.29	3.39	2.64	1.61	1.06	0.83	0.67

Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
12,324	8.98	5.51	5.51	4.37	3.43	2.17	1.42	1.06	0.87
6,535	5.43	3.46	3.46	2.76	2.24	1.46	1.06	0.83	0.63
9,120	7.83	5.16	5.20	4.13	3.35	2.24	1.57	1.22	0.98
11,642	9.96	6.65	6.69	5.43	4.45	2.99	2.09	1.61	1.26
6,725	5.12	3.50	3.46	2.83	2.32	1.50	1.02	0.75	0.63
9,310	7.28	5.08	5.00	4.13	3.39	2.20	1.46	1.10	0.83
11,785	9.25	6.54	6.42	5.31	4.41	2.87	1.93	1.50	1.10
6,677	5.98	3.62	3.74	2.83	2.17	1.26	0.79	0.59	0.43
9,279	8.54	5.31	5.47	4.21	3.23	1.89	1.18	0.87	0.67
11,658	10.79	6.89	7.05	5.43	4.25	2.52	1.57	1.14	0.87
6,900	4.84	3.19	3.15	2.60	2.09	1.46	1.02	0.83	0.67
9,628	7.05	4.76	4.69	3.94	3.19	2.20	1.54	1.18	0.94
12,245	9.02	6.18	6.06	5.08	4.17	2.87	2.05	1.54	1.22
6,804	6.93	3.98	3.90	2.83	1.93	1.06	0.71	0.59	0.43
9,548	9.88	5.79	5.63	4.13	2.91	1.61	0.98	0.79	0.59
12,038	12.68	7.48	7.32	5.43	3.90	2.17	1.34	1.06	0.83
6,804	7.91	4.13	4.25	2.76	1.89	0.91	0.59	0.47	0.43
9,548	10.98	5.87	5.94	3.98	2.76	1.42	0.91	0.71	0.63
12,134	13.58	7.44	7.48	5.04	3.58	1.89	1.22	0.98	0.83
6,868	8.23	4.02	4.17	2.72	1.89	1.10	0.71	0.55	0.39
9,596	11.65	5.94	6.06	4.06	2.87	1.61	1.02	0.75	0.55
12,165	14.57	7.68	7.68	5.24	3.74	2.17	1.34	0.98	0.71
12,467	11.10	6.69	6.85	4.17	2.60	1.93	0.91	0.00	0.00
6,868	4.92	3.31	3.27	2.20	1.50	1.14	0.98	0.00	0.00
9,342	6.77	4.69	4.69	3.07	2.05	1.50	1.10	0.00	0.00
12,435	9.25	6.34	6.42	4.29	2.76	2.05	1.42	0.00	0.00
6,820	6.34	4.21	4.13	2.68	1.85	1.46	1.22	0.00	0.00
9,406	8.50	5.75	5.83	3.78	2.56	1.93	1.61	0.00	0.00
12,419	11.30	7.76	7.87	5.16	3.35	2.48	2.01	0.00	0.00
6,773	5.87	4.13	3.98	2.68	1.89	1.50	1.18	0.00	0.00
9,374	8.15	5.67	5.79	3.74	2.64	2.05	1.61	0.00	0.00
12,324	10.87	7.64	7.80	5.08	3.50	2.64	2.01	0.00	0.00
6,820	6.50	3.86	3.62	2.17	1.42	1.14	0.94	0.00	0.00
9,390	8.70	5.28	5.08	3.03	2.01	1.42	1.18	0.00	0.00
12,498	11.46	7.13	6.81	4.13	2.68	1.89	1.46	0.00	0.00
6,804	7.76	4.21	4.13	1.93	1.22	0.94	0.91	0.00	0.00
9,247	10.67	5.94	5.87	2.80	1.69	1.30	0.98	0.00	0.00
12,324	14.09	7.95	8.03	3.94	2.28	1.61	1.26	0.00	0.00
6,868	4.84	3.11	3.15	2.05	1.38	0.98	0.71	0.00	0.00
9,437	6.69	4.41	4.45	2.95	2.01	1.38	0.98	0.00	0.00
12,451	8.94	5.91	5.98	4.02	2.64	1.81	1.14	0.00	0.00
6,820	6.54	3.90	3.94	2.28	1.38	1.06	0.87	0.00	0.00
9,263	8.74	5.43	5.51	3.15	1.85	1.34	0.98	0.00	0.00
12,340	11.73	7.32	7.56	4.45	2.60	1.81	1.26	0.00	0.00
6,931	5.04	3.35	3.31	2.05	1.38	0.98	0.75	0.00	0.00
9,421	6.97	4.65	4.69	2.95	1.93	1.34	0.94	0.00	0.00

Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
12,419	9.25	6.22	6.26	4.06	2.68	1.81	1.30	0.00	0.00
6,836	7.05	4.45	4.25	2.40	1.50	1.06	0.91	0.00	0.00
9,406	9.61	6.10	5.94	3.43	2.09	1.46	1.18	0.00	0.00
12,403	12.72	8.15	7.99	4.65	2.80	1.93	1.50	0.00	0.00
6,138	6.77	3.62	3.50	2.48	1.81	1.10	0.79	0.63	0.59
8,708	9.57	5.35	5.20	3.74	2.80	1.69	1.14	0.94	0.79
11,055	12.17	6.93	6.85	5.00	3.78	2.28	1.54	1.22	1.02
6,789	6.22	3.43	3.58	2.68	2.09	1.34	0.98	0.79	0.63
9,517	8.90	5.04	5.28	4.06	3.23	2.09	1.50	1.14	0.91
11,959	11.34	6.61	6.93	5.39	4.29	2.83	1.97	1.50	1.14
6,677	6.89	3.86	3.78	2.83	2.20	1.46	1.10	0.91	0.75
9,390	9.80	5.79	5.59	4.29	3.39	2.28	1.69	1.34	1.06
11,943	12.40	7.52	7.28	5.67	4.49	3.03	2.24	1.77	1.42
6,677	8.35	4.33	4.33	2.99	2.17	1.34	0.94	0.79	0.63
6,820	8.15	4.49	4.41	2.28	1.38	1.02	0.83	0.00	0.00
9,231	10.91	6.10	5.98	3.07	1.89	1.34	1.10	0.00	0.00
12,213	14.57	8.07	7.99	4.09	2.48	1.77	1.42	0.00	0.00
6,931	6.85	3.50	3.70	1.89	1.14	0.87	0.55	0.00	0.00
9,453	9.29	4.96	5.20	2.72	1.57	1.14	0.75	0.00	0.00
12,419	12.09	6.54	7.01	3.74	2.05	1.50	0.98	0.00	0.00
6,868	9.13	4.45	4.29	1.93	1.22	0.94	0.83	0.00	0.00
9,358	12.09	6.14	5.98	2.68	1.61	1.26	0.98	0.00	0.00
12,308	15.71	8.07	8.07	3.66	2.17	1.69	1.14	0.00	0.00
6,868	6.73	3.86	3.86	2.01	1.18	0.87	0.75	0.00	0.00
9,421	8.98	5.20	5.28	2.76	1.57	1.18	0.87	0.00	0.00
12,372	11.42	6.69	6.81	3.66	2.05	1.38	1.18	0.00	0.00
6,884	6.46	3.98	3.94	2.24	1.38	0.98	0.87	0.00	0.00
9,342	11.93	6.54	6.38	4.57	3.43	2.05	1.46	1.22	0.91
11,880	15.20	8.54	8.35	6.10	4.65	2.83	1.97	1.61	1.22
6,455	5.43	3.27	3.15	2.28	1.69	0.98	0.63	0.51	0.43
9,057	7.76	4.69	4.53	3.39	2.56	1.46	0.94	0.75	0.59
11,499	9.84	6.06	5.87	4.41	3.35	2.01	1.26	0.94	0.79
6,582	6.02	3.62	3.46	2.60	1.97	1.06	0.67	0.51	0.39
9,199	8.54	5.31	5.08	3.86	2.99	1.69	1.02	0.79	0.59
11,610	10.67	6.77	6.50	4.96	3.86	2.24	1.38	0.98	0.79
6,662	5.35	3.03	3.03	2.13	1.57	0.87	0.55	0.43	0.35
9,310	7.44	4.33	4.33	3.15	2.32	1.30	0.83	0.63	0.51
11,753	9.25	5.51	5.47	4.06	3.03	1.77	1.14	0.83	0.67
6,566	7.40	4.17	3.98	2.76	2.05	1.22	0.87	0.75	0.59
9,739	14.33	8.62	8.39	6.34	4.92	3.07	2.20	1.73	1.38
12,245	18.19	11.10	10.79	8.19	6.42	4.02	2.83	2.24	1.81
7,042	6.42	3.86	3.82	3.07	2.48	1.77	1.34	1.06	0.83
9,897	9.61	5.98	5.91	4.80	3.94	2.76	2.01	1.54	1.26
12,451	12.48	7.95	7.83	6.42	5.24	3.66	2.64	2.01	1.61
6,614	7.40	4.49	4.53	3.39	2.48	1.38	0.83	0.59	0.47
9,231	10.71	6.57	6.61	4.92	3.70	2.05	1.22	0.87	0.67

Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
11,610	13.66	8.58	8.62	6.46	4.88	2.72	1.61	1.10	0.91
6,677	7.17	4.69	4.49	3.43	2.60	1.61	1.02	0.79	0.55
9,184	10.79	7.20	6.93	5.31	4.13	2.52	1.61	1.14	0.91
11,658	13.98	9.53	9.25	7.17	5.55	3.39	2.13	1.50	1.14
6,931	5.24	2.99	2.99	2.36	1.93	1.30	0.98	0.83	0.67
9,659	7.68	5.59	5.59	4.76	3.94	2.72	1.85	1.34	0.98
12,276	9.96	7.36	7.36	6.22	5.24	3.58	2.44	1.77	1.26
6,789	5.75	4.02	4.02	3.11	2.44	1.46	0.91	0.63	0.43
9,469	8.31	5.79	5.79	4.57	3.54	2.13	1.30	0.87	0.63
11,959	10.59	7.36	7.32	5.75	4.53	2.72	1.65	1.10	0.79
6,915	6.85	4.09	3.98	3.07	2.40	1.57	1.10	0.87	0.71
9,612	9.92	6.06	5.94	4.61	3.62	2.36	1.65	1.30	1.02
12,007	12.68	7.91	7.76	6.06	4.80	3.15	2.17	1.65	1.30
6,344	10.12	6.02	5.94	4.17	2.87	1.42	0.79	0.59	0.47
8,850	14.49	8.82	8.70	6.10	4.25	2.13	1.14	0.83	0.71
11,388	18.31	11.34	11.10	7.87	5.51	2.76	1.50	1.10	0.91
6,344	8.35	5.63	5.59	4.37	3.46	2.20	1.50	0.91	0.71
8,835	12.28	8.39	8.31	6.61	5.28	3.35	2.17	1.50	1.02
11,277	15.75	10.87	10.79	8.62	6.93	4.41	2.83	1.97	1.34
6,963	7.01	4.37	4.37	3.19	2.32	1.26	0.67	0.47	0.31
9,659	9.61	5.98	6.02	4.45	3.31	1.73	0.94	0.59	0.43
12,229	11.77	7.40	7.36	5.43	4.06	2.20	1.18	0.75	0.55
7,026	8.11	5.55	5.47	4.45	3.62	2.48	1.73	1.30	0.98
9,818	11.77	8.11	8.03	6.54	5.39	3.66	2.56	1.85	1.38
12,419	15.08	10.51	10.43	8.54	7.05	4.84	3.35	2.40	1.81
6,804	6.38	4.13	4.21	3.27	2.56	1.46	0.91	0.75	0.47
9,517	9.37	6.02	6.10	4.72	3.74	2.17	1.34	0.94	0.75
11,927	12.05	7.80	7.95	6.18	4.88	2.83	1.73	1.26	0.94
6,725	7.68	5.16	5.12	3.90	2.95	1.65	0.91	0.63	0.43
10,627	9.53	5.98	5.91	4.49	3.43	2.05	1.30	0.98	0.75
13,466	11.93	7.56	7.44	5.75	4.45	2.68	1.69	1.26	0.94
7,661	5.83	3.98	3.86	3.03	2.40	1.38	0.91	0.67	0.51
10,722	8.23	5.67	5.51	4.45	3.54	2.13	1.38	0.94	0.71
13,672	10.31	7.13	7.01	5.75	4.61	2.83	1.77	1.22	0.91
7,645	7.09	4.69	4.69	3.58	2.72	1.54	0.98	0.75	0.59
10,722	9.96	6.73	6.77	5.28	4.09	2.32	1.46	1.10	0.83
13,640	12.36	8.50	8.50	6.69	5.28	3.07	1.93	1.42	1.10
6,582	5.43	3.46	3.46	2.64	2.01	1.22	0.87	0.75	0.55
9,215	7.68	5.00	4.96	3.82	2.95	1.81	1.26	0.98	0.79
11,753	9.69	6.38	6.34	4.92	3.82	2.40	1.65	1.26	1.02
6,455	5.24	3.27	3.23	2.44	1.89	1.18	0.83	0.63	0.51
9,628	7.91	4.61	4.69	3.39	2.56	1.61	1.18	0.94	0.87
12,086	9.84	5.83	5.94	4.45	3.31	2.09	1.54	1.26	1.06
7,137	4.37	2.91	2.80	2.09	1.57	0.98	0.67	0.55	0.43
9,564	6.18	4.02	3.86	2.87	2.24	1.38	0.94	0.75	0.59
12,165	7.95	5.16	5.04	3.86	2.95	1.85	1.26	0.98	0.79

Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
6,566	4.69	2.68	2.72	1.97	1.50	0.94	0.71	0.59	0.47
9,152	6.57	3.90	3.94	2.87	2.20	1.46	1.06	0.87	0.71
11,642	8.31	5.00	5.00	3.70	2.87	1.93	1.42	1.18	0.91
6,344	5.63	3.74	3.82	3.15	2.52	1.69	1.22	0.98	0.75
8,898	8.19	5.59	5.67	4.65	3.86	2.60	1.85	1.42	1.10
11,356	10.47	7.24	7.32	6.02	5.00	3.43	2.44	1.85	1.42
7,312	5.16	3.78	3.66	3.03	2.48	1.69	1.26	0.98	0.79
9,437	8.74	5.51	5.51	3.19	1.89	1.38	1.14	0.00	0.00
12,372	11.38	7.17	7.20	4.25	2.56	1.77	1.26	0.00	0.00
6,852	6.46	3.70	3.70	2.13	1.26	0.98	0.91	0.00	0.00
9,406	8.54	4.96	5.08	2.87	1.65	1.22	1.02	0.00	0.00
12,403	11.14	6.61	6.81	3.90	2.28	1.65	1.42	0.00	0.00
6,852	6.57	3.62	3.78	1.97	1.18	0.98	0.87	0.00	0.00
9,390	8.70	4.84	5.20	2.76	1.46	1.22	0.98	0.00	0.00
12,403	11.14	6.18	6.69	3.70	1.81	1.46	1.10	0.00	0.00
6,868	6.10	3.78	3.74	2.28	1.38	0.98	0.71	0.00	0.00
9,421	8.23	5.12	5.20	3.19	1.81	1.26	0.91	0.00	0.00
12,467	10.75	6.93	6.81	4.25	2.64	1.77	1.26	0.00	0.00
6,900	6.42	3.74	3.74	2.28	1.42	1.14	0.83	0.00	0.00
9,406	8.50	5.04	5.16	3.11	1.93	1.42	0.87	0.00	0.00
9,184	10.63	6.10	5.79	4.13	3.19	1.89	1.34	1.06	0.91
11,483	13.39	7.87	7.44	5.39	4.09	2.52	1.77	1.46	1.18
6,265	5.47	3.31	3.35	2.44	1.89	1.14	0.79	0.67	0.51
8,835	7.87	4.92	4.92	3.74	2.83	1.77	1.22	0.98	0.75
11,277	10.04	6.38	6.38	4.88	3.78	2.40	1.57	1.30	1.02
6,963	7.32	4.02	3.86	2.64	1.93	1.10	0.75	0.59	0.43
9,755	10.51	5.87	5.59	3.86	2.87	1.69	1.10	0.87	0.67
12,356	13.27	7.60	7.24	5.08	3.78	2.24	1.46	1.14	0.87
6,551	6.54	3.39	3.46	2.64	2.13	1.50	1.10	0.83	0.67
9,168	9.37	5.12	5.20	4.02	3.27	2.32	1.69	1.30	0.98
11,594	11.93	6.73	6.73	5.31	4.37	3.03	2.20	1.69	1.30
7,026	10.12	5.94	5.79	4.29	3.35	2.13	1.50	1.18	0.94
9,643	7.56	4.45	4.49	3.58	2.91	1.97	1.46	1.22	0.94
12,229	9.65	5.83	5.83	4.72	3.86	2.64	1.93	1.57	1.22
6,693	6.14	3.62	3.70	2.80	2.13	1.30	0.91	0.75	0.59
9,342	9.02	5.59	5.59	4.25	3.31	2.01	1.38	1.06	0.83
11,785	11.65	7.32	7.36	5.71	4.41	2.68	1.77	1.34	1.10
6,915	7.24	4.37	4.37	3.27	2.44	1.38	0.87	0.63	0.51
9,659	10.51	6.42	6.42	4.80	3.62	2.05	1.18	0.91	0.75
12,165	13.54	8.46	8.39	6.30	4.76	2.68	1.61	1.14	0.94
7,153	7.72	5.00	5.08	3.86	2.91	1.65	0.98	0.79	0.55
9,929	11.10	7.17	7.24	5.55	4.25	2.44	1.46	1.02	0.83
12,530	14.29	9.25	9.33	7.17	5.51	3.15	1.93	1.38	1.06
6,963	5.12	3.66	3.70	3.11	2.60	1.77	1.22	0.91	0.67
9,390	11.14	7.44	7.36	5.67	4.33	2.40	1.30	0.87	0.63
11,785	14.25	9.61	9.53	7.32	5.63	3.11	1.73	1.14	0.83

Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
6,677	5.83	3.86	3.78	2.99	2.40	1.50	0.94	0.67	0.47
9,247	8.70	5.79	5.71	4.53	3.58	2.24	1.42	0.98	0.67
11,610	11.30	7.64	7.52	5.98	4.80	2.99	1.89	1.30	0.83
6,408	7.68	5.47	5.16	3.98	3.07	1.85	1.10	0.71	0.47
8,914	11.14	7.99	7.52	5.83	4.49	2.72	1.57	0.98	0.67
11,515	14.25	10.31	9.76	7.60	5.87	3.50	2.05	1.30	0.83
7,026	6.18	3.90	3.86	2.80	2.09	1.18	0.71	0.55	0.39
9,802	9.09	5.79	5.67	4.17	3.11	1.77	1.06	0.79	0.59
12,403	11.65	7.52	7.44	5.51	4.17	2.36	1.46	1.06	0.83
7,058	5.71	3.35	3.35	2.56	1.97	1.26	0.91	0.71	0.59
9,802	8.54	5.12	5.12	3.94	3.07	2.01	1.42	1.10	0.87
12,387	11.02	6.81	6.77	5.24	4.13	2.72	1.89	1.46	1.14
6,804	9.09	5.79	5.55	4.09	3.07	1.69	1.06	0.79	0.63
9,437	13.07	8.31	7.99	5.94	4.45	2.48	1.54	1.10	0.91
11,927	16.61	10.67	10.35	7.72	5.83	3.27	1.97	1.46	1.18
7,106	5.55	3.82	3.74	2.95	2.36	1.50	0.94	0.71	0.51
9,818	8.03	5.47	5.35	4.29	3.43	2.17	1.38	1.06	0.71
12,483	10.47	7.09	6.93	5.55	4.45	2.83	1.81	1.34	0.91
7,201	8.66	5.59	5.71	4.45	3.50	2.24	1.54	1.18	0.87
10,088	12.40	8.03	8.19	6.46	5.12	3.31	2.24	1.69	1.26
12,721	15.79	10.39	10.55	8.35	6.61	4.33	2.95	2.24	1.65
6,741	7.40	4.69	4.72	3.66	2.87	1.77	1.22	0.94	0.75
9,374	10.51	6.81	6.85	5.31	4.17	2.60	1.73	1.34	1.06
11,785	13.35	8.82	8.86	6.93	5.43	3.39	2.32	1.73	1.38
6,789	7.01	4.53	4.65	3.66	2.83	1.81	1.26	0.94	0.79
9,469	10.20	6.69	6.77	5.35	4.21	2.64	1.89	1.38	1.14
11,927	12.99	8.70	8.70	6.93	5.43	3.46	2.40	1.81	1.50
6,646	6.26	4.21	4.17	3.31	2.68	1.73	1.18	0.87	0.67
9,247	9.13	6.26	6.22	5.00	4.02	2.64	1.81	1.26	0.98
11,642	11.85	8.23	8.15	6.57	5.35	3.46	2.32	1.65	1.22
7,026	6.18	4.33	4.25	3.46	2.80	1.77	1.10	0.75	0.51
9,945	9.02	6.34	6.22	5.08	4.09	2.60	1.65	0.98	0.71
12,578	11.46	8.15	8.07	6.61	5.35	3.43	2.13	1.38	0.91
6,820	5.94	3.50	3.39	2.56	1.93	1.14	0.79	0.63	0.51
9,374	8.31	4.96	4.84	3.66	2.80	1.65	1.14	0.91	0.71
11,848	10.43	6.30	6.14	4.69	3.58	2.13	1.46	1.18	0.91
7,122	6.54	4.13	4.13	3.15	2.40	1.34	0.83	0.63	0.51
9,913	9.41	6.02	5.98	4.61	3.46	1.97	1.18	0.91	0.71
12,578	12.01	7.83	7.80	5.98	4.65	2.64	1.61	1.18	0.94
6,233	6.30	3.66	3.62	2.52	1.77	0.91	0.59	0.47	0.39
8,755	9.06	5.39	5.35	3.74	2.64	1.38	0.87	0.67	0.55
11,325	11.61	7.09	7.01	4.96	3.54	1.85	1.18	0.91	0.71
6,344	5.83	3.31	3.35	2.40	1.81	1.10	0.79	0.67	0.55
8,882	8.23	4.84	4.84	3.54	2.64	1.61	1.18	0.94	0.75
11,372	10.47	6.30	6.26	4.69	3.50	2.13	1.54	1.26	1.02
6,757	6.89	4.37	4.45	3.46	2.72	1.77	1.30	1.02	0.87

Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
9,421	9.96	6.54	6.61	5.20	4.13	2.68	1.93	1.50	1.22
11,927	12.72	8.54	8.54	6.77	5.43	3.58	2.40	1.93	1.54
6,376	6.22	3.78	3.74	2.68	2.01	1.18	0.87	0.63	0.59
9,025	8.86	5.51	5.43	3.98	2.99	1.81	1.26	0.98	0.87
11,594	11.22	7.09	7.01	5.24	3.94	2.40	1.65	1.30	1.10
7,566	5.67	3.78	3.90	2.95	2.28	1.30	0.87	0.67	0.51
10,500	7.80	5.28	5.39	4.13	3.23	1.93	1.26	0.94	0.71
13,498	9.96	6.65	6.85	5.31	4.17	2.56	1.65	1.26	0.94
8,010	5.43	3.62	3.50	2.72	2.13	1.34	0.91	0.71	0.51
11,182	7.68	5.24	5.12	4.06	3.19	2.05	1.38	1.06	0.79
14,164	9.72	6.77	6.61	5.35	4.21	2.76	1.89	1.38	1.06
7,613	6.81	4.09	4.09	3.03	2.28	1.34	0.87	0.71	0.51
9,057	7.56	4.88	4.80	3.70	2.87	1.77	1.22	0.91	0.75
11,563	9.65	6.34	6.22	4.88	3.78	2.40	1.61	1.22	0.98
7,090	5.08	3.27	3.27	2.56	2.01	1.26	0.87	0.67	0.55
9,739	7.28	4.88	4.84	3.82	3.03	1.97	1.34	1.02	0.79
12,387	9.37	6.34	6.30	5.00	4.02	2.64	1.81	1.30	1.02
6,582	5.55	3.23	3.23	2.32	1.73	1.02	0.71	0.59	0.43
9,231	7.99	4.80	4.80	3.50	2.64	1.57	1.06	0.83	0.63
11,864	10.12	6.22	6.26	4.65	3.54	2.13	1.42	1.10	0.87
7,740	7.36	4.57	4.61	3.35	2.40	1.38	0.91	0.71	0.51
10,722	9.92	6.30	6.34	4.69	3.35	1.97	1.30	0.98	0.75
13,672	12.17	7.83	7.87	5.87	4.29	2.56	1.69	1.26	0.98
6,900	5.63	3.15	3.19	2.28	1.69	1.06	0.83	0.71	0.59
10,167	7.32	5.47	5.31	4.41	3.66	2.56	1.85	1.38	1.10
12,911	9.33	6.97	6.85	5.71	4.76	3.31	2.36	1.81	1.42
6,455	5.71	3.86	3.86	3.03	2.40	1.57	1.18	0.94	0.79
9,072	8.46	5.91	5.87	4.69	3.78	2.48	1.77	1.42	1.14
11,579	10.98	7.76	7.68	6.22	5.08	3.35	2.36	1.85	1.50
7,026	5.94	3.86	3.82	2.91	2.28	1.42	0.98	0.79	0.67
9,818	8.50	5.59	5.59	4.37	3.39	2.13	1.46	1.18	0.98
12,387	10.94	7.28	7.24	5.71	4.49	2.83	1.97	1.50	1.22
6,360	5.12	2.99	3.03	2.20	1.65	0.98	0.71	0.55	0.39
9,009	7.48	4.57	4.57	3.43	2.56	1.57	1.06	0.83	0.63
11,563	9.57	5.98	5.94	4.49	3.46	2.13	1.42	1.06	0.83
6,551	4.41	2.99	3.07	2.48	2.01	1.34	1.02	0.83	0.67
9,199	6.57	4.61	4.65	3.82	3.11	2.13	1.57	1.26	1.02
11,769	8.50	6.02	6.10	5.00	4.13	2.83	2.01	1.54	1.26
6,329	4.88	3.23	3.15	2.52	2.01	1.42	1.10	0.94	0.79
8,914	7.32	5.00	4.84	3.86	3.19	2.20	1.69	1.38	1.14
11,420	9.45	6.61	6.42	5.20	4.29	3.03	2.28	1.81	1.54
6,598	5.63	3.62	3.70	2.76	2.09	1.30	0.94	0.79	0.67
9,184	7.87	5.16	5.24	4.02	3.03	1.93	1.38	1.14	0.91
11,642	9.80	6.50	6.54	5.00	3.90	2.48	1.77	1.46	1.18
6,471	4.80	3.15	3.15	2.40	1.89	1.18	0.79	0.63	0.47
9,088	6.85	4.61	4.61	3.58	2.83	1.73	1.18	0.91	0.67

Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
11,610	8.70	5.91	5.87	4.61	3.66	2.28	1.54	1.14	0.87
7,074	4.88	3.11	3.15	2.36	1.81	1.10	0.79	0.67	0.51
9,786	6.97	4.61	4.61	3.54	2.76	1.73	1.22	0.91	0.71
12,403	8.98	5.98	6.02	4.69	3.66	2.32	1.57	1.22	0.91

Table 3. Normalized (9000-lb) deflection data – I-195 (English units).

Station	Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
0	9,000	2.66	1.97	2.06	1.78	1.51	1.07	0.77	0.58	0.41
0	9,000	5.30	3.91	4.07	3.52	3.02	2.21	1.55	1.08	0.77
0	9,000	8.56	6.37	6.66	5.84	5.11	3.70	2.68	1.99	1.41
0.1	9,000	3.12	2.40	2.29	1.97	1.68	1.19	0.87	0.64	0.49
0.1	9,000	6.29	4.87	4.67	4.10	3.45	2.48	1.83	1.42	1.01
0.1	9,000	10.03	7.87	7.61	6.53	5.60	4.06	2.93	2.21	1.59
0.2	9,000	4.16	2.92	2.88	2.39	1.95	1.33	0.93	0.71	0.53
0.2	9,000	8.13	5.69	5.65	4.67	3.90	2.65	1.88	1.41	1.07
0.2	9,000	13.02	9.22	9.12	7.54	6.35	4.39	3.15	2.33	1.79
0.3	9,000	3.82	2.75	2.70	2.21	1.80	1.20	0.87	0.55	0.52
0.3	9,000	7.60	5.49	5.41	4.49	3.68	2.46	1.69	1.27	0.96
0.3	9,000	12.40	9.10	8.95	7.43	6.15	4.18	2.90	2.21	1.72
0.4	9,000	4.97	4.14	4.23	3.69	2.94	2.06	1.49	1.11	0.86
0.4	9,000	9.79	8.11	8.35	7.39	6.03	4.20	3.08	2.32	1.76
0.4	9,000	15.26	12.64	13.05	11.59	9.47	6.70	4.84	3.63	2.82
0.504924	9,000	2.98	2.35	2.33	2.16	1.98	1.65	1.38	1.16	0.95
0.504924	9,000	6.01	4.83	4.75	4.40	4.10	3.41	2.87	2.37	1.95
0.504924	9,000	9.72	7.77	7.72	7.18	6.59	5.57	4.64	3.81	3.13
0.60303	9,000	4.80	3.11	3.05	2.37	1.91	1.30	0.94	0.78	0.65
0.60303	9,000	9.89	6.39	6.26	4.97	4.05	2.76	2.07	1.66	1.38
0.60303	9,000	16.36	10.67	10.55	8.50	6.92	4.69	3.46	2.81	2.35
0.7	9,000	4.45	3.00	3.07	2.80	2.53	2.02	1.65	1.32	1.08
0.7	9,000	8.85	6.00	6.19	5.66	5.14	4.09	3.38	2.76	2.19
0.7	9,000	14.08	9.71	10.02	9.11	8.26	6.68	5.46	4.43	3.58
0.8	9,000	4.06	2.76	2.73	2.40	2.10	1.60	1.27	1.00	0.80
0.8	9,000	8.21	5.68	5.58	4.88	4.32	3.33	2.63	2.06	1.64
0.8	9,000	13.19	9.29	9.11	8.03	7.07	5.46	4.20	3.36	2.64
0.909091	9,000	4.74	3.57	3.60	3.28	2.87	2.21	1.74	1.33	1.01
0.909091	9,000	9.59	7.27	7.32	6.60	5.89	4.60	3.61	2.77	2.10
0.909091	9,000	15.46	11.73	11.79	10.59	9.56	7.50	5.84	4.46	3.38
1.075	9,000	5.06	3.23	3.26	2.72	2.31	1.65	1.23	0.98	0.79
1.075	9,000	10.34	6.78	6.82	5.74	4.83	3.43	2.57	1.99	1.58
1.075	9,000	16.60	11.03	11.09	9.36	7.99	5.69	4.19	3.27	2.64
1.242045	9,000	4.56	2.72	2.81	2.19	1.72	1.16	0.87	0.72	0.59
1.242045	9,000	9.16	5.67	5.84	4.60	3.67	2.52	1.81	1.46	1.20
1.242045	9,000	15.02	9.43	9.66	7.68	6.21	4.24	3.05	2.43	1.92
1.422917	9,000	4.40	2.56	2.56	2.10	1.77	1.20	0.93	0.77	0.60
1.422917	9,000	8.84	5.32	5.36	4.33	3.67	2.59	1.93	1.55	1.18
1.422917	9,000	14.52	8.88	8.88	7.20	6.12	4.32	3.24	2.58	2.04
1.5	9,000	7.74	4.96	4.67	3.26	2.24	1.18	0.77	0.64	0.51
1.5	9,000	14.99	9.77	9.41	6.66	4.73	2.48	1.58	1.13	0.99
1.5	9,000	23.55	15.57	15.11	10.95	7.87	4.16	2.57	1.94	1.60
1.609091	9,000	4.92	3.35	3.29	2.52	1.95	1.15	0.80	0.64	0.48
1.609091	9,000	9.71	6.65	6.61	5.13	3.96	2.38	1.57	1.21	0.99
1.609091	9,000	15.86	10.86	10.80	8.50	6.66	4.08	2.70	2.07	1.67
1.904924	9,000	4.38	2.78	2.78	2.25	1.86	1.27	0.88	0.69	0.56
1.904924	9,000	8.77	5.63	5.68	4.66	3.88	2.63	1.80	1.43	1.11
1.904924	9,000	14.52	9.36	9.48	7.88	6.52	4.44	3.08	2.31	1.84

Station	Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
2.071023	9,000	5.32	3.48	3.45	2.86	2.40	1.71	1.31	1.08	0.82
2.071023	9,000	10.71	7.14	7.14	5.98	5.10	3.66	2.73	2.18	1.76
2.071023	9,000	17.66	11.81	11.75	9.91	8.47	6.15	4.59	3.64	2.92
2.236932	9,000	4.14	2.65	2.72	2.20	1.78	1.10	0.74	0.58	0.45
2.236932	9,000	7.94	5.25	5.34	4.38	3.61	2.24	1.51	1.14	0.87
2.236932	9,000	13.09	8.47	8.65	7.19	5.90	3.74	2.51	1.87	1.46
2.40303	9,000	4.09	2.60	2.60	2.16	1.82	1.25	0.88	0.68	0.51
2.40303	9,000	8.03	5.13	5.13	4.37	3.71	2.57	1.81	1.38	1.05
2.40303	9,000	13.19	8.51	8.57	7.29	6.20	4.38	3.04	2.25	1.70
2.568939	9,000	4.62	3.18	3.12	2.61	2.18	1.54	1.14	0.90	0.70
2.568939	9,000	9.45	6.66	6.57	5.62	4.72	3.35	2.50	1.89	1.46
2.568939	9,000	15.41	11.00	10.88	9.31	7.92	5.68	4.17	3.20	2.48
2.735038	9,000	4.43	2.92	2.89	2.43	2.03	1.41	1.05	0.79	0.59
2.735038	9,000	9.14	6.27	6.22	5.34	4.50	3.16	2.27	1.72	1.30
2.735038	9,000	15.26	10.55	10.49	9.00	7.69	5.42	3.93	2.98	2.26
2.900947	9,000	5.78	3.99	3.86	3.05	2.44	1.56	1.04	0.78	0.58
2.900947	9,000	11.78	8.19	8.00	6.39	5.15	3.31	2.21	1.61	1.20
2.900947	9,000	19.48	13.65	13.36	10.77	8.83	5.71	3.82	2.77	2.06
3.00303	9,000	5.52	3.49	3.69	2.89	2.23	1.33	0.90	0.70	0.60
3.00303	9,000	10.94	6.95	7.37	5.82	4.51	2.77	1.83	1.41	1.17
3.00303	9,000	17.62	11.45	12.11	9.65	7.55	4.68	3.06	2.34	1.92
3	9,000	5.54	3.60	3.57	2.77	2.10	1.27	0.87	0.70	0.57
3	9,000	10.90	7.12	7.17	5.61	4.29	2.64	1.79	1.32	1.18
3	9,000	17.55	11.78	11.84	9.37	7.21	4.51	3.00	2.34	1.92
3.1	9,000	4.52	2.77	2.80	2.12	1.64	1.03	0.79	0.68	0.58
3.1	9,000	8.97	5.63	5.72	4.46	3.54	2.23	1.65	1.36	1.16
3.1	9,000	14.84	9.46	9.64	7.60	6.06	3.89	2.84	2.29	1.98
3.2	9,000	3.96	2.52	2.49	2.06	1.77	1.18	0.88	0.75	0.59
3.2	9,000	8.03	5.25	5.11	4.32	3.57	2.51	1.86	1.49	1.21
3.2	9,000	13.29	8.68	8.62	7.31	6.17	4.31	3.17	2.45	2.04
3.200947	9,000	3.96	2.53	2.46	2.03	1.70	1.17	0.87	0.70	0.60
3.200947	9,000	8.01	5.23	5.14	4.29	3.53	2.45	1.79	1.41	1.18
3.200947	9,000	13.13	8.67	8.49	7.11	5.96	4.16	3.07	2.35	1.99
3.300947	9,000	3.90	2.44	2.34	1.85	1.46	0.88	0.62	0.52	0.42
3.300947	9,000	7.80	4.94	4.75	3.83	3.09	1.94	1.34	1.06	0.92
3.300947	9,000	12.84	8.23	7.99	6.45	5.33	3.37	2.37	1.83	1.60
3.427083	9,000	3.90	2.40	2.36	1.83	1.43	0.90	0.67	0.60	0.47
3.427083	9,000	7.67	4.75	4.70	3.72	2.96	1.88	1.36	1.08	0.89
3.427083	9,000	12.21	7.58	7.58	6.08	4.81	3.19	2.23	1.86	1.44
3.5	9,000	3.87	2.34	2.37	1.90	1.54	1.00	0.67	0.50	0.37
3.5	9,000	7.52	4.67	4.72	3.83	3.13	2.05	1.40	1.07	0.75
3.5	9,000	12.39	7.66	7.78	6.35	5.21	3.47	2.34	1.74	1.32
3.597917	9,000	3.95	2.47	2.44	1.90	1.51	0.96	0.64	0.51	0.39
3.597917	9,000	7.94	4.95	4.86	3.86	3.09	2.00	1.36	1.04	0.77
3.597917	9,000	13.04	8.17	8.00	6.37	5.16	3.36	2.32	1.74	1.33
3.7	9,000	4.14	2.51	2.58	2.04	1.63	1.02	0.68	0.51	0.41
3.7	9,000	7.98	4.99	5.04	3.99	3.23	2.09	1.38	1.09	0.76
3.7	9,000	12.81	8.11	8.17	6.59	5.37	3.48	2.32	1.71	1.34
3.800947	9,000	5.42	3.51	3.44	2.57	1.95	1.14	0.78	0.62	0.52

Station	Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
3.800947	9,000	10.21	6.76	6.67	5.15	3.96	2.39	1.66	1.29	1.10
3.800947	9,000	16.06	10.73	10.55	8.27	6.45	3.93	2.70	2.17	1.76
3.9	9,000	3.95	2.63	2.60	2.19	1.85	1.32	0.98	0.81	0.67
3.9	9,000	7.96	5.39	5.34	4.58	3.86	2.76	2.05	1.62	1.33
3.9	9,000	12.99	8.88	8.76	7.60	6.43	4.59	3.37	2.70	2.21
4	9,000	5.11	3.33	3.20	2.36	1.82	1.08	0.67	0.50	0.37
4	9,000	9.89	6.53	6.34	4.78	3.69	2.22	1.42	1.04	0.80
4	9,000	15.83	10.39	10.15	7.80	6.10	3.75	2.36	1.75	1.33
4.070076	9,000	4.54	3.13	3.06	2.46	1.99	1.25	0.81	0.64	0.44
4.070076	9,000	8.92	6.18	6.09	4.94	4.03	2.59	1.73	1.25	0.91
4.070076	9,000	14.00	9.82	9.70	7.92	6.51	4.24	2.76	2.15	1.54
4.332007	9,000	4.85	2.99	2.99	2.25	1.78	1.11	0.74	0.57	0.44
4.332007	9,000	9.36	5.91	5.91	4.54	3.59	2.27	1.51	1.18	0.90
4.332007	9,000	15.23	9.73	9.55	7.49	5.98	3.87	2.60	1.99	1.51
4.497917	9,000	4.16	2.68	2.71	2.11	1.64	1.01	0.64	0.47	0.37
4.497917	9,000	8.20	5.35	5.40	4.26	3.36	2.09	1.28	0.95	0.71
4.497917	9,000	13.14	8.66	8.72	7.03	5.51	3.45	2.12	1.51	1.09
4.664962	9,000	4.79	3.27	3.17	2.62	2.13	1.36	0.91	0.71	0.55
4.664962	9,000	9.59	6.57	6.39	5.25	4.29	2.78	1.87	1.42	1.10
4.664962	9,000	15.58	10.70	10.47	8.61	7.09	4.65	3.08	2.33	1.80
4.829924	9,000	5.44	3.45	3.42	2.70	2.15	1.33	0.86	0.65	0.44
4.829924	9,000	10.33	6.66	6.57	5.22	4.20	2.66	1.69	1.16	0.82
4.829924	9,000	16.33	10.60	10.41	8.38	6.78	4.25	2.71	1.91	1.36
5	9,000	5.09	3.44	3.44	2.80	2.29	1.52	1.01	0.78	0.57
5	9,000	10.27	6.84	6.89	5.66	4.66	3.09	2.09	1.57	1.19
5	9,000	16.67	11.26	11.26	9.25	7.67	5.11	3.41	2.56	1.83
5.179924	9,000	4.80	3.18	3.11	2.47	1.93	1.15	0.71	0.54	0.41
5.179924	9,000	9.15	6.13	6.04	4.81	3.77	2.31	1.42	1.04	0.75
5.179924	9,000	14.88	9.88	9.70	7.71	6.14	3.79	2.29	1.69	1.26
5.343939	9,000	5.99	4.06	3.96	3.20	2.56	1.77	1.30	1.03	0.87
5.343939	9,000	12.10	8.30	8.16	6.57	5.35	3.61	2.58	2.06	1.74
5.343939	9,000	19.59	13.68	13.32	10.93	8.90	6.03	4.24	3.35	2.75
5.497917	9,000	4.89	3.53	3.50	3.10	2.68	2.01	1.52	1.16	0.86
5.497917	9,000	9.64	7.00	7.00	6.16	5.38	4.03	3.06	2.32	1.71
5.497917	9,000	15.81	11.64	11.58	10.20	9.01	6.80	5.07	3.76	2.80
5.664962	9,000	4.76	3.23	3.23	2.75	2.38	1.67	1.26	1.02	0.85
5.664962	9,000	9.49	6.52	6.52	5.56	4.75	3.45	2.54	2.06	1.68
5.664962	9,000	15.42	10.59	10.59	9.06	7.77	5.63	4.16	3.30	2.69
5.829924	9,000	6.75	3.87	4.04	2.71	1.85	0.86	0.53	0.46	0.40
5.829924	9,000	13.00	7.68	7.87	5.42	3.77	1.79	1.08	0.90	0.85
5.829924	9,000	20.39	12.22	12.46	8.71	6.17	3.03	1.94	1.69	1.39
6	9,000	3.89	2.57	2.47	1.96	1.59	1.05	0.78	0.64	0.54
6	9,000	8.00	5.27	5.17	4.21	3.45	2.35	1.68	1.34	1.05
6	9,000	13.22	8.83	8.65	7.07	5.85	4.02	2.80	2.13	1.71
6.1	9,000	5.13	3.21	3.21	2.41	1.85	1.08	0.77	0.59	0.49
6.1	9,000	9.81	6.18	6.18	4.76	3.78	2.31	1.57	1.23	0.98
6.1	9,000	15.87	10.10	10.04	7.90	6.21	3.89	2.63	2.07	1.69
6.218939	9,000	5.61	3.66	3.66	2.79	2.16	1.22	0.73	0.52	0.35
6.218939	9,000	10.65	7.05	7.00	5.40	4.18	2.43	1.41	1.02	0.68

Station	Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
6.218939	9,000	16.85	11.19	11.13	8.64	6.78	3.98	2.36	1.62	1.12
6.3	9,000	7.56	4.63	4.67	3.38	2.44	1.25	0.70	0.52	0.42
6.3	9,000	14.04	8.76	8.80	6.46	4.84	2.54	1.42	1.03	0.78
6.3	9,000	21.88	13.75	13.82	10.19	7.56	4.13	2.38	1.63	1.25
6.400947	9,000	4.03	2.57	2.57	2.09	1.74	1.15	0.80	0.59	0.45
6.400947	9,000	7.81	5.00	5.00	4.12	3.44	2.33	1.60	1.16	0.92
6.400947	9,000	12.75	8.32	8.26	6.90	5.73	3.94	2.71	1.97	1.48
6.5	9,000	5.71	3.94	3.94	3.16	2.55	1.63	1.12	0.82	0.61
6.5	9,000	11.57	8.08	8.03	6.55	5.35	3.44	2.34	1.72	1.29
6.5	9,000	18.56	13.14	13.14	10.83	8.88	5.84	3.96	2.86	2.13
6.600947	9,000	5.54	3.23	3.13	2.27	1.69	0.93	0.55	0.38	0.31
6.600947	9,000	10.42	6.10	5.95	4.37	3.36	1.82	1.06	0.72	0.58
6.600947	9,000	15.92	9.41	9.22	6.87	5.19	2.89	1.69	1.21	0.90
6.7	9,000	4.67	3.13	3.00	2.33	1.85	1.08	0.66	0.49	0.38
6.7	9,000	8.93	6.05	5.80	4.63	3.66	2.19	1.37	0.98	0.73
6.7	9,000	14.11	9.64	9.26	7.46	5.91	3.61	2.24	1.62	1.18
6.782955	9,000	6.31	3.89	3.89	2.69	1.79	0.83	0.50	0.40	0.33
6.782955	9,000	12.04	7.53	7.48	5.27	3.62	1.79	1.03	0.85	0.66
6.782955	9,000	18.77	11.79	11.73	8.30	5.77	2.89	1.68	1.32	1.02
6.9	9,000	4.44	2.97	2.92	2.21	1.72	1.06	0.71	0.52	0.38
6.9	9,000	9.02	6.10	6.06	4.68	3.72	2.30	1.53	1.11	0.81
6.9	9,000	14.62	10.15	9.96	7.80	6.23	3.97	2.60	1.91	1.37
7	9,000	4.59	2.77	2.74	2.00	1.48	0.83	0.54	0.43	0.34
7	9,000	8.96	5.54	5.54	4.14	3.15	1.79	1.15	0.88	0.68
7	9,000	14.35	9.03	9.03	6.85	5.22	3.04	1.98	1.47	1.17
7.167993	9,000	3.92	2.38	2.41	1.74	1.26	0.73	0.48	0.42	0.34
7.167993	9,000	7.74	4.86	4.86	3.55	2.65	1.58	1.03	0.83	0.67
7.167993	9,000	12.41	7.89	7.84	5.83	4.42	2.61	1.76	1.36	1.16
7.340909	9,000	5.83	3.32	3.29	2.36	1.75	1.05	0.73	0.58	0.47
7.340909	9,000	11.51	6.83	6.71	4.92	3.66	2.20	1.55	1.22	0.98
7.340909	9,000	18.25	11.08	10.93	8.15	6.13	3.71	2.53	1.96	1.65
7.5	9,000	3.42	2.21	2.24	1.69	1.29	0.75	0.46	0.37	0.29
7.5	9,000	6.78	4.45	4.45	3.49	2.65	1.56	1.00	0.72	0.60
7.5	9,000	10.90	7.28	7.28	5.75	4.43	2.65	1.73	1.22	0.97
7.664015	9,000	3.90	2.28	2.28	1.77	1.40	0.85	0.55	0.43	0.34
7.664015	9,000	7.74	4.70	4.66	3.68	2.86	1.75	1.15	0.90	0.73
7.664015	9,000	12.29	7.55	7.55	5.98	4.69	2.97	1.94	1.46	1.19
7.832007	9,000	3.94	2.52	2.52	2.00	1.63	1.06	0.77	0.60	0.46
7.832007	9,000	7.94	5.23	5.27	4.19	3.39	2.27	1.60	1.24	1.00
7.832007	9,000	12.88	8.61	8.66	7.03	5.75	3.87	2.70	2.09	1.63
8	9,000	3.82	2.62	2.59	2.12	1.74	1.12	0.76	0.56	0.47
8	9,000	7.53	5.25	5.17	4.28	3.50	2.28	1.51	1.14	0.86
8	9,000	12.11	8.56	8.40	6.96	5.77	3.76	2.53	1.96	1.44
8.165909	9,000	4.44	2.69	2.77	2.10	1.61	0.93	0.58	0.44	0.32
8.165909	9,000	8.81	5.48	5.64	4.34	3.33	1.95	1.22	0.89	0.69
8.165909	9,000	13.97	8.92	9.13	7.04	5.51	3.26	2.04	1.48	1.12
8.332007	9,000	3.71	2.44	2.41	1.99	1.60	1.12	0.78	0.63	0.51
8.332007	9,000	7.54	5.10	5.01	4.21	3.41	2.36	1.64	1.26	1.01
8.332007	9,000	12.27	8.41	8.25	6.91	5.68	3.91	2.79	2.09	1.66

Station	Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
8.497916	9,000	5.24	3.01	2.95	2.14	1.46	0.80	0.54	0.45	0.33
8.497916	9,000	10.48	6.14	5.97	4.39	3.09	1.71	1.04	0.84	0.63
8.497916	9,000	16.96	10.01	9.80	7.27	5.21	2.90	1.79	1.42	1.11
8.664962	9,000	5.98	3.13	3.21	2.08	1.43	0.68	0.45	0.36	0.33
8.664962	9,000	11.65	6.22	6.31	4.22	2.92	1.50	0.96	0.75	0.67
8.664962	9,000	18.31	10.03	10.08	6.79	4.83	2.55	1.65	1.33	1.11
8.835985	9,000	6.28	3.06	3.18	2.07	1.44	0.84	0.54	0.42	0.30
8.835985	9,000	12.43	6.34	6.46	4.32	3.06	1.72	1.09	0.80	0.59
8.835985	9,000	19.69	10.38	10.38	7.08	5.06	2.93	1.81	1.33	0.96
9.7	9,000	15.38	9.27	9.49	5.78	3.60	2.67	1.25	0.00	0.00
9.8	9,000	3.76	2.52	2.49	1.68	1.14	0.87	0.75	0.00	0.00
9.8	9,000	7.03	4.86	4.86	3.19	2.13	1.55	1.14	0.00	0.00
9.8	9,000	12.78	8.76	8.87	5.93	3.81	2.83	1.96	0.00	0.00
9.9	9,000	4.80	3.19	3.13	2.03	1.40	1.10	0.92	0.00	0.00
9.9	9,000	8.89	6.01	6.09	3.95	2.67	2.02	1.69	0.00	0.00
9.9	9,000	15.59	10.70	10.87	7.12	4.62	3.42	2.77	0.00	0.00
10	9,000	4.41	3.11	2.99	2.01	1.42	1.13	0.89	0.00	0.00
10	9,000	8.49	5.90	6.03	3.90	2.75	2.13	1.68	0.00	0.00
10	9,000	14.88	10.46	10.67	6.95	4.80	3.61	2.75	0.00	0.00
10.166	9,000	4.92	2.92	2.74	1.64	1.07	0.87	0.72	0.00	0.00
10.166	9,000	9.08	5.50	5.30	3.16	2.09	1.48	1.23	0.00	0.00
10.166	9,000	15.91	9.90	9.46	5.74	3.72	2.62	2.02	0.00	0.00
10.332	9,000	5.86	3.18	3.13	1.46	0.92	0.71	0.68	0.00	0.00
10.332	9,000	10.96	6.11	6.03	2.87	1.74	1.33	1.01	0.00	0.00
10.332	9,000	19.30	10.89	11.00	5.39	3.13	2.21	1.73	0.00	0.00
10.5	9,000	3.70	2.37	2.40	1.56	1.05	0.75	0.54	0.00	0.00
10.5	9,000	7.02	4.62	4.66	3.10	2.11	1.44	1.03	0.00	0.00
10.5	9,000	12.36	8.17	8.28	5.56	3.65	2.51	1.58	0.00	0.00
10.67	9,000	4.95	2.95	2.98	1.73	1.04	0.81	0.66	0.00	0.00
10.67	9,000	9.00	5.59	5.67	3.24	1.90	1.38	1.01	0.00	0.00
10.67	9,000	16.09	10.04	10.36	6.10	3.56	2.48	1.73	0.00	0.00
10.835	9,000	3.88	2.58	2.55	1.58	1.06	0.76	0.58	0.00	0.00
10.835	9,000	7.29	4.86	4.90	3.09	2.02	1.40	0.99	0.00	0.00
10.835	9,000	12.77	8.58	8.64	5.60	3.69	2.50	1.79	0.00	0.00
10.995	9,000	5.35	3.38	3.23	1.82	1.14	0.81	0.69	0.00	0.00
10.995	9,000	10.04	6.38	6.21	3.58	2.18	1.52	1.23	0.00	0.00
10.995	9,000	17.53	11.23	11.01	6.40	3.85	2.66	2.06	0.00	0.00
11	9,000	4.62	2.47	2.39	1.69	1.24	0.75	0.54	0.43	0.40
11	9,000	9.26	5.18	5.03	3.62	2.70	1.64	1.10	0.91	0.76
11	9,000	14.94	8.51	8.41	6.14	4.64	2.80	1.89	1.50	1.26
11.11098	9,000	4.69	2.58	2.70	2.02	1.57	1.01	0.74	0.59	0.48
11.11098	9,000	9.41	5.33	5.58	4.29	3.41	2.21	1.58	1.21	0.96
11.11098	9,000	15.07	8.79	9.21	7.17	5.70	3.77	2.62	1.99	1.52
11.23106	9,000	5.11	2.86	2.80	2.10	1.64	1.08	0.82	0.67	0.55
11.23106	9,000	10.23	6.04	5.83	4.48	3.53	2.38	1.77	1.40	1.11
11.23106	9,000	16.46	9.98	9.67	7.52	5.96	4.02	2.98	2.35	1.88
11.30095	9,000	6.19	3.21	3.21	2.22	1.61	0.99	0.70	0.58	0.47
9	9,000	6.18	3.40	3.34	1.73	1.04	0.78	0.63	0.00	0.00
9	9,000	11.19	6.26	6.14	3.15	1.94	1.37	1.13	0.00	0.00

Station	Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
9	9,000	19.77	10.95	10.85	5.56	3.37	2.40	1.92	0.00	0.00
9	9,000	5.28	2.70	2.85	1.46	0.88	0.67	0.42	0.00	0.00
9	9,000	9.76	5.21	5.46	2.85	1.65	1.20	0.79	0.00	0.00
9	9,000	16.68	9.02	9.67	5.16	2.83	2.06	1.36	0.00	0.00
9.1	9,000	6.97	3.39	3.27	1.47	0.93	0.72	0.63	0.00	0.00
9.1	9,000	12.57	6.39	6.22	2.78	1.68	1.31	1.02	0.00	0.00
9.1	9,000	21.48	11.04	11.04	5.01	2.96	2.32	1.56	0.00	0.00
9.2	9,000	5.14	2.94	2.94	1.53	0.90	0.66	0.57	0.00	0.00
9.2	9,000	9.40	5.44	5.52	2.88	1.65	1.24	0.91	0.00	0.00
9.2	9,000	15.69	9.20	9.36	5.03	2.81	1.89	1.62	0.00	0.00
9.3	9,000	4.94	3.04	3.01	1.72	1.05	0.75	0.66	0.00	0.00
11.30095	9,000	12.38	6.78	6.62	4.74	3.56	2.13	1.51	1.27	0.94
11.30095	9,000	20.06	11.28	11.02	8.06	6.13	3.74	2.60	2.13	1.61
11.4	9,000	3.90	2.34	2.26	1.64	1.21	0.71	0.45	0.37	0.31
11.4	9,000	7.80	4.71	4.56	3.41	2.58	1.47	0.95	0.75	0.59
11.4	9,000	12.58	7.75	7.50	5.63	4.28	2.57	1.61	1.21	1.01
11.5	9,000	4.41	2.65	2.53	1.90	1.44	0.78	0.49	0.37	0.29
11.5	9,000	8.73	5.43	5.19	3.94	3.06	1.73	1.05	0.80	0.60
11.5	9,000	13.76	8.74	8.38	6.40	4.98	2.89	1.78	1.27	1.02
11.61799	9,000	3.96	2.24	2.24	1.57	1.17	0.64	0.41	0.32	0.26
11.61799	9,000	7.70	4.48	4.48	3.26	2.40	1.34	0.86	0.65	0.53
11.61799	9,000	12.08	7.20	7.15	5.30	3.96	2.31	1.49	1.08	0.87
11.7	9,000	5.40	3.04	2.90	2.01	1.49	0.89	0.63	0.55	0.43
12.33201	9,000	15.51	9.33	9.07	6.86	5.33	3.32	2.39	1.87	1.49
12.33201	9,000	24.75	15.11	14.68	11.14	8.73	5.46	3.86	3.05	2.46
12.49905	9,000	5.02	3.02	2.99	2.40	1.94	1.39	1.05	0.83	0.65
12.49905	9,000	10.56	6.58	6.49	5.28	4.33	3.03	2.21	1.69	1.39
12.49905	9,000	17.27	11.00	10.84	8.88	7.24	5.07	3.65	2.78	2.23
12.66401	9,000	5.44	3.30	3.33	2.49	1.82	1.01	0.61	0.43	0.35
12.66401	9,000	10.98	6.74	6.78	5.05	3.80	2.10	1.25	0.89	0.69
12.66401	9,000	17.62	11.07	11.12	8.33	6.30	3.50	2.08	1.42	1.17
12.78201	9,000	5.32	3.48	3.33	2.54	1.93	1.20	0.76	0.58	0.41
12.78201	9,000	11.01	7.35	7.07	5.42	4.22	2.57	1.65	1.17	0.92
12.78201	9,000	18.10	12.34	11.98	9.28	7.19	4.39	2.75	1.94	1.48
12.95	9,000	4.03	2.30	2.30	1.82	1.49	1.00	0.76	0.64	0.52
13.49792	9,000	8.24	6.00	6.00	5.11	4.23	2.92	1.99	1.44	1.06
13.49792	9,000	13.59	10.04	10.04	8.49	7.14	4.89	3.33	2.42	1.72
13.66705	9,000	4.34	3.03	3.03	2.35	1.84	1.10	0.68	0.48	0.33
13.66705	9,000	8.74	6.09	6.09	4.80	3.73	2.24	1.37	0.91	0.66
13.66705	9,000	14.07	9.78	9.73	7.64	6.02	3.61	2.20	1.46	1.05
13.83201	9,000	5.26	3.15	3.06	2.36	1.85	1.21	0.85	0.67	0.54
13.83201	9,000	10.60	6.48	6.35	4.92	3.87	2.52	1.77	1.39	1.09
13.83201	9,000	16.91	10.56	10.35	8.09	6.41	4.20	2.89	2.21	1.73
14	9,000	7.13	4.25	4.19	2.94	2.03	1.00	0.56	0.42	0.33
14	9,000	14.25	8.67	8.56	6.00	4.18	2.09	1.12	0.81	0.70
14	9,000	23.16	14.35	14.05	9.96	6.97	3.49	1.89	1.39	1.15
14.1	9,000	5.88	3.97	3.94	3.08	2.44	1.55	1.05	0.64	0.50
14.1	9,000	12.06	8.23	8.15	6.49	5.18	3.28	2.13	1.47	1.00
14.1	9,000	19.73	13.62	13.52	10.80	8.68	5.53	3.55	2.47	1.68

Station	Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
14.2	9,000	5.42	3.38	3.38	2.47	1.80	0.97	0.52	0.37	0.24
14.2	9,000	10.31	6.42	6.46	4.77	3.55	1.86	1.01	0.63	0.46
14.2	9,000	15.99	10.06	10.00	7.38	5.51	3.00	1.60	1.02	0.75
14.3	9,000	6.33	4.33	4.27	3.47	2.83	1.94	1.35	1.01	0.77
14.3	9,000	12.84	8.85	8.76	7.13	5.88	3.99	2.79	2.02	1.50
14.3	9,000	20.81	14.51	14.40	11.79	9.72	6.68	4.62	3.31	2.50
14.4	9,000	4.82	3.13	3.18	2.47	1.93	1.10	0.68	0.57	0.36
14.4	9,000	9.91	6.37	6.45	5.00	3.95	2.29	1.42	1.00	0.79
14.4	9,000	15.97	10.33	10.54	8.19	6.47	3.76	2.30	1.67	1.25
14.50208	9,000	5.74	3.85	3.82	2.91	2.21	1.24	0.68	0.47	0.32
17.3	9,000	11.25	7.07	6.97	5.30	4.04	2.42	1.53	1.16	0.88
17.3	9,000	17.85	11.31	11.13	8.60	6.66	4.01	2.53	1.89	1.41
17.40303	9,000	4.96	3.38	3.28	2.58	2.04	1.17	0.77	0.57	0.44
17.40303	9,000	9.80	6.75	6.57	5.30	4.22	2.53	1.64	1.13	0.84
17.40303	9,000	15.67	10.83	10.65	8.73	7.00	4.31	2.69	1.85	1.38
17.5	9,000	6.02	3.98	3.98	3.04	2.31	1.30	0.84	0.64	0.50
17.5	9,000	11.87	8.02	8.07	6.29	4.88	2.77	1.74	1.31	0.98
17.5	9,000	18.74	12.89	12.89	10.14	8.00	4.65	2.92	2.15	1.67
17.6	9,000	3.97	2.53	2.53	1.93	1.47	0.89	0.63	0.55	0.40
17.6	9,000	7.86	5.12	5.08	3.91	3.02	1.85	1.29	1.01	0.81
17.6	9,000	12.65	8.33	8.28	6.43	4.99	3.14	2.16	1.65	1.34
17.7	9,000	3.76	2.34	2.32	1.75	1.36	0.85	0.59	0.45	0.37
18.16591	9,000	8.47	4.93	5.01	3.62	2.74	1.73	1.26	1.01	0.93
18.16591	9,000	13.22	7.82	7.98	5.97	4.44	2.80	2.06	1.69	1.43
18.33409	9,000	3.47	2.31	2.22	1.65	1.25	0.78	0.53	0.44	0.34
18.33409	9,000	6.57	4.27	4.10	3.05	2.38	1.46	1.00	0.79	0.63
18.33409	9,000	10.75	6.97	6.81	5.22	3.99	2.50	1.70	1.33	1.06
18.49792	9,000	3.42	1.95	1.98	1.44	1.09	0.69	0.52	0.43	0.34
18.49792	9,000	6.69	3.96	4.00	2.92	2.24	1.48	1.08	0.88	0.72
18.49792	9,000	10.75	6.47	6.47	4.79	3.72	2.50	1.83	1.53	1.17
18.66591	9,000	3.97	2.64	2.69	2.22	1.78	1.19	0.86	0.69	0.53
18.66591	9,000	8.10	5.53	5.61	4.59	3.81	2.57	1.83	1.40	1.09
18.66591	9,000	13.21	9.14	9.24	7.60	6.31	4.32	3.08	2.33	1.79
18.82992	9,000	4.19	3.07	2.97	2.46	2.02	1.38	1.02	0.80	0.64
9.3	9,000	9.16	5.78	5.78	3.34	1.98	1.44	1.20	0.00	0.00
9.3	9,000	15.64	9.85	9.90	5.84	3.52	2.44	1.73	0.00	0.00
9.4	9,000	4.92	2.82	2.82	1.62	0.96	0.75	0.69	0.00	0.00
9.4	9,000	8.93	5.18	5.31	3.00	1.73	1.28	1.07	0.00	0.00
9.4	9,000	15.35	9.12	9.39	5.37	3.15	2.28	1.95	0.00	0.00
9.5	9,000	5.01	2.76	2.88	1.50	0.90	0.75	0.66	0.00	0.00
9.5	9,000	9.08	5.05	5.42	2.88	1.52	1.27	1.03	0.00	0.00
9.5	9,000	15.35	8.52	9.22	5.10	2.50	2.01	1.52	0.00	0.00
9.6	9,000	4.66	2.88	2.85	1.74	1.05	0.75	0.54	0.00	0.00
9.6	9,000	8.61	5.36	5.44	3.34	1.90	1.32	0.95	0.00	0.00
9.6	9,000	14.89	9.60	9.43	5.89	3.65	2.45	1.75	0.00	0.00
9.7	9,000	4.92	2.87	2.87	1.75	1.09	0.88	0.63	0.00	0.00
9.7	9,000	8.89	5.27	5.39	3.25	2.02	1.48	0.91	0.00	0.00
11.7	9,000	10.85	6.23	5.91	4.22	3.25	1.93	1.37	1.08	0.92
11.7	9,000	17.08	10.05	9.49	6.88	5.22	3.21	2.26	1.86	1.51

tion	Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
1.8	9,000	3.81	2.30	2.33	1.70	1.32	0.79	0.55	0.47	0.36
1.8	9,000	7.73	4.83	4.83	3.67	2.78	1.74	1.20	0.97	0.73
1.8	9,000	12.58	7.99	7.99	6.12	4.74	3.01	1.97	1.63	1.28

Station	Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
15.66401	9,000	10.73	7.04	7.12	5.63	4.43	2.78	1.99	1.45	1.20
15.66401	9,000	17.22	11.53	11.53	9.18	7.20	4.59	3.18	2.40	1.98
15.83106	9,000	4.62	3.11	3.08	2.44	1.98	1.28	0.87	0.64	0.49
15.83106	9,000	9.38	6.43	6.39	5.14	4.13	2.71	1.86	1.29	1.01
15.83106	9,000	15.33	10.64	10.54	8.50	6.93	4.48	3.00	2.14	1.58
16	9,000	4.83	3.38	3.32	2.70	2.18	1.38	0.86	0.58	0.40
16	9,000	9.96	7.00	6.87	5.61	4.52	2.87	1.83	1.09	0.78
16	9,000	16.01	11.39	11.28	9.24	7.48	4.79	2.97	1.93	1.27
16.17708	9,000	4.51	2.66	2.57	1.94	1.46	0.87	0.60	0.48	0.39
16.17708	9,000	8.65	5.17	5.04	3.81	2.91	1.72	1.19	0.94	0.74
16.17708	9,000	13.73	8.29	8.09	6.17	4.72	2.80	1.92	1.55	1.19
16.33295	9,000	5.17	3.27	3.27	2.49	1.90	1.06	0.65	0.50	0.40
16.33295	9,000	10.36	6.63	6.59	5.07	3.82	2.17	1.30	1.00	0.78
16.33295	9,000	16.78	10.95	10.89	8.36	6.49	3.69	2.26	1.65	1.32
16.49792	9,000	4.36	2.54	2.51	1.75	1.23	0.63	0.41	0.33	0.27
16.49792	9,000	8.81	5.25	5.21	3.64	2.57	1.34	0.84	0.65	0.54
16.49792	9,000	14.61	8.92	8.82	6.24	4.46	2.33	1.49	1.14	0.89
16.66401	9,000	4.11	2.33	2.36	1.69	1.28	0.78	0.56	0.47	0.39
16.66401	9,000	8.12	4.78	4.78	3.50	2.60	1.59	1.17	0.93	0.74
16.66401	9,000	13.23	7.96	7.91	5.92	4.43	2.69	1.94	1.59	1.29
16.83106	9,000	5.17	3.28	3.34	2.60	2.04	1.33	0.98	0.77	0.65
16.83106	9,000	10.43	6.84	6.92	5.44	4.33	2.80	2.02	1.57	1.28
16.83106	9,000	16.85	11.32	11.32	8.97	7.20	4.75	3.18	2.56	2.03
17	9,000	4.41	2.68	2.65	1.90	1.42	0.84	0.61	0.45	0.42
17	9,000	8.88	5.53	5.45	3.99	3.00	1.82	1.26	0.99	0.87
17	9,000	14.45	9.13	9.03	6.75	5.07	3.09	2.13	1.67	1.42
17.1	9,000	4.77	3.18	3.28	2.48	1.92	1.09	0.73	0.56	0.43
17.1	9,000	9.09	6.15	6.29	4.82	3.77	2.25	1.47	1.10	0.83
17.1	9,000	14.94	9.98	10.27	7.97	6.26	3.84	2.48	1.89	1.42
17.2	9,000	4.84	3.22	3.12	2.42	1.89	1.19	0.81	0.63	0.46
17.2	9,000	9.54	6.51	6.36	5.04	3.96	2.54	1.71	1.32	0.98
17.2	9,000	15.30	10.66	10.41	8.43	6.63	4.34	2.97	2.17	1.67
17.3	9,000	5.76	3.46	3.46	2.56	1.93	1.13	0.73	0.60	0.43
17.7	9,000	7.61	4.91	4.83	3.72	2.89	1.78	1.23	0.91	0.75
17.7	9,000	12.39	8.14	7.99	6.27	4.86	3.09	2.07	1.57	1.26
17.8	9,000	4.00	2.57	2.57	2.02	1.58	0.99	0.68	0.53	0.43
17.8	9,000	7.88	5.28	5.24	4.13	3.28	2.13	1.45	1.11	0.85
17.8	9,000	12.90	8.72	8.67	6.88	5.53	3.63	2.49	1.79	1.41
17.9	9,000	4.06	2.36	2.36	1.70	1.27	0.75	0.52	0.43	0.32
17.9	9,000	8.20	4.93	4.93	3.59	2.71	1.62	1.09	0.85	0.65
17.9	9,000	13.34	8.20	8.25	6.12	4.67	2.80	1.87	1.45	1.14
18	9,000	6.33	3.93	3.96	2.88	2.07	1.19	0.78	0.61	0.44
18	9,000	11.82	7.50	7.55	5.58	3.99	2.35	1.55	1.17	0.89
18	9,000	18.48	11.90	11.96	8.91	6.52	3.89	2.57	1.91	1.50
18.16591	9,000	4.32	2.41	2.44	1.75	1.30	0.81	0.63	0.54	0.45
18.82992	9,000	8.27	6.18	6.00	4.98	4.14	2.89	2.09	1.56	1.25
18.82992	9,000	13.39	10.00	9.83	8.19	6.83	4.74	3.39	2.60	2.03
19	9,000	4.09	2.77	2.77	2.17	1.72	1.13	0.85	0.68	0.56
19	9,000	8.53	5.95	5.91	4.72	3.81	2.50	1.79	1.43	1.15

Station	Load-lb	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
19	9,000	14.13	9.98	9.88	8.00	6.53	4.31	3.04	2.38	1.92
19.16591	9,000	4.64	3.01	2.98	2.27	1.78	1.11	0.77	0.61	0.52
19.16591	9,000	9.28	6.10	6.10	4.77	3.69	2.32	1.59	1.29	1.07
19.16591	9,000	15.06	10.02	9.97	7.86	6.18	3.90	2.71	2.06	1.68
19.33409	9,000	3.62	2.11	2.14	1.56	1.17	0.70	0.50	0.39	0.28
19.33409	9,000	7.49	4.57	4.57	3.43	2.56	1.58	1.06	0.83	0.63
19.33409	9,000	12.29	7.69	7.64	5.77	4.45	2.73	1.82	1.37	1.06
19.49792	9,000	3.21	2.18	2.24	1.81	1.46	0.97	0.75	0.60	0.49
19.49792	9,000	6.72	4.71	4.75	3.90	3.18	2.17	1.61	1.29	1.05
19.49792	9,000	11.12	7.88	7.98	6.54	5.41	3.71	2.63	2.01	1.65
19.66496	9,000	3.43	2.27	2.21	1.77	1.41	1.00	0.78	0.66	0.55
19.66496	9,000	7.25	4.95	4.80	3.82	3.16	2.18	1.68	1.36	1.13
19.66496	9,000	11.99	8.39	8.14	6.59	5.45	3.85	2.90	2.30	1.95
19.84091	9,000	4.13	2.66	2.71	2.02	1.53	0.95	0.69	0.58	0.49
19.84091	9,000	8.03	5.26	5.34	4.10	3.09	1.97	1.41	1.17	0.92
19.84091	9,000	12.68	8.40	8.45	6.47	5.04	3.21	2.29	1.88	1.53
20	9,000	3.45	2.26	2.26	1.73	1.36	0.85	0.57	0.45	0.34
20	9,000	6.92	4.65	4.65	3.62	2.86	1.75	1.19	0.91	0.68
20	9,000	11.22	7.62	7.57	5.94	4.72	2.95	1.98	1.47	1.12
20.1	9,000	3.84	2.44	2.48	1.86	1.42	0.87	0.62	0.53	0.40
20.1	9,000	7.58	5.01	5.01	3.85	3.00	1.88	1.33	0.98	0.77
20.1	9,000	12.37	8.25	8.30	6.46	5.05	3.20	2.17	1.68	1.25

Table 4. Average normalized deflections – I-195 (English units).

Station	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
0.00	5.51	4.09	4.26	3.71	3.21	2.32	1.66	1.22	0.87
0.10	6.48	5.05	4.85	4.20	3.58	2.57	1.88	1.42	1.03
0.20	8.44	5.94	5.88	4.87	4.07	2.79	1.99	1.49	1.13
0.30	7.94	5.78	5.69	4.71	3.88	2.61	1.82	1.34	1.07
0.40	10.01	8.30	8.54	7.56	6.15	4.32	3.13	2.35	1.81
0.50	6.24	4.98	4.93	4.58	4.22	3.54	2.96	2.45	2.01
0.60	10.35	6.73	6.62	5.28	4.29	2.92	2.16	1.75	1.46
0.70	9.13	6.24	6.42	5.86	5.31	4.26	3.50	2.84	2.28
0.80	8.49	5.91	5.81	5.10	4.50	3.46	2.70	2.14	1.69
0.91	9.93	7.52	7.57	6.83	6.11	4.77	3.73	2.85	2.16
1.08	10.67	7.01	7.06	5.94	5.04	3.59	2.67	2.08	1.67
1.24	9.58	5.94	6.10	4.82	3.87	2.64	1.91	1.54	1.24
1.42	9.25	5.59	5.60	4.54	3.85	2.70	2.03	1.63	1.27
1.50	15.43	10.10	9.73	6.96	4.95	2.61	1.64	1.23	1.03
1.61	10.16	6.95	6.90	5.38	4.19	2.54	1.69	1.31	1.04
1.90	9.22	5.92	5.98	4.93	4.09	2.78	1.92	1.48	1.17
2.07	11.23	7.48	7.45	6.25	5.32	3.84	2.88	2.30	1.84
2.24	8.39	5.46	5.57	4.59	3.76	2.36	1.59	1.20	0.93
2.40	8.44	5.41	5.43	4.61	3.91	2.73	1.91	1.43	1.08
2.57	9.83	6.95	6.85	5.85	4.94	3.53	2.60	2.00	1.55
2.74	9.61	6.58	6.53	5.59	4.74	3.33	2.42	1.83	1.39
2.90	12.34	8.61	8.41	6.74	5.47	3.53	2.36	1.72	1.28
3.00	11.33	7.50	7.53	5.92	4.54	2.81	1.89	1.46	1.22
3.00	11.36	7.30	7.72	6.12	4.76	2.93	1.93	1.48	1.23
3.10	9.44	5.95	6.06	4.73	3.75	2.38	1.76	1.44	1.24
3.20	8.43	5.48	5.41	4.56	3.84	2.67	1.97	1.56	1.28
3.20	8.37	5.48	5.36	4.48	3.73	2.59	1.91	1.49	1.25
3.30	8.18	5.20	5.03	4.04	3.29	2.06	1.44	1.14	0.98
3.43	7.93	4.91	4.88	3.87	3.07	1.99	1.42	1.18	0.93
3.50	7.93	4.89	4.96	4.03	3.29	2.18	1.47	1.10	0.81
3.60	8.31	5.20	5.10	4.04	3.25	2.11	1.44	1.10	0.83
3.70	8.31	5.20	5.26	4.20	3.41	2.20	1.46	1.10	0.84
3.80	10.57	7.00	6.89	5.33	4.12	2.49	1.71	1.36	1.13
3.90	8.30	5.63	5.57	4.79	4.05	2.89	2.13	1.71	1.40
4.00	10.28	6.75	6.56	4.98	3.87	2.35	1.48	1.10	0.83
4.07	9.15	6.38	6.28	5.11	4.17	2.69	1.77	1.35	0.96
4.33	9.81	6.21	6.15	4.76	3.79	2.42	1.62	1.25	0.95
4.50	8.50	5.57	5.61	4.47	3.51	2.18	1.35	0.98	0.72
4.66	9.98	6.85	6.68	5.49	4.51	2.93	1.95	1.48	1.15
4.83	10.70	6.91	6.80	5.43	4.38	2.75	1.75	1.24	0.87
5.00	10.68	7.18	7.20	5.90	4.87	3.24	2.17	1.63	1.20
5.18	9.61	6.40	6.28	5.00	3.95	2.42	1.47	1.09	0.81
5.34	12.56	8.68	8.48	6.90	5.60	3.80	2.71	2.15	1.78
5.50	10.11	7.39	7.36	6.49	5.69	4.28	3.22	2.41	1.79
5.66	9.89	6.78	6.78	5.79	4.97	3.58	2.65	2.13	1.74
5.83	13.38	7.92	8.12	5.61	3.93	1.89	1.18	1.02	0.88
6.00	8.37	5.56	5.43	4.41	3.63	2.47	1.75	1.37	1.10

Station	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
6.10	10.27	6.50	6.48	5.02	3.95	2.43	1.66	1.30	1.05
6.22	11.04	7.30	7.26	5.61	4.37	2.54	1.50	1.05	0.72
6.30	14.49	9.05	9.10	6.68	4.95	2.64	1.50	1.06	0.82
6.40	8.20	5.30	5.27	4.37	3.64	2.47	1.70	1.24	0.95
6.50	11.95	8.39	8.37	6.85	5.60	3.64	2.47	1.80	1.34
6.60	10.63	6.25	6.10	4.50	3.41	1.88	1.10	0.77	0.60
6.70	9.24	6.27	6.02	4.81	3.80	2.29	1.42	1.03	0.77
6.78	12.38	7.74	7.70	5.42	3.73	1.84	1.07	0.86	0.67
6.90	9.36	6.41	6.31	4.90	3.89	2.45	1.61	1.18	0.85
7.00	9.30	5.78	5.77	4.33	3.28	1.89	1.22	0.92	0.73
7.17	8.02	5.04	5.03	3.71	2.78	1.64	1.09	0.87	0.72
7.34	11.86	7.08	6.98	5.14	3.85	2.32	1.60	1.25	1.03
7.50	7.03	4.65	4.66	3.65	2.79	1.65	1.06	0.77	0.62
7.66	7.98	4.84	4.83	3.81	2.98	1.86	1.21	0.93	0.75
7.83	8.26	5.45	5.48	4.41	3.59	2.40	1.69	1.31	1.03
8.00	7.82	5.48	5.39	4.45	3.67	2.39	1.60	1.22	0.92
8.17	9.07	5.70	5.85	4.49	3.48	2.05	1.28	0.94	0.71
8.33	7.84	5.32	5.23	4.37	3.56	2.46	1.74	1.33	1.06
8.50	10.89	6.38	6.24	4.60	3.25	1.80	1.12	0.90	0.69
8.66	11.98	6.46	6.54	4.37	3.06	1.58	1.02	0.81	0.70
8.84	12.80	6.59	6.68	4.49	3.19	1.83	1.15	0.85	0.62
9.00	11.47	6.26	6.38	3.32	1.95	1.41	1.04	0.00	0.00
9.10	13.67	6.94	6.84	3.09	1.86	1.45	1.07	0.00	0.00
9.20	10.08	5.86	5.94	3.15	1.79	1.26	1.03	0.00	0.00
9.30	9.91	6.22	6.23	3.64	2.18	1.54	1.20	0.00	0.00
9.40	9.73	5.71	5.84	3.33	1.94	1.43	1.24	0.00	0.00
9.50	9.81	5.44	5.84	3.16	1.64	1.34	1.07	0.00	0.00
9.60	9.39	5.95	5.91	3.66	2.20	1.51	1.08	0.00	0.00
9.70	9.73	5.80	5.92	3.59	2.23	1.68	0.93	0.00	0.00
9.80	7.86	5.38	5.41	3.60	2.36	1.75	1.28	0.00	0.00
9.90	9.76	6.63	6.70	4.37	2.90	2.18	1.79	0.00	0.00
10.00	9.26	6.49	6.56	4.29	2.99	2.29	1.77	0.00	0.00
10.17	9.97	6.11	5.83	3.51	2.30	1.66	1.32	0.00	0.00
10.33	12.04	6.73	6.72	3.24	1.93	1.42	1.14	0.00	0.00
10.50	7.69	5.06	5.12	3.40	2.27	1.57	1.05	0.00	0.00
10.67	10.01	6.20	6.34	3.69	2.17	1.56	1.13	0.00	0.00
10.84	7.98	5.34	5.36	3.42	2.26	1.55	1.12	0.00	0.00
11.00	10.97	7.00	6.82	3.94	2.39	1.66	1.33	0.00	0.00
11.00	9.61	5.39	5.28	3.82	2.86	1.73	1.18	0.95	0.81
11.11	9.72	5.57	5.83	4.49	3.56	2.33	1.65	1.26	0.98
11.23	10.60	6.29	6.10	4.70	3.71	2.50	1.85	1.47	1.18
11.30	12.88	7.09	6.95	5.01	3.76	2.29	1.60	1.33	1.01
11.40	8.09	4.93	4.77	3.56	2.69	1.58	1.00	0.78	0.64
11.50	8.97	5.61	5.37	4.08	3.16	1.80	1.10	0.82	0.64
11.62	7.91	4.64	4.62	3.38	2.51	1.43	0.92	0.68	0.56
11.70	11.11	6.44	6.10	4.37	3.32	2.01	1.42	1.16	0.95
11.80	8.04	5.04	5.05	3.83	2.94	1.85	1.24	1.02	0.79
11.90	11.76	6.63	6.33	4.40	3.27	1.92	1.26	0.99	0.75
12.11	9.89	5.45	5.50	4.29	3.50	2.45	1.79	1.37	1.05

Station	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
12.33	16.05	9.69	9.42	7.12	5.56	3.48	2.47	1.95	1.56
12.50	10.95	6.87	6.77	5.52	4.50	3.16	2.30	1.77	1.42
12.66	11.35	7.04	7.08	5.29	3.97	2.21	1.31	0.91	0.73
12.78	11.48	7.72	7.46	5.75	4.45	2.72	1.72	1.23	0.94
12.95	8.41	5.00	5.01	4.03	3.28	2.23	1.65	1.36	1.06
13.00	9.73	6.03	6.07	4.66	3.60	2.19	1.47	1.14	0.91
13.17	11.72	7.23	7.19	5.39	4.07	2.29	1.37	1.00	0.82
13.33	12.76	8.25	8.34	6.39	4.89	2.80	1.69	1.22	0.94
13.50	8.60	6.29	6.30	5.33	4.46	3.06	2.09	1.52	1.10
13.67	9.05	6.30	6.28	4.93	3.86	2.32	1.42	0.95	0.68
13.83	10.92	6.73	6.58	5.12	4.04	2.64	1.83	1.42	1.12
14.00	14.85	9.09	8.93	6.30	4.39	2.19	1.19	0.87	0.73
14.10	12.56	8.61	8.54	6.79	5.43	3.45	2.24	1.52	1.06
14.20	10.58	6.62	6.62	4.87	3.62	1.94	1.05	0.67	0.49
14.30	13.33	9.23	9.14	7.46	6.15	4.20	2.92	2.12	1.59
14.40	10.23	6.61	6.73	5.22	4.12	2.38	1.47	1.08	0.80
14.50	12.01	8.07	7.99	6.14	4.70	2.60	1.43	0.96	0.69
14.60	9.28	6.22	6.12	4.86	3.89	2.43	1.53	1.06	0.70
14.70	11.58	8.34	7.87	6.11	4.71	2.83	1.65	1.05	0.69
14.80	10.26	6.57	6.48	4.77	3.59	2.04	1.24	0.92	0.70
14.90	9.65	5.86	5.84	4.50	3.53	2.30	1.62	1.25	0.99
15.00	14.20	9.08	8.77	6.52	4.90	2.74	1.67	1.23	1.00
15.17	9.22	6.27	6.13	4.90	3.92	2.49	1.59	1.19	0.81
15.33	14.38	9.39	9.55	7.53	5.96	3.87	2.64	2.00	1.48
15.50	11.32	7.38	7.42	5.78	4.54	2.82	1.92	1.46	1.16
15.66	11.08	7.33	7.39	5.86	4.59	2.91	2.04	1.52	1.26
15.83	9.78	6.73	6.67	5.36	4.34	2.82	1.91	1.36	1.03
16.00	10.27	7.26	7.16	5.85	4.73	3.01	1.89	1.20	0.82
16.18	8.96	5.37	5.23	3.97	3.03	1.80	1.23	0.99	0.77
16.33	10.77	6.95	6.92	5.31	4.07	2.30	1.40	1.05	0.84
16.50	9.26	5.57	5.51	3.88	2.75	1.43	0.91	0.71	0.57
16.66	8.49	5.02	5.02	3.70	2.77	1.69	1.22	1.00	0.81
16.83	10.82	7.15	7.20	5.67	4.52	2.96	2.06	1.63	1.32
17.00	9.25	5.78	5.71	4.21	3.16	1.92	1.34	1.04	0.90
17.10	9.60	6.44	6.61	5.09	3.98	2.39	1.56	1.18	0.89
17.20	9.89	6.80	6.63	5.29	4.16	2.69	1.83	1.37	1.04
17.30	11.62	7.28	7.19	5.49	4.21	2.52	1.60	1.22	0.91
17.40	10.14	6.99	6.83	5.54	4.42	2.67	1.70	1.18	0.89
17.50	12.21	8.30	8.31	6.49	5.06	2.91	1.83	1.37	1.05
17.60	8.16	5.33	5.30	4.09	3.16	1.96	1.36	1.07	0.85
17.70	7.92	5.13	5.05	3.92	3.03	1.91	1.30	0.98	0.79
17.80	8.26	5.53	5.49	4.34	3.46	2.25	1.54	1.14	0.90
17.90	8.53	5.16	5.18	3.81	2.88	1.72	1.16	0.91	0.70
18.00	12.21	7.78	7.82	5.79	4.19	2.47	1.63	1.23	0.94
18.17	8.67	5.06	5.15	3.78	2.83	1.78	1.32	1.08	0.94
18.33	6.93	4.52	4.38	3.31	2.54	1.58	1.08	0.85	0.68
18.50	6.95	4.13	4.15	3.05	2.35	1.56	1.14	0.95	0.75
18.67	8.43	5.77	5.85	4.80	3.97	2.69	1.92	1.48	1.14
18.83	8.62	6.42	6.27	5.21	4.33	3.00	2.17	1.65	1.31

Station	D1-mils	D2-mils	D3-mils	D4-mils	D5-mils	D6-mils	D7-mils	D8-mils	D9-mils
19.00	8.92	6.23	6.19	4.97	4.02	2.65	1.89	1.50	1.21
19.17	9.66	6.38	6.35	4.97	3.88	2.44	1.69	1.32	1.09
19.33	7.80	4.79	4.78	3.58	2.73	1.67	1.13	0.86	0.66
19.50	7.02	4.92	4.99	4.08	3.35	2.28	1.66	1.30	1.06
19.66	7.56	5.20	5.05	4.06	3.34	2.34	1.78	1.44	1.21
19.84	8.28	5.44	5.50	4.20	3.22	2.04	1.46	1.21	0.98
20.00	7.20	4.84	4.83	3.76	2.98	1.85	1.25	0.95	0.71
20.10	7.93	5.23	5.26	4.06	3.16	1.98	1.37	1.06	0.81

Table 5. Core/bore data – I-195.

MP	AC	AGG	SNmin
0	12.33	12.33	3.82
0.1	12.33	12.33	3.82
0.2	12.33	12.33	3.82
0.3	12.33	12.33	3.82
0.4	12.33	12.33	3.82
0.5	12.33	12.33	3.82
0.6	12.33	12.33	3.82
0.7	12.33	12.33	3.82
0.8	12.33	12.33	3.82
0.9	12.33	12.33	3.82
1	12.33	12.33	3.82
1.1	12.33	12.33	3.82
1.2	12.33	12.33	3.82
1.3	12.33	12.33	3.82
1.4	12.33	12.33	3.82
1.5	12.33	12.33	3.82
1.6	12.33	12.33	3.82
1.7	12.33	12.33	3.82
1.8	12.33	12.33	3.82
1.9	12.33	12.33	3.82
2	12.33	12.33	3.82
2.1	12.33	12.33	3.82
2.2	12.33	12.33	3.82
2.3	12.33	12.33	3.82
2.4	12.33	12.33	3.82
2.5	12.33	12.33	3.82
2.6	12.33	12.33	3.82
2.7	12.33	12.33	3.82
2.8	12.33	12.33	3.82
2.9	12.33	12.33	3.82
3	12.00	8.00	3.28
3.1	12.00	8.00	3.28
3.2	12.00	8.00	3.28
3.3	12.00	8.00	3.28
3.4	12.00	8.00	3.28
3.5	12.00	8.00	3.28
3.6	12.00	8.00	3.28
3.7	12.00	8.00	3.28
3.8	12.00	8.00	3.28
3.9	12.00	8.00	3.28
4	12.00	8.00	3.28
4.1	12.00	8.00	3.28
4.2	12.00	8.00	3.28

MP	AC	AGG	SNmin
4.3	12.00	8.00	3.28
4.4	12.00	8.00	3.28
4.5	12.00	8.00	3.28
4.6	12.00	8.00	3.28
4.7	12.00	8.00	3.28
4.8	12.00	8.00	3.28
4.9	12.00	8.00	3.28
5	12.00	8.00	3.28
5.1	12.00	8.00	3.28
5.2	12.00	8.00	3.28
5.3	12.00	8.00	3.28
5.4	12.00	8.00	3.28
5.5	12.00	8.00	3.28
5.6	12.00	8.00	3.28
5.7	12.00	8.00	3.28
5.8	12.00	8.00	3.28
5.9	12.00	8.00	3.28
6	12.50	15.00	4.15
6.1	12.50	15.00	4.15
6.2	12.50	15.00	4.15
6.3	12.50	15.00	4.15
6.4	12.50	15.00	4.15
6.5	12.50	15.00	4.15
6.6	12.50	15.00	4.15
6.7	12.50	15.00	4.15
6.8	12.50	15.00	4.15
6.9	12.50	15.00	4.15
7	12.50	15.00	4.15
7.1	12.50	15.00	4.15
7.2	12.50	15.00	4.15
7.3	12.50	15.00	4.15
7.4	12.50	15.00	4.15
7.5	12.50	15.00	4.15
7.6	12.50	15.00	4.15
7.7	12.50	15.00	4.15
7.8	12.50	15.00	4.15
7.9	12.50	15.00	4.15
8	12.50	15.00	4.15
8.1	12.50	15.00	4.15
8.2	12.50	15.00	4.15
8.3	12.50	15.00	4.15
8.4	12.50	15.00	4.15
8.5	12.50	15.00	4.15

MP	AC	AGG	SNmin
8.6	12.50	15.00	4.15
8.7	12.50	15.00	4.15
8.8	12.50	15.00	4.15
8.9	12.50	15.00	4.15
9	11.00	30.00	5.50
9.1	11.00	30.00	5.50
9.2	11.00	30.00	5.50
9.3	11.00	30.00	5.50
9.4	11.00	30.00	5.50
9.5	11.00	30.00	5.50
9.6	11.00	30.00	5.50
9.7	11.00	30.00	5.50
9.8	11.00	30.00	5.50
9.9	11.00	30.00	5.50
10	11.00	30.00	5.50
10.1	11.00	30.00	5.50
10.2	11.00	30.00	5.50
10.3	11.00	30.00	5.50
10.4	11.00	30.00	5.50
10.5	11.00	30.00	5.50
10.6	11.00	30.00	5.50
10.7	11.00	30.00	5.50
10.8	11.00	30.00	5.50
10.9	11.00	30.00	5.50
11	10.25	12.00	3.37
11.1	10.25	12.00	3.37
11.2	10.25	12.00	3.37
11.3	10.25	12.00	3.37
11.4	10.25	12.00	3.37
11.5	10.25	12.00	3.37
11.6	10.25	12.00	3.37
11.7	10.25	12.00	3.37
11.8	10.25	12.00	3.37
11.9	10.25	12.00	3.37
12	10.25	12.00	3.37
12.1	10.25	12.00	3.37
12.2	10.25	12.00	3.37
12.3	10.25	12.00	3.37
12.4	10.25	12.00	3.37
12.5	10.25	12.00	3.37
12.6	10.25	12.00	3.37
12.7	10.25	12.00	3.37
12.8	10.25	12.00	3.37

MP	AC	AGG	SNmin
12.9	10.25	12.00	3.37
13	10.25	12.00	3.37
13.1	10.25	12.00	3.37
13.2	10.25	12.00	3.37
13.3	10.25	12.00	3.37
13.4	10.25	12.00	3.37
13.5	10.25	12.00	3.37
13.6	10.25	12.00	3.37
13.7	10.25	12.00	3.37
13.8	10.25	12.00	3.37
13.9	10.25	12.00	3.37
14	10.25	10.00	3.15
14.1	10.25	10.00	3.15
14.2	10.25	10.00	3.15
14.3	10.25	10.00	3.15
14.4	10.25	10.00	3.15
14.5	10.25	10.00	3.15
14.6	10.25	10.00	3.15
14.7	10.25	10.00	3.15
14.8	10.25	10.00	3.15
14.9	10.25	10.00	3.15
15	10.25	10.00	3.15
15.1	10.25	10.00	3.15
15.2	10.25	10.00	3.15
15.3	10.25	10.00	3.15
15.4	10.25	10.00	3.15
15.5	10.25	10.00	3.15
15.6	10.25	10.00	3.15
15.7	10.25	10.00	3.15
15.8	10.25	10.00	3.15
15.9	10.25	10.00	3.15
16	10.25	10.00	3.15
16.1	10.25	10.00	3.15
16.2	10.25	10.00	3.15
16.3	10.25	10.00	3.15
16.4	10.25	10.00	3.15
16.5	10.25	10.00	3.15
16.6	10.25	10.00	3.15
16.7	10.25	10.00	3.15
16.8	10.25	10.00	3.15
16.9	10.25	10.00	3.15
17	9.00	10.00	2.90
17.1	9.00	10.00	2.90

MP	AC	AGG	SNmin
17.2	9.00	10.00	2.90
17.3	9.00	10.00	2.90
17.4	9.00	10.00	2.90
17.5	9.00	10.00	2.90
17.6	9.00	10.00	2.90
17.7	9.00	10.00	2.90
17.8	9.00	10.00	2.90
17.9	9.00	10.00	2.90
18	9.00	10.00	2.90
18.1	9.00	10.00	2.90
18.2	9.00	10.00	2.90
18.3	9.00	10.00	2.90
18.4	9.00	10.00	2.90
18.5	9.00	10.00	2.90
18.6	9.00	10.00	2.90
18.7	9.00	10.00	2.90
18.8	9.00	10.00	2.90
18.9	9.00	10.00	2.90
19	9.00	10.00	2.90
19.1	9.00	10.00	2.90
19.2	9.00	10.00	2.90
19.3	9.00	10.00	2.90
19.4	9.00	10.00	2.90
19.5	9.00	10.00	2.90
19.6	9.00	10.00	2.90
19.7	9.00	10.00	2.90
19.8	9.00	10.00	2.90
19.9	9.00	10.00	2.90
20	8.50	10.00	2.80

Table 6. Results of backcalculation analysis – I195.

Station	MR	Ep	SNeff
0.00	8,827	321,331	7.60
0.10	8,727	273,627	7.21
0.20	9,132	204,747	6.54
0.30	7,914	173,566	6.19
0.40	5,008	176,103	6.22
0.50	5,258	338,571	7.74
0.60	9,923	171,490	6.17
0.70	6,798	291,932	7.36
0.80	8,392	273,627	7.21
0.91	5,506	256,142	7.05
1.08	7,615	178,186	6.25
1.24	10,230	167,667	6.12
1.42	11,074	201,161	6.50
1.50	11,456	84,788	4.88
1.61	11,460	152,934	5.94
1.90	10,833	197,543	6.46
2.07	7,630	175,935	6.22
2.24	12,578	198,009	6.47
2.40	11,631	237,074	6.87
2.57	8,735	217,300	6.67
2.74	9,067	210,203	6.60
2.90	8,690	140,983	5.78
3.00	11,323	168,582	4.97
3.00	10,868	153,276	5.94
3.10	13,563	219,085	5.42
3.20	11,134	263,814	5.77
3.20	11,726	274,198	5.85
3.30	14,745	220,222	5.43
3.43	15,395	241,308	5.60
3.50	14,431	249,813	5.67
3.60	13,898	210,380	5.35
3.70	14,877	238,095	5.58
3.80	11,960	162,460	4.91
3.90	10,738	303,610	6.05
4.00	14,140	172,186	5.01
4.07	12,268	231,049	5.52
4.33	13,324	191,648	5.19
4.50	15,319	217,367	5.41
4.66	10,156	192,285	5.19
4.83	12,264	183,451	5.11
5.00	9,951	200,972	5.27
5.18	13,815	185,276	5.13
5.34	7,965	165,870	4.94
5.50	6,792	266,141	5.79
5.66	8,662	252,751	5.69
5.83	17,522	103,139	4.22
6.00	13,023	216,079	7.43
6.10	14,141	165,658	6.80

Station	MR	Ep	SNeff
6.22	14,200	146,499	6.52
6.30	14,183	102,907	5.80
6.40	13,442	230,160	7.58
6.50	8,971	150,933	6.59
6.60	18,440	133,824	6.33
6.70	15,451	182,047	7.01
6.78	18,521	106,078	5.86
6.90	8,826	120,273	6.11
7.00	12,446	117,520	6.06
7.17	13,806	132,029	6.30
7.34	10,103	94,270	5.63
7.50	14,450	166,051	6.80
7.66	14,246	161,911	6.74
7.83	9,381	153,898	6.63
8.00	9,947	174,172	6.91
8.17	11,971	128,512	6.24
8.33	10,125	187,745	7.09
8.50	14,339	99,788	5.74
8.66	16,386	86,570	5.47
8.84	14,270	84,075	5.42
9.00	13,130	90,107	8.26
9.10	12,332	72,999	7.71
9.20	13,561	103,509	8.66
9.30	11,455	110,500	8.85
9.40	11,708	111,604	8.88
9.50	12,686	108,100	8.79
9.60	12,509	116,412	9.01
9.70	12,518	111,547	8.88
9.80	10,372	153,017	9.87
9.90	7,877	123,583	9.19
10.00	7,678	132,154	9.40
10.17	10,508	112,030	8.89
10.33	11,910	85,138	8.12
10.50	12,334	150,705	9.82
10.67	11,499	107,130	8.76
10.84	12,093	144,418	9.68
11.00	10,549	99,562	8.55
11.00	11,927	105,051	4.72
11.11	10,398	141,686	5.22
11.23	9,290	123,339	4.98
11.30	10,408	86,639	4.43
11.40	14,752	133,912	5.12
11.50	13,656	121,682	4.96
11.62	17,135	133,834	5.12
11.70	11,182	96,517	4.59
11.80	11,713	137,153	5.16
11.90	13,776	98,997	4.63
12.11	9,027	124,882	5.00
12.33	7,189	83,669	4.38

Station	MR	Ep	SNeff
12.50	8,123	146,309	5.28
12.66	11,241	94,599	4.56
12.78	8,984	104,573	4.72
12.95	10,955	166,858	5.51
13.00	10,938	122,442	4.97
13.17	11,756	101,219	4.67
13.33	10,198	104,961	4.72
13.50	8,391	193,046	5.79
13.67	11,013	139,992	5.20
13.83	9,351	120,518	4.95
14.00	11,126	61,279	3.59
14.10	6,345	100,285	4.23
14.20	14,628	106,695	4.32
14.30	6,155	130,834	4.63
14.40	10,785	126,297	4.57
14.50	10,217	96,559	4.18
14.60	10,000	139,966	4.73
14.70	8,382	101,669	4.25
14.80	13,742	118,392	4.47
14.90	11,367	145,248	4.79
15.00	9,326	80,800	3.94
15.17	10,944	160,709	4.95
15.33	7,084	108,001	4.34
15.50	8,398	111,470	4.39
15.66	8,180	121,565	4.51
15.83	8,256	137,652	4.70
16.00	9,240	145,925	4.80
16.18	13,192	129,338	4.61
16.33	12,368	120,976	4.51
16.50	15,421	99,540	4.22
16.66	12,413	130,512	4.62
16.83	8,050	130,700	4.62
17.00	11,502	115,892	4.17
17.10	13,007	161,739	4.66
17.20	12,810	183,934	4.86
17.30	12,690	122,593	4.25
17.40	12,248	157,079	4.61
17.50	11,254	122,659	4.25
17.60	11,696	143,195	4.47
17.70	11,804	142,801	4.47
17.80	11,735	168,244	4.72
17.90	13,801	124,148	4.26
18.00	12,860	114,615	4.15
18.17	13,395	137,647	4.41
18.33	15,990	178,310	4.81
18.50	14,243	161,374	4.65
18.67	7,879	156,858	4.61
18.83	9,084	213,656	5.11
19.00	8,374	145,079	4.49

Station	MR	Ep	SNeff
19.17	10,663	138,730	4.43
19.33	13,507	132,900	4.36
19.50	9,884	207,255	5.06
19.66	8,905	179,406	4.82
19.84	10,891	140,818	4.45
20.00	12,255	167,876	4.59
20.10	13,227	170,750	4.62

Table 7. Deflection data – I-78 (metric units).

Station	LoadSize	Test	JointNo	D1	D2	D3	D4	D5	D6	D7	D8	D9
1.31	405.00	A	1.00	354.00	274.00	58.00	54.00	47.00	35.00	25.00	17.00	9.00
1.31	568.00	A	1.00	465.00	359.00	74.00	66.00	60.00	45.00	33.00	23.00	13.00
1.31	722.00	A	1.00	548.00	426.00	85.00	78.00	71.00	55.00	42.00	29.00	18.00
1.31	404.00	A	2.00	265.00	198.00	48.00	41.00	36.00	28.00	19.00	13.00	14.00
1.31	587.00	A	2.00	337.00	251.00	80.00	70.00	61.00	46.00	31.00	19.00	13.00
1.31	763.00	A	2.00	393.00	294.00	120.00	103.00	91.00	69.00	46.00	29.00	20.00
1.31	410.00	A	3.00	624.00	491.00	15.00	13.00	13.00	10.00	9.00	8.00	7.00
1.31	593.00	A	3.00	763.00	592.00	21.00	19.00	18.00	15.00	13.00	10.00	9.00
1.31	783.00	A	3.00	879.00	681.00	31.00	29.00	28.00	23.00	20.00	16.00	14.00
1.32	408.00	A	6.00	572.00	459.00	106.00	99.00	91.00	75.00	62.00	49.00	36.00
1.32	589.00	A	6.00	739.00	588.00	121.00	113.00	105.00	89.00	73.00	61.00	47.00
1.32	768.00	A	6.00	856.00	678.00	130.00	122.00	114.00	95.00	80.00	68.00	52.00
1.32	436.00	A	7.00	392.00	299.00	19.00	16.00	16.00	13.00	12.00	9.00	9.00
1.32	622.00	A	7.00	471.00	356.00	28.00	24.00	23.00	19.00	16.00	13.00	10.00
1.32	807.00	A	7.00	541.00	410.00	34.00	30.00	28.00	23.00	20.00	16.00	12.00
1.32	450.00	A	8.00	188.00	300.00	151.00	132.00	114.00	81.00	53.00	34.00	19.00
1.32	646.00	A	8.00	253.00	379.00	204.00	178.00	156.00	110.00	74.00	48.00	28.00
1.32	826.00	A	8.00	317.00	445.00	253.00	221.00	192.00	138.00	93.00	61.00	36.00
1.33	414.00	A	9.00	735.00	590.00	59.00	52.00	45.00	31.00	22.00	20.00	20.00
1.33	594.00	A	9.00	847.00	677.00	74.00	65.00	57.00	40.00	30.00	28.00	25.00
1.33	763.00	A	9.00	936.00	744.00	82.00	72.00	63.00	43.00	31.00	32.00	26.00
1.33	439.00	A	10.00	201.00	158.00	172.00	153.00	134.00	101.00	69.00	42.00	17.00
1.33	613.00	A	10.00	273.00	214.00	238.00	211.00	185.00	137.00	92.00	54.00	19.00
1.33	784.00	A	10.00	335.00	260.00	289.00	258.00	227.00	167.00	114.00	70.00	29.00
1.33	402.00	A	11.00	357.00	273.00	20.00	19.00	17.00	17.00	17.00	16.00	14.00
1.33	574.00	A	11.00	452.00	344.00	31.00	30.00	28.00	27.00	26.00	23.00	21.00
1.33	739.00	A	11.00	526.00	402.00	31.00	30.00	27.00	25.00	24.00	22.00	20.00
2.01	420.00	A	12.00	243.00	191.00	224.00	200.00	176.00	132.00	94.00	63.00	35.00
2.01	598.00	A	12.00	326.00	257.00	301.00	269.00	239.00	179.00	127.00	86.00	48.00
2.01	767.00	A	12.00	393.00	308.00	361.00	321.00	286.00	215.00	151.00	101.00	60.00
2.18	421.00	A	13.00	283.00	230.00	250.00	224.00	200.00	152.00	108.00	72.00	41.00
2.18	589.00	A	13.00	369.00	301.00	324.00	290.00	258.00	195.00	139.00	93.00	53.00
2.18	748.00	A	13.00	442.00	358.00	384.00	343.00	304.00	230.00	162.00	109.00	61.00
2.36	418.00	A	14.00	431.00	357.00	392.00	357.00	323.00	254.00	190.00	137.00	90.00
2.36	583.00	A	14.00	577.00	471.00	525.00	476.00	431.00	341.00	255.00	184.00	122.00
2.36	740.00	A	14.00	674.00	549.00	607.00	551.00	498.00	393.00	293.00	209.00	140.00
2.50	376.00	A	15.00	943.00	802.00	85.00	79.00	71.00	53.00	41.00	30.00	23.00
2.50	529.00	A	15.00	1211.00	1020.00	88.00	82.00	74.00	57.00	47.00	38.00	28.00
2.50	674.00	A	15.00	1336.00	1119.00	52.00	50.00	37.00	32.00	28.00	24.00	17.00
2.68	407.00	A	16.00	724.00	597.00	36.00	34.00	34.00	27.00	22.00	17.00	13.00
2.68	589.00	A	16.00	915.00	745.00	36.00	34.00	32.00	25.00	21.00	17.00	12.00
2.68	770.00	A	16.00	1041.00	842.00	41.00	39.00	36.00	28.00	23.00	20.00	15.00
2.85	462.00	A	17.00	782.00	655.00	75.00	70.00	65.00	53.00	43.00	36.00	23.00
2.85	653.00	A	17.00	999.00	829.00	101.00	93.00	86.00	72.00	59.00	47.00	35.00
2.85	826.00	A	17.00	1153.00	950.00	127.00	117.00	109.00	91.00	75.00	60.00	44.00
3.00	392.00	A	18.00	978.00	829.00	112.00	102.00	92.00	73.00	58.00	38.00	28.00
3.00	546.00	A	18.00	1224.00	1029.00	149.00	137.00	124.00	99.00	77.00	57.00	39.00

3.00	690.00	A	18.00	1378.00	1149.00	168.00	154.00	139.00	111.00	86.00	65.00	44.00
3.18	418.00	A	19.00	639.00	517.00	20.00	19.00	16.00	15.00	16.00	14.00	11.00
3.18	464.00	A	19.00	145.00	720.00	123.00	111.00	99.00	76.00	56.00	39.00	24.00
3.18	596.00	A	19.00	761.00	615.00	29.00	27.00	25.00	22.00	22.00	19.00	16.00
3.18	659.00	A	19.00	241.00	897.00	203.00	182.00	165.00	126.00	92.00	63.00	40.00
3.18	769.00	A	19.00	848.00	682.00	35.00	35.00	31.00	28.00	27.00	24.00	19.00
3.18	844.00	A	19.00	366.00	915.00	306.00	274.00	247.00	189.00	137.00	95.00	58.00
3.32	422.00	A	20.00	565.00	464.00	80.00	76.00	65.00	52.00	41.00	33.00	26.00
3.32	592.00	A	20.00	702.00	574.00	102.00	96.00	86.00	69.00	56.00	44.00	35.00
3.32	746.00	A	20.00	796.00	651.00	121.00	112.00	101.00	83.00	68.00	55.00	43.00
3.49	396.00	A	21.00	858.00	703.00	16.00	13.00	11.00	8.00	5.00	4.00	4.00
3.49	589.00	A	21.00	1026.00	834.00	15.00	12.00	11.00	8.00	6.00	5.00	2.00
3.49	791.00	A	21.00	1139.00	922.00	17.00	13.00	13.00	9.00	6.00	5.00	3.00
3.74	411.00	A	22.00	554.00	432.00	55.00	53.00	49.00	42.00	37.00	31.00	26.00
3.74	594.00	A	22.00	695.00	542.00	55.00	51.00	46.00	36.00	30.00	22.00	15.00
3.74	779.00	A	22.00	826.00	643.00	79.00	76.00	73.00	59.00	51.00	42.00	34.00
3.85	467.00	A	23.00	306.00	233.00	134.00	123.00	113.00	92.00	72.00	55.00	36.00
3.85	649.00	A	23.00	411.00	314.00	179.00	164.00	148.00	121.00	96.00	69.00	54.00
3.85	823.00	A	23.00	497.00	380.00	194.00	179.00	163.00	136.00	108.00	81.00	64.00
4.00	404.00	A	24.00	487.00	405.00	168.00	149.00	133.00	98.00	69.00	43.00	22.00
4.00	587.00	A	24.00	636.00	524.00	198.00	176.00	157.00	119.00	86.00	57.00	35.00
4.00	770.00	A	24.00	736.00	605.00	225.00	200.00	179.00	138.00	100.00	69.00	43.00
4.66	421.00	A	25.00	456.00	396.00	54.00	55.00	53.00	52.00	52.00	51.00	50.00
4.66	600.00	A	25.00	575.00	501.00	67.00	67.00	62.00	57.00	54.00	50.00	45.00
4.66	767.00	A	25.00	667.00	581.00	82.00	82.00	80.00	72.00	67.00	63.00	58.00
4.67	399.00	A	26.00	930.00	800.00	68.00	64.00	59.00	54.00	51.00	47.00	46.00
4.67	568.00	A	26.00	1117.00	952.00	72.00	69.00	65.00	58.00	53.00	48.00	44.00
4.67	735.00	A	26.00	1223.00	1040.00	99.00	96.00	87.00	82.00	73.00	67.00	63.00
4.67	394.00	A	27.00	374.00	305.00	66.00	63.00	61.00	50.00	46.00	39.00	33.00
4.67	567.00	A	27.00	468.00	380.00	89.00	84.00	82.00	69.00	61.00	52.00	44.00
4.67	731.00	A	27.00	548.00	444.00	112.00	106.00	100.00	86.00	77.00	66.00	55.00
4.67	431.00	A	28.00	691.00	575.00	38.00	37.00	36.00	32.00	31.00	29.00	26.00
4.67	624.00	A	28.00	823.00	678.00	41.00	43.00	43.00	40.00	37.00	41.00	36.00
4.67	808.00	A	28.00	921.00	757.00	46.00	46.00	46.00	44.00	40.00	42.00	36.00
4.67	399.00	A	29.00	732.00	614.00	51.00	49.00	47.00	38.00	36.00	31.00	24.00
4.67	579.00	A	29.00	891.00	742.00	71.00	72.00	64.00	56.00	52.00	45.00	37.00
4.67	757.00	A	29.00	1008.00	837.00	85.00	81.00	75.00	65.00	57.00	49.00	39.00
4.68	407.00	A	30.00	323.00	254.00	299.00	271.00	242.00	187.00	134.00	82.00	33.00
4.68	571.00	A	30.00	436.00	342.00	381.00	346.00	311.00	239.00	172.00	104.00	39.00
4.68	717.00	A	30.00	556.00	438.00	414.00	376.00	338.00	261.00	187.00	115.00	46.00
4.68	425.00	A	31.00	307.00	251.00	37.00	37.00	34.00	29.00	27.00	25.00	20.00
4.68	605.00	A	31.00	436.00	359.00	61.00	57.00	55.00	47.00	42.00	37.00	30.00
4.68	779.00	A	31.00	504.00	418.00	65.00	61.00	58.00	53.00	48.00	43.00	36.00
4.68	399.00	A	32.00	643.00	539.00	31.00	30.00	28.00	25.00	24.00	22.00	20.00
4.68	561.00	A	32.00	833.00	700.00	39.00	38.00	35.00	31.00	31.00	27.00	25.00
4.68	714.00	A	32.00	965.00	807.00	52.00	49.00	48.00	43.00	41.00	37.00	35.00
4.68	387.00	A	33.00	656.00	553.00	39.00	37.00	34.00	29.00	29.00	25.00	24.00
4.68	552.00	A	33.00	890.00	746.00	52.00	50.00	46.00	39.00	39.00	33.00	31.00
4.68	708.00	A	33.00	1077.00	899.00	66.00	62.00	55.00	49.00	49.00	40.00	38.00
4.69	404.00	A	34.00	333.00	264.00	80.00	73.00	67.00	53.00	41.00	33.00	25.00

4.69	574.00	A	34.00	435.00	342.00	103.00	94.00	87.00	69.00	53.00	44.00	35.00
4.69	742.00	A	34.00	515.00	404.00	123.00	113.00	104.00	84.00	65.00	55.00	43.00
1.31	408.00	L	1.00	189.00	173.00	148.00	130.00	111.00	77.00	50.00	28.00	10.00
1.31	579.00	L	1.00	251.00	232.00	199.00	174.00	149.00	105.00	67.00	38.00	13.00
1.31	739.00	L	1.00	302.00	282.00	238.00	207.00	179.00	126.00	80.00	45.00	15.00
1.31	411.00	L	2.00	159.00	124.00	123.00	103.00	87.00	56.00	30.00	19.00	29.00
1.31	585.00	L	2.00	193.00	164.00	150.00	126.00	106.00	69.00	37.00	25.00	44.00
1.31	747.00	L	2.00	236.00	203.00	183.00	155.00	130.00	86.00	47.00	32.00	56.00
1.31	419.00	L	3.00	164.00	13.00	126.00	109.00	91.00	60.00	35.00	16.00	7.00
1.31	592.00	L	3.00	233.00	34.00	180.00	153.00	129.00	88.00	50.00	22.00	7.00
1.31	760.00	L	3.00	275.00	25.00	212.00	183.00	156.00	104.00	61.00	31.00	16.00
1.31	432.00	L	5.00	243.00	174.00	201.00	177.00	156.00	117.00	82.00	57.00	35.00
1.31	608.00	L	5.00	331.00	235.00	271.00	237.00	210.00	155.00	109.00	76.00	46.00
1.31	769.00	L	5.00	405.00	288.00	330.00	290.00	255.00	190.00	134.00	91.00	58.00
1.32	397.00	L	6.00	354.00	335.00	299.00	271.00	244.00	193.00	147.00	107.00	72.00
1.32	562.00	L	6.00	449.00	433.00	376.00	339.00	306.00	240.00	180.00	133.00	88.00
1.32	716.00	L	6.00	519.00	505.00	434.00	391.00	353.00	275.00	206.00	153.00	101.00
1.32	454.00	L	7.00	220.00	14.00	168.00	140.00	118.00	71.00	31.00	23.00	36.00
1.32	640.00	L	7.00	294.00	17.00	221.00	186.00	156.00	97.00	44.00	28.00	50.00
1.32	819.00	L	7.00	355.00	21.00	270.00	228.00	191.00	119.00	54.00	37.00	65.00
1.32	443.00	L	8.00	322.00	55.00	253.00	215.00	184.00	128.00	83.00	50.00	27.00
1.32	636.00	L	8.00	390.00	103.00	306.00	264.00	227.00	159.00	103.00	64.00	32.00
1.32	828.00	L	8.00	450.00	141.00	352.00	304.00	262.00	184.00	120.00	75.00	39.00
1.33	417.00	L	9.00	345.00	348.00	298.00	271.00	247.00	201.00	150.00	106.00	60.00
1.33	587.00	L	9.00	451.00	441.00	387.00	353.00	321.00	256.00	191.00	133.00	74.00
1.33	757.00	L	9.00	480.00	494.00	410.00	375.00	339.00	269.00	199.00	136.00	78.00
1.33	426.00	L	10.00	210.00	183.00	166.00	142.00	121.00	81.00	47.00	26.00	43.00
1.33	604.00		10.00	296.00	254.00	231.00	198.00	169.00	114.00	66.00	35.00	58.00
1.33	773.00	L	10.00	362.00	312.00	285.00	245.00	210.00	141.00	83.00	42.00	66.00
1.33	430.00	L	11.00	218.00	22.00	181.00	163.00	146.00	115.00	89.00	70.00	49.00
1.33	609.00	L	11.00	282.00	69.00	233.00	211.00	189.00	147.00	115.00	91.00	62.00
1.33	778.00	L	11.00	333.00	110.00	275.00	247.00	222.00	173.00	134.00	104.00	73.00
2.01	433.00	L	12.00	231.00	235.00	182.00	158.00	136.00	95.00	61.00	34.00	9.00
2.01	608.00	L	12.00	324.00	326.00	256.00	224.00	194.00	138.00	92.00	52.00	21.00
2.01	778.00	L	12.00	378.00	381.00	299.00	260.00	224.00	159.00	104.00	60.00	22.00
2.18	438.00	L	13.00	286.00	278.00	227.00	198.00	171.00	119.00	76.00	42.00	15.00
2.18	617.00	L	13.00	369.00	359.00	293.00	255.00	220.00	153.00	96.00	54.00	18.00
2.18	785.00	L	13.00	435.00	421.00	344.00	298.00	257.00	178.00	112.00	63.00	22.00
2.36	410.00	L	14.00	424.00	388.00	347.00	309.00	272.00	199.00	136.00	90.00	54.00
2.36	575.00	L	14.00	580.00	528.00	476.00	422.00	372.00	273.00	189.00	124.00	76.00
2.36	726.00	L	14.00	672.00	603.00	547.00	484.00	425.00	314.00	216.00	141.00	86.00
2.50	395.00	L	15.00	403.00	425.00	329.00	293.00	258.00	190.00	134.00	88.00	50.00
2.50	560.00	L	15.00	521.00	542.00	422.00	376.00	329.00	244.00	172.00	114.00	67.00
2.50	720.00	L	15.00	610.00	636.00	495.00	438.00	386.00	286.00	201.00	134.00	80.00
2.68	384.00	L	16.00	918.00	51.00	775.00	702.00	633.00	498.00	372.00	265.00	174.00
2.68	541.00	L	16.00	1149.00	168.00	971.00	878.00	792.00	624.00	465.00	333.00	221.00
2.68	747.00	L	16.00	1268.00	311.00	1069.00	965.00	871.00	685.00	509.00	365.00	242.00
2.85	388.00	L	17.00	869.00	107.00	737.00	674.00	614.00	493.00	386.00	291.00	211.00
2.85	550.00	L	17.00	1069.00	235.00	912.00	830.00	757.00	608.00	474.00	359.00	262.00
2.85	703.00	L	17.00	1208.00	364.00	1023.00	929.00	847.00	677.00	525.00	400.00	294.00

3.00	401.00	L	18.00	429.00	373.00	352.00	314.00	276.00	206.00	150.00	104.00	69.00
3.00	576.00	L	18.00	559.00	519.00	457.00	407.00	359.00	268.00	195.00	137.00	91.00
3.00	733.00	L	18.00	658.00	638.00	538.00	479.00	423.00	317.00	232.00	162.00	109.00
3.18	416.00	L	19.00	598.00	22.00	483.00	425.00	371.00	269.00	182.00	114.00	62.00
3.18	591.00	L	19.00	762.00	33.00	614.00	538.00	469.00	339.00	227.00	143.00	80.00
3.18	769.00	L	19.00	892.00	32.00	718.00	628.00	547.00	394.00	264.00	167.00	94.00
3.33	436.00	L	20.00	230.00	244.00	179.00	155.00	133.00	94.00	66.00	47.00	32.00
3.33	615.00	L	20.00	317.00	335.00	246.00	213.00	184.00	131.00	93.00	68.00	44.00
3.33	779.00	L	20.00	378.00	401.00	295.00	256.00	222.00	161.00	114.00	84.00	58.00
3.49	417.00	L	21.00	200.00	217.00	153.00	130.00	109.00	72.00	43.00	21.00	4.00
3.49	587.00	L	21.00	266.00	286.00	205.00	175.00	148.00	99.00	59.00	30.00	4.00
3.49	756.00	L	21.00	323.00	347.00	250.00	214.00	182.00	124.00	76.00	40.00	7.00
3.85	417.00	L	23.00	382.00	188.00	328.00	300.00	273.00	222.00	172.00	130.00	95.00
3.85	596.00	L	23.00	466.00	254.00	399.00	364.00	331.00	267.00	206.00	156.00	113.00
3.85	773.00	L	23.00	537.00	315.00	458.00	418.00	381.00	306.00	237.00	179.00	130.00
4.00	435.00	L	24.00	279.00	285.00	224.00	197.00	172.00	125.00	85.00	51.00	25.00
4.00	614.00	L	24.00	378.00	386.00	303.00	267.00	235.00	172.00	118.00	75.00	38.00
4.00	783.00	L	24.00	461.00	466.00	374.00	331.00	291.00	215.00	150.00	98.00	52.00
4.66	443.00	L	25.00	299.00	219.00	249.00	226.00	203.00	162.00	128.00	99.00	74.00
4.66	630.00	L	25.00	389.00	297.00	325.00	294.00	265.00	211.00	167.00	131.00	98.00
4.66	804.00	L	25.00	464.00	364.00	388.00	351.00	317.00	254.00	203.00	161.00	123.00
4.67	414.00	L	26.00	253.00	233.00	210.00	188.00	167.00	129.00	96.00	72.00	59.00
4.67	587.00	L	26.00	329.00	296.00	272.00	244.00	221.00	170.00	129.00	99.00	84.00
4.67	742.00	L	26.00	388.00	342.00	320.00	287.00	256.00	197.00	147.00	110.00	95.00
4.67	425.00	L	27.00	384.00	60.00	314.00	281.00	250.00	194.00	147.00	107.00	70.00
4.67	598.00	L	27.00	491.00	79.00	401.00	359.00	321.00	251.00	193.00	140.00	94.00
4.67	764.00	L	27.00	572.00	94.00	469.00	421.00	377.00	297.00	230.00	170.00	114.00
4.67	402.00	L	28.00	228.00	182.00	184.00	163.00	144.00	109.00	80.00	54.00	32.00
4.67	569.00	L	28.00	292.00	222.00	235.00	208.00	184.00	139.00	103.00	72.00	41.00
4.67	727.00	L	28.00	354.00	267.00	286.00	256.00	226.00	173.00	131.00	94.00	57.00
4.67	399.00	L	29.00	479.00	56.00	404.00	367.00	330.00	257.00	194.00	137.00	78.00
4.67	576.00	L	29.00	568.00	76.00	475.00	428.00	384.00	297.00	215.00	142.00	68.00
4.67	744.00	L	29.00	650.00	98.00	542.00	493.00	442.00	341.00	249.00	164.00	79.00
4.68	421.00	L	30.00	293.00	322.00	239.00	211.00	184.00	131.00	81.00	39.00	4.00
4.68	590.00	L	30.00	378.00	416.00	309.00	275.00	242.00	173.00	112.00	59.00	15.00
4.68	753.00	L	30.00	449.00	497.00	367.00	324.00	285.00	204.00	128.00	61.00	11.00
4.68	423.00	L	31.00	314.00	36.00	258.00	232.00	207.00	161.00	125.00	94.00	65.00
4.68	594.00	L	31.00	412.00	52.00	339.00	305.00	273.00	215.00	168.00	127.00	89.00
4.68	758.00	L	31.00	493.00	66.00	407.00	366.00	327.00	259.00	205.00	156.00	110.00
4.68	416.00	L	32.00	287.00	175.00	232.00	208.00	182.00	137.00	101.00	71.00	50.00
4.68	593.00	L	32.00	373.00	220.00	303.00	271.00	239.00	183.00	138.00	99.00	71.00
4.68	761.00	L	32.00	439.00	283.00	357.00	317.00	281.00	213.00	157.00	112.00	79.00
4.68	422.00	L	33.00	115.00	117.00	90.00	78.00	68.00	49.00	36.00	27.00	20.00
4.68	596.00	L	33.00	159.00	159.00	124.00	109.00	95.00	69.00	51.00	37.00	28.00
4.68	761.00	L	33.00	197.00	193.00	154.00	134.00	117.00	87.00	64.00	46.00	35.00
4.69	417.00	L	34.00	216.00	183.00	172.00	150.00	131.00	93.00	64.00	40.00	22.00
4.69	587.00	L	34.00	273.00	233.00	217.00	190.00	167.00	120.00	84.00	57.00	38.00
4.69	745.00	L	34.00	330.00	288.00	262.00	230.00	200.00	144.00	101.00	71.00	47.00
1.30	**423.00**	**M**	**1.00**	**91.00**	**70.00**	**105.00**	**112.00**	**119.00**	**137.00**	**155.00**	**16.00**	**15.00**
1.30	**596.00**	**M**	**1.00**	**131.00**	**103.00**	**151.00**	**160.00**	**170.00**	**193.00**	**215.00**	**20.00**	**16.00**

1.30	771.00	M	1.00	169.00	136.00	192.00	204.00	216.00	242.00	268.00	22.00	19.00
1.31	402.00	M	2.00	65.00	57.00	66.00	66.00	68.00	69.00	73.00	5.00	5.00
1.31	578.00	M	2.00	97.00	85.00	97.00	97.00	97.00	100.00	105.00	7.00	6.00
1.31	736.00	M	2.00	128.00	114.00	128.00	128.00	129.00	131.00	134.00	11.00	10.00
1.31	449.00	M	3.00	68.00	58.00	69.00	71.00	73.00	80.00	87.00	9.00	8.00
1.31	634.00	M	3.00	101.00	89.00	103.00	103.00	106.00	113.00	121.00	10.00	9.00
1.31	812.00	M	3.00	131.00	116.00	132.00	133.00	136.00	143.00	151.00	14.00	13.00
1.31	428.00	M	4.00	89.00	97.00	72.00	63.00	55.00	39.00	26.00	18.00	9.00
1.31	603.00	M	4.00	128.00	140.00	105.00	92.00	80.00	58.00	40.00	27.00	13.00
1.31	770.00	M	4.00	166.00	181.00	136.00	120.00	106.00	78.00	54.00	36.00	18.00
1.31	425.00	M	5.00	232.00	181.00	170.00	153.00	138.00	106.00	78.00	58.00	38.00
1.31	604.00	M	5.00	313.00	244.00	229.00	205.00	185.00	144.00	105.00	77.00	51.00
1.31	765.00	M	5.00	382.00	298.00	277.00	249.00	224.00	174.00	127.00	93.00	62.00
1.31	421.00	M	6.00	63.00	57.00	60.00	59.00	58.00	57.00	58.00	59.00	61.00
1.31	602.00	M	6.00	91.00	83.00	87.00	86.00	84.00	83.00	83.00	85.00	86.00
1.31	768.00	M	6.00	118.00	109.00	114.00	111.00	109.00	107.00	107.00	109.00	113.00
1.32	419.00	M	7.00	108.00	108.00	80.00	68.00	56.00	33.00	18.00	24.00	38.00
1.32	595.00	M	7.00	150.00	149.00	113.00	95.00	78.00	47.00	22.00	36.00	50.00
1.32	756.00	M	7.00	194.00	187.00	148.00	124.00	102.00	61.00	35.00	53.00	71.00
1.32	450.00	M	8.00	79.00	68.00	85.00	89.00	94.00	103.00	9.00	9.00	8.00
1.32	636.00	M	8.00	116.00	99.00	122.00	126.00	132.00	143.00	12.00	11.00	10.00
1.32	813.00	M	8.00	153.00	131.00	159.00	163.00	168.00	181.00	15.00	12.00	14.00
1.32	465.00	M	9.00	75.00	62.00	78.00	73.00	69.00	69.00	74.00	78.00	81.00
1.32	668.00	M	9.00	106.00	87.00	110.00	103.00	99.00	100.00	106.00	112.00	117.00
1.32	856.00	M	9.00	132.00	110.00	134.00	126.00	122.00	119.00	122.00	125.00	129.00
1.33	454.00	M	10.00	68.00	74.00	57.00	52.00	46.00	36.00	28.00	23.00	16.00
1.33	640.00	M	10.00	98.00	103.00	81.00	72.00	65.00	51.00	39.00	30.00	20.00
1.33	820.00	M	10.00	133.00	142.00	111.00	99.00	89.00	69.00	52.00	36.00	22.00
1.33	432.00	M	11.00	78.00	65.00	89.00	94.00	100.00	111.00	124.00	46.00	41.00
1.33	609.00	M	11.00	113.00	95.00	124.00	130.00	136.00	149.00	163.00	2.00	1.00
1.33	778.00	M	11.00	140.00	117.00	152.00	157.00	163.00	177.00	192.00	6.00	4.00
2.00	431.00	M	12.00	49.00	45.00	45.00	42.00	38.00	31.00	27.00	23.00	16.00
2.00	600.00	M	12.00	67.00	60.00	60.00	57.00	52.00	43.00	36.00	30.00	25.00
2.00	762.00	M	12.00	88.00	81.00	81.00	75.00	70.00	59.00	49.00	41.00	33.00
2.18	406.00	M	13.00	99.00	93.00	94.00	90.00	85.00	75.00	65.00	56.00	47.00
2.18	570.00	M	13.00	138.00	128.00	129.00	123.00	117.00	103.00	89.00	76.00	65.00
2.18	724.00	M	13.00	171.00	160.00	162.00	156.00	147.00	129.00	112.00	96.00	82.00
2.36	425.00	M	14.00	67.00	62.00	60.00	55.00	52.00	42.00	35.00	27.00	23.00
2.36	604.00	M	14.00	94.00	89.00	86.00	80.00	74.00	62.00	51.00	42.00	34.00
2.36	770.00	M	14.00	121.00	113.00	110.00	102.00	95.00	80.00	65.00	54.00	44.00
2.49	434.00	M	15.00	84.00	79.00	79.00	75.00	69.00	61.00	52.00	45.00	37.00
2.49	609.00	M	15.00	121.00	114.00	113.00	107.00	101.00	87.00	75.00	65.00	53.00
2.49	779.00	M	15.00	155.00	145.00	145.00	138.00	130.00	114.00	97.00	83.00	69.00
2.67	407.00	M	16.00	93.00	100.00	81.00	74.00	71.00	61.00	54.00	49.00	44.00
2.67	578.00	M	16.00	126.00	138.00	112.00	105.00	98.00	88.00	79.00	72.00	67.00
2.67	743.00	M	16.00	158.00	174.00	142.00	132.00	125.00	111.00	100.00	92.00	85.00
2.85	408.00	M	17.00	267.00	195.00	218.00	194.00	172.00	132.00	98.00	65.00	47.00
2.85	578.00	M	17.00	367.00	269.00	298.00	264.00	234.00	180.00	133.00	94.00	65.00
2.85	735.00	M	17.00	439.00	323.00	355.00	314.00	279.00	212.00	157.00	114.00	79.00
3.00	429.00	M	18.00	82.00	77.00	79.00	74.00	71.00	63.00	56.00	49.00	41.00

3.00	601.00	M	18.00	116.00	108.00	110.00	104.00	99.00	89.00	79.00	69.00	58.00
3.00	767.00	M	18.00	146.00	136.00	138.00	132.00	126.00	113.00	99.00	89.00	75.00
3.18	428.00	M	19.00	41.00	38.00	37.00	34.00	33.00	30.00	30.00	30.00	32.00
3.18	603.00	M	19.00	60.00	55.00	53.00	49.00	46.00	42.00	40.00	40.00	44.00
3.18	767.00	M	19.00	78.00	72.00	69.00	65.00	60.00	54.00	51.00	51.00	55.00
3.32	440.00	M	20.00	55.00	52.00	51.00	48.00	44.00	37.00	32.00	28.00	22.00
3.32	624.00	M	20.00	79.00	74.00	74.00	69.00	64.00	53.00	45.00	40.00	32.00
3.32	795.00	M	20.00	104.00	94.00	94.00	87.00	81.00	68.00	57.00	49.00	41.00
3.49	438.00	M	21.00	63.00	56.00	56.00	50.00	45.00	36.00	27.00	20.00	14.00
3.49	617.00	M	21.00	92.00	81.00	81.00	73.00	67.00	53.00	40.00	30.00	21.00
3.49	795.00	M	21.00	117.00	102.00	102.00	93.00	84.00	67.00	50.00	38.00	26.00
3.74	429.00	M	22.00	91.00	100.00	79.00	77.00	73.00	69.00	69.00	74.00	74.00
3.74	605.00	M	22.00	129.00	141.00	114.00	110.00	105.00	101.00	101.00	105.00	106.00
3.74	776.00	M	22.00	161.00	174.00	145.00	139.00	135.00	134.00	136.00	143.00	148.00
3.85	438.00	M	23.00	59.00	58.00	54.00	51.00	46.00	37.00	31.00	25.00	18.00
3.85	619.00	M	23.00	92.00	83.00	85.00	80.00	76.00	65.00	55.00	47.00	37.00
3.85	787.00	M	23.00	116.00	106.00	108.00	103.00	97.00	84.00	70.00	59.00	48.00
4.00	436.00	M	24.00	72.00	68.00	67.00	63.00	58.00	49.00	41.00	34.00	29.00
4.00	611.00	M	24.00	103.00	97.00	96.00	90.00	85.00	71.00	59.00	51.00	38.00
4.00	774.00	M	24.00	132.00	124.00	123.00	116.00	109.00	93.00	78.00	64.00	54.00
4.66	426.00	M	25.00	165.00	177.00	151.00	143.00	137.00	124.00	113.00	102.00	92.00
4.66	597.00	M	25.00	254.00	274.00	234.00	222.00	211.00	194.00	178.00	152.00	141.00
4.66	756.00	M	25.00	288.00	312.00	264.00	250.00	237.00	213.00	191.00	172.00	150.00
4.66	425.00	M	26.00	155.00	146.00	167.00	173.00	181.00	194.00	213.00	234.00	251.00
4.66	600.00	M	26.00	202.00	187.00	221.00	231.00	242.00	265.00	295.00	323.00	351.00
4.66	770.00	M	26.00	251.00	233.00	273.00	286.00	299.00	328.00	364.00	399.00	434.00
4.67	412.00	M	27.00	153.00	149.00	131.00	118.00	106.00	81.00	57.00	40.00	32.00
4.67	582.00	M	27.00	211.00	205.00	181.00	163.00	146.00	111.00	76.00	54.00	43.00
4.67	741.00	M	27.00	261.00	252.00	222.00	199.00	178.00	133.00	88.00	61.00	58.00
4.67	422.00	M	28.00	121.00	129.00	117.00	114.00	113.00	111.00	113.00	114.00	116.00
4.67	595.00	M	28.00	154.00	163.00	148.00	145.00	144.00	143.00	147.00	151.00	156.00
4.67	754.00	M	28.00	197.00	210.00	187.00	184.00	181.00	179.00	182.00	185.00	191.00
4.67	409.00	M	29.00	99.00	103.00	95.00	92.00	91.00	90.00	91.00	94.00	97.00
4.67	574.00	M	29.00	144.00	150.00	139.00	136.00	135.00	135.00	138.00	142.00	147.00
4.67	736.00	M	29.00	200.00	208.00	194.00	193.00	193.00	194.00	203.00	213.00	225.00
4.68	431.00	M	30.00	140.00	137.00	147.00	149.00	152.00	157.00	152.00	127.00	101.00
4.68	604.00	M	30.00	195.00	185.00	203.00	210.00	214.00	222.00	210.00	176.00	142.00
4.68	772.00	M	30.00	249.00	235.00	259.00	266.00	272.00	285.00	250.00	210.00	170.00
4.68	416.00	M	31.00	118.00	132.00	105.00	96.00	88.00	72.00	57.00	44.00	17.00
4.68	582.00	M	31.00	165.00	181.00	146.00	135.00	125.00	104.00	85.00	66.00	26.00
4.68	737.00	M	31.00	206.00	223.00	184.00	171.00	160.00	135.00	112.00	91.00	34.00
4.68	425.00	M	32.00	128.00	101.00	154.00	170.00	183.00	210.00	244.00	29.00	26.00
4.68	597.00	M	32.00	174.00	137.00	209.00	230.00	247.00	285.00	330.00	38.00	34.00
4.68	760.00	M	32.00	217.00	172.00	259.00	285.00	306.00	352.00	406.00	44.00	40.00
4.68	425.00	M	33.00	50.00	44.00	47.00	46.00	44.00	39.00	37.00	31.00	32.00
4.68	604.00	M	33.00	84.00	77.00	80.00	78.00	75.00	69.00	65.00	62.00	58.00
4.68	773.00	M	33.00	103.00	94.00	98.00	94.00	91.00	83.00	76.00	70.00	67.00
4.69	406.00	M	34.00	59.00	55.00	46.00	40.00	34.00	25.00	19.00	14.00	15.00
4.69	576.00	M	34.00	84.00	79.00	67.00	58.00	50.00	37.00	27.00	20.00	21.00
4.69	737.00	M	34.00	107.00	100.00	85.00	74.00	65.00	47.00	33.00	23.00	25.00

Table 8. Deflection data – I-78 (English units).

Station	Test Type	JointNo	Load#	D1	D2	D3	D4	D5	D6	D7	D8	D9
1.31	A	1.00	6423.71	13.94	10.79	2.28	2.13	1.85	1.38	0.98	0.67	0.35
1.31	A	1.00	9009.05	18.31	14.13	2.91	2.60	2.36	1.77	1.30	0.91	0.51
1.31	A	1.00	11451.64	21.57	16.77	3.35	3.07	2.80	2.17	1.65	1.14	0.71
1.31	A	2.00	6407.84	10.43	7.80	1.89	1.61	1.42	1.10	0.75	0.51	0.55
1.31	A	2.00	9310.41	13.27	9.88	3.15	2.76	2.40	1.81	1.22	0.75	0.51
1.31	A	2.00	12101.94	15.47	11.57	4.72	4.06	3.58	2.72	1.81	1.14	0.79
1.31	A	3.00	6503.01	24.57	19.33	0.59	0.51	0.51	0.39	0.35	0.31	0.28
1.31	A	3.00	9405.57	30.04	23.31	0.83	0.75	0.71	0.59	0.51	0.39	0.35
1.31	A	3.00	12419.16	34.61	26.81	1.22	1.14	1.10	0.91	0.79	0.63	0.55
1.32	A	6.00	6471.29	22.52	18.07	4.17	3.90	3.58	2.95	2.44	1.93	1.42
1.32	A	6.00	9342.13	29.09	23.15	4.76	4.45	4.13	3.50	2.87	2.40	1.85
1.32	A	6.00	12181.25	33.70	26.69	5.12	4.80	4.49	3.74	3.15	2.68	2.05
1.32	A	7.00	6915.40	15.43	11.77	0.75	0.63	0.63	0.51	0.47	0.35	0.35
1.32	A	7.00	9865.54	18.54	14.02	1.10	0.94	0.91	0.75	0.63	0.51	0.39
1.32	A	7.00	12799.83	21.30	16.14	1.34	1.18	1.10	0.91	0.79	0.63	0.47
1.32	A	8.00	7137.45	7.40	11.81	5.94	5.20	4.49	3.19	2.09	1.34	0.75
1.32	A	8.00	10246.21	9.96	14.92	8.03	7.01	6.14	4.33	2.91	1.89	1.10
1.32	A	8.00	13101.19	12.48	17.52	9.96	8.70	7.56	5.43	3.66	2.40	1.42
1.33	A	9.00	6566.45	28.94	23.23	2.32	2.05	1.77	1.22	0.87	0.79	0.79
1.33	A	9.00	9421.43	33.35	26.65	2.91	2.56	2.24	1.57	1.18	1.10	0.98
1.33	A	9.00	12101.94	36.85	29.29	3.23	2.83	2.48	1.69	1.22	1.26	1.02
1.33	A	10.00	6962.98	7.91	6.22	6.77	6.02	5.28	3.98	2.72	1.65	0.67
1.33	A	10.00	9722.79	10.75	8.43	9.37	8.31	7.28	5.39	3.62	2.13	0.75
1.33	A	10.00	12435.02	13.19	10.24	11.38	10.16	8.94	6.57	4.49	2.76	1.14
1.33	A	11.00	6376.12	14.06	10.75	0.79	0.75	0.67	0.67	0.67	0.63	0.55
1.33	A	11.00	9104.21	17.80	13.54	1.22	1.18	1.10	1.06	1.02	0.91	0.83
1.33	A	11.00	11721.28	20.71	15.83	1.22	1.18	1.06	0.98	0.94	0.87	0.79
2.01	A	12.00	6661.62	9.57	7.52	8.82	7.87	6.93	5.20	3.70	2.48	1.38
2.01	A	12.00	9484.88	12.83	10.12	11.85	10.59	9.41	7.05	5.00	3.39	1.89
2.01	A	12.00	12165.39	15.47	12.13	14.21	12.64	11.26	8.46	5.94	3.98	2.36
2.18	A	13.00	6677.48	11.14	9.06	9.84	8.82	7.87	5.98	4.25	2.83	1.61
2.18	A	13.00	9342.13	14.53	11.85	12.76	11.42	10.16	7.68	5.47	3.66	2.09
2.18	A	13.00	11864.03	17.40	14.09	15.12	13.50	11.97	9.06	6.38	4.29	2.40
2.36	A	14.00	6629.90	16.97	14.06	15.43	14.06	12.72	10.00	7.48	5.39	3.54
2.36	A	14.00	9246.96	22.72	18.54	20.67	18.74	16.97	13.43	10.04	7.24	4.80
2.36	A	14.00	11737.14	26.54	21.61	23.90	21.69	19.61	15.47	11.54	8.23	5.51
2.50	A	15.00	5963.74	37.13	31.57	3.35	3.11	2.80	2.09	1.61	1.18	0.91
2.50	A	15.00	8390.47	47.68	40.16	3.46	3.23	2.91	2.24	1.85	1.50	1.10
2.50	A	15.00	10690.31	52.60	44.06	2.05	1.97	1.46	1.26	1.10	0.94	0.67
2.68	A	16.00	6455.43	28.50	23.50	1.42	1.34	1.34	1.06	0.87	0.67	0.51
2.68	A	16.00	9342.13	36.02	29.33	1.42	1.34	1.26	0.98	0.83	0.67	0.47
2.68	A	16.00	12212.97	40.98	33.15	1.61	1.54	1.42	1.10	0.91	0.79	0.59
2.85	A	17.00	7327.78	30.79	25.79	2.95	2.76	2.56	2.09	1.69	1.42	0.91
2.85	A	17.00	10357.23	39.33	32.64	3.98	3.66	3.39	2.83	2.32	1.85	1.38
2.85	A	17.00	13101.19	45.39	37.40	5.00	4.61	4.29	3.58	2.95	2.36	1.73
3.00	A	18.00	6217.51	38.50	32.64	4.41	4.02	3.62	2.87	2.28	1.50	1.10
3.00	A	18.00	8660.11	48.19	40.51	5.87	5.39	4.88	3.90	3.03	2.24	1.54

3.00	A	18.00	10944.09	54.25	45.24	6.61	6.06	5.47	4.37	3.39	2.56	1.73
3.18	A	19.00	6629.90	25.16	20.35	0.79	0.75	0.63	0.59	0.63	0.55	0.43
3.18	A	19.00	7359.50	5.71	28.35	4.84	4.37	3.90	2.99	2.20	1.54	0.94
3.18	A	19.00	9453.16	29.96	24.21	1.14	1.06	0.98	0.87	0.87	0.75	0.63
3.18	A	19.00	10452.40	9.49	35.31	7.99	7.17	6.50	4.96	3.62	2.48	1.57
3.18	A	19.00	12197.11	33.39	26.85	1.38	1.38	1.22	1.10	1.06	0.94	0.75
3.18	A	19.00	13386.68	14.41	36.02	12.05	10.79	9.72	7.44	5.39	3.74	2.28
3.32	A	20.00	6693.34	22.24	18.27	3.15	2.99	2.56	2.05	1.61	1.30	1.02
3.32	A	20.00	9389.71	27.64	22.60	4.02	3.78	3.39	2.72	2.20	1.73	1.38
3.32	A	20.00	11832.31	31.34	25.63	4.76	4.41	3.98	3.27	2.68	2.17	1.69
3.49	A	21.00	6280.96	33.78	27.68	0.63	0.51	0.43	0.31	0.20	0.16	0.16
3.49	A	21.00	9342.13	40.39	32.83	0.59	0.47	0.43	0.31	0.24	0.20	0.08
3.49	A	21.00	12546.05	44.84	36.30	0.67	0.51	0.51	0.35	0.24	0.20	0.12
3.74	A	22.00	6518.87	21.81	17.01	2.17	2.09	1.93	1.65	1.46	1.22	1.02
3.74	A	22.00	9421.43	27.36	21.34	2.17	2.01	1.81	1.42	1.18	0.87	0.59
3.74	A	22.00	12355.72	32.52	25.31	3.11	2.99	2.87	2.32	2.01	1.65	1.34
3.85	A	23.00	7407.09	12.05	9.17	5.28	4.84	4.45	3.62	2.83	2.17	1.42
3.85	A	23.00	10293.79	16.18	12.36	7.05	6.46	5.83	4.76	3.78	2.72	2.13
3.85	A	23.00	13053.60	19.57	14.96	7.64	7.05	6.42	5.35	4.25	3.19	2.52
4.00	A	24.00	6407.84	19.17	15.94	6.61	5.87	5.24	3.86	2.72	1.69	0.87
4.00	A	24.00	9310.41	25.04	20.63	7.80	6.93	6.18	4.69	3.39	2.24	1.38
4.00	A	24.00	12212.97	28.98	23.82	8.86	7.87	7.05	5.43	3.94	2.72	1.69
4.66	A	25.00	6677.48	17.95	15.59	2.13	2.17	2.09	2.05	2.05	2.01	1.97
4.66	A	25.00	9516.60	22.64	19.72	2.64	2.64	2.44	2.24	2.13	1.97	1.77
4.66	A	25.00	12165.39	26.26	22.87	3.23	3.23	3.15	2.83	2.64	2.48	2.28
4.67	A	26.00	6328.54	36.61	31.50	2.68	2.52	2.32	2.13	2.01	1.85	1.81
4.67	A	26.00	9009.05	43.98	37.48	2.83	2.72	2.56	2.28	2.09	1.89	1.73
4.67	A	26.00	11657.84	48.15	40.94	3.90	3.78	3.43	3.23	2.87	2.64	2.48
4.67	A	27.00	6249.23	14.72	12.01	2.60	2.48	2.40	1.97	1.81	1.54	1.30
4.67	A	27.00	8993.19	18.43	14.96	3.50	3.31	3.23	2.72	2.40	2.05	1.73
4.67	A	27.00	11594.39	21.57	17.48	4.41	4.17	3.94	3.39	3.03	2.60	2.17
4.67	A	28.00	6836.09	27.20	22.64	1.50	1.46	1.42	1.26	1.22	1.14	1.02
4.67	A	28.00	9897.26	32.40	26.69	1.61	1.69	1.69	1.57	1.46	1.61	1.42
4.67	A	28.00	12815.69	36.26	29.80	1.81	1.81	1.81	1.73	1.57	1.65	1.42
4.67	A	29.00	6328.54	28.82	24.17	2.01	1.93	1.85	1.50	1.42	1.22	0.94
4.67	A	29.00	9183.52	35.08	29.21	2.80	2.83	2.52	2.20	2.05	1.77	1.46
4.67	A	29.00	12006.78	39.69	32.95	3.35	3.19	2.95	2.56	2.24	1.93	1.54
4.68	A	30.00	6455.43	12.72	10.00	11.77	10.67	9.53	7.36	5.28	3.23	1.30
4.68	A	30.00	9056.63	17.17	13.46	15.00	13.62	12.24	9.41	6.77	4.09	1.54
4.68	A	30.00	11372.34	21.89	17.24	16.30	14.80	13.31	10.28	7.36	4.53	1.81
4.68	A	31.00	6740.93	12.09	9.88	1.46	1.46	1.34	1.14	1.06	0.98	0.79
4.68	A	31.00	9595.91	17.17	14.13	2.40	2.24	2.17	1.85	1.65	1.46	1.18
4.68	A	31.00	12355.72	19.84	16.46	2.56	2.40	2.28	2.09	1.89	1.69	1.42
4.68	A	32.00	6328.54	25.31	21.22	1.22	1.18	1.10	0.98	0.94	0.87	0.79
4.68	A	32.00	8898.02	32.80	27.56	1.54	1.50	1.38	1.22	1.22	1.06	0.98
4.68	A	32.00	11324.75	37.99	31.77	2.05	1.93	1.89	1.69	1.61	1.46	1.38
4.68	A	33.00	6138.21	25.83	21.77	1.54	1.46	1.34	1.14	1.14	0.98	0.94
4.68	A	33.00	8755.27	35.04	29.37	2.05	1.97	1.81	1.54	1.54	1.30	1.22
4.68	A	33.00	11229.59	42.40	35.39	2.60	2.44	2.17	1.93	1.93	1.57	1.50
4.69	A	34.00	6407.84	13.11	10.39	3.15	2.87	2.64	2.09	1.61	1.30	0.98

4.69	A	34.00	9104.21	17.13	13.46	4.06	3.70	3.43	2.72	2.09	1.73	1.38
4.69	A	34.00	11768.86	20.28	15.91	4.84	4.45	4.09	3.31	2.56	2.17	1.69
1.31	L	1.00	6471.29	7.44	6.81	5.83	5.12	4.37	3.03	1.97	1.10	0.39
1.31	L	1.00	9183.52	9.88	9.13	7.83	6.85	5.87	4.13	2.64	1.50	0.51
1.31	L	1.00	11721.28	11.89	11.10	9.37	8.15	7.05	4.96	3.15	1.77	0.59
1.31	L	2.00	6518.87	6.26	4.88	4.84	4.06	3.43	2.20	1.18	0.75	1.14
1.31	L	2.00	9278.69	7.60	6.46	5.91	4.96	4.17	2.72	1.46	0.98	1.73
1.31	L	2.00	11848.17	9.29	7.99	7.20	6.10	5.12	3.39	1.85	1.26	2.20
1.31	L	3.00	6645.76	6.46	0.51	4.96	4.29	3.58	2.36	1.38	0.63	0.28
1.31	L	3.00	9389.71	9.17	1.34	7.09	6.02	5.08	3.46	1.97	0.87	0.28
1.31	L	3.00	12054.36	10.83	0.98	8.35	7.20	6.14	4.09	2.40	1.22	0.63
1.31	L	5.00	6851.95	9.57	6.85	7.91	6.97	6.14	4.61	3.23	2.24	1.38
1.31	L	5.00	9643.49	13.03	9.25	10.67	9.33	8.27	6.10	4.29	2.99	1.81
1.31	L	5.00	12197.11	15.94	11.34	12.99	11.42	10.04	7.48	5.28	3.58	2.28
1.32	L	6.00	6296.82	13.94	13.19	11.77	10.67	9.61	7.60	5.79	4.21	2.83
1.32	L	6.00	8913.88	17.68	17.05	14.80	13.35	12.05	9.45	7.09	5.24	3.46
1.32	L	6.00	11356.48	20.43	19.88	17.09	15.39	13.90	10.83	8.11	6.02	3.98
1.32	L	7.00	7200.89	8.66	0.55	6.61	5.51	4.65	2.80	1.22	0.91	1.42
1.32	L	7.00	10151.04	11.57	0.67	8.70	7.32	6.14	3.82	1.73	1.10	1.97
1.32	L	7.00	12990.16	13.98	0.83	10.63	8.98	7.52	4.69	2.13	1.46	2.56
1.32	L	8.00	7026.42	12.68	2.17	9.96	8.46	7.24	5.04	3.27	1.97	1.06
1.32	L	8.00	10087.60	15.35	4.06	12.05	10.39	8.94	6.26	4.06	2.52	1.26
1.32	L	8.00	13132.91	17.72	5.55	13.86	11.97	10.31	7.24	4.72	2.95	1.54
1.33	L	9.00	6614.04	13.58	13.70	11.73	10.67	9.72	7.91	5.91	4.17	2.36
1.33	L	9.00	9310.41	17.76	17.36	15.24	13.90	12.64	10.08	7.52	5.24	2.91
1.33	L	9.00	12006.78	18.90	19.45	16.14	14.76	13.35	10.59	7.83	5.35	3.07
1.33	L	10.00	6756.79	8.27	7.20	6.54	5.59	4.76	3.19	1.85	1.02	1.69
1.33	L	10.00	12260.55	14.25	12.28	11.22	9.65	8.27	5.55	3.27	1.65	2.60
1.33	L	11.00	6820.23	8.58	0.87	7.13	6.42	5.75	4.53	3.50	2.76	1.93
1.33	L	11.00	9659.35	11.10	2.72	9.17	8.31	7.44	5.79	4.53	3.58	2.44
1.33	L	11.00	12339.86	13.11	4.33	10.83	9.72	8.74	6.81	5.28	4.09	2.87
2.01	L	12.00	6867.81	9.09	9.25	7.17	6.22	5.35	3.74	2.40	1.34	0.35
2.01	L	12.00	9643.49	12.76	12.83	10.08	8.82	7.64	5.43	3.62	2.05	0.83
2.01	L	12.00	12339.86	14.88	15.00	11.77	10.24	8.82	6.26	4.09	2.36	0.87
2.18	L	13.00	6947.12	11.26	10.94	8.94	7.80	6.73	4.69	2.99	1.65	0.59
2.18	L	13.00	9786.24	14.53	14.13	11.54	10.04	8.66	6.02	3.78	2.13	0.71
2.18	L	13.00	12450.89	17.13	16.57	13.54	11.73	10.12	7.01	4.41	2.48	0.87
2.36	L	14.00	6503.01	16.69	15.28	13.66	12.17	10.71	7.83	5.35	3.54	2.13
2.36	L	14.00	9120.08	22.83	20.79	18.74	16.61	14.65	10.75	7.44	4.88	2.99
2.36	L	14.00	11515.09	26.46	23.74	21.54	19.06	16.73	12.36	8.50	5.55	3.39
2.50	L	15.00	6265.10	15.87	16.73	12.95	11.54	10.16	7.48	5.28	3.46	1.97
2.50	L	15.00	8882.16	20.51	21.34	16.61	14.80	12.95	9.61	6.77	4.49	2.64
2.50	L	15.00	11419.92	24.02	25.04	19.49	17.24	15.20	11.26	7.91	5.28	3.15
2.68	L	16.00	6090.62	36.14	2.01	30.51	27.64	24.92	19.61	14.65	10.43	6.85
2.68	L	16.00	8580.80	45.24	6.61	38.23	34.57	31.18	24.57	18.31	13.11	8.70
2.68	L	16.00	11848.17	49.92	12.24	42.09	37.99	34.29	26.97	20.04	14.37	9.53
2.85	L	17.00	6154.07	34.21	4.21	29.02	26.54	24.17	19.41	15.20	11.46	8.31
2.85	L	17.00	8723.55	42.09	9.25	35.91	32.68	29.80	23.94	18.66	14.13	10.31
2.85	L	17.00	11150.28	47.56	14.33	40.28	36.57	33.35	26.65	20.67	15.75	11.57
3.00	L	18.00	6360.26	16.89	14.69	13.86	12.36	10.87	8.11	5.91	4.09	2.72

3.00	L	18.00	9135.94	22.01	20.43	17.99	16.02	14.13	10.55	7.68	5.39	3.58
3.00	L	18.00	11626.11	25.91	25.12	21.18	18.86	16.65	12.48	9.13	6.38	4.29
3.18	L	19.00	6598.18	23.54	0.87	19.02	16.73	14.61	10.59	7.17	4.49	2.44
3.18	L	19.00	9373.85	30.00	1.30	24.17	21.18	18.46	13.35	8.94	5.63	3.15
3.18	L	19.00	12197.11	35.12	1.26	28.27	24.72	21.54	15.51	10.39	6.57	3.70
3.33	L	20.00	6915.40	9.06	9.61	7.05	6.10	5.24	3.70	2.60	1.85	1.26
3.33	L	20.00	9754.52	12.48	13.19	9.69	8.39	7.24	5.16	3.66	2.68	1.73
3.33	L	20.00	12355.72	14.88	15.79	11.61	10.08	8.74	6.34	4.49	3.31	2.28
3.49	L	21.00	6614.04	7.87	8.54	6.02	5.12	4.29	2.83	1.69	0.83	0.16
3.49	L	21.00	9310.41	10.47	11.26	8.07	6.89	5.83	3.90	2.32	1.18	0.16
3.49	L	21.00	11990.92	12.72	13.66	9.84	8.43	7.17	4.88	2.99	1.57	0.28
3.85	L	23.00	6614.04	15.04	7.40	12.91	11.81	10.75	8.74	6.77	5.12	3.74
3.85	L	23.00	9453.16	18.35	10.00	15.71	14.33	13.03	10.51	8.11	6.14	4.45
3.85	L	23.00	12260.55	21.14	12.40	18.03	16.46	15.00	12.05	9.33	7.05	5.12
4.00	L	24.00	6899.54	10.98	11.22	8.82	7.76	6.77	4.92	3.35	2.01	0.98
4.00	L	24.00	9738.65	14.88	15.20	11.93	10.51	9.25	6.77	4.65	2.95	1.50
4.00	L	24.00	12419.16	18.15	18.35	14.72	13.03	11.46	8.46	5.91	3.86	2.05
4.66	L	25.00	7026.42	11.77	8.62	9.80	8.90	7.99	6.38	5.04	3.90	2.91
4.66	L	25.00	9992.43	15.31	11.69	12.80	11.57	10.43	8.31	6.57	5.16	3.86
4.66	L	25.00	12752.24	18.27	14.33	15.28	13.82	12.48	10.00	7.99	6.34	4.84
4.67	L	26.00	6566.45	9.96	9.17	8.27	7.40	6.57	5.08	3.78	2.83	2.32
4.67	L	26.00	9310.41	12.95	11.65	10.71	9.61	8.70	6.69	5.08	3.90	3.31
4.67	L	26.00	11768.86	15.28	13.46	12.60	11.30	10.08	7.76	5.79	4.33	3.74
4.67	L	27.00	6740.93	15.12	2.36	12.36	11.06	9.84	7.64	5.79	4.21	2.76
4.67	L	27.00	9484.88	19.33	3.11	15.79	14.13	12.64	9.88	7.60	5.51	3.70
4.67	L	27.00	12117.80	22.52	3.70	18.46	16.57	14.84	11.69	9.06	6.69	4.49
4.67	L	28.00	6376.12	8.98	7.17	7.24	6.42	5.67	4.29	3.15	2.13	1.26
4.67	L	28.00	9024.91	11.50	8.74	9.25	8.19	7.24	5.47	4.06	2.83	1.61
4.67	L	28.00	11530.95	13.94	10.51	11.26	10.08	8.90	6.81	5.16	3.70	2.24
4.67	L	29.00	6328.54	18.86	2.20	15.91	14.45	12.99	10.12	7.64	5.39	3.07
4.67	L	29.00	9135.94	22.36	2.99	18.70	16.85	15.12	11.69	8.46	5.59	2.68
4.67	L	29.00	11800.58	25.59	3.86	21.34	19.41	17.40	13.43	9.80	6.46	3.11
4.68	L	30.00	6677.48	11.54	12.68	9.41	8.31	7.24	5.16	3.19	1.54	0.16
4.68	L	30.00	9357.99	14.88	16.38	12.17	10.83	9.53	6.81	4.41	2.32	0.59
4.68	L	30.00	11943.33	17.68	19.57	14.45	12.76	11.22	8.03	5.04	2.40	0.43
4.68	L	31.00	6709.20	12.36	1.42	10.16	9.13	8.15	6.34	4.92	3.70	2.56
4.68	L	31.00	9421.43	16.22	2.05	13.35	12.01	10.75	8.46	6.61	5.00	3.50
4.68	L	31.00	12022.64	19.41	2.60	16.02	14.41	12.87	10.20	8.07	6.14	4.33
4.68	L	32.00	6598.18	11.30	6.89	9.13	8.19	7.17	5.39	3.98	2.80	1.97
4.68	L	32.00	9405.57	14.69	8.66	11.93	10.67	9.41	7.20	5.43	3.90	2.80
4.68	L	32.00	12070.22	17.28	11.14	14.06	12.48	11.06	8.39	6.18	4.41	3.11
4.68	L	33.00	6693.34	4.53	4.61	3.54	3.07	2.68	1.93	1.42	1.06	0.79
4.68	L	33.00	9453.16	6.26	6.26	4.88	4.29	3.74	2.72	2.01	1.46	1.10
4.68	L	33.00	12070.22	7.76	7.60	6.06	5.28	4.61	3.43	2.52	1.81	1.38
4.69	L	34.00	6614.04	8.50	7.20	6.77	5.91	5.16	3.66	2.52	1.57	0.87
4.69	L	34.00	9310.41	10.75	9.17	8.54	7.48	6.57	4.72	3.31	2.24	1.50
4.69	L	34.00	11816.45	12.99	11.34	10.31	9.06	7.87	5.67	3.98	2.80	1.85
1.30	**M**	**1.00**	**6709.20**	**3.58**	**2.76**	**4.13**	**4.41**	**4.69**	**5.39**	**6.10**	**0.63**	**0.59**
1.30	**M**	**1.00**	**9453.16**	**5.16**	**4.06**	**5.94**	**6.30**	**6.69**	**7.60**	**8.46**	**0.79**	**0.63**
1.30	**M**	**1.00**	**12228.83**	**6.65**	**5.35**	**7.56**	**8.03**	**8.50**	**9.53**	**10.55**	**0.87**	**0.75**

1.31	M	2.00	6376.12	2.56	2.24	2.60	2.60	2.68	2.72	2.87	0.20	0.20
1.31	M	2.00	9167.66	3.82	3.35	3.82	3.82	3.82	3.94	4.13	0.28	0.24
1.31	M	2.00	11673.70	5.04	4.49	5.04	5.04	5.08	5.16	5.28	0.43	0.39
1.31	M	3.00	7121.59	2.68	2.28	2.72	2.80	2.87	3.15	3.43	0.35	0.31
1.31	M	3.00	10055.87	3.98	3.50	4.06	4.06	4.17	4.45	4.76	0.39	0.35
1.31	M	3.00	12879.13	5.16	4.57	5.20	5.24	5.35	5.63	5.94	0.55	0.51
1.31	M	4.00	6788.51	3.50	3.82	2.83	2.48	2.17	1.54	1.02	0.71	0.35
1.31	M	4.00	9564.18	5.04	5.51	4.13	3.62	3.15	2.28	1.57	1.06	0.51
1.31	M	4.00	12212.97	6.54	7.13	5.35	4.72	4.17	3.07	2.13	1.42	0.71
1.31	M	5.00	6740.93	9.13	7.13	6.69	6.02	5.43	4.17	3.07	2.28	1.50
1.31	M	5.00	9580.04	12.32	9.61	9.02	8.07	7.28	5.67	4.13	3.03	2.01
1.31	M	5.00	12133.67	15.04	11.73	10.91	9.80	8.82	6.85	5.00	3.66	2.44
1.31	M	6.00	6677.48	2.48	2.24	2.36	2.32	2.28	2.24	2.28	2.32	2.40
1.31	M	6.00	9548.32	3.58	3.27	3.43	3.39	3.31	3.27	3.27	3.35	3.39
1.31	M	6.00	12181.25	4.65	4.29	4.49	4.37	4.29	4.21	4.21	4.29	4.45
1.32	M	7.00	6645.76	4.25	4.25	3.15	2.68	2.20	1.30	0.71	0.94	1.50
1.32	M	7.00	9437.30	5.91	5.87	4.45	3.74	3.07	1.85	0.87	1.42	1.97
1.32	M	7.00	11990.92	7.64	7.36	5.83	4.88	4.02	2.40	1.38	2.09	2.80
1.32	M	8.00	7137.45	3.11	2.68	3.35	3.50	3.70	4.06	0.35	0.35	0.31
1.32	M	8.00	10087.60	4.57	3.90	4.80	4.96	5.20	5.63	0.47	0.43	0.39
1.32	M	8.00	12894.99	6.02	5.16	6.26	6.42	6.61	7.13	0.59	0.47	0.55
1.32	M	9.00	7375.37	2.95	2.44	3.07	2.87	2.72	2.72	2.91	3.07	3.19
1.32	M	9.00	10595.15	4.17	3.43	4.33	4.06	3.90	3.94	4.17	4.41	4.61
1.32	M	9.00	13577.02	5.20	4.33	5.28	4.96	4.80	4.69	4.80	4.92	5.08
1.33	M	10.00	7200.89	2.68	2.91	2.24	2.05	1.81	1.42	1.10	0.91	0.63
1.33	M	10.00	10151.04	3.86	4.06	3.19	2.83	2.56	2.01	1.54	1.18	0.79
1.33	M	10.00	13006.02	5.24	5.59	4.37	3.90	3.50	2.72	2.05	1.42	0.87
1.33	M	11.00	6851.95	3.07	2.56	3.50	3.70	3.94	4.37	4.88	1.81	1.61
1.33	M	11.00	9659.35	4.45	3.74	4.88	5.12	5.35	5.87	6.42	0.08	0.04
1.33	M	11.00	12339.86	5.51	4.61	5.98	6.18	6.42	6.97	7.56	0.24	0.16
2.00	M	12.00	6836.09	1.93	1.77	1.77	1.65	1.50	1.22	1.06	0.91	0.63
2.00	M	12.00	9516.60	2.64	2.36	2.36	2.24	2.05	1.69	1.42	1.18	0.98
2.00	M	12.00	12086.08	3.46	3.19	3.19	2.95	2.76	2.32	1.93	1.61	1.30
2.18	M	13.00	6439.57	3.90	3.66	3.70	3.54	3.35	2.95	2.56	2.20	1.85
2.18	M	13.00	9040.77	5.43	5.04	5.08	4.84	4.61	4.06	3.50	2.99	2.56
2.18	M	13.00	11483.36	6.73	6.30	6.38	6.14	5.79	5.08	4.41	3.78	3.23
2.36	M	14.00	6740.93	2.64	2.44	2.36	2.17	2.05	1.65	1.38	1.06	0.91
2.36	M	14.00	9580.04	3.70	3.50	3.39	3.15	2.91	2.44	2.01	1.65	1.34
2.36	M	14.00	12212.97	4.76	4.45	4.33	4.02	3.74	3.15	2.56	2.13	1.73
2.49	M	15.00	6883.67	3.31	3.11	3.11	2.95	2.72	2.40	2.05	1.77	1.46
2.49	M	15.00	9659.35	4.76	4.49	4.45	4.21	3.98	3.43	2.95	2.56	2.09
2.49	M	15.00	12355.72	6.10	5.71	5.71	5.43	5.12	4.49	3.82	3.27	2.72
2.67	M	16.00	6455.43	3.66	3.94	3.19	2.91	2.80	2.40	2.13	1.93	1.73
2.67	M	16.00	9167.66	4.96	5.43	4.41	4.13	3.86	3.46	3.11	2.83	2.64
2.67	M	16.00	11784.72	6.22	6.85	5.59	5.20	4.92	4.37	3.94	3.62	3.35
2.85	M	17.00	6471.29	10.51	7.68	8.58	7.64	6.77	5.20	3.86	2.56	1.85
2.85	M	17.00	9167.66	14.45	10.59	11.73	10.39	9.21	7.09	5.24	3.70	2.56
2.85	M	17.00	11657.84	17.28	12.72	13.98	12.36	10.98	8.35	6.18	4.49	3.11
3.00	M	18.00	6804.37	3.23	3.03	3.11	2.91	2.80	2.48	2.20	1.93	1.61
3.00	M	18.00	9532.46	4.57	4.25	4.33	4.09	3.90	3.50	3.11	2.72	2.28

3.00	M	18.00	12165.39	5.75	5.35	5.43	5.20	4.96	4.45	3.90	3.50	2.95
3.18	M	19.00	6788.51	1.61	1.50	1.46	1.34	1.30	1.18	1.18	1.18	1.26
3.18	M	19.00	9564.18	2.36	2.17	2.09	1.93	1.81	1.65	1.57	1.57	1.73
3.18	M	19.00	12165.39	3.07	2.83	2.72	2.56	2.36	2.13	2.01	2.01	2.17
3.32	M	20.00	6978.84	2.17	2.05	2.01	1.89	1.73	1.46	1.26	1.10	0.87
3.32	M	20.00	9897.26	3.11	2.91	2.91	2.72	2.52	2.09	1.77	1.57	1.26
3.32	M	20.00	12609.50	4.09	3.70	3.70	3.43	3.19	2.68	2.24	1.93	1.61
3.49	M	21.00	6947.12	2.48	2.20	2.20	1.97	1.77	1.42	1.06	0.79	0.55
3.49	M	21.00	9786.24	3.62	3.19	3.19	2.87	2.64	2.09	1.57	1.18	0.83
3.49	M	21.00	12609.50	4.61	4.02	4.02	3.66	3.31	2.64	1.97	1.50	1.02
3.74	M	22.00	6804.37	3.58	3.94	3.11	3.03	2.87	2.72	2.72	2.91	2.91
3.74	M	22.00	9595.91	5.08	5.55	4.49	4.33	4.13	3.98	3.98	4.13	4.17
3.74	M	22.00	12308.14	6.34	6.85	5.71	5.47	5.31	5.28	5.35	5.63	5.83
3.85	M	23.00	6947.12	2.32	2.28	2.13	2.01	1.81	1.46	1.22	0.98	0.71
3.85	M	23.00	9817.96	3.62	3.27	3.35	3.15	2.99	2.56	2.17	1.85	1.46
3.85	M	23.00	12482.61	4.57	4.17	4.25	4.06	3.82	3.31	2.76	2.32	1.89
4.00	M	24.00	6915.40	2.83	2.68	2.64	2.48	2.28	1.93	1.61	1.34	1.14
4.00	M	24.00	9691.07	4.06	3.82	3.78	3.54	3.35	2.80	2.32	2.01	1.50
4.00	M	24.00	12276.41	5.20	4.88	4.84	4.57	4.29	3.66	3.07	2.52	2.13
4.66	M	25.00	6756.79	6.50	6.97	5.94	5.63	5.39	4.88	4.45	4.02	3.62
4.66	M	25.00	9469.02	10.00	10.79	9.21	8.74	8.31	7.64	7.01	5.98	5.55
4.66	M	25.00	11990.92	11.34	12.28	10.39	9.84	9.33	8.39	7.52	6.77	5.91
4.66	M	26.00	6740.93	6.10	5.75	6.57	6.81	7.13	7.64	8.39	9.21	9.88
4.66	M	26.00	9516.60	7.95	7.36	8.70	9.09	9.53	10.43	11.61	12.72	13.82
4.66	M	26.00	12212.97	9.88	9.17	10.75	11.26	11.77	12.91	14.33	15.71	17.09
4.67	M	27.00	6534.73	6.02	5.87	5.16	4.65	4.17	3.19	2.24	1.57	1.26
4.67	M	27.00	9231.10	8.31	8.07	7.13	6.42	5.75	4.37	2.99	2.13	1.69
4.67	M	27.00	11753.00	10.28	9.92	8.74	7.83	7.01	5.24	3.46	2.40	2.28
4.67	M	28.00	6693.34	4.76	5.08	4.61	4.49	4.45	4.37	4.45	4.49	4.57
4.67	M	28.00	9437.30	6.06	6.42	5.83	5.71	5.67	5.63	5.79	5.94	6.14
4.67	M	28.00	11959.19	7.76	8.27	7.36	7.24	7.13	7.05	7.17	7.28	7.52
4.67	M	29.00	6487.15	3.90	4.06	3.74	3.62	3.58	3.54	3.58	3.70	3.82
4.67	M	29.00	9104.21	5.67	5.91	5.47	5.35	5.31	5.31	5.43	5.59	5.79
4.67	M	29.00	11673.70	7.87	8.19	7.64	7.60	7.60	7.64	7.99	8.39	8.86
4.68	M	30.00	6836.09	5.51	5.39	5.79	5.87	5.98	6.18	5.98	5.00	3.98
4.68	M	30.00	9580.04	7.68	7.28	7.99	8.27	8.43	8.74	8.27	6.93	5.59
4.68	M	30.00	12244.69	9.80	9.25	10.20	10.47	10.71	11.22	9.84	8.27	6.69
4.68	M	31.00	6598.18	4.65	5.20	4.13	3.78	3.46	2.83	2.24	1.73	0.67
4.68	M	31.00	9231.10	6.50	7.13	5.75	5.31	4.92	4.09	3.35	2.60	1.02
4.68	M	31.00	11689.56	8.11	8.78	7.24	6.73	6.30	5.31	4.41	3.58	1.34
4.68	M	32.00	6740.93	5.04	3.98	6.06	6.69	7.20	8.27	9.61	1.14	1.02
4.68	M	32.00	9469.02	6.85	5.39	8.23	9.06	9.72	11.22	12.99	1.50	1.34
4.68	M	32.00	12054.36	8.54	6.77	10.20	11.22	12.05	13.86	15.98	1.73	1.57
4.68	M	33.00	6740.93	1.97	1.73	1.85	1.81	1.73	1.54	1.46	1.22	1.26
4.68	M	33.00	9580.04	3.31	3.03	3.15	3.07	2.95	2.72	2.56	2.44	2.28
4.68	M	33.00	12260.55	4.06	3.70	3.86	3.70	3.58	3.27	2.99	2.76	2.64
4.69	M	34.00	6439.57	2.32	2.17	1.81	1.57	1.34	0.98	0.75	0.55	0.59
4.69	M	34.00	9135.94	3.31	3.11	2.64	2.28	1.97	1.46	1.06	0.79	0.83
4.69	M	34.00	11689.56	4.21	3.94	3.35	2.91	2.56	1.85	1.30	0.91	0.98

Table 9. Normalized (9000-lb) deflection data – I-78 (English units).

Station	TestType	JointNo	Load#	D1	D2	D3	D4	D5	D6	D7	D8	D9
1.31	A	1.00	9000.00	19.53	15.11	3.20	2.98	2.59	1.93	1.38	0.94	0.50
1.31	A	1.00	9000.00	18.29	14.12	2.91	2.60	2.36	1.77	1.30	0.90	0.51
1.31	A	1.00	9000.00	16.96	13.18	2.63	2.41	2.20	1.70	1.30	0.90	0.56
1.31	A	2.00	9000.00	14.65	10.95	2.65	2.27	1.99	1.55	1.05	0.72	0.77
1.31	A	2.00	9000.00	12.83	9.55	3.04	2.66	2.32	1.75	1.18	0.72	0.49
1.31	A	2.00	9000.00	11.51	8.61	3.51	3.02	2.66	2.02	1.35	0.85	0.59
1.31	A	3.00	9000.00	34.00	26.75	0.82	0.71	0.71	0.54	0.49	0.44	0.38
1.31	A	3.00	9000.00	28.74	22.30	0.79	0.72	0.68	0.57	0.49	0.38	0.34
1.31	A	3.00	9000.00	25.08	19.43	0.88	0.83	0.80	0.66	0.57	0.46	0.40
1.32	A	6.00	9000.00	31.32	25.13	5.80	5.42	4.98	4.11	3.39	2.68	1.97
1.32	A	6.00	9000.00	28.03	22.30	4.59	4.29	3.98	3.38	2.77	2.31	1.78
1.32	A	6.00	9000.00	24.90	19.72	3.78	3.55	3.32	2.76	2.33	1.98	1.51
1.32	A	7.00	9000.00	20.09	15.32	0.97	0.82	0.82	0.67	0.61	0.46	0.46
1.32	A	7.00	9000.00	16.92	12.79	1.01	0.86	0.83	0.68	0.57	0.47	0.36
1.32	A	7.00	9000.00	14.98	11.35	0.94	0.83	0.78	0.64	0.55	0.44	0.33
1.32	A	8.00	9000.00	9.33	14.89	7.50	6.55	5.66	4.02	2.63	1.69	0.94
1.32	A	8.00	9000.00	8.75	13.11	7.05	6.16	5.39	3.80	2.56	1.66	0.97
1.32	A	8.00	9000.00	8.57	12.04	6.84	5.98	5.19	3.73	2.52	1.65	0.97
1.33	A	9.00	9000.00	39.66	31.84	3.18	2.81	2.43	1.67	1.19	1.08	1.08
1.33	A	9.00	9000.00	31.85	25.46	2.78	2.44	2.14	1.50	1.13	1.05	0.94
1.33	A	9.00	9000.00	27.40	21.78	2.40	2.11	1.84	1.26	0.91	0.94	0.76
1.33	A	10.00	9000.00	10.23	8.04	8.75	7.79	6.82	5.14	3.51	2.14	0.87
1.33	A	10.00	9000.00	9.95	7.80	8.67	7.69	6.74	4.99	3.35	1.97	0.69
1.33	A	10.00	9000.00	9.55	7.41	8.23	7.35	6.47	4.76	3.25	1.99	0.83
1.33	A	11.00	9000.00	19.84	15.17	1.11	1.06	0.94	0.94	0.94	0.89	0.78
1.33	A	11.00	9000.00	17.59	13.39	1.21	1.17	1.09	1.05	1.01	0.90	0.82
1.33	A	11.00	9000.00	15.90	12.15	0.94	0.91	0.82	0.76	0.73	0.67	0.60
2.01	A	12.00	9000.00	12.93	10.16	11.91	10.64	9.36	7.02	5.00	3.35	1.86
2.01	A	12.00	9000.00	12.18	9.60	11.24	10.05	8.93	6.69	4.74	3.21	1.79
2.01	A	12.00	9000.00	11.45	8.97	10.51	9.35	8.33	6.26	4.40	2.94	1.75
2.18	A	13.00	9000.00	15.02	12.20	13.27	11.89	10.61	8.07	5.73	3.82	2.18
2.18	A	13.00	9000.00	14.00	11.42	12.29	11.00	9.79	7.40	5.27	3.53	2.01
2.18	A	13.00	9000.00	13.20	10.69	11.47	10.24	9.08	6.87	4.84	3.26	1.82
2.36	A	14.00	9000.00	23.03	19.08	20.95	19.08	17.26	13.57	10.15	7.32	4.81
2.36	A	14.00	9000.00	22.11	18.05	20.12	18.24	16.52	13.07	9.77	7.05	4.67
2.36	A	14.00	9000.00	20.35	16.57	18.32	16.63	15.03	11.86	8.85	6.31	4.23
2.50	A	15.00	9000.00	56.03	47.65	5.05	4.69	4.22	3.15	2.44	1.78	1.37
2.50	A	15.00	9000.00	51.14	43.07	3.72	3.46	3.13	2.41	1.98	1.60	1.18
2.50	A	15.00	9000.00	44.28	37.09	1.72	1.66	1.23	1.06	0.93	0.80	0.56
2.68	A	16.00	9000.00	39.74	32.77	1.98	1.87	1.87	1.48	1.21	0.93	0.71
2.68	A	16.00	9000.00	34.70	28.26	1.37	1.29	1.21	0.95	0.80	0.64	0.46
2.68	A	16.00	9000.00	30.20	24.43	1.19	1.13	1.04	0.81	0.67	0.58	0.44
2.85	A	17.00	9000.00	37.81	31.67	3.63	3.38	3.14	2.56	2.08	1.74	1.11
2.85	A	17.00	9000.00	34.18	28.36	3.46	3.18	2.94	2.46	2.02	1.61	1.20
2.85	A	17.00	9000.00	31.18	25.69	3.43	3.16	2.95	2.46	2.03	1.62	1.19
3.00	A	18.00	9000.00	55.74	47.24	6.38	5.81	5.24	4.16	3.31	2.17	1.60
3.00	A	18.00	9000.00	50.08	42.10	6.10	5.61	5.07	4.05	3.15	2.33	1.60
3.00	A	18.00	9000.00	44.61	37.20	5.44	4.99	4.50	3.59	2.78	2.10	1.42

3.18	A	19.00	9000.00	34.15	27.63	1.07	1.02	0.86	0.80	0.86	0.75	0.59
3.18	A	19.00	9000.00	6.98	34.67	5.92	5.34	4.77	3.66	2.70	1.88	1.16
3.18	A	19.00	9000.00	28.52	23.05	1.09	1.01	0.94	0.82	0.82	0.71	0.60
3.18	A	19.00	9000.00	8.17	30.41	6.88	6.17	5.59	4.27	3.12	2.14	1.36
3.18	A	19.00	9000.00	24.63	19.81	1.02	1.02	0.90	0.81	0.78	0.70	0.55
3.18	A	19.00	9000.00	9.69	24.22	8.10	7.25	6.54	5.00	3.63	2.51	1.54
3.32	A	20.00	9000.00	29.91	24.56	4.24	4.02	3.44	2.75	2.17	1.75	1.38
3.32	A	20.00	9000.00	26.49	21.66	3.85	3.62	3.25	2.60	2.11	1.66	1.32
3.32	A	20.00	9000.00	23.84	19.49	3.62	3.35	3.02	2.49	2.04	1.65	1.29
3.49	A	21.00	9000.00	48.40	39.66	0.90	0.73	0.62	0.45	0.28	0.23	0.23
3.49	A	21.00	9000.00	38.91	31.63	0.57	0.46	0.42	0.30	0.23	0.19	0.08
3.49	A	21.00	9000.00	32.17	26.04	0.48	0.37	0.37	0.25	0.17	0.14	0.08
3.74	A	22.00	9000.00	30.11	23.48	2.99	2.88	2.66	2.28	2.01	1.68	1.41
3.74	A	22.00	9000.00	26.14	20.38	2.07	1.92	1.73	1.35	1.13	0.83	0.56
3.74	A	22.00	9000.00	23.69	18.44	2.27	2.18	2.09	1.69	1.46	1.20	0.98
3.85	A	23.00	9000.00	14.64	11.15	6.41	5.88	5.41	4.40	3.44	2.63	1.72
3.85	A	23.00	9000.00	14.15	10.81	6.16	5.65	5.09	4.17	3.30	2.38	1.86
3.85	A	23.00	9000.00	13.49	10.31	5.27	4.86	4.42	3.69	2.93	2.20	1.74
4.00	A	24.00	9000.00	26.93	22.40	9.29	8.24	7.35	5.42	3.82	2.38	1.22
4.00	A	24.00	9000.00	24.20	19.94	7.54	6.70	5.98	4.53	3.27	2.17	1.33
4.00	A	24.00	9000.00	21.35	17.55	6.53	5.80	5.19	4.00	2.90	2.00	1.25
4.66	A	25.00	9000.00	24.20	21.01	2.87	2.92	2.81	2.76	2.76	2.71	2.65
4.66	A	25.00	9000.00	21.41	18.65	2.49	2.49	2.31	2.12	2.01	1.86	1.68
4.66	A	25.00	9000.00	19.43	16.92	2.39	2.39	2.33	2.10	1.95	1.83	1.69
4.67	A	26.00	9000.00	52.07	44.79	3.81	3.58	3.30	3.02	2.86	2.63	2.58
4.67	A	26.00	9000.00	43.93	37.44	2.83	2.71	2.56	2.28	2.08	1.89	1.73
4.67	A	26.00	9000.00	37.17	31.61	3.01	2.92	2.64	2.49	2.22	2.04	1.91
4.67	A	27.00	9000.00	21.21	17.29	3.74	3.57	3.46	2.83	2.61	2.21	1.87
4.67	A	27.00	9000.00	18.44	14.97	3.51	3.31	3.23	2.72	2.40	2.05	1.73
4.67	A	27.00	9000.00	16.75	13.57	3.42	3.24	3.06	2.63	2.35	2.02	1.68
4.67	A	28.00	9000.00	35.82	29.80	1.97	1.92	1.87	1.66	1.61	1.50	1.35
4.67	A	28.00	9000.00	29.46	24.27	1.47	1.54	1.54	1.43	1.32	1.47	1.29
4.67	A	28.00	9000.00	25.46	20.93	1.27	1.27	1.27	1.22	1.11	1.16	1.00
4.67	A	29.00	9000.00	40.98	34.38	2.86	2.74	2.63	2.13	2.02	1.74	1.34
4.67	A	29.00	9000.00	34.38	28.63	2.74	2.78	2.47	2.16	2.01	1.74	1.43
4.67	A	29.00	9000.00	29.75	24.70	2.51	2.39	2.21	1.92	1.68	1.45	1.15
4.68	A	30.00	9000.00	17.73	13.94	16.41	14.87	13.28	10.26	7.36	4.50	1.81
4.68	A	30.00	9000.00	17.06	13.38	14.91	13.54	12.17	9.35	6.73	4.07	1.53
4.68	A	30.00	9000.00	17.32	13.65	12.90	11.72	10.53	8.13	5.83	3.58	1.43
4.68	A	31.00	9000.00	16.14	13.19	1.94	1.94	1.79	1.52	1.42	1.31	1.05
4.68	A	31.00	9000.00	16.10	13.26	2.25	2.10	2.03	1.74	1.55	1.37	1.11
4.68	A	31.00	9000.00	14.45	11.99	1.86	1.75	1.66	1.52	1.38	1.23	1.03
4.68	A	32.00	9000.00	36.00	30.18	1.74	1.68	1.57	1.40	1.34	1.23	1.12
4.68	A	32.00	9000.00	33.17	27.87	1.55	1.51	1.39	1.23	1.23	1.08	1.00
4.68	A	32.00	9000.00	30.19	25.25	1.63	1.53	1.50	1.35	1.28	1.16	1.10
4.68	A	33.00	9000.00	37.87	31.92	2.25	2.14	1.96	1.67	1.67	1.44	1.39
4.68	A	33.00	9000.00	36.02	30.19	2.10	2.02	1.86	1.58	1.58	1.34	1.25
4.68	A	33.00	9000.00	33.98	28.37	2.08	1.96	1.74	1.55	1.55	1.26	1.20
4.69	A	34.00	9000.00	18.41	14.60	4.42	4.04	3.70	2.93	2.27	1.82	1.38
4.69	A	34.00	9000.00	16.93	13.31	4.01	3.66	3.39	2.69	2.06	1.71	1.36

4.69	A	34.00	9000.00	15.51	12.16	3.70	3.40	3.13	2.53	1.96	1.66	1.29
1.31	L	1.00	9000.00	10.35	9.47	8.10	7.12	6.08	4.22	2.74	1.53	0.55
1.31	L	1.00	9000.00	9.68	8.95	7.68	6.71	5.75	4.05	2.59	1.47	0.50
1.31	L	1.00	9000.00	9.13	8.52	7.19	6.26	5.41	3.81	2.42	1.36	0.45
1.31	L	2.00	9000.00	8.64	6.74	6.69	5.60	4.73	3.04	1.63	1.03	1.58
1.31	L	2.00	9000.00	7.37	6.26	5.73	4.81	4.05	2.63	1.41	0.95	1.68
1.31	L	2.00	9000.00	7.06	6.07	5.47	4.64	3.89	2.57	1.41	0.96	1.67
1.31	L	3.00	9000.00	8.74	0.69	6.72	5.81	4.85	3.20	1.87	0.85	0.37
1.31	L	3.00	9000.00	8.79	1.28	6.79	5.77	4.87	3.32	1.89	0.83	0.26
1.31	L	3.00	9000.00	8.08	0.73	6.23	5.38	4.59	3.06	1.79	0.91	0.47
1.31	L	5.00	9000.00	12.57	9.00	10.39	9.15	8.07	6.05	4.24	2.95	1.81
1.31	L	5.00	9000.00	12.16	8.63	9.96	8.71	7.72	5.70	4.00	2.79	1.69
1.31	L	5.00	9000.00	11.77	8.37	9.59	8.42	7.41	5.52	3.89	2.64	1.68
1.32	L	6.00	9000.00	19.92	18.85	16.83	15.25	13.73	10.86	8.27	6.02	4.05
1.32	L	6.00	9000.00	17.85	17.21	14.95	13.48	12.16	9.54	7.16	5.29	3.50
1.32	L	6.00	9000.00	16.19	15.76	13.54	12.20	11.01	8.58	6.43	4.77	3.15
1.32	L	7.00	9000.00	10.83	0.69	8.27	6.89	5.81	3.49	1.53	1.13	1.77
1.32	L	7.00	9000.00	10.26	0.59	7.71	6.49	5.45	3.39	1.54	0.98	1.75
1.32	L	7.00	9000.00	9.68	0.57	7.36	6.22	5.21	3.25	1.47	1.01	1.77
1.32	L	8.00	9000.00	16.24	2.77	12.76	10.84	9.28	6.45	4.19	2.52	1.36
1.32	L	8.00	9000.00	13.70	3.62	10.75	9.27	7.97	5.58	3.62	2.25	1.12
1.32	L	8.00	9000.00	12.14	3.80	9.50	8.20	7.07	4.96	3.24	2.02	1.05
1.33	L	9.00	9000.00	18.48	18.64	15.96	14.52	13.23	10.77	8.04	5.68	3.21
1.33	L	9.00	9000.00	17.16	16.78	14.73	13.43	12.22	9.74	7.27	5.06	2.82
1.33	L	9.00	9000.00	14.17	14.58	12.10	11.07	10.00	7.94	5.87	4.01	2.30
1.33	L	10.00	9000.00	11.01	9.60	8.71	7.45	6.35	4.25	2.46	1.36	2.25
1.33	0.00	10.00	9000.00	10.95	9.39	8.54	7.32	6.25	4.22	2.44	1.29	2.15
1.33	L	10.00	9000.00	10.46	9.02	8.24	7.08	6.07	4.07	2.40	1.21	1.91
1.33	L	11.00	9000.00	11.33	1.14	9.40	8.47	7.59	5.97	4.62	3.64	2.55
1.33	L	11.00	9000.00	10.34	2.53	8.55	7.74	6.93	5.39	4.22	3.34	2.27
1.33	L	11.00	9000.00	9.56	3.16	7.90	7.09	6.37	4.97	3.85	2.99	2.10
2.01	L	12.00	9000.00	11.92	12.12	9.39	8.15	7.02	4.90	3.15	1.75	0.46
2.01	L	12.00	9000.00	11.90	11.98	9.41	8.23	7.13	5.07	3.38	1.91	0.77
2.01	L	12.00	9000.00	10.85	10.94	8.59	7.47	6.43	4.57	2.99	1.72	0.63
2.18	L	13.00	9000.00	14.59	14.18	11.58	10.10	8.72	6.07	3.88	2.14	0.77
2.18	L	13.00	9000.00	13.36	13.00	10.61	9.23	7.97	5.54	3.48	1.96	0.65
2.18	L	13.00	9000.00	12.38	11.98	9.79	8.48	7.31	5.07	3.19	1.79	0.63
2.36	L	14.00	9000.00	23.10	21.14	18.91	16.84	14.82	10.84	7.41	4.90	2.94
2.36	L	14.00	9000.00	22.53	20.51	18.49	16.40	14.45	10.61	7.34	4.82	2.95
2.36	L	14.00	9000.00	20.68	18.55	16.83	14.89	13.08	9.66	6.65	4.34	2.65
2.50	L	15.00	9000.00	22.79	24.04	18.61	16.57	14.59	10.75	7.58	4.98	2.83
2.50	L	15.00	9000.00	20.78	21.62	16.83	15.00	13.12	9.73	6.86	4.55	2.67
2.50	L	15.00	9000.00	18.93	19.73	15.36	13.59	11.98	8.87	6.24	4.16	2.48
2.68	L	16.00	9000.00	53.41	2.97	45.09	40.84	36.83	28.97	21.64	15.42	10.12
2.68	L	16.00	9000.00	47.45	6.94	40.10	36.26	32.70	25.77	19.20	13.75	9.13
2.68	L	16.00	9000.00	37.92	9.30	31.97	28.86	26.05	20.49	15.22	10.92	7.24
2.85	L	17.00	9000.00	50.03	6.16	42.43	38.81	35.35	28.39	22.22	16.75	12.15
2.85	L	17.00	9000.00	43.42	9.55	37.04	33.71	30.75	24.70	19.25	14.58	10.64
2.85	L	17.00	9000.00	38.39	11.57	32.51	29.52	26.92	21.51	16.68	12.71	9.34
3.00	L	18.00	9000.00	23.90	20.78	19.61	17.49	15.38	11.48	8.36	5.79	3.84

3.00	L	18.00	9000.00	21.68	20.13	17.72	15.79	13.92	10.39	7.56	5.31	3.53
3.00	L	18.00	9000.00	20.05	19.44	16.40	14.60	12.89	9.66	7.07	4.94	3.32
3.18	L	19.00	9000.00	32.11	1.18	25.94	22.82	19.92	14.45	9.77	6.12	3.33
3.18	L	19.00	9000.00	28.80	1.25	23.21	20.34	17.73	12.81	8.58	5.41	3.02
3.18	L	19.00	9000.00	25.91	0.93	20.86	18.24	15.89	11.45	7.67	4.85	2.73
3.33	L	20.00	9000.00	11.78	12.50	9.17	7.94	6.81	4.82	3.38	2.41	1.64
3.33	L	20.00	9000.00	11.51	12.17	8.94	7.74	6.68	4.76	3.38	2.47	1.60
3.33	L	20.00	9000.00	10.84	11.50	8.46	7.34	6.37	4.62	3.27	2.41	1.66
3.49	L	21.00	9000.00	10.71	11.63	8.20	6.96	5.84	3.86	2.30	1.13	0.21
3.49	L	21.00	9000.00	10.12	10.88	7.80	6.66	5.63	3.77	2.25	1.14	0.15
3.49	L	21.00	9000.00	9.54	10.25	7.39	6.32	5.38	3.66	2.25	1.18	0.21
3.85	L	23.00	9000.00	20.46	10.07	17.57	16.07	14.63	11.89	9.21	6.96	5.09
3.85	L	23.00	9000.00	17.47	9.52	14.96	13.64	12.41	10.01	7.72	5.85	4.24
3.85	L	23.00	9000.00	15.52	9.10	13.24	12.08	11.01	8.84	6.85	5.17	3.76
4.00	L	24.00	9000.00	14.33	14.64	11.50	10.12	8.83	6.42	4.37	2.62	1.28
4.00	L	24.00	9000.00	13.75	14.04	11.02	9.71	8.55	6.26	4.29	2.73	1.38
4.00	L	24.00	9000.00	13.15	13.30	10.67	9.44	8.30	6.13	4.28	2.80	1.48
4.66	L	25.00	9000.00	15.08	11.04	12.56	11.40	10.24	8.17	6.45	4.99	3.73
4.66	L	25.00	9000.00	13.79	10.53	11.52	10.43	9.40	7.48	5.92	4.65	3.48
4.66	L	25.00	9000.00	12.89	10.11	10.78	9.75	8.81	7.06	5.64	4.47	3.42
4.67	L	26.00	9000.00	13.65	12.57	11.33	10.14	9.01	6.96	5.18	3.89	3.18
4.67	L	26.00	9000.00	12.52	11.27	10.35	9.29	8.41	6.47	4.91	3.77	3.20
4.67	L	26.00	9000.00	11.68	10.30	9.63	8.64	7.71	5.93	4.43	3.31	2.86
4.67	L	27.00	9000.00	20.18	3.15	16.51	14.77	13.14	10.20	7.73	5.62	3.68
4.67	L	27.00	9000.00	18.34	2.95	14.98	13.41	11.99	9.38	7.21	5.23	3.51
4.67	L	27.00	9000.00	16.73	2.75	13.71	12.31	11.02	8.68	6.73	4.97	3.33
4.67	L	28.00	9000.00	12.67	10.11	10.23	9.06	8.00	6.06	4.45	3.00	1.78
4.67	L	28.00	9000.00	11.46	8.72	9.23	8.17	7.22	5.46	4.04	2.83	1.61
4.67	L	28.00	9000.00	10.88	8.20	8.79	7.87	6.94	5.32	4.03	2.89	1.75
4.67	L	29.00	9000.00	26.82	3.14	22.62	20.55	18.48	14.39	10.86	7.67	4.37
4.67	L	29.00	9000.00	22.03	2.95	18.42	16.60	14.89	11.52	8.34	5.51	2.64
4.67	L	29.00	9000.00	19.52	2.94	16.27	14.80	13.27	10.24	7.48	4.92	2.37
4.68	L	30.00	9000.00	15.55	17.09	12.68	11.20	9.76	6.95	4.30	2.07	0.21
4.68	L	30.00	9000.00	14.31	15.75	11.70	10.41	9.16	6.55	4.24	2.23	0.57
4.68	L	30.00	9000.00	13.32	14.74	10.89	9.61	8.46	6.05	3.80	1.81	0.33
4.68	L	31.00	9000.00	16.58	1.90	13.63	12.25	10.93	8.50	6.60	4.96	3.43
4.68	L	31.00	9000.00	15.49	1.96	12.75	11.47	10.27	8.09	6.32	4.78	3.35
4.68	L	31.00	9000.00	14.53	1.95	12.00	10.79	9.64	7.63	6.04	4.60	3.24
4.68	L	32.00	9000.00	15.41	9.40	12.46	11.17	9.77	7.36	5.42	3.81	2.69
4.68	L	32.00	9000.00	14.05	8.29	11.41	10.21	9.00	6.89	5.20	3.73	2.67
4.68	L	32.00	9000.00	12.89	8.31	10.48	9.31	8.25	6.25	4.61	3.29	2.32
4.68	L	33.00	9000.00	6.09	6.19	4.76	4.13	3.60	2.59	1.91	1.43	1.06
4.68	L	33.00	9000.00	5.96	5.96	4.65	4.09	3.56	2.59	1.91	1.39	1.05
4.68	L	33.00	9000.00	5.78	5.67	4.52	3.93	3.43	2.55	1.88	1.35	1.03
4.69	L	34.00	9000.00	11.57	9.80	9.21	8.04	7.02	4.98	3.43	2.14	1.18
4.69	L	34.00	9000.00	10.39	8.87	8.26	7.23	6.36	4.57	3.20	2.17	1.45
4.69	L	34.00	9000.00	9.90	8.64	7.86	6.90	6.00	4.32	3.03	2.13	1.41
1.30	**M**	**1.00**	**9000.00**	**4.81**	**3.70**	**5.55**	**5.92**	**6.28**	**7.24**	**8.19**	**0.85**	**0.79**
1.30	**M**	**1.00**	**9000.00**	**4.91**	**3.86**	**5.66**	**6.00**	**6.37**	**7.23**	**8.06**	**0.75**	**0.60**
1.30	**M**	**1.00**	**9000.00**	**4.90**	**3.94**	**5.56**	**5.91**	**6.26**	**7.01**	**7.77**	**0.64**	**0.55**

1.31	M	2.00	9000.00	3.61	3.17	3.67	3.67	3.78	3.83	4.06	0.28	0.28
1.31	M	2.00	9000.00	3.75	3.29	3.75	3.75	3.75	3.87	4.06	0.27	0.23
1.31	M	2.00	9000.00	3.89	3.46	3.89	3.89	3.92	3.98	4.07	0.33	0.30
1.31	M	3.00	9000.00	3.38	2.89	3.43	3.53	3.63	3.98	4.33	0.45	0.40
1.31	M	3.00	9000.00	3.56	3.14	3.63	3.63	3.74	3.98	4.26	0.35	0.32
1.31	M	3.00	9000.00	3.60	3.19	3.63	3.66	3.74	3.93	4.15	0.39	0.36
1.31	M	4.00	9000.00	4.65	5.06	3.76	3.29	2.87	2.04	1.36	0.94	0.47
1.31	M	4.00	9000.00	4.74	5.19	3.89	3.41	2.96	2.15	1.48	1.00	0.48
1.31	M	4.00	9000.00	4.82	5.25	3.95	3.48	3.08	2.26	1.57	1.04	0.52
1.31	M	5.00	9000.00	12.19	9.51	8.94	8.04	7.25	5.57	4.10	3.05	2.00
1.31	M	5.00	9000.00	11.58	9.02	8.47	7.58	6.84	5.33	3.88	2.85	1.89
1.31	M	5.00	9000.00	11.16	8.70	8.09	7.27	6.54	5.08	3.71	2.72	1.81
1.31	M	6.00	9000.00	3.34	3.02	3.18	3.13	3.08	3.02	3.08	3.13	3.24
1.31	M	6.00	9000.00	3.38	3.08	3.23	3.19	3.12	3.08	3.08	3.15	3.19
1.31	M	6.00	9000.00	3.43	3.17	3.32	3.23	3.17	3.11	3.11	3.17	3.29
1.32	M	7.00	9000.00	5.76	5.76	4.27	3.63	2.99	1.76	0.96	1.28	2.03
1.32	M	7.00	9000.00	5.63	5.59	4.24	3.57	2.93	1.76	0.83	1.35	1.88
1.32	M	7.00	9000.00	5.73	5.53	4.37	3.66	3.01	1.80	1.03	1.57	2.10
1.32	M	8.00	9000.00	3.92	3.38	4.22	4.42	4.67	5.11	0.45	0.45	0.40
1.32	M	8.00	9000.00	4.07	3.48	4.29	4.43	4.64	5.02	0.42	0.39	0.35
1.32	M	8.00	9000.00	4.20	3.60	4.37	4.48	4.62	4.97	0.41	0.33	0.38
1.32	M	9.00	9000.00	3.60	2.98	3.75	3.51	3.31	3.31	3.56	3.75	3.89
1.32	M	9.00	9000.00	3.54	2.91	3.68	3.44	3.31	3.34	3.54	3.75	3.91
1.32	M	9.00	9000.00	3.44	2.87	3.50	3.29	3.18	3.11	3.18	3.26	3.37
1.33	M	10.00	9000.00	3.35	3.64	2.80	2.56	2.26	1.77	1.38	1.13	0.79
1.33	M	10.00	9000.00	3.42	3.60	2.83	2.51	2.27	1.78	1.36	1.05	0.70
1.33	M	10.00	9000.00	3.62	3.87	3.02	2.70	2.42	1.88	1.42	0.98	0.60
1.33	M	11.00	9000.00	4.03	3.36	4.60	4.86	5.17	5.74	6.41	2.38	2.12
1.33	M	11.00	9000.00	4.15	3.48	4.55	4.77	4.99	5.47	5.98	0.07	0.04
1.33	M	11.00	9000.00	4.02	3.36	4.36	4.51	4.68	5.08	5.51	0.17	0.11
2.00	M	12.00	9000.00	2.54	2.33	2.33	2.18	1.97	1.61	1.40	1.19	0.83
2.00	M	12.00	9000.00	2.49	2.23	2.23	2.12	1.94	1.60	1.34	1.12	0.93
2.00	M	12.00	9000.00	2.58	2.37	2.37	2.20	2.05	1.73	1.44	1.20	0.97
2.18	M	13.00	9000.00	5.45	5.12	5.17	4.95	4.68	4.13	3.58	3.08	2.59
2.18	M	13.00	9000.00	5.41	5.02	5.06	4.82	4.59	4.04	3.49	2.98	2.55
2.18	M	13.00	9000.00	5.28	4.94	5.00	4.81	4.54	3.98	3.46	2.96	2.53
2.36	M	14.00	9000.00	3.52	3.26	3.15	2.89	2.73	2.21	1.84	1.42	1.21
2.36	M	14.00	9000.00	3.48	3.29	3.18	2.96	2.74	2.29	1.89	1.55	1.26
2.36	M	14.00	9000.00	3.51	3.28	3.19	2.96	2.76	2.32	1.89	1.57	1.28
2.49	M	15.00	9000.00	4.32	4.07	4.07	3.86	3.55	3.14	2.68	2.32	1.90
2.49	M	15.00	9000.00	4.44	4.18	4.15	3.93	3.70	3.19	2.75	2.38	1.94
2.49	M	15.00	9000.00	4.45	4.16	4.16	3.96	3.73	3.27	2.78	2.38	1.98
2.67	M	16.00	9000.00	5.10	5.49	4.45	4.06	3.90	3.35	2.96	2.69	2.42
2.67	M	16.00	9000.00	4.87	5.33	4.33	4.06	3.79	3.40	3.05	2.78	2.59
2.67	M	16.00	9000.00	4.75	5.23	4.27	3.97	3.76	3.34	3.01	2.77	2.56
2.85	M	17.00	9000.00	14.62	10.68	11.94	10.62	9.42	7.23	5.37	3.56	2.57
2.85	M	17.00	9000.00	14.18	10.40	11.52	10.20	9.04	6.96	5.14	3.63	2.51
2.85	M	17.00	9000.00	13.34	9.82	10.79	9.54	8.48	6.44	4.77	3.46	2.40
3.00	M	18.00	9000.00	4.27	4.01	4.11	3.85	3.70	3.28	2.92	2.55	2.14
3.00	M	18.00	9000.00	4.31	4.01	4.09	3.87	3.68	3.31	2.94	2.56	2.16

3.00	M	18.00	9000.00	4.25	3.96	4.02	3.84	3.67	3.29	2.88	2.59	2.18
3.18	M	19.00	9000.00	2.14	1.98	1.93	1.77	1.72	1.57	1.57	1.57	1.67
3.18	M	19.00	9000.00	2.22	2.04	1.96	1.82	1.70	1.56	1.48	1.48	1.63
3.18	M	19.00	9000.00	2.27	2.10	2.01	1.89	1.75	1.57	1.49	1.49	1.60
3.32	M	20.00	9000.00	2.79	2.64	2.59	2.44	2.23	1.88	1.62	1.42	1.12
3.32	M	20.00	9000.00	2.83	2.65	2.65	2.47	2.29	1.90	1.61	1.43	1.15
3.32	M	20.00	9000.00	2.92	2.64	2.64	2.44	2.28	1.91	1.60	1.38	1.15
3.49	M	21.00	9000.00	3.21	2.86	2.86	2.55	2.30	1.84	1.38	1.02	0.71
3.49	M	21.00	9000.00	3.33	2.93	2.93	2.64	2.43	1.92	1.45	1.09	0.76
3.49	M	21.00	9000.00	3.29	2.87	2.87	2.61	2.36	1.88	1.41	1.07	0.73
3.74	M	22.00	9000.00	4.74	5.21	4.11	4.01	3.80	3.59	3.59	3.85	3.85
3.74	M	22.00	9000.00	4.76	5.21	4.21	4.06	3.88	3.73	3.73	3.88	3.91
3.74	M	22.00	9000.00	4.63	5.01	4.17	4.00	3.89	3.86	3.92	4.12	4.26
3.85	M	23.00	9000.00	3.01	2.96	2.75	2.60	2.35	1.89	1.58	1.28	0.92
3.85	M	23.00	9000.00	3.32	3.00	3.07	2.89	2.74	2.35	1.98	1.70	1.34
3.85	M	23.00	9000.00	3.29	3.01	3.07	2.92	2.75	2.38	1.99	1.67	1.36
4.00	M	24.00	9000.00	3.69	3.48	3.43	3.23	2.97	2.51	2.10	1.74	1.49
4.00	M	24.00	9000.00	3.77	3.55	3.51	3.29	3.11	2.60	2.16	1.86	1.39
4.00	M	24.00	9000.00	3.81	3.58	3.55	3.35	3.15	2.68	2.25	1.85	1.56
4.66	M	25.00	9000.00	8.65	9.28	7.92	7.50	7.18	6.50	5.93	5.35	4.82
4.66	M	25.00	9000.00	9.50	10.25	8.76	8.31	7.90	7.26	6.66	5.69	5.28
4.66	M	25.00	9000.00	8.51	9.22	7.80	7.39	7.00	6.29	5.64	5.08	4.43
4.66	M	26.00	9000.00	8.15	7.67	8.78	9.09	9.51	10.20	11.20	12.30	13.19
4.66	M	26.00	9000.00	7.52	6.96	8.23	8.60	9.01	9.87	10.98	12.03	13.07
4.66	M	26.00	9000.00	7.28	6.76	7.92	8.30	8.67	9.52	10.56	11.58	12.59
4.67	M	27.00	9000.00	8.30	8.08	7.10	6.40	5.75	4.39	3.09	2.17	1.74
4.67	M	27.00	9000.00	8.10	7.87	6.95	6.26	5.60	4.26	2.92	2.07	1.65
4.67	M	27.00	9000.00	7.87	7.60	6.69	6.00	5.37	4.01	2.65	1.84	1.75
4.67	M	28.00	9000.00	6.41	6.83	6.19	6.03	5.98	5.88	5.98	6.03	6.14
4.67	M	28.00	9000.00	5.78	6.12	5.56	5.44	5.41	5.37	5.52	5.67	5.86
4.67	M	28.00	9000.00	5.84	6.22	5.54	5.45	5.36	5.30	5.39	5.48	5.66
4.67	M	29.00	9000.00	5.41	5.63	5.19	5.03	4.97	4.92	4.97	5.13	5.30
4.67	M	29.00	9000.00	5.60	5.84	5.41	5.29	5.25	5.25	5.37	5.53	5.72
4.67	M	29.00	9000.00	6.07	6.31	5.89	5.86	5.86	5.89	6.16	6.47	6.83
4.68	M	30.00	9000.00	7.26	7.10	7.62	7.72	7.88	8.14	7.88	6.58	5.24
4.68	M	30.00	9000.00	7.21	6.84	7.51	7.77	7.92	8.21	7.77	6.51	5.25
4.68	M	30.00	9000.00	7.21	6.80	7.49	7.70	7.87	8.25	7.23	6.08	4.92
4.68	M	31.00	9000.00	6.34	7.09	5.64	5.16	4.73	3.87	3.06	2.36	0.91
4.68	M	31.00	9000.00	6.33	6.95	5.60	5.18	4.80	3.99	3.26	2.53	1.00
4.68	M	31.00	9000.00	6.24	6.76	5.58	5.18	4.85	4.09	3.39	2.76	1.03
4.68	M	32.00	9000.00	6.73	5.31	8.09	8.94	9.62	11.04	12.83	1.52	1.37
4.68	M	32.00	9000.00	6.51	5.13	7.82	8.61	9.24	10.66	12.35	1.42	1.27
4.68	M	32.00	9000.00	6.38	5.06	7.61	8.38	8.99	10.35	11.93	1.29	1.18
4.68	M	33.00	9000.00	2.63	2.31	2.47	2.42	2.31	2.05	1.94	1.63	1.68
4.68	M	33.00	9000.00	3.11	2.85	2.96	2.88	2.77	2.55	2.40	2.29	2.15
4.68	M	33.00	9000.00	2.98	2.72	2.83	2.72	2.63	2.40	2.20	2.02	1.94
4.69	M	34.00	9000.00	3.25	3.03	2.53	2.20	1.87	1.38	1.05	0.77	0.83
4.69	M	34.00	9000.00	3.26	3.06	2.60	2.25	1.94	1.44	1.05	0.78	0.81
4.69	M	34.00	9000.00	3.24	3.03	2.58	2.24	1.97	1.42	1.00	0.70	0.76

Table 10. Average normalized deflections – I-78 (English units).

Station	TestType	JointNo	Load#	D1	D2	D3	D4	D5	D6	D7	D8	D9
1.31	AAvg	1	9000	18.02	13.96	2.86	2.35	1.78	1.32	0.91	0.00	0.00
1.31	AAvg	2	9000	12.67	9.46	3.16	2.39	1.82	1.22	0.78	0.00	0.00
1.31	AAvg	3	9000	28.36	22.08	0.84	0.74	0.60	0.53	0.43	0.00	0.00
1.32	AAvg	6	9000	27.44	21.85	4.52	3.93	3.28	2.72	2.25	0.00	0.00
1.32	AAvg	7	9000	16.81	12.75	0.97	0.80	0.66	0.57	0.45	0.00	0.00
1.32	AAvg	8	9000	8.81	13.06	7.06	5.37	3.82	2.56	1.66	0.00	0.00
1.33	AAvg	9	9000	31.78	25.38	2.71	2.08	1.44	1.05	1.01	0.00	0.00
1.33	AAvg	10	9000	9.84	7.69	8.51	6.64	4.93	3.35	2.02	0.00	0.00
1.33	AAvg	11	9000	17.38	13.27	1.07	0.94	0.90	0.87	0.79	0.00	0.00
2.01	AAvg	12	9000	12.04	9.46	11.09	8.77	6.58	4.66	3.13	0.00	0.00
2.18	AAvg	13	9000	13.90	11.30	12.17	9.68	7.33	5.20	3.48	0.00	0.00
2.36	AAvg	14	9000	21.60	17.68	19.57	16.07	12.68	9.48	6.80	0.00	0.00
2.50	AAvg	15	9000	49.41	41.64	3.19	2.58	2.01	1.64	1.30	0.00	0.00
2.68	AAvg	16	9000	33.88	27.61	1.43	1.29	1.01	0.83	0.68	0.00	0.00
2.85	AAvg	17	9000	33.77	28.01	3.49	2.99	2.49	2.04	1.65	0.00	0.00
3.00	AAvg	18	9000	49.10	41.24	5.88	4.87	3.88	3.03	2.19	0.00	0.00
3.18	AAvg	19	9000	17.87	25.89	4.27	3.47	2.72	2.09	1.51	0.00	0.00
3.32	AAvg	20	9000	26.17	21.43	3.84	3.20	2.59	2.09	1.67	0.00	0.00
3.49	AAvg	21	9000	38.03	30.93	0.60	0.44	0.31	0.21	0.18	0.00	0.00
3.74	AAvg	22	9000	25.97	20.24	2.37	2.10	1.71	1.48	1.19	0.00	0.00
3.85	AAvg	23	9000	13.99	10.69	5.84	4.89	4.02	3.18	2.36	0.00	0.00
4.00	AAvg	24	9000	23.58	19.46	7.50	5.95	4.50	3.23	2.14	0.00	0.00
4.66	AAvg	25	9000	21.22	18.47	2.54	2.44	2.26	2.16	2.05	0.00	0.00
4.67	AAvg	26	9000	42.95	36.67	3.14	2.77	2.55	2.32	2.13	0.00	0.00
4.67	AAvg	27	9000	18.35	14.91	3.53	3.21	2.71	2.43	2.07	0.00	0.00
4.67	AAvg	28	9000	29.20	24.10	1.50	1.50	1.39	1.30	1.34	0.00	0.00
4.67	AAvg	29	9000	33.90	28.25	2.67	2.40	2.05	1.87	1.61	0.00	0.00
4.68	AAvg	30	9000	17.33	13.63	14.42	11.74	9.05	6.50	3.97	0.00	0.00
4.68	AAvg	31	9000	15.40	12.70	2.01	1.82	1.59	1.44	1.30	0.00	0.00
4.68	AAvg	32	9000	32.58	27.30	1.63	1.48	1.32	1.28	1.15	0.00	0.00
4.68	AAvg	33	9000	35.58	29.81	2.13	1.83	1.59	1.59	1.33	0.00	0.00
4.69	AAvg	34	9000	16.67	13.13	3.98	3.35	2.68	2.07	1.72	0.00	0.00
1.31	LAvg	1	9000	9.61	8.90	7.58	5.69	3.99	2.55	1.44	0.00	0.00
1.31	LAvg	2	9000	7.54	6.29	5.84	4.14	2.70	1.46	0.97	0.00	0.00
1.31	LAvg	3	9000	8.48	0.91	6.54	4.75	3.18	1.84	0.87	0.00	0.00
1.31	LAvg	5	9000	12.09	8.61	9.90	7.67	5.71	4.01	2.77	0.00	0.00
1.32	LAvg	6	9000	17.64	16.99	14.80	12.05	9.45	7.11	5.24	0.00	0.00
1.32	LAvg	7	9000	10.14	0.61	7.69	5.43	3.35	1.51	1.03	0.00	0.00
1.32	LAvg	8	9000	13.61	3.50	10.67	7.88	5.51	3.58	2.21	0.00	0.00
1.33	LAvg	9	9000	16.19	16.28	13.89	11.51	9.21	6.85	4.76	0.00	0.00
1.33	LAvg	10	9000	10.75	9.28	8.45	6.20	4.16	2.43	1.28	0.00	0.00
1.33	LAvg	11	9000	10.24	2.47	8.47	6.84	5.35	4.15	3.26	0.00	0.00
2.01	LAvg	12	9000	11.46	11.58	9.06	6.81	4.82	3.16	1.79	0.00	0.00
2.18	LAvg	13	9000	13.24	12.85	10.50	7.87	5.47	3.45	1.93	0.00	0.00
2.36	LAvg	14	9000	21.90	19.84	17.90	13.97	10.27	7.07	4.64	0.00	0.00
2.50	LAvg	15	9000	20.47	21.39	16.63	12.98	9.61	6.77	4.48	0.00	0.00
2.68	LAvg	16	9000	44.59	7.09	37.63	30.70	24.16	17.99	12.87	0.00	0.00

2.85	LAvg	17	9000	42.83	9.61	36.38	30.19	24.20	18.85	14.29	0.00	0.00
3.00	LAvg	18	9000	21.50	19.99	17.60	13.82	10.33	7.54	5.26	0.00	0.00
3.18	LAvg	19	9000	28.33	1.09	22.83	17.45	12.60	8.47	5.33	0.00	0.00
3.33	LAvg	20	9000	11.29	11.96	8.79	6.58	4.71	3.33	2.43	0.00	0.00
3.49	LAvg	21	9000	10.01	10.78	7.71	5.57	3.74	2.26	1.15	0.00	0.00
3.85	LAvg	23	9000	17.33	9.47	14.83	12.33	9.95	7.70	5.82	0.00	0.00
4.00	LAvg	24	9000	13.63	13.86	10.98	8.51	6.24	4.30	2.73	0.00	0.00
4.66	LAvg	25	9000	13.70	10.47	11.44	9.34	7.46	5.92	4.65	0.00	0.00
4.67	LAvg	26	9000	12.43	11.16	10.28	8.25	6.36	4.77	3.60	0.00	0.00
4.67	LAvg	27	9000	18.08	2.91	14.79	11.84	9.27	7.12	5.21	0.00	0.00
4.67	LAvg	28	9000	11.50	8.83	9.28	7.29	5.54	4.13	2.89	0.00	0.00
4.67	LAvg	29	9000	22.05	2.99	18.47	15.02	11.63	8.55	5.76	0.00	0.00
4.68	LAvg	30	9000	14.18	15.64	11.59	9.00	6.43	4.07	2.01	0.00	0.00
4.68	LAvg	31	9000	15.33	1.94	12.63	10.15	7.99	6.26	4.74	0.00	0.00
4.68	LAvg	32	9000	13.87	8.56	11.26	8.86	6.73	5.00	3.56	0.00	0.00
4.68	LAvg	33	9000	5.91	5.89	4.62	3.52	2.57	1.90	1.38	0.00	0.00
4.69	LAvg	34	9000	10.46	8.99	8.32	6.36	4.56	3.18	2.15	0.00	0.00
1.31	MAvg*	4	9000	4.75	5.19	3.88	2.99	2.17	1.49	1.01	0.00	0.00
1.31	MAvg	5	9000	11.54	9.00	8.42	6.81	5.28	3.86	2.84	0.00	0.00
1.32	MAvg	7	9000	5.70	5.60	4.30	2.98	1.78	0.95	1.43	0.00	0.00
1.33	MAvg	10	9000	3.49	3.72	2.91	2.33	1.82	1.39	1.04	0.00	0.00
2.00	MAvg	12	9000	2.54	2.32	2.32	1.99	1.66	1.39	1.17	0.00	0.00
2.18	MAvg	13	9000	5.36	5.00	5.06	4.58	4.03	3.49	2.99	0.00	0.00
2.36	MAvg	14	9000	3.50	3.28	3.18	2.74	2.28	1.87	1.53	0.00	0.00
2.49	MAvg	15	9000	4.42	4.15	4.13	3.68	3.21	2.75	2.37	0.00	0.00
2.67	MAvg	16	9000	4.87	5.33	4.33	3.80	3.36	3.01	2.75	0.00	0.00
2.85	MAvg	17	9000	13.92	10.21	11.30	8.89	6.80	5.03	3.54	0.00	0.00
3.00	MAvg	18	9000	4.28	3.99	4.07	3.68	3.29	2.91	2.57	0.00	0.00
3.18	MAvg	19	9000	2.23	2.05	1.98	1.73	1.57	1.50	1.50	0.00	0.00
3.32	MAvg	20	9000	2.86	2.64	2.63	2.27	1.90	1.61	1.41	0.00	0.00
3.49	MAvg	21	9000	3.28	2.88	2.88	2.37	1.88	1.41	1.06	0.00	0.00
3.74	MAvg	22	9000	4.71	5.12	4.17	3.87	3.75	3.78	3.98	0.00	0.00
3.85	MAvg	23	9000	3.23	2.99	2.99	2.65	2.25	1.89	1.59	0.00	0.00
4.00	MAvg	24	9000	3.77	3.55	3.51	3.09	2.61	2.18	1.83	0.00	0.00
4.66	MAvg	25	9000	8.88	9.58	8.15	7.35	6.67	6.05	5.35	0.00	0.00
4.67	MAvg	27	9000	8.05	7.81	6.88	5.54	4.19	2.85	2.00	0.00	0.00
4.68	MAvg	31	9000	6.30	6.91	5.60	4.81	4.01	3.27	2.59	0.00	0.00
4.69	MAvg	34	9000	3.25	3.04	2.57	1.94	1.42	1.03	0.74	0.00	0.00

*The data of mid-slab tests (M) for Joint Number 1, 2 and 3 did not pass AC/QA tests, therefore they have been removed.

Table 11. Results of backcalculation analysis – I-78 LTE

Station	TestType	JointNo	LTE	Condition
1.31	AAvg	1.00	98	Good
1.31	AAvg	2.00	85	Good
1.31	AAvg	3.00	89	Good
1.32	AAvg	6.00	87	Good
1.32	AAvg	7.00	77	Good
1.32	AAvg	8.00	100	Good
1.33	AAvg	9.00	97	Good
1.33	AAvg	10.00	73	Good
1.33	AAvg	11.00	91	Good
2.01	AAvg	12.00	82	Good
2.18	AAvg	13.00	87	Good
2.36	AAvg	14.00	86	Good
2.50	AAvg	15.00	90	Good
2.68	AAvg	16.00	75	Good
2.85	AAvg	17.00	100	Good
3.00	AAvg	18.00	90	Good
3.18	AAvg	19.00	100	Good
3.32	AAvg	20.00	89	Good
3.49	AAvg	21.00	93	Good
3.74	AAvg	22.00	72	Good
3.85	AAvg	23.00	83	Good
4.00	AAvg	24.00	88	Good
4.66	AAvg	25.00	81	Good
4.67	AAvg	26.00	92	Good
4.67	AAvg	27.00	84	Good
4.67	AAvg	28.00	78	Good
4.67	AAvg	29.00	80	Good
4.68	AAvg	30.00	82	Good
4.68	AAvg	31.00	75	Good
4.68	AAvg	32.00	100	Good
4.68	AAvg	33.00	92	Good
4.69	AAvg	34.00	84	Good
1.31	LAvg	1.00	82	Good
1.31	LAvg	2.00	85	Good
1.31	LAvg	3.00	88	Good
1.31	LAvg	5.00	96	Good
1.32	LAvg	6.00	85	Good
1.32	LAvg	7.00	77	Good
1.32	LAvg	8.00	92	Good
1.33	LAvg	9.00	86	Good
1.33	LAvg	10.00	74	Good
1.33	LAvg	11.00	99	Good
2.01	LAvg	12.00	79	Good
2.18	LAvg	13.00	80	Good
2.36	LAvg	14.00	86	Good
2.50	LAvg	15.00	79	Good

2.68	LAvg	16.00	77	Good
2.85	LAvg	17.00	100	Good
3.00	LAvg	18.00	85	Good
3.18	LAvg	19.00	87	Good
3.33	LAvg	20.00	76	Good
3.49	LAvg	21.00	74	Good
3.85	LAvg	23.00	92	Good
4.00	LAvg	24.00	80	Good
4.66	LAvg	25.00	77	Good
4.67	LAvg	26.00	87	Good
4.67	LAvg	27.00	84	Good
4.67	LAvg	28.00	76	Good
4.67	LAvg	29.00	80	Good
4.68	LAvg	30.00	78	Good
4.68	LAvg	31.00	75	Good
4.68	LAvg	32.00	100	Good
4.68	LAvg	33.00	78	Good
4.69	LAvg	34.00	85	Good

Table 12. Results of backcalculation analysis – I-78 (Epcc and Kstatic)

Station	TestType	SlabNo	Epcc	Condition
1.31	MAvg	4.00	1,375,860	Good
1.31	MAvg	5.00	440,799	Slab Repair
1.32	MAvg	7.00	725,503	Slab Repair
1.33	MAvg	10.00	2,268,417	Good
2.00	MAvg	12.00	6,259,286	Good
2.18	MAvg	13.00	5,268,185	Good
2.36	MAvg	14.00	4,480,364	Good
2.49	MAvg	15.00	5,360,357	Good
2.67	MAvg	16.00	3,171,210	Good
2.85	MAvg	17.00	489,379	Slab Repair
3.00	MAvg	18.00	7,260,419	Good
3.18	MAvg	19.00	7,023,194	Good
3.32	MAvg	20.00	6,022,636	Good
3.49	MAvg	21.00	3,262,560	Good
3.74	MAvg	22.00	4,550,367	Good
3.85	MAvg	23.00	6,289,628	Good
4.00	MAvg	24.00	5,514,526	Good
4.66	MAvg	25.00	2,538,774	Good
4.67	MAvg	27.00	1,078,911	Good
4.68	MAvg	31.00	2,151,142	Good
4.69	MAvg	34.00	1,750,664	Good