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16. Abstract (Limit: 200 words)

This report presents the results of an investigation into the use of the Superpave asphalt mix design methodology at the local government level in Minnesota.

In the project, researchers combined low-cost natural sand with locally available aggregates from four sources: limestone, quartzite, and partially crushed river gravel, and granite. They evaluated coarse and fine aggregate gradations, along with the use of two asphalt grades.

It was difficult to achieve the Superpave volumetric requirements of voids in mineral aggregate (VMA) and voids filled with asphalt (VFA) at 4 percent air voids, regardless of the gradation. A target air void content of 3 percent satisfied the VFA requirement, even though the VMA requirement could not be fulfilled. The fine aggregate gradations produced densities indicating that the mixtures might be tender during construction, but not necessarily be susceptible to rutting. The coarse-graded mixtures did not show the tenderness problem, but did show that they might be susceptible to rutting.

Resilient modulus testing showed little or no difference in the mixtures, regardless of aggregate source or gradation. The difference in resilient modulus due to asphalt grade was apparent only at the intermediate temperatures, and not at the highest or lowest test temperatures. Moisture sensitivity testing showed that all the mixtures studied had adequate durability. Indirect tensile creep and APA rut testing indicated that resistance to low temperature cracking and rutting may be improved by decreasing the lower PG binder grade and increasing the upper PG binder grade, respectively.

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SUPERPAVE LEVEL ONE MIX DESIGN AT THE LOCAL GOVERNMENT LEVEL

Final Report

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EXECUTIVE SUMMARY

This report presents the results of an investigation into the use of the Superpave asphalt mix design methodology at the local government level in Minnesota. It is commonly believed that the use of Superpave criteria will result in more costly asphalt mixtures, which may be prohibitive for cities and counties. A low-cost natural sand was combined with locally available aggregates from four sources: a limestone, a quartzite, a partially-crushed river gravel and a granite. The fine aggregate was combined with the coarse aggregates to produce coarse and fine aggregate gradations for evaluation. Additionally, the use of two asphalt grades, PG 52-34 and PG 58-40 were investigated.

The mix design effort showed that it was difficult to achieve the Superpave volumetric requirements of voids in mineral aggregate (VMA) and voids filled with asphalt at 4 percent air voids for a 12.5-mm maximum aggregate size, regardless of whether the gradation was coarse or fine. It was found that a target air void content of 3 percent allowed the VFA requirement to be satisfied, even though the VMA requirement could not be fulfilled. Compaction data showed that the fine aggregate gradations produced densities which would indicate that the mixtures might be tender during construction, but which would not necessarily be susceptible to rutting. The coarse-graded mixtures did not show the tenderness problem, but did show that they might be susceptible to rutting.

Resilient modulus testing showed little or no difference in the mixtures, regardless of aggregate source or gradation. The difference in resilient modulus due to asphalt grade was apparent only at the intermediate temperatures, and not at the highest or lowest test temperatures. Moisture sensitivity testing showed that all the mixtures studied had adequate durability. This was likely due to higher asphalt content.

Low temperature creep compliance testing indicated that mixtures made with PG 58-40 binder may be less susceptible to low temperature cracking than those made with PG 52-34 binder. Asphalt Pavement Analyzer (APA) rut testing indicated that PG 58-40 mixtures may also be less susceptible to rutting in the asphalt layer than PG 52-34 mixtures. While aggregate type had little effect on the measured rut depth in PG 58-40 mixtures, PG 52-34 limestone mixtures had almost twice the rut depth of PG 52-34 quartzite mixtures.

For low-volume roads, it is recommended that if VMA requirements cannot be met using standard Superpave procedures, a lower design air void content of three percent be used with a fine aggregate gradation to ensure durability. Although this may result in tenderness problems, these may normally be overcome by adjustments in field compaction procedures.

In addition, decreasing the lower binder grade and increasing the upper PG binder grade may be effective in improving the low temperature cracking resistance and rut resistance of a pavement, respectively.

CHAPTER 1
- INTRODUCTION -

MOTIVATION

The Strategic Highway Research Program (SHRP) Superpave asphalt mixture design system, with its stringent material requirements was specifically developed to produce pavements to meet the expectations of the American public. The Superpave system includes a performance graded asphalt binder system, criteria for aggregate properties, a new mix design procedure using the Superpave gyratory compactor, and refined procedures and requirements for mixture analysis. To date, the Superpave system has primarily been used on medium to high volume roadways, where funding is more readily available. Issues concerning aggregate availability and local economy have limited its use on low-volume roads at the local government level. Therefore, the question is: Can the material and testing requirements of the Superpave system be economically applied at the local government level without compromising pavement performance? To answer the above question, the two key requirements of the Superpave system, material requirements and testing requirements, were evaluated.

RELATIONSHIP TO PREVIOUS WORK

The Superpave system has existed since 1987 when it was developed by the Strategic Highway Research Program (Asphalt Institute, 1996). It has been used with varying degrees of success by several State Departments of Transportation on high-volume roads such as urban interstates. Due to its high material and construction costs relative to other mix design systems, however, its use at the local government level has yet to be widely accepted. The results of this research presents a slightly modified Superpave system for use at the local level for low-volume roadways in the state of Minnesota.

OBJECTIVE

The intent of this research was to investigate the feasibility of using the Superpave Level One mix design system at the local government level for use on low-volume roadways in the state of Minnesota. The effects of different gradations, aggregate sources, and asphalt performance grades were evaluated.

SCOPE

Two different aggregate gradations were evaluated: coarse and fine. The fine aggregate (passing the 9.5 mm (3/8 in.) sieve) in all mixes was composed solely of a sand from Lakeland, Minnesota—a very readily available, low-cost aggregate. Four different coarse aggregates (retained on the 12.5 mm (1/2 in.) and 9.5 mm (3/8 in.) sieves) were evaluated: Granite Falls granite, New Ulm quartzite, Kasota limestone, and Cedar Grove gravel—all readily available at varying costs. Lastly, the effects of two different asphalt performance grades (PG 52-34 and PG 58-40) were evaluated. A Brovold gyratory compactor was used to prepare all samples.

ORGANIZATION OF REPORT

This report is arranged into five sections: Introduction, Literature Review, Research Methodology, Results and Discussion, and Conclusions and Recommendations. The Literature Review provides a background on the mechanics of asphalt compaction, the importance of volumetrics, and current mix design methods—with special emphasis on the Superpave method. Research Methodology discusses the aggregate properties, laboratory mixtures, gyratory compactor, compaction procedure, test methods and data analysis methods. Results and Discussion presents the results of the mix design, resilient modulus tests, moisture sensitivity tests, low-temperature behavior and rutting characteristics and discusses their significance. The report closes with some final conclusions and recommendations. Literature sources used as supporting references are cited in the bibliography and additional summarized test data are provided in the appendices.

CHAPTER 2
- LITERATURE REVIEW -

INTRODUCTION

The purpose of compaction is to densify an asphalt pavement. Resistance to shear deformation cannot be developed without close contact of the aggregate particles in the mix. The close contact of the particles allows the development of interparticle friction necessary to resist displacement of the mix under load. Likewise, the development of a high degree of impermeability results only when a well-designed and manufactured mix is thoroughly compacted. It has been conclusively shown that the durability of the pavement is directly related to permeability—the amount of air and water passing through the mix. Exposure to air may cause oxidation of the asphalt leading to premature hardening of the pavement and a susceptibility to cracking and stripping. According to Marker [1], unless the compactive effort has placed the particles close enough together, the tensile strength of a mix cannot be developed by the cohesiveness of the asphalt films coating each particle. Simply stated, a tough, durable, smooth pavement can only be accomplished with proper compaction.

COMPACTION

A pavement's resistance to shear is a function of the cohesive, internal friction and confining forces within the asphalt mix. These forces are best illustrated by Mohr's Circle (Figure 2.1), where Coulomb's equation is used to calculate shear strength:

$$\tau = c + \sigma \tan \phi \tag{2.1}$$

Where:

τ = shear stress
c = cohesion
σ = confining pressure
ϕ = angle of internal friction

The basic principles of asphalt compaction are similar to soil compaction. Sowers [2] lists three ways that soil compaction can occur: reorientation of particles; fracture of the bonds between them (followed by reorientation); and distortion of the particles and their adsorbed layers. Cohesive soil densification is primarily the result of distortion and particle reorientation. The fracturing and reorientation of particles enables densification of cohesionless soils such as crushed rock. The internal friction between particles, however, resists particle reorientation. Therefore, increasing aggregate angularity increases the material's resistance to densification.

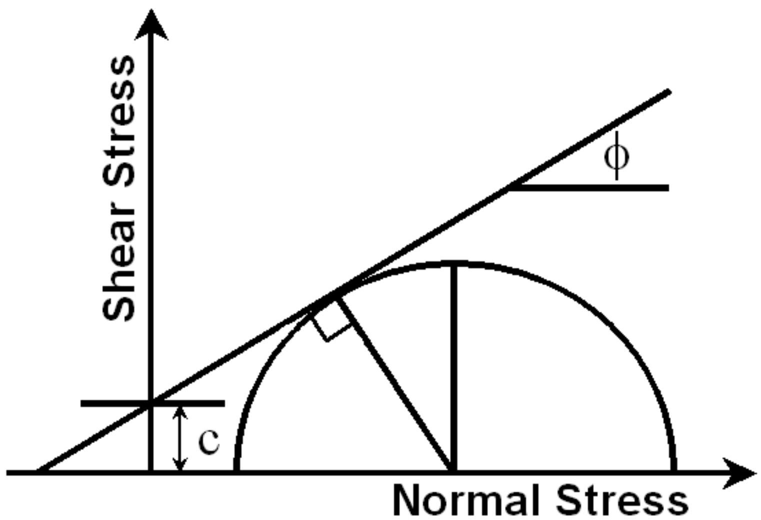

Figure 2.1 Mohr's Circle

The moisture content of soils, similar to asphalt content in hot mix asphalt, plays an important role in densification. In cohesive materials, the interparticle cohesive forces decrease as moisture content increases. Increasing moisture content in cohesionless materials cause the capillary tension between particle grains to decrease. Sowers [2] stated that the resulting decrease in interparticle contact pressures decreases the internal friction of the soil. Increases in moisture contents to optimum levels prior to compaction results in the most effective compactive effort.

Another important element of effective compaction is lateral confinement of the material. In the laboratory, confinement of the mixture is achieved via the mold. In the field, the flow properties of the material must enable adequate resistance to lateral flow. Geller [3] demonstrated that without lateral flow confinement, vertical compression cannot take place. The confining ability of pneumatic (rubber-tire) rollers makes them ideal for compacting tender mixtures.

Nijboer [4] explained the three primary forces resisting compaction within hot mix asphalt:

1. the angle of internal friction (frictional resistance)
2. the initial resistance (cohesive and interlocking resistances)

3. the viscous resistance (viscosity of the mix times rate of flow)

The first resistance, angle of internal friction, is primarily a function of the aggregate properties. The second, initial resistance, is a function of the bitumen and filler properties acting as a thin film coating the aggregate, the interlocking action of the particle shapes comes into effect toward the completion of the compaction process. Viscous resistance is a function of both aggregate and binder properties.

Kari [5] explained how in the field, the rolling of a hot asphalt concrete pavement provides a means of applying vertical pressure and kneading action to a mix enabling densification to occur. The conditions existing under a moving roller are shown in Figure 2.2. The roller wheel or tires sink into the asphalt mix until the contact area is large enough to reduce the contact pressure of the wheel to approximately that of the mix's bearing capacity. The roller wheel's motion creates shear forces within the asphalt. The horizontal shear forces developed in the front and rear of the roller create zones of decompaction within the pavement. The vertical shear forces developed directly underneath the roller wheel create a zone of compaction.

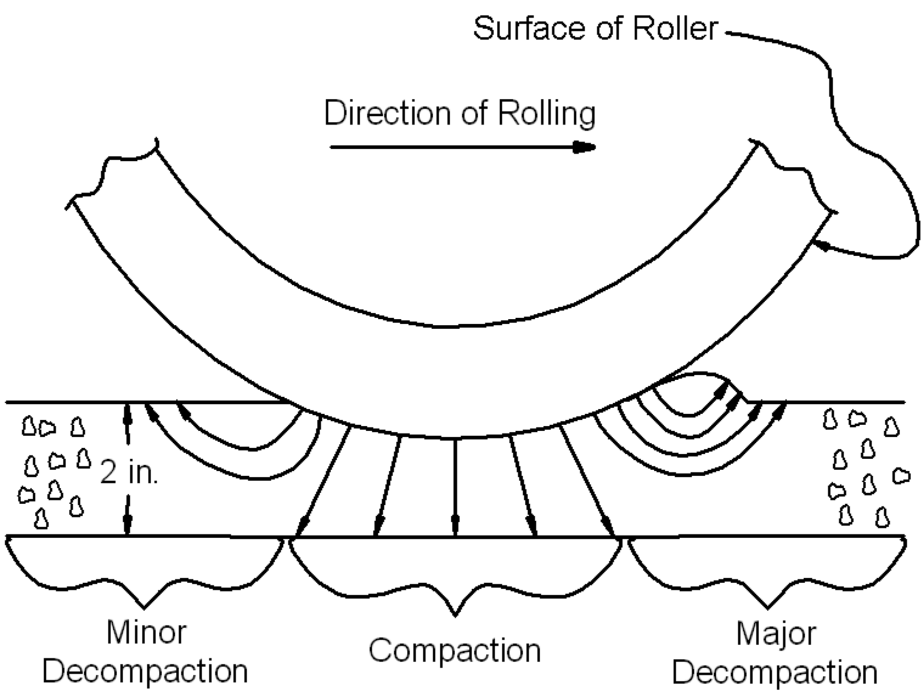

Figure 2.2 Compaction Process (after Kari, [5])

Kari [5] described two unfavorable compaction conditions: understressed and overstressed. A mix is understressed when the bearing capacity of the mixture is greater than the contact pressure applied by the roller—the roller simply rides on top of the mix without any compaction taking place (Figure 2.3). A mix is overstressed when it cannot support the weight of the roller—the roller sinks deep into the mix resulting in shoving and severe cracking but little to no densification. Thus, the bearing capacity of the mix and the roller weight and configuration must complement each other to achieve maximum density and toughness.

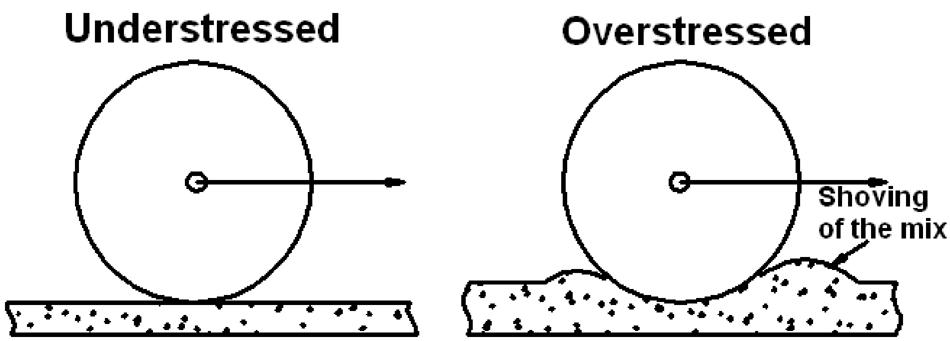

Figure 2.3 Understressed and Overstressed Conditions (after Kari,[5])

MATERIALS EVALUATION AND THEIR AFFECT ON COMPACTION

Binder

The asphalt binder is considered a viscoelastic material because it exhibits properties of both a viscous and an elastic material. As such, the asphalt binder affects compaction in a variety of ways. The viscosity of asphalt is extremely temperature dependent: at room temperature asphalt is virtually a solid, above 121 °C it is a fluid. Increasing the temperature of a mixture decreases the binder's viscosity causing a reduction in the overall stiffness of the mix. If a mix is too hot, it will be tender and move laterally from underneath the roller. Conversely, as the mix cools, it stiffens, requiring a greater compactive effort to densify it.

The influence of the binder on an asphalt mixture's resistance to compaction was shown in a study by McLeod [6]. A high viscosity asphalt cement at a typical placement temperature of 135 °C has a viscosity of approximately 5 poise. The viscosity of the same asphalt cement at 63 °C, when rolling often ends, was 5000 poise—a 1000-fold increase. The respective Marshall stabilities of the mix at the two temperatures were 667 N and 6672 N - a 10-fold increase. In only a 72 °C temperature difference, a 1000-fold increase in the binder's viscosity resulted in a 10-fold increase in the mix's strength.

Aggregate

Gradation, surface texture and angularity are the primary aggregate characteristics affecting the workability and resistance to compaction of a mix. Larger aggregate sizes and/or higher coarse aggregate percentages result in lower workability and higher compactive efforts. Likewise, a rough surface texture, as opposed to a smooth, glassy texture, results in a stiffer, less workable mix. Using highly angular coarse and fine aggregate results in a high degree of internal friction (and thus, high shear strength), increasing the resistance of the mix to permanent deformation. According to the Asphalt Institute [7], limiting the percentage of elongated particles minimizes the potential for aggregate crushing during mixing and construction.

If workability is too low, rounded sands are often added to increase the mix's workability. However, too much rounded sand results in tender mixes—mixes with high workability but low stability. Tender mixes are often easily overstressed by heavy rollers and over-rolling resulting in the lateral movement of the mix from under the roller.

Filler

Fines, or filler content, affect the compactibility of a mix because they combine with the asphalt cement to provide the binding, cohesive forces of the mix. Filler material increases the effective viscosity of the binder matrix, effectively creating a mastic.

Santucci and Schmidt [8] explained that there exists an optimum filler content for maximum compaction (Figure 2.4). A study by Bissada [9] showed higher filler contents resulted in higher stiffness values achieved at lower resistances to compaction. Additionally, filler will help offset the tenderness of mixes with too much sand. However, too much filler results in "gummy" mixes that are difficult to compact.

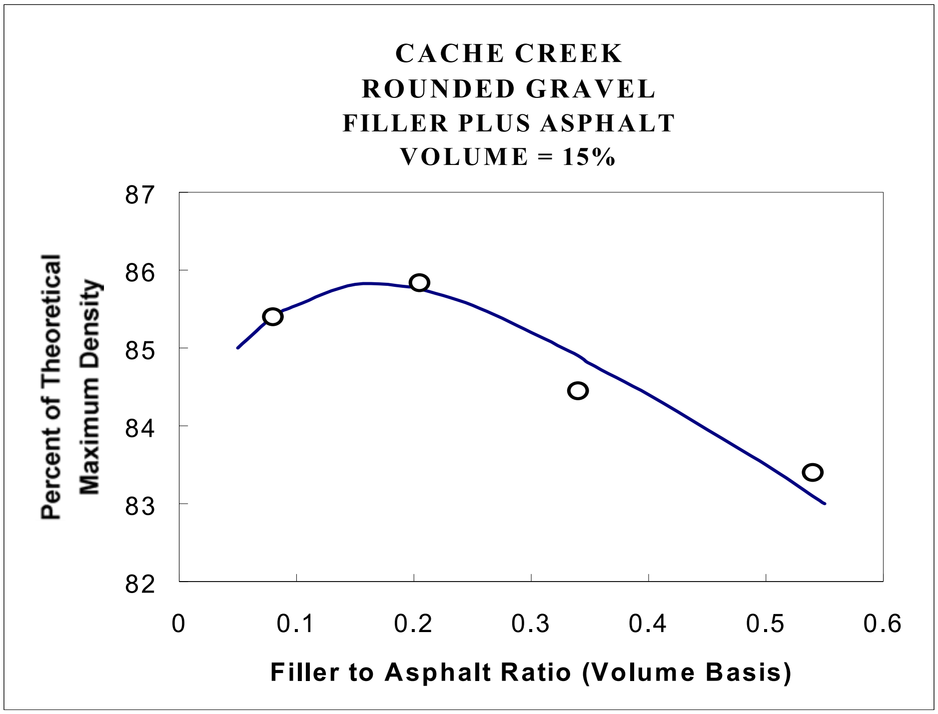

Figure 2.4 Influence of Filler on Compactive Effort (after Santucci & Schmidt [8])

FACTORS AFFECTING COMPACTION

Mix Properties

At higher temperatures, the lower viscosity of the asphalt cement causes it to act as a liquid, allowing the aggregate particles to effectively interlock. At slightly lower temperatures, the binder acts as a lubricant permitting the aggregate to shift and densify during compaction. Further reduction in temperature results in a stiffening of the binder where its cohesion will prevent further densification.

As the asphalt content increases, so does the film thickness of the asphalt on the aggregate. At compaction temperatures, the thicker films increase the lubricating effect of the asphalt. Additionally, a study by Harvey and Tsai [10] showed pavement overlay life increased 10 to 20 percent with each 0.5% increase in asphalt content (when compacted to the same air void content) with respect to fatigue. If asphalt contents are excessive, however, the resulting tender mix will bleed.

The temperature of the mix affects the compaction process in much the same way as asphalt content. As previously discussed, the workability of the mix increases as the temperature of the mix increases. The upper limit for mix temperature is approximately 150 °C (300 °F); temperatures above 150 °C may result in damage to the asphalt by accelerated hardening. The lower limit for effective compaction is approximately 85 °C (185 °F); below which great compactive effort is required for little to no gain in densification of the mix. Figure 2.5 shows the effect of compaction temperature on void content using a Marshall compactor at 50-blows per side. Parker's [11] work showed compaction at 150 °C (300 °F) yielded an air void content four times greater than compaction at 135 °C (275 °F).

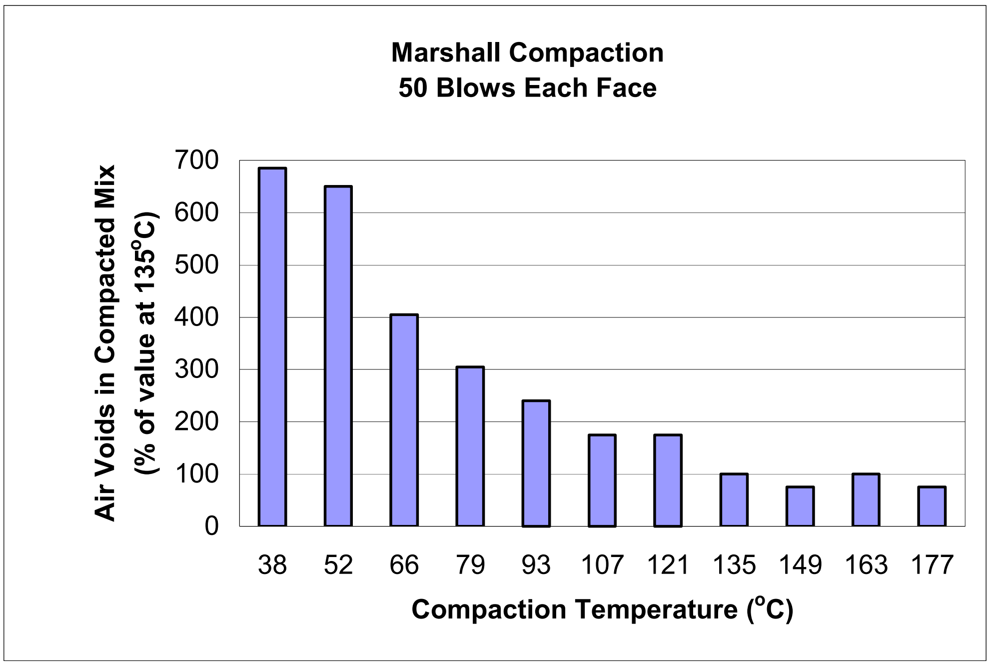

Figure 2.5 Influence of Compaction Temperature on Percent Air Voids (after Parker [11])

A study by Kennedy, et al [12] showed that low temperatures during compaction have an adverse effect on the engineering properties such as tensile strength, resilient modulus and Marshal stability of an asphalt concrete resulting in reduced pavement performance. Hadley, et al [13] found that of seven factors studied (aggregate type, aggregate gradation, asphalt cement, asphalt content, mixing temperature, compaction temperature, and curing temperature), compaction temperature dominated the results. Kennedy, et al concluded tensile strength, static and resilient moduli, Marshall stability, and Hveem stability of asphalt are all reduced when compaction occurs at lower temperatures. Brown [14] reported that temperatures in excess of 155 °C

(310 °F), however, can cause compaction problems (lateral movement) and increase oxidation of the binder which can result in hard and brittle pavements.

Environmental

According to the Asphalt Institute [15], the rate at which an asphalt mix cools directly affects the length of time during which density can and must be achieved. The ambient air temperature, humidity, wind velocity and the surface temperature under the mix all affect the rate of cooling of a freshly placed asphalt layer. Cool air temperatures, high humidity, strong winds, and cool surfaces either alone or together adversely shrink the effective compaction window.

Layer (Lift) Thickness

Thicker asphalt layers retain heat longer. Therefore, less compactive effort is required to achieve target density in thicker asphalt layers than in thinner layers. The heat-retaining ability of larger lifts make their use desirable when placing stiffer mixes or when paving in adverse environmental conditions. The Asphalt Institute [15] stated that retained heat of thicker lifts also permits lower paving temperatures, so either lower mixing temperatures or longer hauling distances are possible. A summary of the factors affecting compaction and their corrective actions can be found in Table 2.1.

VOLUMETRIC PROPERTIES

Characterization of asphalt mixtures generally consists of several volumetric properties including voids in the total mix (VTM), voids in the mineral aggregate (VMA) and voids filled with asphalt (VFA). The most important property in construction is VTM, or air voids, a direct relation to density. A mix having 4% air voids has a density of 96% of maximum. Research and past performance have shown a final compacted void content of 4% is ideal for most dense-graded mixtures. Generally, mixes having low compacted air voids (less than 3%) will be unstable and exhibit premature rutting. Mixes having high air voids (greater than 8%) will generally be permeable to water leading to an increased oxidation rate resulting in premature raveling and/or cracking. It is important to note, however, that these figures are nothing more than generalizations. It is quite possible to have an outstanding, long-lasting pavement that compacted to 98% density (2% air voids).

Table 2.1 Summary of Influence on Compaction (Asphalt Institute [15])

ITEM	EFFECT	CORRECTIONS*
Aggregate		
Smooth Surfaced	Low interparticle friction	Use light rollers Lower mix temperature
Rough Surfaced	High interparticle friction	Use heavy rollers
Unsound	Breaks under steel-wheeled rollers	Use sound aggregate Use pneumatic rollers
Absorptive	Dries mix—difficult to compact	Increase asphalt in mix
Asphalt		
Viscosity-High	Particle movement restricted	Use heavy rollers Increase temperature
Viscosity-Low	Particles move easily during compaction	Use light rollers Decrease temperature
Quantity-High	Unstable and plastic under roller	Decrease asphalt in mix
Quantity-Low	Reduced lubrication—difficult compaction	Increase asphalt in mix Use heavy rollers
Mix		
Excess Coarse Aggregate	Harsh mix—difficult to compact	Use heavy rollers
Oversanded	Too workable—difficult to compact	Reduce sand in mix Use light rollers
Too Much Filler	Stiffens mix—difficult to compact	Reduce filler in mix Use heavy rollers
Too Little Filler	Low cohesion—mix may come apart	Increase filler in mix
Mix Temperature		
High	Difficult to compact—mix lacks cohesion	Decrease mixing temperature
Low	Difficult to compact—mix too stiff	Increase mixing temperature
Coarse Thickness		
Thick Lifts	Hold heat—more time to compact	Roll normally
Thin Lifts	Lose heat—less time to compact	Roll before mix cools Increase mix temperature
Weather Conditions		
Low Air Temperature	Cools mix rapidly	Roll before mix cools Increase mix temperature Increase lift thickness
Low Surface Temperature	Cools mix rapidly	Roll before mix cools Increase mix temperature Increase lift thickness
Wind	Cools mix-crusts surface	Roll before mix cools Increase mix temperature Increase lift thickness

VMA, the void space in the aggregate, and probably the most important volumetric property in design, is primarily a function of aggregate gradation, particle shape and surface texture. Since VMA includes air voids (it is the sum of VTM and VFA), low VMA indicates low film coating on the aggregate because there is not enough void space for the asphalt to adequately coat the particles without overfilling the void space. Since overfilling the void space is the same as having a low VTM, premature and excessive rutting can result.

Although of great importance in volumetric proportioning, as the difference between VTM and VMA, VFA is typically not mentioned in volumetric discussions. However, for the purposes of generalities, typical VFA values as reported by Roberts, et al [16], range from 50-70%. When VFA exceeds 80-85%, the voids are considered overfilled (with asphalt) resulting in the low stability problems explained above.

VOID CONTENT

A study by Bell, et al [17], showed that percent compaction (or void content) was the most significant factor affecting mix performance. As shown in Table 2.2, an increase in void content is associated with a decrease in modulus, fatigue life, and resistance to permanent deformation.

Table 2.2 Effect of Compaction on Hot Mix Asphalt Pavements (Bell, et al [17])

			10^7 ESAL Normal Design Life			
Compaction Rating	Voids Content, %	Resilient Modulus, MPa	Horizontal Strain at ACC Bottom	Est. Fatigue Life, # Loads to Fail, 10^6	Vertical Strain at Subgrade Surface	Est. Perm Deform Life, # Loads to Fail, 10^6
Excellent	4	3370	75	110	200	48
Good	8	2060	100	12	245	21
Poor	12	1430	120	2.6	280	12

High stiffness (resilient modulus) values are essential to long-lasting, superior performing hot mix asphalt pavements. The stiffness of a pavement is directly related to the resulting horizontal and vertical strains in the pavement resulting from vehicle loads. Pavements with higher stiffness values exhibit lower strains under the same vehicle loads. Horizontal and vertical strains are important in predicting pavement performance because they directly correlate to fatigue and permanent. The accurate estimation of fundamental engineering properties by the consistent simulation of field compaction is key to a laboratory compaction method's (Hveem, Marshall, gyratory) value in the prediction of long-term pavement performance.

The Asphalt Institute found that changes in stiffness and void content affected fatigue life according to the following expression:

$$N_f = 18.4(C)\times\left(4.32\times10^{-3}\varepsilon_t^{-3.29}E^{-0.854}\right) \quad (2.2)$$

Where:
- N_f = number of load applications to failure
- C = a factor dependent on the asphalt and void contents
- ε_t = tensile strain
- E = modulus of asphalt mixture

Bell, et al [17] used the above equation to calculate the fatigue values shown in Table 2.2. The table clearly shows the profound effect void content has on fatigue life. A 50% reduction in void content from eight to four percent air voids results in nearly a 10-fold increase in fatigue life.

Permanent deformation of flexible pavement may be due to either densification or shear deformation. Densification, or further compaction by traffic, can be reduced by ensuring good compaction during construction. Shear deformation occurs when one or more pavement layers lack bearing capacity. Vertical pressure in unstable layers can be reduced by using stiffer mixes resulting from better compaction. Bell et al [17] found a two-fold increase in the estimated permanent deformation lives of a pavement when reducing the void content from eight to four percent (see Table 2.2).

MIX DESIGN PROCEDURES

Hveem

The basic philosophy of the Hveem method of mix design is summarized by Roberts et al [16]:

1. It should provide sufficient asphalt cement for aggregate absorption and to produce an optimum film content of asphalt cement on the aggregate.
2. It should produce a compacted aggregate-asphalt cement mixture with sufficient stability to resist traffic.
3. It should contain enough asphalt cement for durability from weathering including the effects of oxidation and moisture susceptibility.

In short, the Hveem method of mix design attempts to maximize durability by selecting the highest asphalt content while still exceeding the minimum stability requirements. The Hveem method has two primary advantages. First, the kneading action of laboratory densification (achieved by a rotating ram having about 1/4 the contact area of the 101.6 mm (4”) diameter mold) simulates the densification characteristics of hot mix asphalt compacted in the field. Second, Hveem stability is a direct measurement of the internal friction component of shear strength because it measures the ability of a test specimen to resist lateral displacement from application of a vertical load. However, the Hveem compactor is somewhat expensive, large, and not very portable. Furthermore, the important mixture volumetric properties described above are not routinely determined as part of the Hveem procedure.

The Hveem method uses the oil soak and Centrifuge Kerosene Equivalent (CKE) tests to aid in determining fine and coarse aggregate absorption for use in estimating the initial asphalt requirements of the mix. Once the initial asphalt content (IAC) is determined, test specimens are prepared containing the IAC, 0.5% and 1.0% above the IAC and 0.5% below the IAC. Compacted samples are put through stabilometer and cohesiometer tests to measure stiffness, a swell test to measure the mix’s resistance to moisture, and a density-voids analysis. The optimum asphalt content is determined via a convoluted process involving a highly complex chart requiring several inputs and correction factors.

Marshall

A primary advantage of the Marshall method is the attention given to density and voids properties of asphalt mixtures. This analysis ensures the proper volumetric proportions of mixture materials for achieving a durable hot mix asphalt. Additionally, the required equipment is inexpensive and portable thereby lending itself to quality control operations. The Marshall hammer used in the Marshall method is repeatedly dropped onto a sample a prescribed number of times dependent on the estimated traffic level. However, without a kneading action imparting the horizontal shear forces created by rollers, the Marshall hammer does not simulate mixture densification as it occurs in the field. Furthermore, as explained by Brown, et al [18], the high variability of results and limited ability to simulate field conditions (temperature, load rate, tire pressures, etc.) of Marshall stability does not adequately estimate the shear strength of hot mix asphalt. The Asphalt Institute [7] stated that these two situations make it difficult to ensure rutting resistance of the designed mixture.

The two principle features of the Marshall method of mix design are a density-voids analysis and a stability-flow test of the compacted test specimens. The stability of the test specimens is the maximum load resistance in Newtons (lb.) that the standard test specimen will develop at 60 °C (140 °F). The flow value is the total movement or strain, in units of 0.25 mm (1/100 in.), occurring in the specimen between no load and maximum load during the stability. After determination of an optimum asphalt content, the density-voids analyses and the stability-flow tests are completed on five sets of three samples containing the optimum content, and 0.5 % and 1.0 % above and below optimum.

In the Marshall method, the mix is compacted using a 101.6 mm (4 in.) diameter by 75 mm (3 in.) high mold and a 4.5 kg (10 lb.) compaction hammer constructed to obtain a 457 mm (18 in.) drop height. Depending on design traffic load, the weight is dropped from its 457 mm height 35 times (light traffic), 50 times (medium traffic) or 75 times (heavy traffic). The mold is inverted and the same number of blows are repeated.

Brown [14] found that the advent of the mechanical Marshall hammer actually decreased the effectiveness of Marshall compaction in simulating field compaction. Prior to the advent of mechanical compactors, the top of the hammer was held with one hand while the hammer was raised and dropped with the other. The inability to keep the hammer perfectly vertical resulted in a kneading action. Guides on mechanical hammers reduce the kneading action resulting in substantially different laboratory densities. The Marshall compactor is effective in achieving densification from grain fracturing and particle layer distortion but without a kneading action, densification through particle reorientation is minimal. On examining density-voids relationships of airfield pavements in Kuwait, Bissada [9] found that even the 75-blow Marshall compaction effort was inadequate as a realistic standard for predicting future densification under traffic. The characteristics of Marshall compacted specimens were not necessarily representative of their lifetime service performance.

Superpave

The Strategic Highway Research Program (SHRP) spent five years developing a new mix design methodology, named Superior Performing Pavements, or Superpave. Roberts, et al [16] described several differences between Superpave and the Marshall and Hveem methods: it uses a new "Performance Grade" system for grading asphalt cement; it uses consensus properties for aggregate selection; and it contains new mix design and mixture analysis procedures. The Asphalt Institute [8] described Superpave as a performance-based system because the mixture tests and analyses have direct relationships to field performance.

Traditional grading of asphalts, such as penetration or viscosity graded asphalts, were based on physical properties at standard temperatures. However, such grading systems have two important shortcomings. First, their empirical nature limits their applicability beyond those conditions in which it was developed. A second limitation of previous grading systems is the lack of performance testing over the same temperature range the asphalt will likely see in the field. Superpave's performance graded asphalt system differs from previous grading systems in that the tests measure physical properties that can be directly related to field performance by engineering principles. Another unique feature of the Superpave binder specification system is that instead of performing a test at a constant temperature and varying the specified value, the specified value is constant and the temperature at which this value must be achieved is varied. The result is an identification system comprised of two numbers: the high temperature grade and the low temperature. For example, a PG 52-34 asphalt binder must posses adequate physical properties at the high temperature, 52 °C (126 °F), and at the low temperature, -34 °C (-29 °F).

Another new feature of the Superpave mix design system is the concept of a restricted zone in the aggregate gradation. Brown, et al [14] described the purpose of the restricted zone as a way to help ensure that too much rounded, natural sand is not used in the mixture and to help ensure that the minimum VMA requirement is achieved. For blends with nominal sizes 25 mm (1 in.) and greater, the restricted zone boundaries are placed on the 4.75 mm (No. 4), 2.36 mm (No. 8), 1.18 mm (No. 16), 0.60 mm (No. 30), and 0.30 mm (No. 50) sieve sizes. For blends with nominal maximum aggregate sizes of 19 mm (3/4 in.) and less, the 4.75 mm (No. 4) sieve limits are omitted. It is important to note, however, that the restricted zone is just a guide. It is possible to use aggregate blends that pass through the restricted zone that still function satisfactorily. The Superpave system also uses upper and lower control points on the 0.075 mm (No. 200), 2.36 mm (No. 8), and the nominal sieve size of the blend. Additionally, a lower control limit is placed on the sieve size one size lower than the nominal size. Control and restricted zone limits for all nominal maximum aggregate sizes can be found in sources such as the Asphalt Institute's Superpave Series No. 2 (SP-2) manual [7].

Recognizing the importance of volumetric proportioning, Superpave incorporated aggregate criteria directly into its design procedures. Superpave has two forms of aggregate criteria: consensus properties (aggregate angularity, flat and elongated particles, and sand equivalent or clay content) and source properties (toughness, soundness and deleterious materials). Following is the rationale behind determining the aggregate properties and the test procedures used to determine the properties as given by the SP-2 manual. A complete listing of the minimum required values for the following consensus property tests can be found in the SP-2 manual.

Fine aggregate angularity (FAA) testing is done to ensure a high degree of internal friction and rutting resistance. FAA is defined by the percent of air voids in loosely compacted aggregate smaller than the 2.36 mm (No. 8) sieve. The procedure for FAA testing is outlined in Amercian Association of State Highway and Transportation Officials (AASHTO) TP 33, "Test Method for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, & Grading)" (ASTM C1252). A sample of fine washed aggregate is poured into a small, calibrated cylinder through a standard funnel. By measuring the mass of fine aggregate in the filled cylinder of known volume, the void content can be calculated as the difference between the cylinder volume and fine aggregate volume collected in the cylinder. Superpave requires a minimum FAA value of 40 for use in mixes placed less than 100 mm (4 in.) from the surface.

Coarse aggregate angularity (fractured faces), ensures a high degree of aggregate internal friction and rutting resistance. It is defined as the percent by weight of aggregate larger than the 4.75 mm (No. 4) sieve with one or more fractured faces. The procedure for determining coarse aggregate angularity is given in ASTM D5821-95, "Determining the Percentage of Fractured Particles in Coarse Aggregate." The value is typically expressed as the percent with one or more fractured faces over the percent with two or more fractured faces. Superpave minimum CAA requirements range from 55/(unspecified) for low volume roads to 100/100 for high volume roads.

Flat and elongated coarse aggregate particles are undesirable because they have a tendency to break during construction and under traffic. The fracturing of aggregate is a concern because it can reduce mixture stability and in extreme situations may actually make the gradation finer affecting the optimum asphalt content. The flat and elongated coarse aggregate property is expressed as the percentage by mass of coarse aggregate having a maximum to minimum dimension ratio greater than five to one. It is determined according to ASTM D4791, "Flat or Elongated Particles in Coarse Aggregate" on particles larger than 4.75 mm (0.187 in.). Superpave does not limit the percent of flat and elongated particles for low-volume mix designs, but limits their use to ten percent for all other design levels.

The sand equivalency test is a measure of the clay content in the fraction of the fine aggregate smaller than the 4.75 mm (No. 4) sieve. Sand equivalency is determined by the method in AASHTO T176, "Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test" (ASTM D2419). In the sand equivalency test, a sample of fine aggregate is mixed with a flocculating solution in a graduated cylinder and agitated to loosen the clayey fines and force them into suspension above the granular aggregate. After a settling period, the cylinder heights of the suspended clay and settled sand are measured. The sand equivalent value is the ratio of sand to clay height readings. Minimum Superpave requirements range from 40 percent for low volume roads to 50 percent for high volume.

Samples are compacted in the Superpave gyratory compactor (SGC) and the asphalt content is selected on the basis of volumetric design requirements (the goal being 4% air voids). In its SP-2 manual, the Asphalt Institute [7] identifies several goals of the SHRP efforts in designing the SGC:

- Realistically compact mix specimens to densities achieved under actual pavement climate and loading conditions.
- Accommodate large aggregate sizes.
- Measure compactibility so potential tender mix behavior could be identified.
- Portable enough for use in mixing facility quality control operations.

The loading ram on an SGC produces a constant 600 kPa (87 psi) vertical compaction pressure on a sample contained in a 150-mm (6 in.) diameter mold (which can accommodate mixes having up to 50-mm (2 in.) maximum size aggregate). The base of the SGC rotates at a constant rate of 30 revolutions per minute with the mold positioned at a 1.25° compaction angle. Density can be estimated at any time during the compaction process because the position of the ram is continually recorded as it compacts the specimen (the mass of the mix inside the mold and the mold's diameter are constant). The 1.25° compaction angle coupled with the revolving base enables the SGC to impart a kneading action on the specimen much like it would undergo in the field. The kneading action enables further densification of the specimen through rearrangement of the aggregate particles.

Superpave mixes are designed at a specific level of compactive effort—the number of gyrations necessary, called N-design (N_{des}), to compact the mixture to 4% air voids. N_{des} is a function of climate and traffic levels. Climate is represented by the average design high air temperature and traffic level is represented by the design ESALs (equivalent 80 kN (18,000 lb.) single axle loads). The range of values for N_{des} is show in Table 2.3. The two other values shown in Table 2.3, N-initial (N_{ini}) and N-maximum (N_{max},) also play important roles in the Superpave design process. N_{ini} is considered a measure of mixture compactibility. At N_{ini} gyrations the density of the sample must be greater than 89% of the maximum density. Mixes that compact too quickly (less than 11% air voids at N_{ini}) will probably be tender and unstable. N_{max} is a possible measure of a mix's susceptibility to rutting. The density at Nmax must be less than 98%. Mixes that compact to greater than 98% air voids at Nmax may exhibit premature or excessive rutting.

Table 2.3 Superpave Design Gyratory Compactive Effort (Asphalt Institute [7])

Design ESALs (millions)	Average Design High Air Temperature											
	<39°C			39 - 40°C			41 – 42°C			43 - 44°C		
	N_{ini}	N_{des}	N_{max}	N_{ini}	N_{des}	N_{max}	N_{ini}	N_{des}	N_{max}	N_{ini}	N_{des}	N_{max}
< 0.3	7	68	104	7	74	114	7	78	121	7	82	127
0.3 - 1	7	76	117	7	83	129	7	88	138	8	93	146
1 - 3	7	86	134	8	95	150	8	100	158	8	105	167
3 - 10	8	96	152	8	106	169	8	113	181	9	119	192
10 - 30	8	109	174	9	121	195	9	128	208	9	135	220
30 - 100	9	126	204	9	139	228	9	146	240	10	153	253
> 100	9	143	235	10	158	262	10	165	275	10	172	288

Use in Quality Control

A key part of any mixture design system is its ease and reliability when used in the construction process as part of production quality control. Roberts, et al [16] cited the Federal Highway Administration (FHWA) Demonstration Project No. 74's clear indication that significant differences exist between the volumetric properties of the laboratory designed and plant produced mixtures. Consequently, production quality control is performed by the contractor (typically in on-site laboratories) to ensure the plant is performing as anticipated, and by the owner (typically in mobile laboratories) to ensure production of a consistent, quality product. The first step in production quality control consists of periodic sampling of the material from either behind the paver (preferred) or from the bed of a hauling truck. The sample is then taken to the lab where it is compacted and its volumetric properties are determined. The values are then used to ensure mix production remains within set control limits, and to look for trends signifying the production is out of control (unacceptably large variations) and/or tending towards exceeding a control limit. Without production quality control, there is no means of verifying the product is indeed the consistent, high quality product desired.

When first instituted, the large size and expense of Hveem compactors made efficient production quality control difficult. Furthermore, the absence of routine volumetric property determination in the Hveem method exacerbated problems when volumetric analyses became the primary means of production quality control. The smaller, less costly Marshall hammer, however, was much more suited to on-site laboratories. This situation was acceptable when the majority of mixes were designed using the Marshall method. However, the increasing use of Superpave in the design of asphalt mixtures has brought with it an important question in the quality control process: Can a Marshall compactor (still found in most on-site laboratories) be used to perform production quality control of a Superpave job? D'Angelo, et al [19] conducted a study to determine whether a Marshall hammer could be used to adequately perform quality control on a Superpave mix and vice-versa. The study examined five different mixes from five different plants by compacting each mix with both a mechanical Marshall hammer and a Superpave Gyratory Compactor. Table 2.4 summarizes the design and compaction methods used in the study.

Table 2.4 Summary of Design and Compaction Methods (D'Angelo, et al [19])

Study Number	Design Method	Compaction Effort	Control Compactor	Compaction Effort
# 539	Superpave Level 1	SGC 150x115mm N_d=100 N_m=158	6-in. (152mm) S. Marshall	112 blows/side
# 540	6-in. (152-mm) S. Marshall	112 blows/side	SGC	N_d=100 N_m=158
#641	4-in. (102-mm) S. Marshall	50 blows/side	SGC	N_d=126 N_m=204
# 9401A	4-in. (102-mm) S. Marshall	75 blows/side	SGC	N_d=109 N_m=174
# 9407A	Superpave Level 1	SGC 150x115mm N_d=100 N_m=158	4-in. (102mm) S. Marshall	50 blows/side

The volumetric properties of the mixtures were evaluated to determine if the compaction devices were interchangeable or if the results were dependent on the compaction device used. D'Angelo, et al [19] concluded that when evaluating voids in the total mix (VTM) as the control criterion, the two compactors were interchangeable. Voids in the mineral aggregate (VMA), however, is actually a better criterion to evaluate quality control because it provides a better indication of the aggregate structure within the mix. When using VMA as the criterion, D'Angelo, et al [19] found that the two compactor were not interchangeable.

In two of the mixes, where the SGC indicated a continued increase in VMA with increasing asphalt content, the use of the Marshall hammer resulted in a decrease in VMA. The SGC indicates the additional binder has filled the void space between the particles forcing them apart. With the Marshall hammer, the additional binder lubricated the aggregate allowing the hammer to compact the mixture more densely. The results clearly indicate that when a mix is designed using Superpave, an SGC must be used for production quality control.

RUGGEDNESS EVALUATIONS

Gyratory Compactors

The Marshall and Hveem methods of mix design were developed over 50 years ago. Their strengths and shortcomings are well documented, but Superpave is still relatively new. Its reaction to variabilities in materials and conditions are not well documented. McGennis, et al [20], in cooperation with the FHWA expert task group, conducted a ruggedness test of the

American Association of State Highway and Transportation Officials (AASHTO) Test Method TP4 to evaluate the extent to which variations in test parameters cause variations in test results. AASHTO TP4 is the provisional standard governing the preparation of test specimens with the Superpave Gyratory Compactor. The experiment was conducted using two SGCs that FHWA experiments determined were substantially equivalent: the Pine and Troxler SGCs (D'Angelo, 1995). Table 2.5 shows the seven primary factors and their levels of variation evaluated in the experiment. Table 2.6 lists the eight combinations of variables used in the experiment.

Table 2.5 Main Factors Evaluated in Ruggedness Experiment (McGennis, et al [20])

Factor	Levels
Angle of Gyration, degrees	Low Range (1.22 to 1.24) and High Range (1.26 to 1.28)
Mold Loading Procedure	Transfer Bowl Method and Direct Loading Method
Compaction Pressure, kPa	582 and 618
Precompaction	None and 10 thrusts with Standard Rod
Compaction Temperature, °C	@0.250 Pa-s viscosity and @ 0.310 Pa-s viscosity
Specimen Height, mm	Low (around 110mm) and High (around 120 mm)
Aging Period @ 135°C, hrs	3.5 and 4

Table 2.6 Variable Combinations used in Ruggedness Experiment (McGennis, et al [20])

	Combination							
Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Angle of Gyration, degrees	1.23	1.23	1.23	1.23	1.27	1.27	1.27	1.27
Mold Loading Procedure	TB	TB	DL	DL	TB	TB	DL	DL
Compaction Pressure, kPa	618	582	618	582	618	582	618	582
Precompaction	Y	Y	N	N	N	N	Y	Y
Compaction Temperature, °C	H	L	H	L	L	H	L	H
Specimen Height, mm	L	H	H	L	L	H	H	L
Aging Period @ 135°C, hrs	4.0	3.5	3.5	4.0	3.5	4.0	4.0	3.5

The nominal angle of gyration in AASHTO TP 4 is 1.25° with an allowable tolerance of 0.02°. The tolerance was established by FHWA because several experiments showed density was profoundly affected by small changes in angle. One study on a project in Arizona determined that a 0.25° change in angle of gyration resulted in a four percent change in void content. However, across the 0.04° range of compaction angles evaluated, the trend toward an increase in density was not significant. Less than one percent of the variation was explained by compaction angle.

Although AASHTO TP4 vaguely informs the operator to "place the mixture in the mold in one lift," experience by the Colorado and Texas DOTs has shown that the method of mold loading has a significant influence on specimen density. The experiences of McGennis, et al [20] suggested two extremes of mold loading: loading the bowl with a specially designed "gyro loader" transfer bowl; and using a scoop to load the mold directly from the aging pan. Results of this experiment indicate the mold loading procedure does not have a clear, consistent influence on SGC test specimens.

AASHTO TP4 requires a nominal compactive pressure of 600 kPa (87 psi). The allowable three percent tolerance results in test pressures of 582 (84.4 psi) and 618 kPa (89.6 psi). Results indicate a significant difference in density between the two pressures. However, pressure tolerance is not significant since SGCs have transducers enabling operators to set the pressure at exactly 600 kPa (87 psi).

Although TP4 does not require precompaction (the rodding of the mixture prior to compaction), most previous mix design methods such as the Marshall and Hveem methods have required it. Consequently, it is very likely SGC operators would precompact the mix out of habit. Experience has shown it can take as many as 20 gyrations for the compaction pressure to stabilize at 600 kPa (87 psi). It was hypothesized precompaction would enable quicker pressure stabilization resulting in different measured bulk specific gravity. However, results showed the two extremes (zero and 10 rodding strokes) had no significant effect.

AASHTO TP4 specifies mixtures be compacted within a temperature range that results in a binder viscosity between 0.250 Pa-s (2.5 poise) and 0.310 Pa-s (3.1 poise). For the binder in the McGinnis, et al [20] evaluation, a PG 64-22, the resulting compaction temperatures were 141 °C (286 °F) and 146 °C (295 °F). Results indicated compaction temperatures at the extremes of 141 °C (286 °F) and 146 °C (295 °F) do not have a significant effect.

McGennis, et al [20] discovered the 100-mm (3.94 in.) nominal specimen height requirement of AASHTO TP4 (Edition 1B, September, 1993), is actually incorrect. Most SHRP research had been completed on specimens with a 115-mm (4.53 in.) nominal height. Additionally, the required ± 1 mm (0.0394 in.) tolerance is counter-productive as it is extremely difficult to achieve on the initial compaction and may simply be too stringent. Consequently, McGennis, et al [20] chose to use a tolerance level of ± 5 mm (0.2 in.). Results showed a significant variability when the height difference of fine graded mixtures exceeded ± 12 mm (0.47 in.). Coarse mixtures did not exhibit a significant variability with respect to height. McGennis, et al concluded a ± 5 mm (0.2 in.) tolerance ensures reasonable variability.

Although TP4 requires four hours of short-term oven aging at 135 °C (275 °F), required compaction temperatures may sometimes be higher than 135 °C (275 °F). To achieve compaction temperatures above 135 °C (275 °F), two ovens are often used. The first oven, set at 135 °C (275 °F), is used for short-term aging of the mix. The second oven is used to heat the specimen up to the required compaction temperature. Two acceptable procedures exist for achieving the increased temperature: placing the mixture in the second oven for up to the 30 allowable minutes after the four hours of short-term aging, or removing the mixture from the first oven such that the increased temperature can be obtained within the required four hours of short-term aging. Therefore, McGennis, et al [20] used 3.5 and 4.0 hours for the extremes of short-term aging. Results indicated the extremes of the short-term aging protocols had an insignificant effect. However, it is important to note this conclusion was reached based upon only one binder. McGennis, et al advise binders exhibiting rapid aging characteristics may be more susceptible to variations in short term aging times. In summary, McGennis, et al [20] concluded the Superpave Gyratory Compactor is a rugged, dependable system that is not very susceptible to operating variations.

CONCLUSION

The Marshall and Hveem methods of mix design are proven, 50 year-old design procedures. However, they do have their shortcomings. Their primary material characterization tests (Marshall stability and flow and Hveem stability) are not reliable when conditions are outside those in which the tests were developed (i.e. the continuing increase in axle loads and tire pressures). A hot mix asphalt design procedure that characterizes the mixed based on performance-related fundamental engineering properties is required.

Superpave's gyratory compactor plays an important role in producing laboratory- compacted hot mix asphalt samples that are representative of field compaction. Shear and tensile tests are useless if performed on a laboratory specimen that is not representative of a field specimen. Researchers have concluded that as a gyratory compactor, the SGC does a better job of simulating field compaction because its shearing action simulates the densification through particle reorientation achieved by rollers in the field.

CHAPTER 3
RESEARCH METHODOLOGY

OVERVIEW

The previous section discussed the importance of compaction, the influence of mix properties on volumetrics, and presented the Superpave method of mix design. This section describes the equipment, materials, and procedures used in the production and analysis of mix specimens. Once determined from the mix design, the optimum asphalt contents for the various mixtures were used throughout the remainder of the project. Samples were created at the optimum asphalt content (for 3 percent compacted air voids) for resilient modulus testing at –18, 0, 25, and 40 °C (0, 34, 77, and 104 °F, respectively) to determine each mixture's susceptibility to temperature variation. Moisture sensitivity was evaluated by comparing the indirect tensile strengths between unconditioned, control samples and vacuum-saturated, conditioned samples.

MIX DESIGN

Summary of Laboratory Mixes

Generally speaking, it is economically desirable to use low-cost, locally available materials for roads with low traffic volumes. The fine aggregate (FA - passing the 4.75 mm (No.4) sieve) used for every gradation was a sand from Lakeland, Minnesota. It is readily available at low cost, but has a relatively rounded shape. The coarse aggregate (CA – retained on the 9.5 mm (3/8 in.) and larger sieves) used in the project consisted of aggregate from four different sources: Granite Falls (GF) granite, New Ulm (NU) quartzite, Kasota (KL) limestone, and Cedar Grove (CG) gravel. Two different gradations, shown in Figure 3.1, were used in the project: a fine gradation which ran above the Superpave restricted zone; and a coarse gradation which ran below the restricted zone. Additionally, two different asphalt cement grades were evaluated: a PG 52-34, the primary grade for the project, was used in all 8 mixes; a PG 58-40 cement was used in the fine gradations for the New Ulm quartzite and Kasota limestone mixes.

Eight different aggregate gradations (four above, two through and two below the restricted zone) using Granite Falls granite (CA) and Lakeland gravel (FA) were evaluated in the attempt to satisfy the Superpave VMA criteria. None of the eight gradations resulted in a sample compacted to 4% air voids having a VMA above the Superpave minimum requirement of 14% for low volume roads (300,000 < ESALs < 1,000,000). In fact, the only time the VMA criterion was satisfied was when the 2.36 mm (No. 8) and 1.18 mm (No. 16) Lakeland aggregate was replaced with a Wisconsin, Dresser basalt aggregate having a greater degree of angularity. Since the purpose of the project, however, is to use economical, locally available aggregate, the Dresser aggregate was not used in this project. Instead, the coarse and fine gradations were chosen on the basis of obtaining the best possible VMA/VFA results using a natural sand aggregate source.

The gradation and aggregate sources used in the project are listed in Table 3.1 for both coarse and fine mixes. The Superpave restricted zone, gradation band, and design gradations are illustrated in Figure 3.1.

Table 3.1 Coarse and Fine Mix Gradations

Sieve Size (mm)	Percent Passing (Coarse Gradation)	Percent Passing (Fine Gradation)	Aggregate Source
19	100.0	100.0	
12.5	93.2	96.1	GF/NU/KL/CG
9.5	66.2	83.1	GF/NU/KL/CG
4.75	47.3	70.1	Lakeland Gravel
2.36	33.8	57.1	Lakeland Gravel
1.18	23	44.2	Lakeland Gravel
0.600	16.2	31.2	Lakeland Gravel
0.300	12.2	18.2	Lakeland Gravel
0.150	8.1	7.8	Lakeland Gravel
0.075	4.1	3.9	Lakeland Gravel
PAN	0.0	0.0	Baghouse Fines

Aggregate Properties

The fine aggregate (FA) used for every gradation was a Lakeland gravel. It is readily available at low cost, but has a relatively low fine aggregate angularity (FAA) of 0.40. The coarse aggregates (CA) are Granite Falls Granite, New Ulm Quartzite, Kasota Limestone, and Cedar Grove Gravel. Tables 3.2 and 3.3 list the aggregate properties for the fine and coarse mixes, respectively.

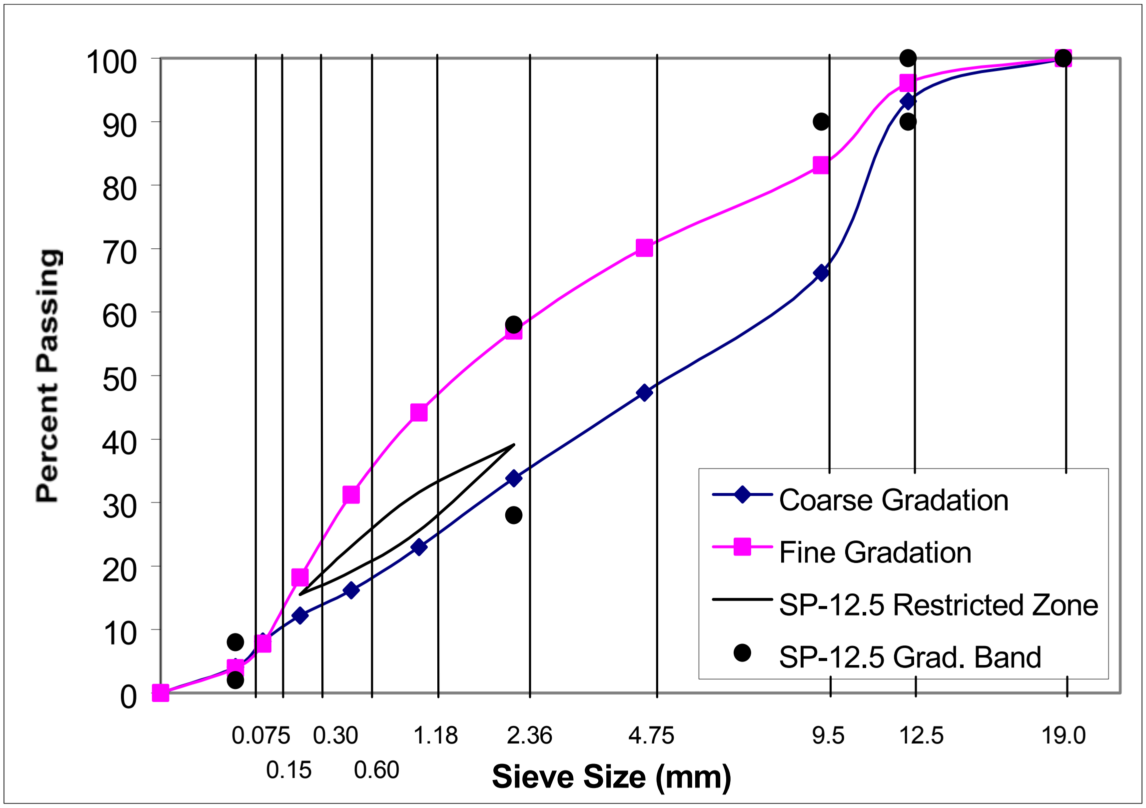

Figure 3.1 Experimental Mix Gradations

Table 3.2 Fine Aggregate Properties

TEST	LAKELAND GRAVEL
G_{sb}	2.602
G_{sa}	2.770
Water Absorption, %	2.3
Fine Aggregate Angularity, %	39.9
Sand Equivalent, %	48

Table 3.3 Coarse Aggregate Properties

TEST	Granite Falls Granite	New Ulm Quartzite	Kasota Limestone	Cedar Grove Gravel
G_{sb}	2.757	2.624	2.492	2.610
G_{sa}	2.797	2.661	2.770	2.731
Water Absorption, %	0.46	0.53	4.0	1.7
Flat/Elongated Particles %, (1:3 Ratio)	14.0	35.0	11.1	8.2
Fractured Faces %, (≥ 1 / ≥ 2)	100/100	100/100	100/100	64.7/38.6

All fine and coarse aggregate consensus property testing was done in accordance with Superpave specifications. The FAA of the Lakeland aggregate was determined using AASHTO TP33, "Test Method for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading—Method A)." The Sand Equivalency of the Lakeland aggregate was determined using AASHTO T176, "Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test" (ASTM D2419).

The procedure used to determine the flat/elongated particle percentage of the Granite Falls, New Ulm, Kasota, and Cedar Grove aggregates was ASTM D4791, "Flat or Elongated Particles in Coarse Aggregate." The final aggregate property, coarse aggregate angularity, or fractured faces, was done in accordance with ASTM D5821-95, "Determining the Percentage of Fractured Particles in Coarse Aggregate."

Gyratory Compactor

The compactor used throughout the project was the Brovold gyratory compactor—a Superpave Gyratory Compactor manufactured by Test Quip. The Brovold compactor is considered an Intensive Compaction Tester (ICT)—operating on a "shear compaction" principle. Compaction occurs via two distinct elements: vertical pressure and shear displacement. These two elements combine to encourage the reorientation of aggregate particles—essential for the compaction of any particulate specimen.

A piston pushing down on a plate resting on top the asphalt specimen inside the compaction mold supplies the vertical pressure. The Superpave standard of 600kPa (87 psi) was used throughout the project. The gyratory motion of the compactor creates the necessary shear force. Increasing the angle of the gyration increases the shear force created by the compactor. Superpave guidelines, however, set the gyratory angle at 1.25° ± 0.02°. Figure 3.2 illustrates the resulting shear displacement described above.

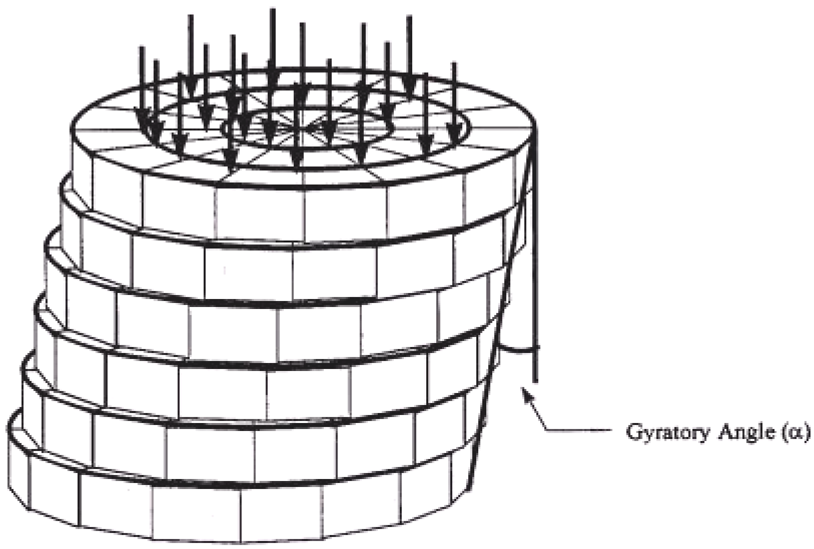

Figure 3.2 Shear Displacement During Gyratory Compaction

The height of the sample is continually recorded by a linear variable displacement transducer (LVDT). The density of the sample at each gyration is calculated using the current height and mass of the sample. The operator is able to control the compaction energy transmitted to the sample by inputting the desired number of gyrations. Superpave specifies the number of gyrations as a function of temperature and anticipated traffic.

Compaction Procedure

Prior to mixing, pre-batched, 12,000-gram (26.5 lb.) aggregate samples were placed in a forced-draft oven for a minimum of four hours to ensure adequate drying. Simultaneously, the asphalt binder was pre-heated to the appropriate mixing temperature, 138 ° (280 °) for PG 52-34 and 145 ° (293 °) for PG 58-40. The aggregate was first poured into a bucket mixer followed by the appropriate amount of asphalt cement. After adequate mixing in the bucket mixer, the mixture was placed in a large pan and mixed by hand to prevent segregation. Each batch was then split into two 4,800 g (10.6 lb.) samples for compaction, and two 1,000 g (2.2 lb.) samples for Theoretical Maximum Specific Gravity testing. Mix design samples were prepared according to the matrix shown in Table 3.4. The initial asphalt content (P_b) was determined using the spreadsheet shown in Appendix A.

Table 3.4 Mix Design Matrix

Aggregate Type	Asphalt Grade	Superpave Level I Mix Design			
		Asphalt Content			
		P_b–0.5	P_b	P_b+0.5	P_b–1.0
GFC	PG 52-34	X	X	X	X
GFF	PG 52-34	X	X	X	X
NUC	PG 52-34	X	X	X	X
NUF	PG 52-34	X	X	X	X
KLC	PG 52-34	X	X	X	X
KLF	PG 52-34	X	X	X	X
CGC	PG 52-34	X	X	X	X
CGF	PG 52-34	X	X	X	X
NUF	PG 58-40	X	X	X	X
KLF	PG 58-40	X	X	X	X

The samples were compacted using Test Quip's Brovold gyratory compactor. The PG 52-34 samples were compacted at 128 °C (262.4 °F) . The PG 58-40 samples were compacted at 135 °C (275 °F) . The required number of gyrations was based on low-volume, level two, traffic: 300,000 to 1,000,000 ESALs. Therefore, Nini = 7, Ndes = 76, and Nmax = 117.

RESILIENT MODULUS

Resilient modulus tests were conducted on all samples to determine the mixtures' susceptibility to temperature changes. The test was conducted in accordance with ASTM D 4123-82 (1987), "Standard Test Method for Indirect Tension Test for Resilient Modulus of Bituminous Mixtures." Samples were typically loaded to a stress level between 5 and 20 percent of indirect tensile strength (measured or estimated prior to conducting resilient modulus tests). Loads were applied in cycles consisting of 0.1 second load and 0.9 second no-load rest. After test completion, the resilient modulus was calculated via the following equation:

$$M_R = \frac{P}{Ht} \times (0.27 + \mu) \quad (3.1)$$

Where:

M_R = resilient modulus, Pa
P = applied load, Newtons
H = horizontal deformation, mm
t = sample thickness, mm
μ = Poisson's ratio

Poisson's ration can be calculated as

$$\mu = 3.59\frac{H}{V} - 0.27 \quad \text{(for 100 mm samples)} \quad (3.2)$$

$$\mu = 4.09\frac{H}{V} - 0.27 \quad \text{(for 150 mm samples)} \quad (3.3)$$

Where:

μ = Poisson's ratio
H = horizontal deformation, mm
V = vertical deformation, mm

The following Poisson's ratio values recommended by Brown, et al [18] were assumed: 0.25 for 5 °C (41 °F); 0.35 for 25 °C (77 °F), or 0.40 for 40 °C (104 °F).

There is much debate over the applicability of resilient modulus values in the prediction of long-term pavement performance. It was once commonly believed stiffer pavements (those with higher resilient modulus values) had greater resistance to permanent deformation. Roberts, et al [16] caution that, to date, there is no solid correlation between M_R and rutting. However, M_R at low temperatures is somewhat related to cracking as stiffer mixes (higher M_R) at low temperatures tend to crack earlier than more flexible mixtures (lower M_R).

For the Superpave project, three 3400 g (7.5 lb.) samples were made for each of the ten mixes. Each of the samples were tested at both zero and 90° orientations. A minimum 2-hour waiting period was maintained between zero and 90° testing to provide the samples time to recover from any distortion that might have resulted from the previous test. All 30 samples were tested at –18, 0, 25, and 40 °C (0, 34, 77, and 104 °F, respectively). At each temperature, the samples were placed in temperature controlled environmental chambers for a minimum of 24 hours to ensure equilibrium had been reached at the respective temperature. Isopropyl alcohol was used to remove any ice accumulation from the extensometers. Due to the inherent high variability of resilient modulus testing, samples with suspected erroneous test results were immediately re-tested. Test results were continually examined to protect against inaccurate data resulting from damaged samples.

MOISTURE SENSITIVITY

The effects of moisture sensitivity can be as minor as the weakening of the bond between the asphalt cement and the aggregate or as drastic as the sudden peeling off of the asphalt so only bare aggregate remains. The more typical scenario is a gradual loss of strength over a period of years resulting in the development of rutting and shoving in the wheel paths. To help protect against moisture damage it is necessary to determine if a mixture is susceptible to water damage in the event of water penetration.

Moisture sensitivity tests were conducted in accordance with ASTM D4867. One set of six specimens for each mixture was compacted to 7 ± 1 percent air voids. Each set was then divided into two subsets of approximate equal void content. One subset was maintained dry while the other subset was partially saturated with water and moisture conditioned. The samples were vacuum saturated to between 55 and 80 percent. After being partially saturated, the conditioned samples were placed in a 60 °C (140 °F) water bath for 24 hours. Both subsets were then subjected to the tensile splitting test and loaded with a diametral load until failure. The tensile strength of each subset was determined by equation 3.4.

$$S_t = \frac{2000P}{\pi t D} \text{ (kPa)} \tag{3.4}$$

Where:
S_t = tensile strength, kPa
P = maximum load, N
t = specimen height before tensile test, mm
D = specimen diameter

The potential for moisture damage is indicated by the tensile strength ratio (TSR): the ratio of the tensile strength of the wet subset to that of the dry subset. The TSR for each mixture is calculated by equation 3.5.

$$TSR = \frac{S_{tw}}{S_{td}} \times 100 \qquad (3.5)$$

Where:
TSR = Tensile Strength Rati, %
Stw = Moisture conditioned tensile strength, kPa
Std = Dry tensile strength, kPa

PERFORMANCE TESTS

Tests were conducted to determine susceptibility to rutting and low temperature cracking. Due to time and budget constraints, a subset of four mix types was selected for this testing. Table 3.5 shows the test matrix for performance testing. Only fine-graded mixtures were chosen because they are more representative of low volume pavements in Minnesota than coarse-graded mixtures. New Ulm quartzite and Kasota limestone were chosen to represent low and high asphalt absorption capacities, respectively. Both the unmodified (PG 52-34) and polymer-modified (PG 58-40) were tested to determine if the expanded temperature range provided a significant reduction in rutting or cracking potential.

Table 3.5 Performance Testing Matrix

Aggregate Type	Asphalt Grade	Performance Tests	
		APA Rut Tester	IDT Low Temperature Creep Compliance
NUF	PG 52-34	X	X
KLF	PG 52-34	X	X
NUF	PG 58-40	X	X
KLF	PG 58-40	X	X

Rut Testing

Laboratory rut testing was conducted on four of the asphalt mixes to determine their susceptibility to rutting. The tests were conducted in accordance with the "Standard Test Method for Determining Rutting Susceptibility Using the Asphalt Pavement Analyzer" (Pavement Technology, Inc. 1999). The Asphalt Pavement Analyzer (APA) is a Loaded Wheel Tester used for evaluating permanent deformation (rutting) in asphalt pavements. Rutting susceptibility of mixes is assessed by placing cylindrical samples under repetitive wheel loads and measuring the amount of permanent deformation under the wheel path. The APA features controllable wheel loads and contact pressure that are representative of actual field conditions, and an environmental chamber allows for samples to be tested under controlled temperature conditions.

The samples were preheated at 40 °C for 6 to 24 hours prior to testing. The testing chamber was also preheated to this temperature. The samples were subject to a total of 8,000 cycles by the APA. The rut depth was determined by subtracting the measurement for each cycle from the initial measurement. Six samples were tested at one time, and they were arranged in front and back and left, center, and right positions. The rut testing was performed by Koch Pavement Solutions in Wichita, Kansas.

Low Temperature Creep Testing

Indirect tensile tests were performed to evaluate the thermal cracking susceptibility of the asphalt mixtures. The Superpave Indirect Tensile Test (IDT) was used to determine the creep compliance and indirect tensile strength of asphalt mixtures at low pavement temperatures. The test results can be used in performance models to predict the low-temperature thermal cracking potential and intermediate-temperature fatigue cracking potential of asphalt pavements. The Superpave IDT consists of a vertical loading frame, specimen deformation measurement devices, an environmental chamber, and a data acquisition and control system. The IDT loads a cylindrical asphalt concrete specimen along its diametrical axis, and the resulting deformations are used to determine the viscoelastic material properties. The test procedures are described in the American Association of State Highway and Transportation Officials (AASHTO) provisional standard TP 9-96, "Standard Test Method for Determining the Creep Compliance and Strength of Hot Mix Asphalt (HMA) Using the Indirect Tensile Test Device."

Creep compliance was tested at three temperatures: 0 °C, -10 °C, and -20 °C. The indirect tensile strength was then tested at -10 °C for each sample.

For the creep compliance tests, the specimens were cooled to the desired temperature. A preconditioning cycle was applied to each specimen consisting of 100 cycles of haversine load with amplitude equivalent to 70 kPa tension. One load cycle consisted of 0.1 seconds of haversine loading and 0.9 seconds of zero-load condition. The amplitude of the load was calculated by:

$$P(N) = 11 \times 10^{4} tD \tag{3.6}$$

Where:

t = specimen thickness, m

D = specimen diameter, m

Then an axial load was applied with a ramp of 8 kN/sec until one of the horizontal extensometers reached a deformation of 0.002 mm. The range of creep loads applied can be found in Table 1. This compressive load was held constant for 100 seconds, and the time-dependent vertical and horizontal deformations of the specimens was measured using extensometers. A typical load history for a test specimen is shown in Figure 1. The data is shown at one-second intervals, so the preconditioning load is not detailed on this graph. Knowing the load and deformations as functions of time, the creep compliance of the asphalt concrete was calculated.

After the creep test was performed at the three temperatures, the indirect tensile strength test was performed on the samples. A vertical displacement was applied to the specimen at a rate of 12.5 mm per minute until the load decreased (10% reduction from the peak value) from its maximum because of specimen failure. The data acquisition system measured the peak load that the specimen was subject to.

CHAPTER 4
RESULTS AND DISCUSSION

RESULTS

Aggregate Testing

Table 4.1 provides the results for the fine aggregate angularity and sand equivalency tests conducted on the fine aggregate and compares them with the Superpave criteria for low volume roads (< 1,000,000 ESALs). Although easily meeting the Sand Equivalent minimum value, the Lakeland aggregate barely made the 40% minimum fine aggregate angularity value. As discussed in the Mix Design section, the low fine aggregate angularity of the Lakeland aggregate is suspected to be the primary cause of the inability to meet the VMA criterion. Table 4.2 provides the same comparison for the flat/elongated particles and fractured faces tests done on the coarse aggregate. A quick review of Table 4.2 shows that all four coarse aggregates are acceptable for use in Superpave low-volume mix designs. As is typical with any non-crushed aggregate such as gravels, the Cedar Grove aggregate had a very low fractured faces value—barely meeting the 65% minimum. As will be discussed later in the Resilient Modulus and Moisture Sensitivity sections, however, the low fractured faces percentage of the Cedar Grove aggregate appeared to have no effect on its performance as compared to the other three aggregates evaluated.

Mix Design

Figures 4.1, 4.2, and 4.3 show the air voids versus asphalt content for the coarse, fine and PG 58-40 mixes, respectively. Figures 4.4, 4.5, and 4.6 show the VMA versus asphalt content for the mixes, and VFA versus asphalt content is shown in Figures 4.7, 4.8, and 4.9. Table 4.3 summarizes the data for both three and four percent air voids. As shown in Table 4.3, the VMA criterion is not satisfied by any of the mixes at 4% compacted air voids. Additionally, at 4% voids, five of the ten mixes did not meet the VFA criteria (65%<VFA<78%), while the remaining five had only 66% VFA. Low VMA and VFA may result in low aggregate film thickness which may lead to accelerated aggregate stripping and other related durability problems.

Table 4.1 Fine Aggregate Properties

TEST	LAKELAND SAND	Superpave Criteria ($<10^6$ ESALS)
Fine Aggregate Angularity, %	40	40 (min)
Sand Equivalent, %	48	40 (min)

Table 4.2 Coarse Aggregate Properties

TEST	Granite Falls Granite	New Ulm Quartzite	Kasota Limestone	Cedar Grove Gravel	SP Criteria ($<10^6$ ESALS)
Flat/Elongated Particles %, (1:3 Ratio)	14	35	11	8	None
Fractured Faces %, (≥ 1 / ≥ 2)	100/100	100/100	100/100	65/39	65/-

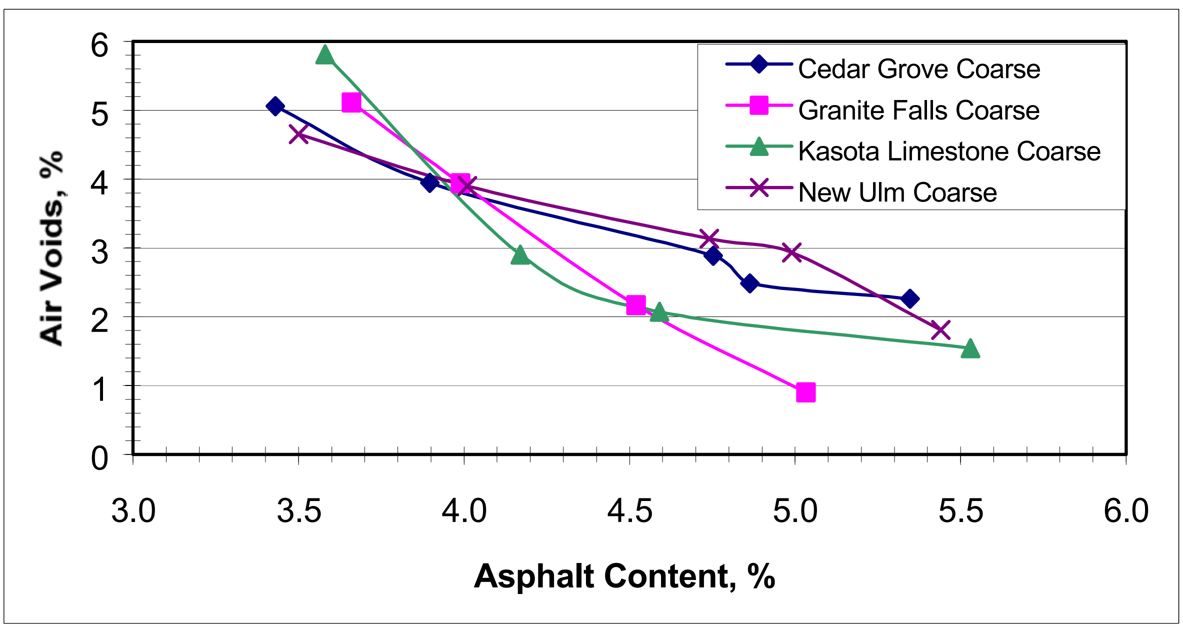

Figure 4.1 Air Voids vs. Asphalt Content for Coarse Mixes

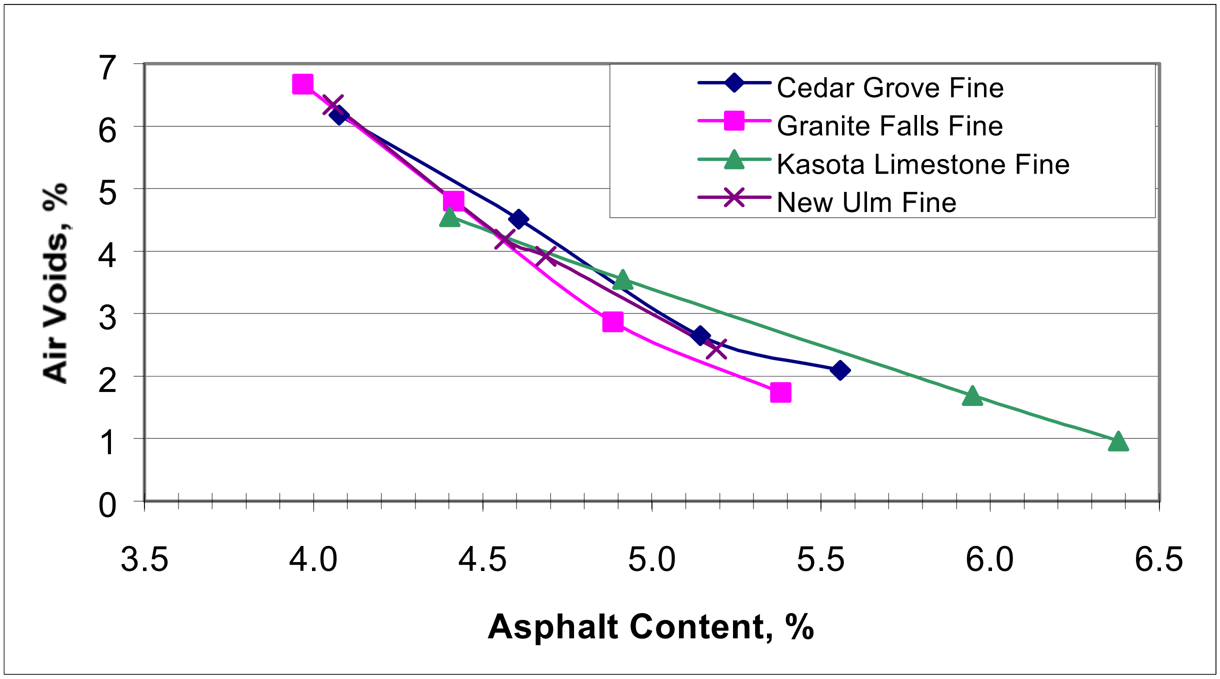

Figure 4.2 Air Voids vs Asphalt Content for Fine Mixes

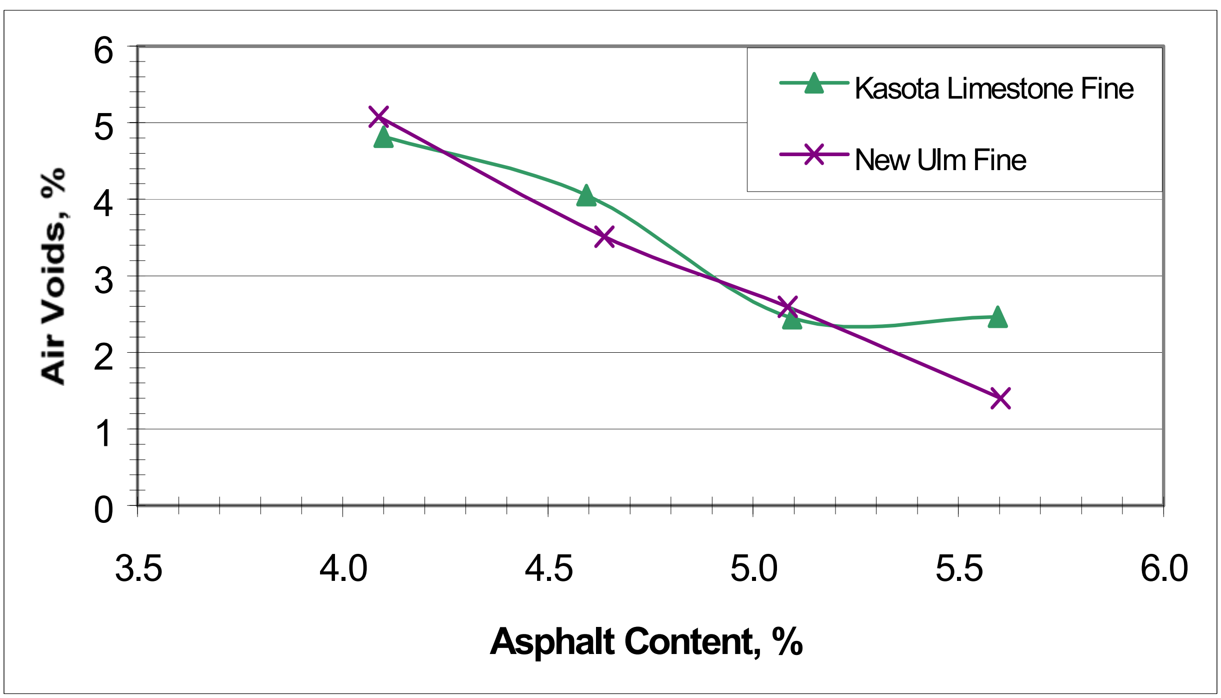

Figure 4.3 Air Voids vs Asphalt Content for PG 58-40 Mixes

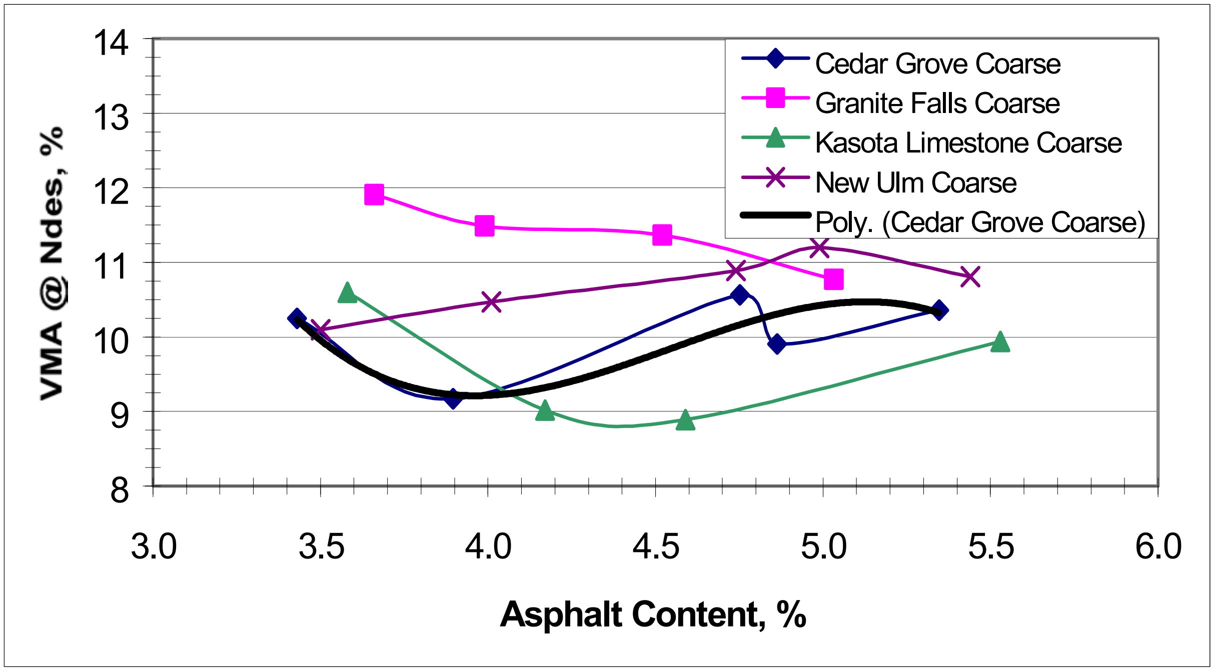

Figure 4.4 VMA @ N_{des} vs. Asphalt Content for Coarse Mixes

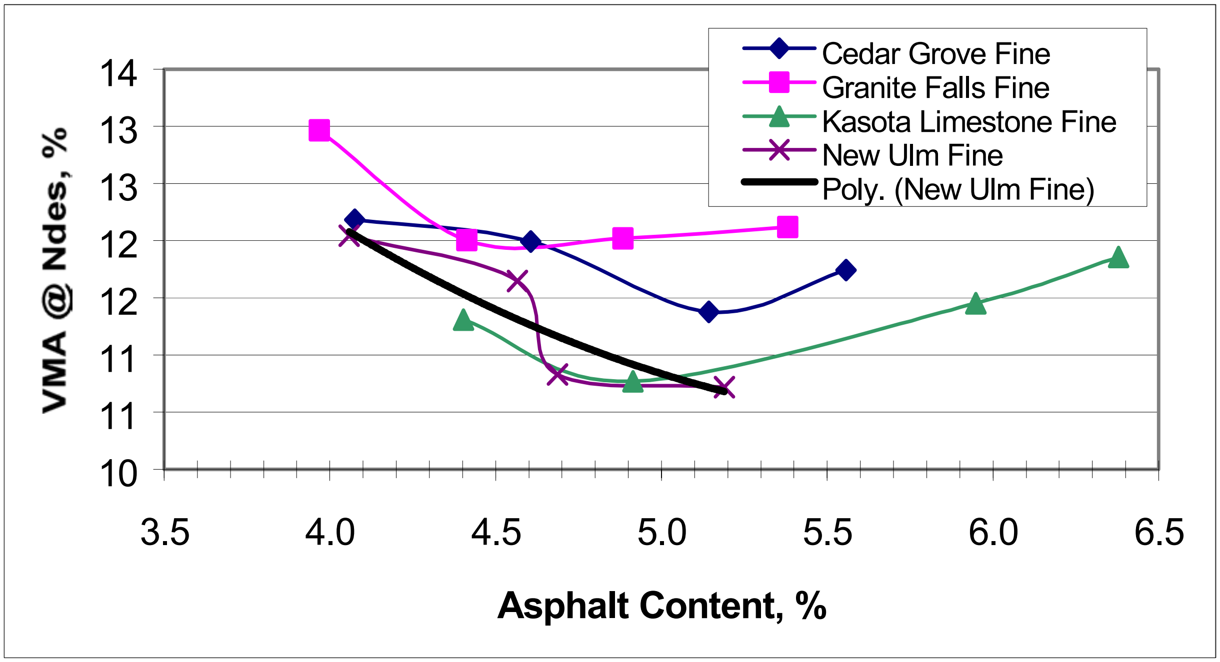

Figure 4.5 VMA @ N_{des} vs. Asphalt Content for Fine Mixes

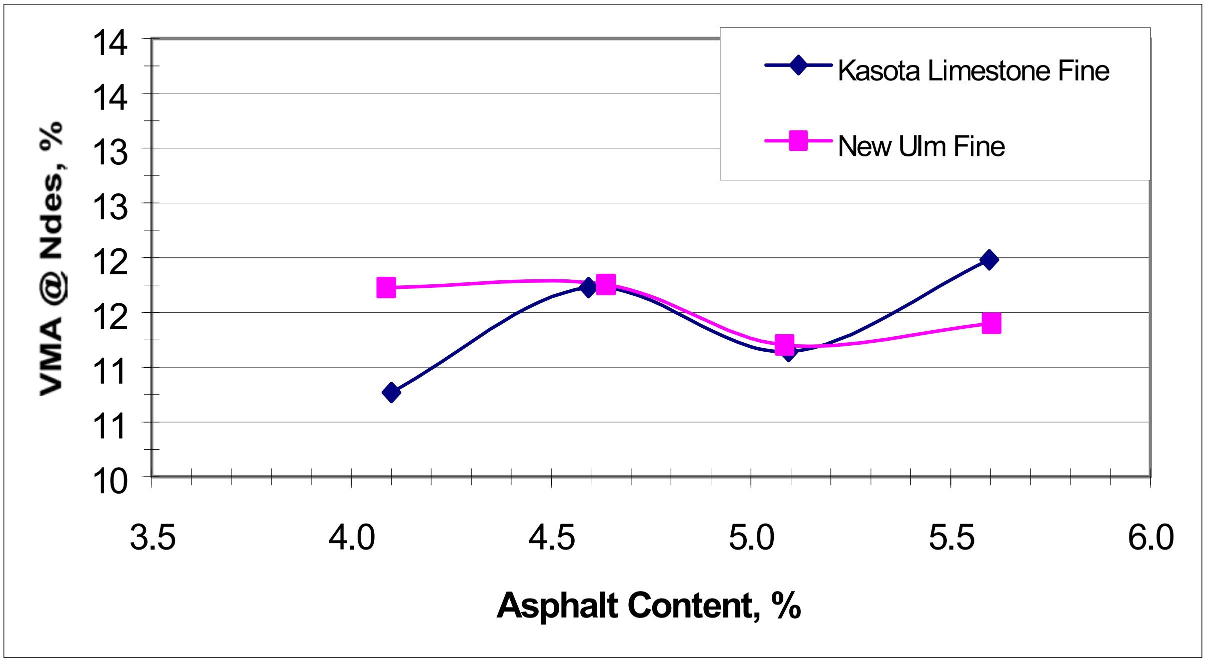

Figure 4.6 VMA @ N_{des} vs. Asphalt Content for PG 58-40 Mixes

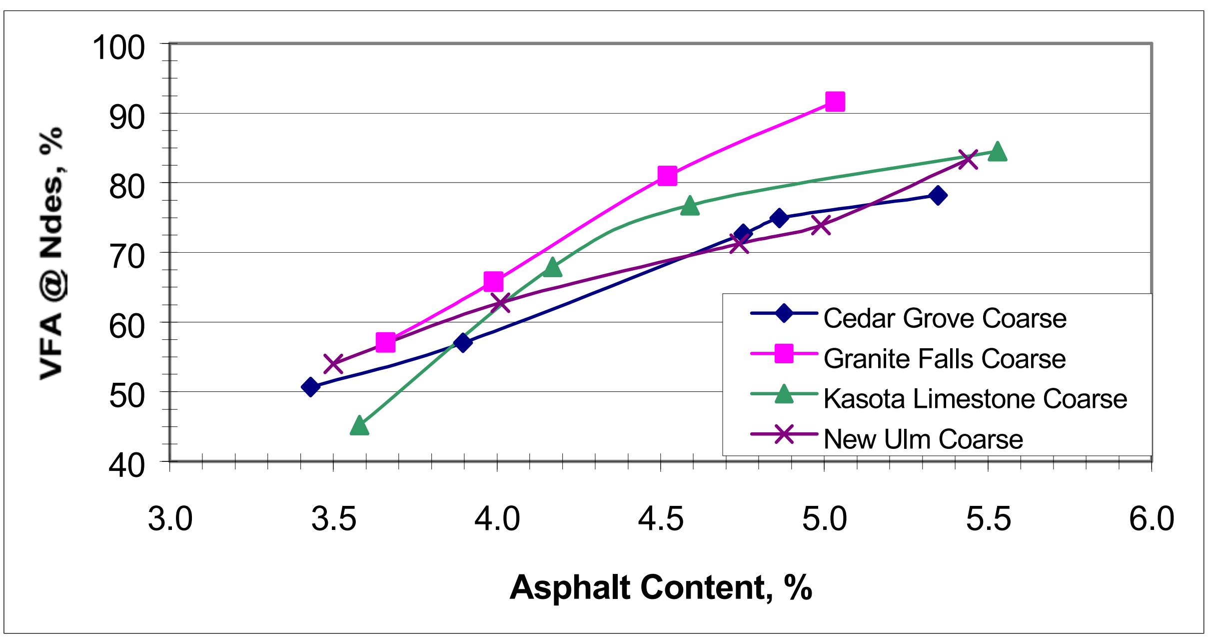

Figure 4.7 VFA @ N_{des} vs. Asphalt Content for Coarse Mixes

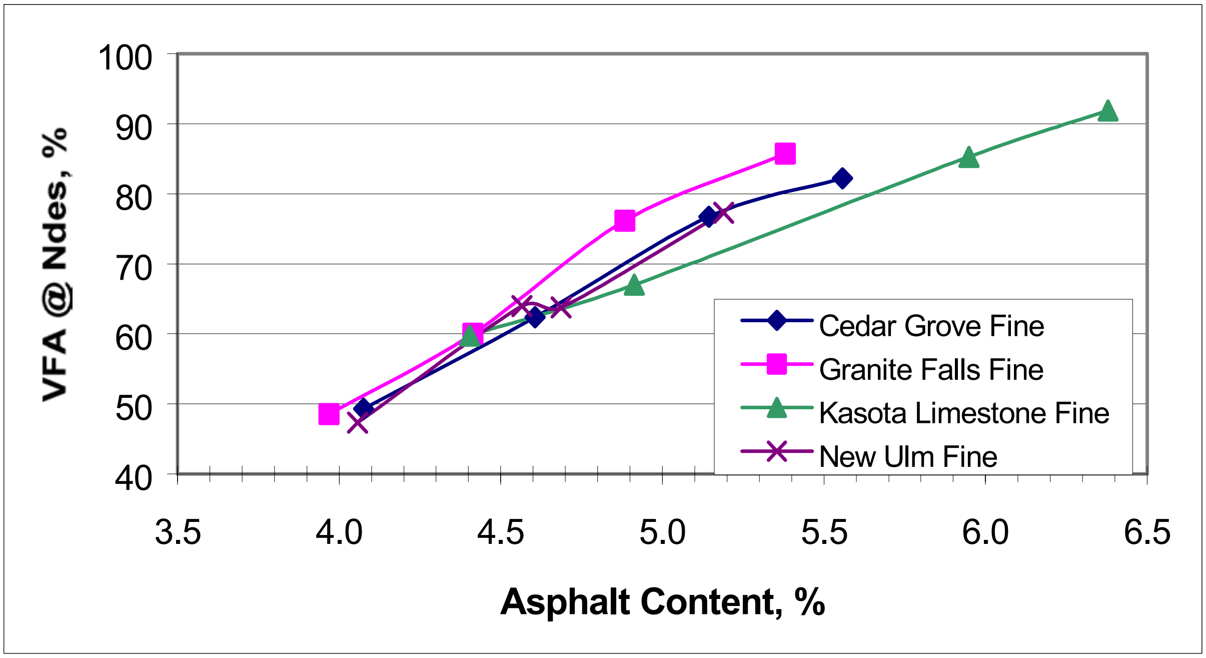

Figure 4.8 VFA @ N_{des} vs. Asphalt Content for Fine Mixes

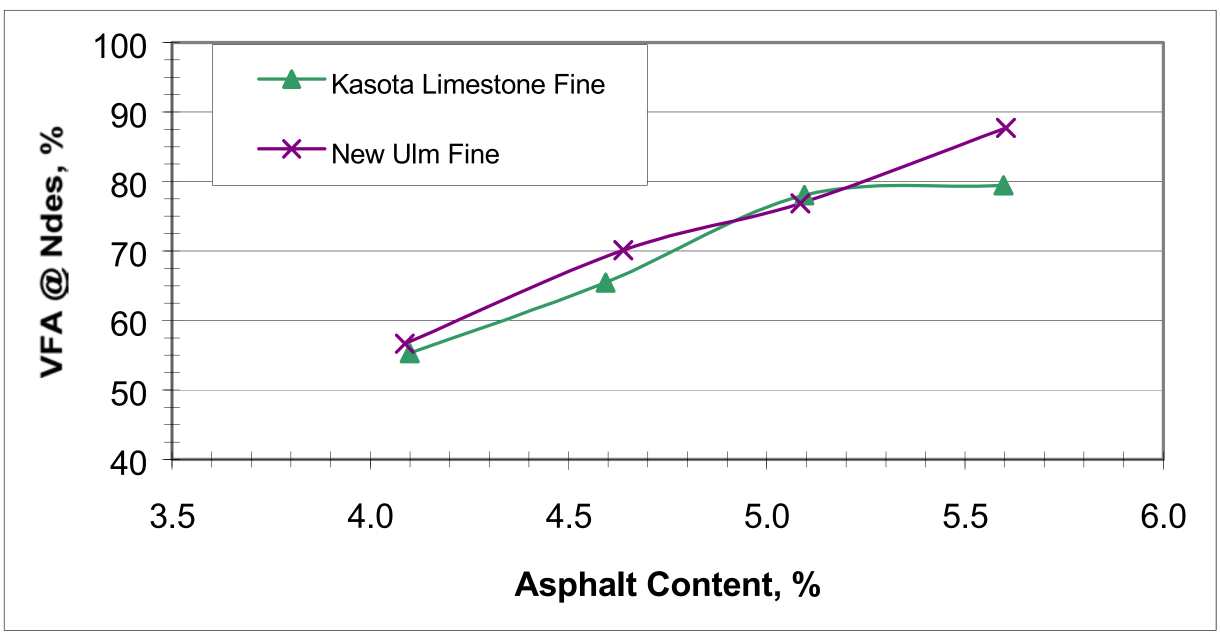

Figure 4.9 VFA @ N_{des} vs. Asphalt Content for PG 58-40 Mixes

Table 4.3 Summarized Mixed Design Results @ 4% Air Voids*

Aggregate	AC Content @ 4% Voids	VMA, % (≥14%)	VFA, % (65-78%)	% Gmm @ Nini < 90.5%?	% Gmm @ Nmax < 98%?	Dust Prop b/w 0.6 and 1.2?
GFC	4.00	11.5	66	88.2	97.1	1.04
GFF	4.60	11.9	66	90.8	96.7	0.87
NUC	3.95	10.4	63	87.6	97.1	1.04
NUF	4.65	10.8	64	90.8	96.7	0.87
KLC	3.95	9.6	59	88.3	97.3	1.04
KLF	4.65	10.8	64	90.9	96.8	0.87
CGC	3.90	9.75	56	88.0	97.1	1.06
CGF	4.75	11.8	66	90.7	96.7	0.84
NUF (58-40)	4.45	11.6	66	90.9	96.6	0.89
KLF (58-40)	4.60	11.5	66	90.8	96.7	0.87

*Underlined values do not meet Superpave criteria.

Table 4.4 Summarized Mixed Design Results @ 3% Air Voids*

Aggregate	AC Content @ 4% Voids	VMA, % (≥13%)	VFA, % (65-78%)	% Gmm @ Nini < 90.5%?	% Gmm @ Nmax < 98%?	Dust Prop b/w 0.6 and 1.2?
GFC	4.30	11.5	74	90.1	98.2	0.97
GFF	4.80	12.4	74	91.6	97.6	0.84
NUC	4.95	11.3	73	88.4	98.1	0.82
NUF	5.00	10.5	73	91.8	97.6	0.80
KLC	4.20	9.0	70	89.0	98.1	0.97
KLF	5.20	10.8	72	91.7	97.8	0.74
CGC	4.70	10.5	72	88.7	98.2	0.86
CGF	5.00	11.5	74	91.5	97.5	0.80
NUF (58-40)	4.90	11.4	74	92.0	97.7	0.82
KLF (58-40)	4.90	11.3	74	91.9	97.7	0.82

*Underlined values do not meet Superpave criteria.

An analysis of the mix design data at 3% air voids shows no significant change in VMA but large increases in VFA. At 3% voids, all 10 mixes satisfy the Superpave VFA criterion. The substantial increase in VFA at 3% air voids should reduce the concern over aggregate film thickness. Therefore, it was determined the target asphalt content for the project would be based on 3% air voids.

As shown in Table 2.1, at 3% air voids, none of the mixes satisfied both Superpave criteria for compacted densities at Nini and Nmax. None of the fine gradation mixes (including the two PG 58-40 mixes) met the <89% of maximum density criterion at Nini. Similarly, none of the coarse gradation mixes met the >98% of maximum density criterion at Nmax. The implications associated with these observations will be addressed in the Discussions section. All 10 mixes met the Superpave dust proportion criterion of 0.6 to 1.2.

Although neither is significantly higher, the Granite Falls aggregate appeared to have the highest VMA of the four coarse aggregates and the PG 58-40 binder bettered the PG 52-34 binder. Another interesting observation shown in Table 4.4 concerns the optimum asphalt content of the coarse graded Kasota limestone mix. Although, the Kasota limestone has the highest water absorption of the four coarse aggregates (see Table 3.3), it had the lowest optimum asphalt content. Although no explanation is known, such a phenomenon is normally the result of either equipment or operator error.

Resilient Modulus

Three samples from each mix type were tested in accordance with ASTM D4123. The average values by temperature for each mix type are shown in Table 4.5. The average coefficient of variation (CV) for each mix is also provided in Table 4.5. Complete test results are provided in Appendix B.

A comparison of coarse versus fine gradations is illustrated in Figure 4.10. Average values for the four coarse mixes and for the four fine mixes were used to make the comparison shown in Figure 4.10. As shown by Figure 4.10, the two gradations are virtually indistinguishable from one another.

Table 4.5 Average Resilient Modulus Test Results

GRADATION	Test Temperature	-18		0		25		40	
	Freqency = 1.0 hz	Res Mod (kPa)	Coef. of Var. (%)	Res Mod (kPa)	Coef. of Var. (%)	Res Mod (kPa)	Coef. of Var. (%)	Res Mod (kPa)	Coef. of Var. (%)
COARSE	Granite Falls Granite	12204	17.71	9273	3.06	1676	2.53	435	3.71
	New Ulm Quartzite	14242	17.05	8160	5.15	1517	1.83	442	2.69
	Kasota Limestone	11560	18.07	9579	3.72	2224	2.08	705	4.84
	Cedar Grove Gravel	14228	23.32	9179	3.94	1835	1.74	526	3.50
FINE	Granite Falls Granite	12326	20.13	9446	3.60	1749	1.74	545	3.72
	New Ulm Quartzite	13115	14.87	9429	4.66	1920	1.55	571	3.25
	Kasota Limestone	12393	11.41	9356	4.54	1874	1.68	598	4.17
	Cedar Grove Gravel	11841	16.42	9325	4.61	1777	1.95	508	4.79
FINE (58-40)	New Ulm Quartzite	11797	10.50	5950	2.78	1136	0.94	636	2.50
	Kasota Limestone	12392	10.86	5812	3.68	1316	1.02	548	2.74

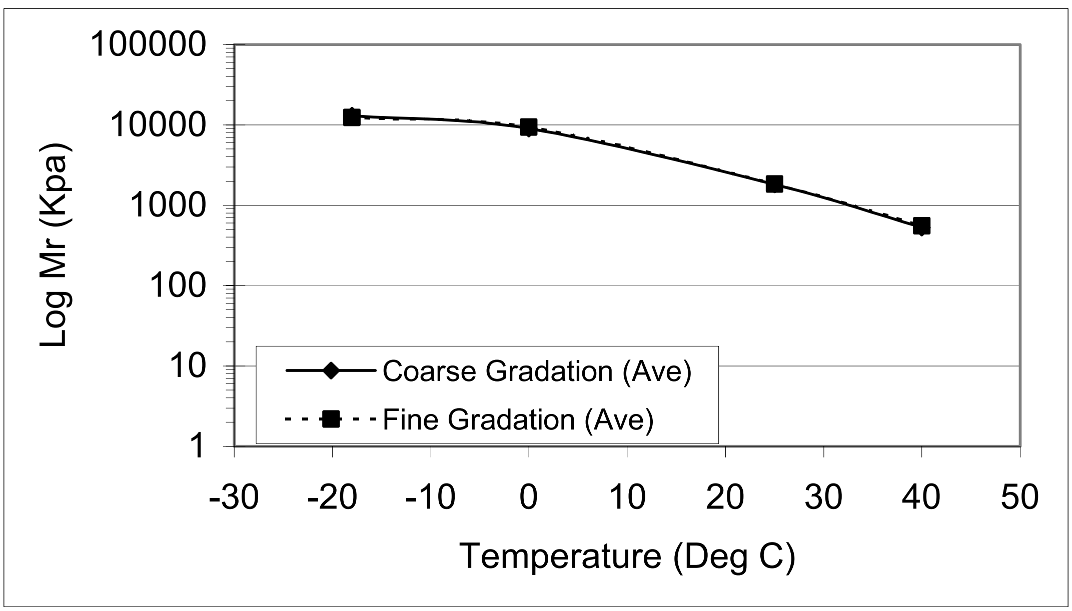

Figure 4.10 Influence of Gradation on Stiffness

The four aggregates (granite, quartzite, limestone, and gravel) are compared in Figure 4.11. Here, the coarse and fine gradations for each aggregate type were averaged together. The Kasota limestone has a slightly higher warm temperature resilient modulus, and the remaining three aggregate types are indistinguishable from one another.

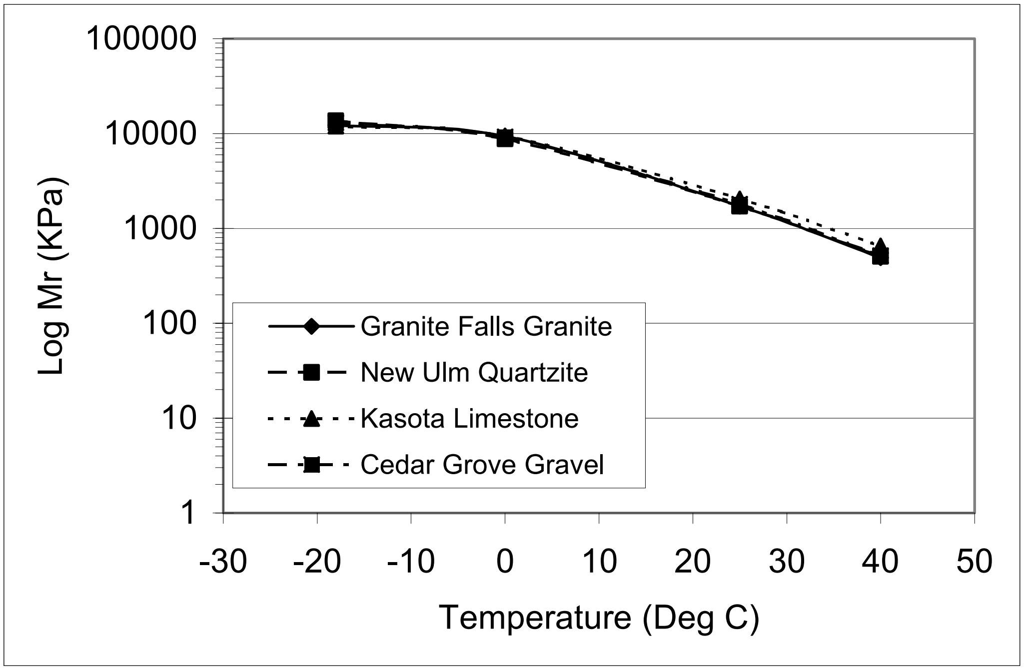

Figure 4.11 Influence of Aggregate on Stiffness

Finally, the two asphalt grades (PG 52-34 verses PG 58-40) are compared in Figure 4.12. This comparison was made by averaging the New Ulm and Kasota values together for each asphalt grade. The results of the performance grade comparison somewhat surprising. It was expected the two grades would have similar resilient moduli at the moderate temperatures and different moduli at the warmest and coldest temperatures. The purpose of the performance graded asphalt system is to ensure adequate pavement flexibility at cold temperatures to reduce cold temperature cracking and adequate stiffness at high tempures to reduce permanent deforemation. Therefore, had the samples been tested at temperature extremes closer to the PG 58-40 rating (i.e. -40°C (-40°F) and 58°C (136°F)), it is expected the PG 58-40 would have had a lower resilient modulus at the cold extreme and a higher resilient modulus at the hot extreme than the PG 52-34.

Moisture Sensitivity

Table 4.6 provides a summary of the moisture sensitivity results. As expected, the effects of the vacuum saturation and the 24-hour warm water bath caused the samples to swell (increase in volume). Superpave criteria require a minimum tensile strength ratio of 80 percent. The TSRs for the 10 mixtures evaluated were all above 95 percent. Although, still debated, high TSR values such as these may indicate a lower susceptibility to moisture damage. Complete test results are provided in Appendix C.

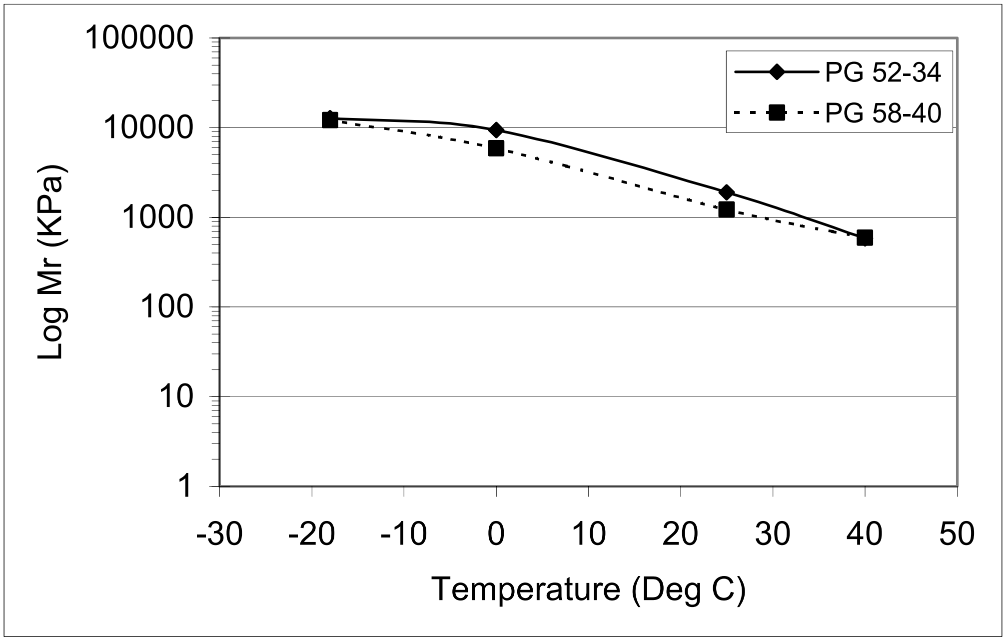

Figure 4.12 Influence of Asphalt Grade on Stiffness

Table 4.6 Summarized Moisture Sensitivity Results

SAMPLE ID	Measurement	PG 52-34 Coarse Gradation				PG 52-34 Fine Gradation				PG 58-40 Fine	
		GFC	NUC	KLC	CGC	GFF	NUF	KLF	CGF	NUF	KLF
Unconditioned Samples	Load (lbf)	4988.3	4970.8	4966.2	4945.7	4958.9	4957.0	4980.6	4962.7	4967.3	4957.7
	Dry Strength	25779	25705	25094	25460	25082	25662	25434	25616	25275	24976
Unconditioned Samples	% Air Voids	6.56	6.79	6.80	7.43	6.76	6.63	6.70	7.12	6.80	7.21
Conditioned Samples	% Air Voids	6.66	7.01	6.73	7.60	6.77	6.46	6.67	7.51	6.83	7.37
After Vacuum Saturation	% Saturation	68.37	69.30	69.39	66.74	71.53	59.22	69.87	70.23	69.24	76.58
	% Swell	3.41	4.32	3.78	3.84	3.03	3.01	3.32	4.59	3.53	3.93
After 140 °F 24-hr Water Bath	% Saturation	86.58	104.43	79.99	82.09	99.84	79.23	86.70	82.56	89.13	108.33
	% Swell	4.84	6.70	5.19	5.09	5.28	4.38	4.40	5.58	4.93	6.31
	Load (lbf)	4976.7	4981.3	4971.2	4971.9	4957.4	4996.2	4971.7	4973.2	4966.9	4966.9
	Wet Strength	24814	25096	24325	25178	24338	25370	24699	25170	25030	24756
Tensile Strength Ratio	TSR	96.73	97.62	96.93	98.88	96.97	99.46	97.11	98.26	99.03	99.34

Rut Testing

The Asphalt Pavement Analyzer tested six samples from each mix type. The mixes were all tested at 40 °C, even though there were two different grades of asphalt binder. The average rut depth measurements after 8000 cycles for each mix type are shown in Table 3. The average coefficient of variation (COV) for each mix is also provided in Table 3.

A comparison of the four mix types is illustrated in Figure 6. The six samples were averaged for each of the four mixes to make the rut depth comparisons in Figure 6. For the PG 58-40 binder, the New Ulm quartzite and Kasota limestone had virtually the same rut depth. They both had approximately 1 mm of rutting after 8000 cycles in the APA. The mixes using PG 52-34 asphalt binders showed significantly more rutting. This behavior is expected since the PG 52-34 is a lower grade binder. The Kasota Limestone PG 52-34 mix had the largest rut depths at over 6.5 mm.

Low Temperature Creep Testing

The Superpave Indirect Tensile Test (IDT) assessed the creep compliance and indirect tensile strength on three samples of each of the four mixes. The creep compliance was tested at three temperatures: 0 °C, -10 °C, and -20 °C. The strength was then tested at -10 °C. For each of the four mixes, a plot of creep compliance vs. time was created. These plots are shown in Figures 2-5.

For all of the mixes, as the test temperature decreases, the creep compliance also decreases. This results in a stiffer mix at lower temperatures. In addition, Young's modulus increases as the temperature decreases. In the elastic range of the material (at time $t = 0$), the modulus is the inverse of the creep compliance. Young's modulus was not actually calculated, but can be inferred qualitatively from Figures 2-5.

The indirect tensile strength of each mix is shown in Table 2. Also included is the Poisson's ratio calculated at half of the maximum load for each specimen. The indirect tensile strength was tested at -10 °C.

DISCUSSION

Mix Design

One of the more important mix design issues to discuss is the difficulty in achieving the minimum voids in the mineral aggregate (VMA) criterion. As described in the mix design methodology, eight different gradations were tried in the attempt to meet the 14% Superpave VMA criterion. In fact, this is not an isolated case. If there is a common theme in Superpave experiences, it is a difficulty in achieving the minimum VMA criterion. Kandhal, et al [21] attribute the problem to the increased compactive effort of the gyratory compactor and the increased use of coarser aggregate mixes.

McLeod [6] first presented the concept of volumetric proportioning to the Highway Research Board in 1956. He developed his volumetric criteria based on specimens compacted with a Marshall hammer (75 blows on each side). McLeod [6] concluded that to ensure adequate durability in a mixture compacted to 5 percent air voids, the mixture must contain a minimum VMA of 15 percent and a minimum asphalt content of 4.5 percent. Further work by McLeod [6] related minimum VMA criteria to nominal maximum particle size of the aggregate. Since VMA is the sum of air voids and voids filled with asphalt, the minimum VMA criteria can be extrapolated to 14 percent for four percent air voids, and 13 percent for three percent air voids. McLeod's original 15% minimum VMA criterion was adopted by the Asphalt Institute in 1964 and revised to include the extrapolated values in 1993 for their MS-2 manual [22]. The revised minimum VMA requirements have also been included in the Superpave mix design. However, the VMA criteria were developed for denser aggregate gradations commonly used in the Marshall mix design. Therefore, it may be questionable to require coarser Superpave mixes to meet the same VMA criteria as denser Marshall mixes.

The rationale behind specifying a minimum VMA percentage is to ensure that the mix contains enough asphalt cement to adequately coat the aggregate particles. This asphalt coating of the aggregate is known as the asphalt film thickness. Adequate film thickness is essential for a long-lasting, durable mix. Campen, et al [23] demonstrated that thicker films produced mixes that were flexible and durable. Thin films produced mixes that were brittle and exhibited excessive cracking, raveling, poor performance, and reduced longevity. Research by Campen, et al [23] showed an optimum film thickness of 6 to 8 μm. They also found that to achieve the desired 6 to 8 μm thickness the asphalt binder requirement increased as surface areas increased, but at a much lower rate.

Recently, a new approach to ensuring adequate film thickness has surfaced. Rather than use VMA to indirectly ensure adequate film thickness, proponents of this new approach suggest estimating the film thickness directly. Unfortunately, however, there is an inherent problem in estimating aggregate film thickness—current methods of calculating film thickness assume an average thickness, but not every aggregate particle is going to have the same thickness. Goode and Lufsey [24] used a bitumen index to avoid the inference that all particles are coated with the same uniform thickness of asphalt cement. The bitumen index is defined as mass of asphalt cement per area of surface. Goode and Lufsey [24] concluded a minimum bitumen index of 6.0 kg/m^2 (0.00123 lb/ft^2, which correlates to 6 μm) was sufficient to ensure adequate film thickness.

Kandhal, et al [21] provided the following equations for the calculation of asphalt film thickness:

$$\text{Volume of Asphalt Binder, } V_b = VMA - V_a \tag{4.1}$$

$$\text{Mass of Asphalt Binder, } W_b = V_b \times \rho_b \times G_b \tag{4.2}$$

$$\text{Mass of Aggregate, } W_{agg} = \frac{W_b}{P_b} \times (100 - P_b) \tag{4.3}$$

$$\text{Mass of Asphalt per Kg of Aggregate, } W_{b/agg} = \frac{W_b}{W_{agg}} \tag{4.4}$$

$$\text{Asphalt Film Thickness, } AFT = \frac{W_{b/agg}}{SA_{agg} \times \rho_w \times G_b} \tag{4.5}$$

Where:

V_a = Air voids
ρ_w = Density of water (1000 kg/m^3)
G_b = Specific gravity of the Binder (1.02)
P_b = Asphalt Content
SA_{agg} = Total surface of the aggregate

The total surface area of the aggregate is a function of the gradation. Aggregate surface area was calculated using the procedure outlined in the Asphalt Institute's MS-2 [22]. Results of the aggregate surface area computations are shown in Tables 4.7 and 4.8 for coarse and fine gradations, respectively.

Table 4.7 Total Surface Area Calculation for Coarse Gradation

Sieve Size	Percent Passing	Surface Area Factor	Surface Area
19	100.0	0.41	0.410
12.5	93.2		
9.5	66.2		
4.75	47.3	0.41	0.194
2.36	33.8	0.82	0.277
1.18	23.0	1.64	0.377
0.600	16.2	2.87	0.465
0.300	12.2	6.14	0.749
0.150	8.1	12.29	0.995
0.075	4.1	32.77	1.34
		Total:	**4.81**

Table 4.8 Total Surface Area Calculation for Fine Gradation

Sieve Size	Percent Passing	Surface Area Factor	Surface Area
19	100.0	0.41	0.410
12.5	96.1		
9.5	83.1		
4.75	70.1	0.41	0.287
2.36	57.1	0.82	0.468
1.18	44.2	1.64	0.725
0.600	31.2	2.87	0.895
0.300	18.2	6.14	1.12
0.150	7.8	12.29	0.959
0.075	3.9	32.77	1.28
		Total:	**6.14**

Equations 4.1 through 4.5 were used to calculate the asphalt film thicknesses for the mixtures in this project. The results are shown below in Table 4.9. It should be noted that all of the asphalt film thickness values exceed the minimum of 6 μm recommended by Campen, et al [23]. In fact, most fell within the optimum range of 8-10 μm recommended by Kandhal, et al [21] and by Kandhal and Chakraborty [25]. As expected, the coarse mixes have a higher AFT than the fines since they have fewer total voids and less surface area.

Table 4.9 Asphalt Film Thickness Calculations

Aggregate	P_b (%)	V_a (%)	VMA (%)	SA_{agg} (m^2/kg)	V_b (%)	W_b (kg)	W_{agg} (kg)	$W_{b/agg}$ (kg)	AFT (µm)
GFC	4.30	3.00	11.50	4.811	8.50	86.7	1929.6	0.0449	9.156
GFF	4.80	3.00	12.40	6.140	9.40	95.88	1901.6	0.0504	8.051
NUC	4.95	3.00	11.25	4.811	8.25	84.15	1615.9	0.0521	10.612
NUF	5.00	3.00	10.50	6.140	7.50	76.5	1453.5	0.0526	8.404
KLC	4.20	3.00	9.00	4.811	6.00	61.2	1395.9	0.0438	8.933
KLF	5.20	3.00	10.80	6.140	7.80	79.56	1450.4	0.0549	8.758
CGC	4.70	3.00	10.50	4.811	7.50	76.5	1551.2	0.0493	10.049
CGF	5.00	3.00	11.50	6.140	8.50	86.7	1647.3	0.0526	8.404
NUF (58-40)	4.90	3.00	11.40	6.140	8.40	85.68	1662.9	0.0515	8.227
KLF (58-40)	4.90	3.00	11.30	6.140	8.30	84.66	1643.1	0.0515	8.227

Kandhal et al. (1998) recommended lowering the Superpave minimum VMA criterion by 1.2 to 1.5 percent based on the results of their research, and specifying an 8 µm minimum AFT. Unfortunately, while all the mixes in the Superpave project exceed the recommended 8 µm minimum AFT, even lowering the VMA criteria by 1.5 percent would only allow the Granite Falls Coarse mixture to meet the 13% minimum.

Another interesting issue is the apparent susceptibility of the coarse gradations to rutting according to the compaction data. Brown, et al [18] showed that mixtures exceeding 98% of maximum density at N_{max} may be more susceptible to rutting than those that remain below 98% of maximum density. Additionally, since all four coarse aggregates exceeded the 98% maximum density criterion, the problem is probably systemic to the gradation rather than any one specific aggregate. All six fine gradations have densities greater than the 89% maximum criterion at $N_{ini.}$ Therefore, it is suspected the fine gradation might exhibit compactibility problems such as tenderness during construction and instability when subjected to traffic.

The concern over failing the N_{ini} and N_{max} criteria is debatable. To date, there is no irrefutable research correlating the failure of the N_{ini} criterion with susceptibility to tenderness nor the failure of the N_{max} criterion with increased rutting potential. In fact, mounting research by Brown, et al [18], Brown and Mallick [26], Habib, et al [27], and Huber, et al [28] is supporting the belief that all three Superpave gyration criteria (N_{ini}, N_{des}, N_{max}) should be lowered (especially with low-volume designs). Superpave Team Leader, Paul Mack [29], addressed this concern by stating the problem is currently being evaluated in preparation of a possible revision to the Superpave N-design table. Mack [29] specifically addresses the failure of the N_{ini} criterion by fine graded mixes stating such failure is common and should not eliminate their use, particularly on low-volume pavements. More concern over the validity of the density criteria arose when an evaluation of four different Superpave gyratory compactors (Texas, Pine, Troxler, and Rainhart) by McGennis, et al [30] showed a high degree of variability in N_{ini} results.

Resilient Modulus

Although the results of the resilient modulus testing were variable, some general conclusions can still be made. As expected, the resilient modulus values decrease considerably as temperature increases. The decreasing values are the result of the softening of the asphalt binder as temperatures increase. Except for the 0 °C temperature, the coefficient of variation values fell well below the 10-20 percent range recommended by Al-Sugair and Almudaiheem [31]. Additionally, the CV values follow the expected trend of increasing at the extreme temperatures. Stroup-Gardiner and Newcomb [32] attributed the increase in variability at the coldest and warmest temperatures as a function of sensor noise and the low stiffness of the binder, respectively.

The lack of a significant difference in the resilient modulus values between the coarse and fine gradations is surprising. It was expected the increased amount of crushed aggregate found in the coarse mixes (except for the Cedar Grove gravel) would have resulted in a stiffer mix. As stated earlier, the mix containing the Kasota limestone aggregate behaved differently than those made with other aggregates.

In Figure 4.12, the PG 58-40 grade asphalt has a slightly lesser slope of temperature susceptibility than the PG 52-34 asphalt. However, at the highest and lowest test temperatures the values were nearly identical. The effect of different asphalt grades on coarse gradations should be investigated.

Moisture Sensitivity

The range of the tensile strength ratio results was somewhat greater and less variable than expected. The TSR values shown in Table 4.6 would seem to indicate the differences in gradation, aggregate and asphalt grade had no significant effect on the moisture sensitivity of the mixtures. Such high TSR results may be explained by work done by McGennis et al. (1996)

who concluded specimens compacted with a Superpave gyratory compactor resulted in significantly higher TSR values. Additionally, Brown, et al [18] noted the low reliability and lack of a satisfactory relationship between laboratory and field conditions as a chronic problem with moisture sensitivity tests.

Rut Testing

The asphalt mixes using PG 52-34 binder showed more rutting susceptibility than the mixes using PG 58-40. At elevated temperatures, the asphalt binder softens and leads to more permanent deformation. Except for the New Ulm Quartzite PG 52-34 mix, the coefficient of variation values were very high. We would like to see much more consistent test results with the APA.

It appears that after 8000 test cycles, the two PG 58-40 mixes have reached a plateau in their rut depths. Conversely, the two PG 52-34 mixes appear to continue rutting in a fairly linear trend with the number of cycles. The PG 58-40 mixes reached approximately 80% of their final rut depths after about 1000 cycles. They did not rut significantly more in the remaining 7000 cycles.

Another interesting observation to note is the variation due to the Asphalt Pavement Analyzer itself. For three out of the four mixes, the samples under the left wheel had the lowest rut depths while the samples under the right wheel had the highest rut depths. When the APA device was being developed, it went through a series of ruggedness studies at three different laboratories. Randy West (1999) pointed out similar differences between the left, center, and right rut depth measurements. He stated that although each wheel load is individually calibrated, the three wheel loads are not necessarily independent. Observations may indicate that the wheel positions do not apply uniform loads to the asphalt specimens.

Low Temperature Creep Testing

In holding the asphalt binder constant and varying the aggregate, there was virtually no difference in creep compliance at -10 °C and -20 °C. For the PG 52-34 binder, the NU mix had 40% lower creep compliance than the KL mix at 0 °C. For the PG 58-40 binder, the KL mix had 20% lower creep compliance than the NU mix at 0 °C.

In holding the aggregate constant and varying the asphalt binder, the PG 52-34 mix had lower creep compliance than the PG 58-40 mix. For the New Ulm quartzite aggregate, the PG 52-34 mix had a 50% lower creep compliance than the PG 58-40 mix at all three low temperatures. For the Kasota limestone aggregate, the PG 52-34 mix had 30%-40% lower creep compliance than the PG 58-40 mix at -10 °C and -20 °C. At 0 °C there was virtually no difference in creep compliance between the two mixes.

From the above analysis, it was determined that the PG 52-34 mixes are stiffer at low temperatures than PG 58-40 mixes. This was an expected behavior, based on the binder grades. At -10 °C and -20 °C, the aggregate was found to have little influence on the creep compliance. However, at 0 °C the aggregates did have an effect on the stiffness of the mix. In addition, the asphalt binder was found to have an effect on creep compliance at all three low temperatures. The PG 58-40 mixes have higher creep compliance than the PG 52-34 mixes.

From the IDT tests, Poisson's ratio was determined to be rather low. However, it was well within the range of possible values for μ. For the PG 52-34 binder, the NU mix had a slightly higher strength than the KL mix. For the PG 58-40 binder, the two aggregates displayed the same strength. The softer binder (PG 58-40) was less affected by aggregate type than the stiffer binder (PG 52-34).

CHAPTER 5
- CONCLUSIONS AND RECOMMENDATIONS –

CONCLUSIONS

1. The locally available Minnesota aggregates Lakeland sand, Granite Falls granite, New Ulm quartzite, Kasota limestone, and Cedar Grove gravel meet Superpave aggregate consensus property criteria for low-volume roads (less than 1,000,000 ESALs). This corresponds to Mn/DOT traffic levels 1 and 2.

2. Meeting Superpave's minimum VMA and VFA criteria was very difficult possibly due to the low angularity of the natural sand. Lowering the target air void content to 3% resulted in compliant VFA, but all mixes still failed the VMA requirement. Use of a more angular fine aggregate would help increase the VMA.

3. None of the six fine-graded mixtures met the N_{ini} criterion (90.5 for Level 2 traffic) indicating fine-graded mixtures produced with the natural sand may be susceptible to tenderness problems. There appeared to be no significant difference in tenderness susceptibility between the different coarse aggregates evaluated.

4. None of the coarse-graded mixtures met the N_{max} criterion indicating coarse-graded mixtures produced with the Lakeland sand may experience premature permanent deformation. All of the fine-graded mixtures met the N_{max} criterion. There appeared to be no significant difference in susceptibility to permanent deformation between the four coarse aggregates evaluated. Based on the gyratory compaction data, there was no significant difference in indications of susceptibility to either tenderness or permanent deformation between the two asphalt grades evaluated.

5. The results of the resilient modulus tests were highly variable. Although high variability is not uncommon to resilient modulus testing, the 1 to 23 percent average coefficients of variation range from this study was greater than the typical 6 to 20 percent range presented by Timm [33].

6. Except for the Kasota limestone which produced slightly greater resilient modulus values, the different coarse aggregates evaluated in this study had no significant effect on resilient modulus. To date, however, no direct correlation has been made between resilient modulus values and long-term susceptibility to permanent deformation.

7. There was no significant difference in resilient modulus values between the coarse and fine gradations evaluated in this study.

8. Mixes produced with the PG 52-34 asphalt binder had higher resilient modulus results at intermediate temperatures than those produced with the PG 58-40 binder. There was no significant difference in resilient modulus values between the two binders at the highest and lowest temperatures tested (40 and -18 °C, respectively). The fact that this temperature range does not include the high and low temperature values for these PG binders may explain the failure of the resilient modulus test to differentiate between the two binders.

9. All mixes evaluated met the Superpave moisture sensitivity criterion. The higher asphalt contents associated with the relatively low 3% design air void content was the probable cause for the high TSR values. High TSR values indicate the higher asphalt content associated with the lower target air void content may improve the durability of low-volume road mixtures.

10. There was no significant difference in moisture sensitivity results between the coarse and fine gradations, coarse aggregate types, or asphalt grades evaluated in this study (values ranged from 96.7 to 99.5%). An examination of the dry and wet tensile strength values also revealed no significant differences - dry values ranged from 1110 to 1140 kPa (161 to 166 psi) and wet values ranged from 1080 to 1130 kPa (157 to 164 psi). As concluded by Stroup-Gardiner and Newcomb [32], lack of a significant difference between material types indicates moisture sensitivity may be more dependent on volumetric parameters than on types of material.

11. The appropriate software for analyzing the low temperature creep compliance data was not available at the time this report was written. For all four mixes (see Table 3.5), as the test

temperature decreased, the creep compliance also decreased and Young's Modulus based on the instantaneous loading portion of the creep compliance test increased.

12. Different aggregates had little effect on creep compliance. The PG 52-34 mixes had lower creep compliance than the PG 58-40 mixes which suggests that the PG 52-34 mixes may be more susceptible to low temperature cracking.

13. Based on the gyratory compaction data, there was no significant difference in indications of susceptibility to either tenderness or permanent deformation between the two asphalt grades evaluated (PG 52-34 and PG 58-40).

14. For a given coarse aggregate type, the PG 52-34 mixes showed more rutting than the PG 58-40 mixes, indicating that increasing the upper grade of the binder may result in a more rut-resistant pavement.

15. The type of aggregate had little effect on rutting in the PG 58-40 mixes. However, in the PG 52-34 mixes, the Kasota Limestone mixes had almost twice the rut depth of the New Ulm Quartzite mixes.

16. Based on the results of the limited testing performed in this study, decreasing the lower PG binder grade and increasing the upper PG binder grade can be effective in improving the low temperature cracking resistance and rut resistance of a pavement, respectively.

RECOMMENDATIONS

1. Consider using a target air void content of three percent when the quality of available aggregates makes it difficult to meet VMA requirements. The higher asphalt content associated with a lower air void target would increase the long-term durability of the pavement. The decrease in stability associated with pavements constructed with higher asphalt contents is offset by the lower volume of heavy-truck traffic experienced on low-volume roads.

2. Since the low angularity of the natural sand resulted in difficulties meeting Superpave volumetric criteria, a more angular aggregate should be used to produce mixtures that can

meet the volumetric criteria. A study should be conducted to investigate the benefit of using a more angular fine aggregate. This study should include an economic evaluation.

3. If volumetric criteria cannot be met, a possible solution would be to lower the target air void content and take the necessary precautions to overcome any tenderness problems that may result. Wolters [34] provides specific recommendations to overcome tenderness problems.

4. An economic analysis should be completed to determine whether the improvements in predicted long-term pavement performance due to the use higher quality materials.

5. A full low-temperature cracking analysis should be performed and master creep compliance curves generated when the software is available.

6. Performance testing (APA and creep compliance) should be conducted to evaluate the difference between coarse and fine aggregate gradations.

7. Further testing should be conducted to evaluate the benefits of decreasing the lower PG grade and increasing the upper PG grade.

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APPENDIX A
MIX DESIGN

Table A.1 Mix Design Data for Granite Falls Coarse Gradation

Project: SUPERPAVE Technician: ______________________ Date: ____________________

CA Source: GRANITE FALLS FA Source: LAKELAND Blend G_{sb}: 2.6560 Blend G_{se}: 2.7302

Gradation: [ ] Above (fine) [X] Below (coarse) the Restricted Zone Nom. Max. Size (mm): 12.5 Batch Weight, Ws, (g): 12000

Asphalt Sourse: KOCH Grade: PG 52 - 34 Polymer: None $P_{b,est}$ = 5.01

T_{mix}: 138 °C T_{comp}: 128 °C Compactor: Brovold N_{ini} 7 N_{des} 76 N_{max} 117 .

Target P_b		$P_{b,est}$ - 0.5 =	4.5	$P_{b,est}$ =	5.0	$P_{b,est}$ + 0.5 =	5.5	$P_{b,est}$ + 1.0 =	6.0
Target W_b (g)		566.8		632.9		699.8		767.3	
Actual W_b (g)		568.1		636		703.5		769.5	
Actual P_b		4.52		5.03		5.54		6.03	
G_{mm}		2.539		2.517		2.509		2.487	
Specimen No.		1	2	1	2	1	2	1	2
Specimen Height (mm)	1	111.2	110.4	111.6	110.5	105.7	105.3	108.4	107.8
	2	111.8	110.6	111..2	110.4	105.8	105.5	108.8	108.2
	3	111.5	110.6	111.2	110.6	105.6	105.9	108.4	107.9
	4	111.3	110.6	111.5	110.8	105.6	105.8	108.8	107.9
Average		111.45	110.55	111.43	110.58	105.68	105.63	108.60	107.95
W_{dry} (g)	A	4785.7	4762.1	4774.9	4713.7	4619.1	4593.9	4663.7	4686.6
$W_{in\ water}$ (g)	C	2825.8	2811.7	2823.9	2780.8	2735.2	2722.2	2752.5	2763.2
W_{SSD} (g)	B	4788.2	4764.8	4776.4	4715.6	4620.3	4597.0	4666.5	4687.5
$G_{mb} = \frac{A}{(B-C)}$		2.439	2.438	2.446	2.436	2.450	2.450	2.437	2.435
Corrected G_{mb}	N_{ini}	2.219	2.210	2.240	2.245	2.242	2.226	2.200	2.232
	N_{des}	2.413	2.408	2.430	2.420	2.436	2.427	2.408	2.421
V_a @ N_{des}		4.98	5.18	3.44	3.84	2.9	3.27	3.18	2.63
Average		5.08		3.64		3.09		2.91	
VMA @ N_{des}		13.26	13.44	13.11	13.47	13.36	13.68	14.80	14.34
Average		13.35		13.29		13.52		14.57	
VFA @ N_{des}		62.43	61.45	73.77	71.50	78.30	76.10	78.51	81.66
Average		61.94		72.63		77.20		80.09	
%G_{mm} @ N_{ini}		87.40	87.04	88.99	89.19	89.36	88.72	88.46	89.75
Average		87.22		89.09		89.04		89.10	
%G_{mm} @ N_{max}		96.05	96.03	97.16	96.79	97.66	97.66	97.97	97.93
Average		96.04		96.98		97.66		97.95	
Dust Proportion		0.49		0.44		0.40		0.37	

Table A.2 Mix Design Data for Granite Falls Fine Gradation

Project: SUPERPAVE Technician: ______ Date: ______

CA Source: GRANITE FALLS FA Source: LAKELAND Blend G_{sb}: 2.6287 Blend G_{se}: 2.7164

Gradation: [X] Above (fine) [ ] Below (coarse) the Restricted Zone Nom. Max. Size (mm): 12.5 Batch Weight, Ws, (g): 12000

Asphalt Sourse: KOCH Grade: PG 52 - 34 Polymer: None $P_{b,est}$ = 5.39

T_{mix}: 138 °C T_{comp}: 128 °C Compactor: Brovold N_{ini} 7 N_{des} 76 N_{max} 117

Target P_b		$P_{b,est}$ - 0.5 =	4.9	$P_{b,est}$ =	5.4	$P_{b,est}$ + 0.5 =	5.9	$P_{b,est}$ + 1.0 =	6.4
Target W_b (g)		617.0		683.6		751.0		819.1	
Actual W_b (g)		616.2		682.4		756.4		817.6	
Actual P_b		4.88		5.38		5.93		6.38	
G_{mm}		2.512		2.511		2.482		2.473	
Specimen No.		1	2	1	2	1	2	1	2
Specimen Height (mm)	1	111.9	111.8	111.4	111.0	111.9	111.8	111.4	111.4
	2	111.9	111.8	111.3	111.2	112.1	111.8	111.5	111.6
	3	112.0	111.7	111.7	111.0	111.9	112.0	111.5	111.5
	4	111.9	111.9	111.7	111.1	112.1	112.2	111.5	111.4
Average		111.93	111.80	111.53	111.08	112.00	111.95	111.48	111.48
W_{dry} (g)	A	4790.1	4796.4	4800.8	4779.3	4796.6	4790.2	4788.4	4786.6
$W_{in\ water}$ (g)	C	2790.8	2794.9	2805.5	2789.2	2779.9	2781.0	2779.7	2772.7
W_{SSD} (g)	B	4790.7	4797.9	4802.0	4781.5	4797.0	4790.5	4788.8	4786.8
$G_{mb} = \frac{A}{(B-C)}$		2.395	2.395	2.405	2.399	2.378	2.384	2.383	2.377
Corrected G_{mb}	N_{ini}	2.256	2.255	2.259	2.251	2.223	2.230	2.248	2.242
	N_{des}	2.380	2.378	2.388	2.382	2.359	2.367	2.377	2.371
V_a @ N_{des}		5.25	5.34	4.91	5.15	4.96	4.63	3.9	4.14
Average		5.30		5.03		4.80		4.02	
VMA @ N_{des}		13.88	13.96	14.04	14.26	15.58	15.29	15.34	15.56
Average		13.92		14.15		15.44		15.45	
VFA @ N_{des}		62.18	61.74	65.04	63.89	68.17	69.73	74.58	73.39
Average		61.96		64.46		68.95		73.98	
%G_{mm} @ N_{ini}		89.81	89.77	89.96	89.65	89.56	89.85	90.90	90.66
Average		89.79		89.80		89.71		90.78	
%G_{mm} @ N_{max}		95.35	95.33	95.76	95.54	95.81	96.04	96.38	96.10
Average		95.34		95.65		95.93		96.24	
Dust Proportion		0.44		0.40		0.36		0.34	

Table A.3 Mix Design Data for New Ulm Quartzite Coarse Gradation

Project: SUPERPAVE   Technician: ______________________   Date: ____________________

CA Source: NEW ULM   FA Source: LAKELAND   Blend G_{sb}: 2.6099   Blend G_{se}: 2.6817

Gradation: [ ] Above (fine) / [X] Below (coarse) the Restricted Zone   Nom. Max. Size (mm): 12.5   Batch Weight, Ws, (g): 12000

Asphalt Sourse: KOCH   Grade: PG 52-34   Polymer: none $P_{b,est}$ = 5.00

T_{mix}: 138 °C T_{comp}: 128 °C   Compactor: Brovold N_{ini} 7 N_{des} 76 N_{max} 117 .

Target P_b		$P_{b,est}$ - 0.5 =	4.5	$P_{b,est}$ =	5.0	$P_{b,est}$ + 0.5 =	5.5	$P_{b,est}$ + 1.0 =	6.0
Target W_b (g)		565.4		631.6		698.4		766.0	
Actual W_b (g)		630.6		690.0		730.8		864.3	
Actual P_b		4.99		5.44		5.74		6.72	
G_{mm}		2.513		2.507		2.499		2.457	
Specimen No.		1	2	1	2	1	2	1	2
Specimen Height (mm)	1	112.0	111.6	109.8	109.9	109.65	110.05	108.53	108.40
	2	112.1	111.6	109.9	110.0	110.44	110.16	109.02	108.22
	3	112.2	111.6	110.0	110.1	110.44	109.96	108.08	108.01
	4	112.1	111.8	110.0	110.0	110.52	109.88	108.34	107.67
	Average	112.1	111.7	109.9	110.0	110.26	110.01	108.49	108.08
W_{dry} (g)	A	4792.5	4794.2	4769.3	4737.0	4756.4	4759.1	4666.2	4670.6
$W_{in\ water}$ (g)	C	2851.0	2854.3	2850.4	2830.0	2828.3	2831.4	2767.4	2764.1
W_{SSD} (g)	B	4794.7	4794.0	4771.5	4739.2	4759.0	4761.6	4667.5	4673.1
$G_{mb} = \frac{A}{(B-C)}$		2.466	2.472	2.483	2.481	2.464	2.466	2.456	2.447
Corrected G_{mb}	N_{ini}	2.228	2.240	2.262	2.235	2.208	2.227	2.225	2.255
	N_{des}	2.435	2.444	2.467	2.456	2.433	2.444	2.443	2.438
V_a @ N_{des}		3.09	2.76	1.59	2.02	2.63	2.21	0.59	0.77
Average		2.93		1.81		2.42		0.68	
VMA @ N_{des}		11.36	11.03	10.61	11.01	12.13	11.73	12.68	12.86
Average		11.20		10.81		11.93		12.77	
VFA @ N_{des}		72.80	74.98	85.02	81.66	78.32	81.16	95.35	94.01
Average		73.89		83.34		79.74		94.68	
%G_{mm} @ N_{ini}		88.66	89.14	90.23	89.15	88.36	89.12	90.56	91.78
Average		88.90		89.69		88.74		91.17	
%G_{mm} @ N_{max}		98.12	98.35	99.03	98.97	98.58	98.66	99.95	99.58
Average		98.23		99.00		98.62		99.76	
Dust Proportion		0.44		0.41		0.39		0.33	

Table A.4 Mix Design Data for New Ulm Quartzite Fine Gradation

Project: SUPERPAVE Technician: ______ Date: ______

CA Source: NEW ULM FA Source: LAKELAND Blend G_{sb}: 2.6059 Blend G_{se}: 2.6922

Gradation: [X] Above (fine) / [ ] Below (coarse) the Restricted Zone Nom. Max. Size (mm): 12.5 Batch Weight, Ws, (g): 12000

Asphalt Sourse: KOCH Grade: PG 52-34 Polymer: none $P_{b,est}$ = 5.19

T_{mix}: 138 °C T_{comp}: 128 °C Compactor: Brovold N_{ini} 7 N_{des} 76 N_{max} 117 .

Target P_b		$P_{b,est}$ - 0.5 =	4.7	$P_{b,est}$ =	5.2	$P_{b,est}$ + 0.5 =	5.7	$P_{b,est}$ + 1.0 =	6.2
Target W_b (g)		590.5		656.9		724.0		791.8	
Actual W_b (g)		590.0		656.9		730.9		866.0	
Actual P_b		4.69		5.19		5.74		6.73	
G_{mm}		2.537		2.515		2.472		2.446	
Specimen No.		1	2	1	2	1	2	1	2
Specimen Height (mm)	1	111.42	111.58	110.69	110.41	110.27	110.92	109.32	110.29
	2	111.4	111.55	111.04	110.25	110.44	110.56	109.48	110.56
	3	111.45	111.52	110.67	110.38	110.74	110.6	109.62	110.51
	4	111.38	111.46	110.73	110.44	110.42	110.48	109.93	110.29
Average		111.41	111.53	110.78	110.37	110.47	110.64	109.59	110.41
W_{dry} (g)	A	4802.5	4805.2	4800.8	4796.1	4786.5	4794.4	4757.9	4772.1
$W_{in\ water}$ (g)	C	2847.8	2847.3	2852.2	2855.1	2838.1	2843.3	2810.8	2812.9
W_{SSD} (g)	B	4803.5	4805.6	4801.9	4796.9	4787.0	4794.9	4758.5	4772.5
$G_{mb} = \frac{A}{(B-C)}$		2.456	2.454	2.462	2.470	2.456	2.457	2.443	2.435
Corrected G_{mb}	N_{ini}	2.307	2.303	2.326	2.327	2.326	2.321	2.362	2.369
	N_{des}	2.439	2.437	2.451	2.457	2.449	2.448	2.436	2.426
V_a @ N_{des}		3.88	3.96	2.55	2.32	0.92	0.96	0.39	0.8
Average		3.92		2.44		0.94		0.60	
VMA @ N_{des}		10.79	10.86	10.83	10.61	11.42	11.45	12.81	13.17
Average		10.83		10.72		11.43		12.99	
VFA @ N_{des}		64.04	63.55	76.45	78.13	91.94	91.62	96.96	93.93
Average		63.80		77.29		91.78		95.44	
%G_{mm} @ N_{ini}		90.93	90.78	92.49	92.52	94.09	93.89	96.57	96.85
Average		90.86		92.50		93.99		96.71	
%G_{mm} @ N_{max}		96.79	96.72	97.91	98.21	99.35	99.38	99.87	99.56
Average		96.76		98.06		99.37		99.72	
Dust Proportion		0.46		0.41		0.37		0.32	

Table A.5 Mix Design Data for Kasota Limestone Coarse Gradation

Project: SUPERPAVE Technician: ______________________ Date: ____________________

CA Source: KASOTA FA Source: LAKELAND Blend G_{sb}: 2.561 Blend G_{se}: 2.686

Gradation: [ ] Above (fine) [X] Below (coarse) the Restricted Zone Nom. Max. Size (mm): 12.5 Batch Weight, Ws, (g): 12000

Asphalt Sourse: KOCH Grade: PG 52-34 Polymer: none $P_{b,est}$ = 6.08

T_{mix}: 138 °C T_{comp}: 128 °C Compactor: Brovold

Target P_b		$P_{b,est}$ - 0.5 =	5.6	$P_{b,est}$ =	6.1	$P_{b,est}$ + 0.5 =	6.6	$P_{b,est}$ + 1.0 =	7.1
Target W_b (g)		709.2		776.8		845.2		914.3	
Actual W_b (g)		707.9		776.0		842.8		929.0	
Actual P_b		5.57		6.07		6.56		7.19	
G_{mm}		2.485		2.464		2.467		2.439	
Specimen No.		1	2	1	2	1	2	1	2
Specimen Height (mm)	1	110.09	111.30	109.74	110.15	110.55	110.18	105.32	107.50
	2	110.81	110.87	110.53	109.93	110.27	109.50	105.96	107.73
	3	110.78	110.94	110.52	109.80	110.46	109.73	105.64	107.57
	4	110.79	110.80	109.87	109.88	110.79	109.61	105.60	107.30
Average		110.62	110.98	110.17	109.94	110.52	109.76	105.63	107.53
W_{dry} (g)	A	4769.2	4760.4	4706.7	4710.2	4692.5	4690.5	4495.8	4576.9
$W_{in\ water}$ (g)	C	2833.2	2825.4	2787.7	2788.6	2774.5	2772.0	2646.2	2690.1
W_{SSD} (g)	B	4769.9	4761.0	4707.9	4710.9	4694.0	4691.4	4497.1	4578.4
$G_{mb} = \frac{A}{(B - C)}$		2.463	2.459	2.451	2.450	2.445	2.444	2.429	2.424
Corrected G_{mb}	N_{ini}	2.206	2.217	2.215	2.220	2.213	2.180	2.273	2.256
	N_{des}	2.434	2.430	2.435	2.430	2.432	2.415	2.420	2.417
V_a @ N_{des}		2.03	2.19	1.16	1.38	1.43	2.09	0.78	0.9
Average		2.11		1.27		1.76		0.84	
VMA @ N_{des}		10.25	10.40	10.70	10.88	11.27	11.89	12.30	12.40
Average		10.33		10.79		11.58		12.35	
VFA @ N_{des}		80.20	78.94	89.15	87.31	87.31	82.42	93.66	92.74
Average		79.57		88.23		84.87		93.20	
%G_{mm} @ N_{ini}		88.77	89.22	89.89	90.10	89.70	88.37	93.19	92.50
Average		88.99		90.00		89.04		92.85	
%G_{mm} @ N_{max}		99.10	98.97	99.48	99.44	99.09	99.06	99.59	99.38
Average		99.03		99.46		99.08		99.48	
Dust Proportion		0.40		0.37		0.34		0.31	

Table A.6 Mix Design Data for Kasota Limestone Fine Gradation

Project: SUPERPAVE	Technician: ______	Date: ______			
CA Source: KASOTA	FA Source: LAKELAND	Blend G_{sb}: 2.581	Blend G_{se}: 2.695		
Gradation: [X] Above (fine) [ ] Below (coarse) the Restricted Zone	Nom. Max. Size (mm): 12.5	Batch Weight, Ws, (g): 12000			
Asphalt Sourse: KOCH	Grade: PG 52-34	Polymer: none	$P_{b,est}$ = 5.38		
T_{mix}: 138 °C	T_{comp}: 128 °C	Compactor: Brovold	N_{ini} 7	N_{des} 76	N_{max} 117

Target P_b		$P_{b,est}$ - 0.5 =	4.9	$P_{b,est}$ =	5.4	$P_{b,est}$ + 0.5 =	5.9	$P_{b,est}$ + 1.0 =	6.4
Target W_b (g)		615.6		682.3		749.7		817.8	
Actual W_b (g)		642.3		695.4		758.9		817.7	
Actual P_b		5.08		5.48		5.95		6.38	
G_{mm}		2.502		2.501		2.472		2.454	
Specimen No.		1	2	1	2	1	2	1	2
Specimen Height (mm)	1	113.48	112.79	103.34	104.38	112.02	112.06	110.09	112.83
	2	113.77	112.62	103.37	104.49	111.81	112.19	110.23	112.35
	3	113.56	112.55	103.28	104.56	112.03	112.07	111.15	111.82
	4	113.42	112.49	103.12	104.52	111.81	111.9	110.44	112.17
Average		113.56	112.61	103.28	104.49	111.92	112.06	110.48	112.29
W_{dry} (g)	A	4800.4	4744.2	4387.0	4442.7	4808.1	4807.4	4751.9	4829.5
$W_{in\ water}$ (g)	C	2820.2	2784.6	2582.2	2617.9	2838.1	2838.8	2802.9	2848.6
W_{SSD} (g)	B	4803.0	4748.4	4389.0	4444.1	4809.1	4807.9	4752.1	4829.9
$G_{mb} = \frac{A}{(B-C)}$		2.421	2.416	2.428	2.433	2.439	2.441	2.438	2.438
Corrected G_{mb}	N_{ini}	2.254	2.250	2.265	2.267	2.298	2.288	2.323	2.320
	N_{des}	2.402	2.395	2.412	2.411	2.430	2.430	2.431	2.429
V_a @ N_{des}		4.00	4.29	3.57	3.59	1.69	1.69	0.92	1.00
Average		4.15		3.58		1.69		0.96	
VMA @ N_{des}		11.66	11.92	11.67	11.70	11.45	11.45	11.82	11.89
Average		11.79		11.69		11.45		11.86	
VFA @ N_{des}		65.70	64.01	69.40	69.33	85.24	85.24	92.22	91.59
Average		64.86		69.36		85.24		91.90	
%G_{mm} @ N_{ini}		90.09	89.93	90.56	90.64	92.96	92.56	94.66	94.54
Average		90.01		90.60		92.76		94.60	
%G_{mm} @ N_{max}		96.76	96.56	97.08	97.27	98.68	98.76	99.34	99.33
Average		96.66		97.18		98.72		99.34	
Dust Proportion		0.42		0.39		0.36		0.34	

Table A.7 Mix Design Data for Cedar Grove Gravel Coarse Gradation

Project: SUPERPAVE			Technician:			Date:		
CA Source: CEDAR GROVE			FA Source: LAKELAND		Blend G_{sb}: 2.6050		Blend G_{se}: 2.695	
Gradation: [ ] Above (fine) [X] Below (coarse)			the Restricted Zone		Nom. Max. Size (mm): 12.5		Batch Weight, Ws, (g): 12000	
Asphalt Sourse: KOCH			Grade: PG 52-34		Polymer: none		$P_{b,est}$ = 5.36	
T_{mix}: 138 °C			T_{comp}: 128 °C		Compactor: Brovold		N_{ini} 7 N_{des} 76 N_{max} 117	
Target P_b		$P_{b,est}$ - 0.5 =	4.9	$P_{b,est}$ =	5.4	$P_{b,est}$ + 0.5 =	5.9	$P_{b,est}$ + 1.0 =	6.4
Target W_b (g)		613.0		679.6		747.0		815.0	
Actual W_b (g)		613.4		677.9		749.5		820.7	
Actual P_b		4.86		5.35		5.88		6.40	
G_{mm}		2.530		2.524		2.475		2.474	
Specimen No.		1	2	1	2	1	2	1	2
Specimen Height (mm)	1	110.35	110.74	110.37	110.74	108.69	108.51	105.81	106.10
	2	110.40	110.71	110.47	110.94	108.44	108.48	105.69	105.84
	3	110.36	110.66	110.30	110.83	108.42	108.46	105.62	106.16
	4	110.36	110.75	109.93	110.79	108.40	108.61	105.67	105.83
Average		110.37	110.72	110.27	110.83	108.49	108.52	105.70	105.98
W_{dry} (g)	A	4789.5	4793.1	4783.5	4786.7	4706.5	4706.3	4574.4	4600.5
$W_{in\ water}$ (g)	C	2869.7	2866.2	2863.4	2864.9	2804.6	2807.6	2724.1	2747.1
W_{SSD} (g)	B	4790.5	4794.4	4783.8	4787.5	4707.1	4706.9	4574.9	4600.9
$G_{mb} = \frac{A}{(B - C)}$		2.493	2.486	2.491	2.490	2.474	2.478	2.472	2.482
Corrected G_{mb}	N_{ini}	2.275	2.242	2.256	2.273	2.300	2.270	2.304	2.296
	N_{des}	2.473	2.461	2.464	2.470	2.465	2.467	2.464	2.473
V_a @ N_{des}		2.26	2.71	2.37	2.15	0.41	0.34	0.40	0.05
Average		2.49		2.26		0.38		0.23	
VMA @ N_{des}		9.68	10.12	10.47	10.25	10.94	10.86	11.47	11.14
Average		9.90		10.36		10.90		11.31	
VFA @ N_{des}		76.66	73.23	77.36	79.03	96.25	96.87	96.51	99.55
Average		74.94		78.20		96.56		98.03	
%G_{mm} @ N_{ini}		89.92	88.62	89.38	90.06	92.93	91.72	93.13	92.81
Average		89.27		89.72		92.32		92.97	
%G_{mm} @ N_{max}		98.56	98.25	98.69	98.64	99.95	100.12	99.90	100.31
Average		98.40		98.66		100.04		100.11	
Dust Proportion		0.46		0.42		0.38		0.35	

Table A.8 Mix Design Data for Cedar Grove Gravel Fine Gradation

Project: SUPERPAVE	Technician: ________________________		Date: 6/21/1999		
CA Source: Cedar Grove Gravel	FA Source: LAKELAND		Blend G_{sb}: 2.6030		Blend G_{se}: 2.699
Gradation: [X] Above (fine) [ ] Below (coarse)	the Restricted Zone	Nom. Max. Size (mm): 12.5		Batch Weight, Ws, (g): 12000	
Asphalt Sourse: KOCH	Grade: PG 52-34		Polymer: none		$P_{b,est}$ = 4.60
T_{mix}: 138 °C	T_{comp}: 128 °C	Compactor: Brovold	N_{ini} 7	N_{des} 76	N_{max} 117

Target P_b		$P_{b,est}$ - 0.5 =	4.1	$P_{b,est}$ =	4.6	$P_{b,est}$ + 0.5 =	5.1	$P_{b,est}$ + 1.0 =	5.6
Target W_b (g)		513.0		578.6		644.9		711.9	
Actual W_b (g)		509.8		579.4		650.7		706.0	
Actual P_b		4.08		4.61		5.14		5.56	
G_{mm}		2.54		2.515		2.499		2.484	
Specimen No.		1	2	1	2	1	2	1	2
Specimen Height (mm)	1								
	2								
	3								
	4								
Average									
W_{dry} (g)	A	4802.4	4809.9	4804.6	4807.2	4789.1	4797.5	4811.0	4800.6
$W_{in\ water}$ (g)	C	2806.0	2815.8	2818.1	2823.2	2838.0	2838.9	2846.9	2839.7
W_{SSD} (g)	B	4807.6	4814.3	4807.0	4809.1	4790.0	4799.2	4811.8	4801.2
$G_{mb} = \frac{A}{(B - C)}$		2.399	2.407	2.416	2.421	2.453	2.447	2.448	2.447
Corrected G_{mb}	N_{ini}	2.239	2.258	2.272	2.274	2.301	2.294	2.301	2.290
	N_{des}	2.378	2.388	2.399	2.404	2.435	2.429	2.433	2.432
V_a @ N_{des}		6.38	5.98	4.61	4.42	2.53	2.76	2.07	2.11
Average		6.18		4.52		2.65		2.09	
VMA @ N_{des}		12.37	12.00	12.08	11.90	11.27	11.48	11.72	11.76
Average		12.18		11.99		11.38		11.74	
VFA @ N_{des}		48.41	50.16	61.84	62.85	77.54	75.97	82.34	82.06
Average		49.28		62.35		76.75		82.20	
%G_{mm} @ N_{ini}		88.15	88.90	90.34	90.42	92.10	91.82	92.63	92.19
Average		88.52		90.38		91.96		92.41	
%G_{mm} @ N_{max}		94.46	94.75	96.05	96.25	98.20	97.95	98.57	98.53
Average		94.61		96.15		98.07		98.55	
Dust Proportion		0.53		0.46		0.42		0.38	

Table A.9 Mix Design Data for New Ulm Quartzite Fine Gradation (PG 58-40)

Project: SUPERPAVE Technician: ________________________ Date: 6/21/1999

CA Source: New Ulm Quartzite FA Source: LAKELAND Blend G_{sb}: 2.6060 Blend G_{se}: 2.6922

Gradation: [X] Above (fine) [ ] Below (coarse) the Restricted Zone Nom. Max. Size (mm): 12.5 Batch Weight, Ws, (g): 12000

Asphalt Sourse: KOCH Grade: PG 58-40 Polymer: yes $P_{b,est}$ = 4.60

T_{mix}: 145 °C T_{comp}: 135 °C Compactor: Brovold N_{ini} 7 N_{des} 76 N_{max} 117 .

Target P_b		$P_{b,est}$ - 0.5 =	4.1	$P_{b,est}$ =	4.6	$P_{b,est}$ + 0.5 =	5.1	$P_{b,est}$ + 1.0 =	5.6
Target W_b (g)		513.0		578.6		644.9		711.9	
Actual W_b (g)		511.4		583.6		642.8		712.3	
Actual P_b		4.09		4.64		5.08		5.60	
G_{mm}		2.527		2.499		2.503		2.481	
Specimen No.		1	2	1	2	1	2	1	2
Specimen Height (mm)	1	113.67	113.42	112.97	112.93	111.87	111.78	111.16	111.35
	2	113.66	113.55	112.93	112.97	111.66	111.92	111.01	111.04
	3	113.87	113.59	112.84	112.76	111.79	111.70	111.11	111.06
	4	113.94	113.75	113.22	112.83	111.78	111.75	111.16	111.17
Average		113.79	113.58	112.99	112.87	111.78	111.79	111.11	111.16
W_{dry} (g)	A	4808.5	4799.0	4805.6	4800.2	4799.2	4820.5	4789.5	4793.7
$W_{in\ water}$ (g)	C	2825.3	2819.6	2830.7	2829.3	2843.1	2863.3	2839.1	2842.9
W_{SSD} (g)	B	4817.7	4807.3	4810.2	4805.7	4802.3	4823.7	4791.6	4796.8
$G_{mb} = \frac{A}{(B - C)}$		2.413	2.414	2.428	2.429	2.450	2.459	2.453	2.453
Corrected G_{mb}	N_{ini}	2.272	2.269	2.284	2.286	2.308	2.321	2.329	2.331
	N_{des}	2.398	2.399	2.411	2.412	2.432	2.444	2.446	2.446
V_a @ N_{des}		5.1	5.06	3.53	3.49	2.82	2.37	1.40	1.40
Average		5.08		3.51		2.60		1.40	
VMA @ N_{des}		11.74	11.71	11.77	11.74	11.42	10.98	11.40	11.40
Average		11.72		11.76		11.20		11.40	
VFA @ N_{des}		56.57	56.77	70.02	70.26	75.31	78.42	87.72	87.72
Average		56.67		70.14		76.87		87.72	
%G_{mm} @ N_{ini}		89.91	89.79	91.40	91.48	92.21	92.73	93.87	93.95
Average		89.85		91.44		92.47		93.91	
%G_{mm} @ N_{max}		95.51	95.54	97.15	97.19	97.87	98.24	98.87	98.89
Average		95.52		97.17		98.05		98.88	
Dust Proportion		0.52		0.46		0.42		0.38	

Table A.10 Mix Design Data for Kasota Limestone Fine Gradation (PG58-40)

Project:	SUPERPAVE	Technician:				Date:	6/21/1999		
CA Source:	Kasota Limestone	FA Source:	LAKELAND			Blend G_{sb}:	2.5810	Blend G_{se}:	2.695
Gradation:	[X] Above (fine) [ ] Below (coarse)	the Restricted Zone		Nom. Max. Size (mm):	12.5	Batch Weight, Ws, (g):	12000		
Asphalt Sourse:	KOCH	Grade:	PG 58-40	Polymer:	yes			$P_{b,est}$ =	4.60
T_{mix}:	145 °C	T_{comp}:	135 °C	Compactor:	Brovold	N_{ini} 7	N_{des} 76	N_{max} 117	

Target P_b		$P_{b,est}$ - 0.5 =	4.1	$P_{b,est}$ =	4.6	$P_{b,est}$ + 0.5 =	5.1	$P_{b,est}$ + 1.0 =	5.6
Target W_b (g)		513.0		578.6		644.9		711.9	
Actual W_b (g)		513.0		577.8		644.2		711.4	
Actual P_b		4.10		4.59		5.09		5.60	
G_{mm}		2.523		2.489		2.477		2.467	
Specimen No.		1	2	1	2	1	2	1	2
Specimen Height (mm)	1	113.41	113.49	113.88	113.81	112.46	112.27	112.52	111.18
	2	113.54	113.49	113.80	113.68	112.55	112.11	112.56	110.75
	3	113.08	113.65	113.80	113.60	112.54	112.52	112.62	110.62
	4	113.18	113.54	113.82	113.76	112.39	112.51	112.7	111.43
Average		113.30	113.54	113.83	113.71	112.49	112.35	112.60	111.00
W_{dry} (g)	A	4795.7	4807.5	4791.0	4791.0	4789.6	4787.4	4789.6	4689.9
$W_{in\ water}$ (g)	C	2817.4	2824.3	2801.4	2806.8	2823.0	2822.5	2819.7	2757.4
W_{SSD} (g)	B	4800.7	4813.4	4794.4	4796.4	4793.0	4790.7	4793.0	4695.1
$G_{mb} = \frac{A}{(B-C)}$		2.418	2.417	2.404	2.408	2.431	2.432	2.427	2.420
Corrected G_{mb}	N_{ini}	2.276	2.278	2.258	2.264	2.292	2.294	2.274	2.272
	N_{des}	2.401	2.402	2.385	2.391	2.416	2.417	2.410	2.403
V_a @ N_{des}		4.84	4.79	4.18	3.93	2.47	2.43	2.32	2.61
Average		4.82		4.06		2.45		2.47	
VMA @ N_{des}		10.79	10.75	11.84	11.62	11.16	11.13	11.85	12.11
Average		10.77		11.73		11.14		11.98	
VFA @ N_{des}		55.13	55.44	64.69	66.17	77.87	78.16	80.42	78.44
Average		55.29		65.43		78.01		79.43	
%G_{mm} @ N_{ini}		90.21	90.29	90.72	90.96	92.53	92.61	92.18	92.10
Average		90.25		90.84		92.57		92.14	
%G_{mm} @ N_{max}		95.84	95.80	96.58	96.75	98.15	98.20	98.39	98.11
Average		95.82		96.66		98.18		98.25	
Dust Proportion		0.52		0.47		0.42		0.38	

APPENDIX B
RESILIENT MODULUS DATA

Table B.1 Resilient Modulus Results for 0 °F Tests

Temp = 0F		Res. Mod			Std. Dev.			CV (%)		
Freqency	ID (deg)	0.33	0.5	1	0.33	0.5	1	0.33	0.5	1
	1 (0)	2172.63	2283.94	2190.33	279.04	349.10	146.02	12.84	15.28	6.67
	1 (90)	1391.62	1583.59	1618.22	127.71	246.06	224.29	9.18	15.54	13.86
GFC	2 (0)	1214.23	1565.29	1577.36	265.28	456.89	515.05	21.85	29.19	32.65
(4.5%)	2 (90)	1492.35	1187.01	1412.87	55.65	209.98	262.60	3.73	17.69	18.59
	3 (0)	2095.81	1936.28	2218.58	346.64	434.46	238.61	16.54	22.44	10.75
	3 (90)	1393.97	1584.06	1602.93	251.37	222.49	380.62	18.03	14.05	23.74
	1 (0)	1993.84	2309.81	2302.62	227.40	165.50	116.69	11.40	7.17	5.07
	1 (90)	1368.26	1284.13	1191.02	166.10	128.12	49.01	12.14	9.98	4.11
GFF	2 (0)	1473.61	1904.68	1459.01	326.77	419.95	374.44	22.17	22.05	25.66
(5.1%)	2 (90)	1361.09	1667.67	1742.96	165.13	325.95	280.07	12.13	19.55	16.07
	3 (0)	2119.95	1775.52	2123.50	529.17	332.36	1269.45	24.96	18.72	59.78
	3 (90)	1661.60	1764.19	1907.43	234.31	214.35	192.63	14.10	12.15	10.10
	1 (0)	1608.95	1563.11	1456.97	449.82	477.04	644.16	27.96	30.52	44.21
	1 (90)	2106.77	2747.99	2456.10	105.65	246.34	335.72	5.01	8.96	13.67
NUC	2 (0)	2116.92	2063.80	2099.05	431.04	374.70	193.24	20.36	18.16	9.21
(4.7%)	2 (90)	1643.43	1518.49	1518.89	303.73	283.12	245.65	18.48	18.64	16.17
	3 (0)	1541.95	2173.93	2711.84	142.61	276.18	351.04	9.25	12.70	12.94
	3 (90)	1850.71	2141.86	2151.38	220.13	245.63	130.79	11.89	11.47	6.08
	1 (0)	1985.00	2068.07	1996.98	259.03	271.19	139.74	13.05	13.11	7.00
	1 (90)	1714.72	1761.84	1969.99	287.21	308.75	593.95	16.75	17.52	30.15
NUF	2 (0)	1374.27	1473.09	1563.87	223.00	68.85	80.99	16.23	4.67	5.18
(5.1%)	2 (90)	1663.11	1689.10	1683.02	314.84	231.39	204.83	18.93	13.70	12.17
	3 (0)	1709.02	2115.77	1843.76	223.76	185.10	299.73	13.09	8.75	16.26
	3 (90)	1893.65	1862.69	2355.57	402.18	234.12	435.04	21.24	12.57	18.47
	1 (0)	1402.17	1403.41	1387.74	164.14	70.54	115.45	11.71	5.03	8.32
	1 (90)	1686.70	1625.26	1867.27	171.31	168.12	185.71	10.16	10.34	9.95
KLC	2 (0)	1370.36	1602.38	1504.30	288.72	341.35	360.36	21.07	21.30	23.96
(4.4%)	2 (90)	1414.69	1592.67	1684.07	237.50	231.46	274.47	16.79	14.53	16.30
	3 (0)	1905.47	1951.13	1932.02	422.76	464.76	490.34	22.19	23.82	25.38
	3 (90)	1648.07	1595.88	1684.02	289.64	372.33	412.53	17.57	23.33	24.50
	1 (0)	1866.45	1986.83	1784.56	202.28	289.10	172.60	10.84	14.55	9.67
	1 (90)	1499.52	1389.03	1465.26	186.05	134.70	100.87	12.41	9.70	6.88
KLF	2 (0)	2207.94	1774.98	1809.16	1099.44	173.92	297.18	49.79	9.80	16.43
(5.1%)	2 (90)	2249.48	2229.46	2323.93	139.10	459.21	140.06	6.18	20.60	6.03
	3 (0)	1764.55	2050.67	1923.62	564.42	393.72	424.68	31.99	19.20	22.08
	3 (90)	1825.91	1879.79	1478.32	156.18	245.23	108.58	8.55	13.05	7.35
	1 (0)	1299.18	1511.62	1539.62	483.44	359.96	350.13	37.21	23.81	22.74
	1 (90)	2111.77	3613.15	2303.79	426.76	625.29	586.81	20.21	17.31	25.47
CGC	2 (0)	1299.69	2308.48	2627.92	201.73	245.90	399.42	15.52	10.65	15.20
(4.6%)	2 (90)	1524.06	1693.85	1814.87	278.77	266.90	423.50	18.29	15.76	23.33
	3 (0)	1318.51	1269.66	1543.28	170.94	307.04	168.84	12.96	24.18	10.94
	3 (90)	2441.10	2232.04	2552.04	327.86	622.82	1078.33	13.43	27.90	42.25
	1 (0)	1645.13	1634.44	1943.62	130.20	137.77	304.36	7.91	8.43	15.66
	1 (90)	1633.10	1177.91	1413.31	234.75	207.59	338.02	14.37	17.62	23.92
CGF	2 (0)	1569.45	1670.77	1670.86	170.42	204.32	257.28	10.86	12.23	15.40
(5.0%)	2 (90)	1506.24	2188.26	2463.16	178.43	207.99	248.63	11.85	9.50	10.09
	3 (0)	1488.94	1370.55	1494.91	249.85	22.30	233.93	16.78	1.63	15.65
	3 (90)	1437.06	1115.99	1318.76	262.98	147.68	234.53	18.30	13.23	17.78

Table B.1 Resilient Modulus Results for 0 °F Tests, continued

Temp = 0F		Res. Mod			Std. Dev.			CV (%)		
Freqency	ID (deg)	0.33	0.5	1	0.33	0.5	1	0.33	0.5	1
	1 (0)	1859.03	1680.71	1923.09	696.01	228.76	200.71	37.44	13.61	10.44
	1 (90)	1723.73	1561.61	1221.76	351.40	521.99	116.91	20.39	33.43	9.57
NUF	2 (0)	1308.80	1177.77	1412.09	104.70	128.39	153.85	8.00	10.90	10.89
(58-40)	2 (90)	1577.23	1553.64	1669.22	97.46	150.10	186.69	6.18	9.66	11.18
(4.9%)	3 (0)	2100.99	2167.08	2196.59	252.89	97.41	282.55	12.04	4.49	12.86
	3 (90)	1800.88	1792.76	1842.92	218.50	161.63	148.51	12.13	9.02	8.06
	1 (0)	1846.81	1836.68	1926.72	180.38	159.19	229.46	9.77	8.67	11.91
	1 (90)	1864.91	2114.13	2103.62	103.07	140.20	86.16	5.53	6.63	4.10
KLF	2 (0)	1830.09	1699.25	1864.09	254.89	177.33	221.06	13.93	10.44	11.86
(58-40)	2 (90)	1941.27	1895.34	1820.74	251.63	176.33	64.18	12.96	9.30	3.52
(4.9%)	3 (0)	1427.18	1116.37	1173.38	358.89	235.26	257.48	25.15	21.07	21.94
	3 (90)	1697.17	2005.81	1895.63	247.75	770.66	224.73	14.60	38.42	11.86

Key

Abbreviation	Mix Type	Binder
GFC	Granite Falls granite, coarse gradation,	PG 52-34
GFF	Granite Falls granite, fine gradation,	PG 52-34
NUC	New Ulm quartzite, coarse gradation	PG 52-34
NUF	New Ulm quartzite, fine gradation	PG 52-34
KLC	Kasota limestone, coarse gradation	PG 52-34
KLF	Kasota limestone, fine gradation	PG 52-34
CGC	Cedar Grove gravel, coarse gradation	PG 52-34
CGF	Cedar Grove gravel, fine gradation	PG 52-34
NUF (58-40)	New Ulm quartzite, fine gradation	PG 58-40
KLF (58-40)	Kasota limestone, fine gradation	PG 58-40

Table B.2 Resilient Modulus Results for 34 °F Tests

Temp = 34F			Res. Mod			Std. Dev.			Coeficient of Variance (%)	
Freqency	ID (deg)	0.33	0.5	1	0.33	0.5	1	0.33	0.5	1
	1 (0)	1231.73	1261.85	1243.96	143.05	45.76	47.32	11.61	3.63	3.80
	1 (90)	1189.42	1316.83	1308.97	116.78	91.91	30.40	9.82	6.98	2.32
GFC	2 (0)	1141.11	979.11	1182.30	154.92	64.99	26.54	13.58	6.64	2.25
(4.5%)	2 (90)	1484.32	1480.81	1558.65	120.14	123.41	64.09	8.09	8.33	4.11
	3 (0)	1222.55	1078.15	1117.57	77.68	94.31	32.81	6.35	8.75	2.94
	3 (90)	1701.06	1600.36	1658.16	215.56	87.50	48.82	12.67	5.47	2.94
	1 (0)	1303.46	1290.13	1313.70	196.80	95.45	79.21	15.10	7.40	6.03
	1 (90)	1273.38	1279.33	1356.05	109.36	46.21	77.45	8.59	3.61	5.71
GFF	2 (0)	1342.22	1324.13	1289.75	107.01	76.76	19.37	7.97	5.80	1.50
(5.1%)	2 (90)	1449.08	1522.79	1441.38	51.49	74.49	28.50	3.55	4.89	1.98
	3 (0)	1570.86	1441.20	1460.77	321.31	100.96	49.34	20.45	7.01	3.38
	3 (90)	1288.46	1268.12	1358.32	104.87	34.84	40.80	8.14	2.75	3.00
	1 (0)	1048.69	1083.96	1095.61	50.65	46.79	22.89	4.83	4.32	2.09
	1 (90)	1179.38	1151.28	1211.22	100.84	54.62	37.74	8.55	4.74	3.12
NUC	2 (0)	1183.74	1111.77	1135.64	76.33	44.88	25.40	6.45	4.04	2.24
(4.7%)	2 (90)	1333.05	1425.85	1329.57	204.10	117.76	154.90	15.31	8.26	11.65
	3 (0)	1193.35	1217.75	1208.64	87.71	55.12	53.88	7.35	4.53	4.46
	3 (90)	1195.34	1119.76	1120.18	95.10	68.53	82.08	7.96	6.12	7.33
	1 (0)	1286.75	1305.75	1290.82	91.41	152.07	93.28	7.10	11.65	7.23
	1 (90)	1232.36	1297.36	1325.87	119.49	116.24	85.61	9.70	8.96	6.46
NUF	2 (0)	1306.14	1343.82	1348.11	103.55	58.77	38.56	7.93	4.37	2.86
(5.1%)	2 (90)	1480.50	1435.83	1496.42	92.86	104.15	50.91	6.27	7.25	3.40
	3 (0)	1419.75	1350.29	1386.60	196.15	85.71	63.88	13.82	6.35	4.61
	3 (90)	1413.14	1348.87	1357.96	97.46	128.01	46.35	6.90	9.49	3.41
	1 (0)	1407.99	1311.37	1377.39	101.90	138.25	43.88	7.24	10.54	3.19
	1 (90)	1496.87	1528.41	1580.33	283.65	97.81	87.86	18.95	6.40	5.56
KLC	2 (0)	1223.46	1290.74	1254.71	100.64	68.53	43.97	8.23	5.31	3.50
(4.4%)	2 (90)	1374.99	1297.12	1386.99	98.95	72.15	67.60	7.20	5.56	4.87
	3 (0)	1324.96	1321.98	1393.36	110.24	121.39	22.23	8.32	9.18	1.60
	3 (90)	1420.88	1437.80	1343.29	99.49	100.97	48.59	7.00	7.02	3.62
	1 (0)	1414.75	1474.61	1516.36	95.84	56.80	50.17	6.77	3.85	3.31
	1 (90)	1235.29	1304.08	1360.78	61.52	67.11	54.98	4.98	5.15	4.04
KLF	2 (0)	1333.81	1326.25	1446.78	77.87	75.28	80.78	5.84	5.68	5.58
(5.1%)	2 (90)	1160.16	1208.38	1173.19	80.64	134.93	39.03	6.95	11.17	3.33
	3 (0)	1368.82	1383.66	1423.98	77.12	72.23	81.37	5.63	5.22	5.71
	3 (90)	1229.29	1227.13	1220.99	94.21	71.68	64.08	7.66	5.84	5.25
	1 (0)	1322.69	1358.04	1385.72	133.60	37.05	28.06	10.10	2.73	2.03
	1 (90)	1353.11	1370.87	1402.66	79.33	76.52	45.46	5.86	5.58	3.24
CGC	2 (0)	1383.31	1357.07	1378.15	122.36	43.72	36.77	8.85	3.22	2.67
(4.6%)	2 (90)	1190.26	1198.69	1230.81	109.52	97.29	79.14	9.20	8.12	6.43
	3 (0)	1257.28	1222.32	1270.63	82.05	58.97	47.62	6.53	4.82	3.75
	3 (90)	1252.99	1284.41	1319.83	104.77	94.35	73.25	8.36	7.35	5.55
	1 (0)	1268.80	1239.35	1245.56	190.05	82.21	62.77	14.98	6.63	5.04
	1 (90)	1273.26	1175.71	1377.03	118.27	66.29	59.38	9.29	5.64	4.31
CGF	2 (0)	1457.37	1439.52	1445.20	95.42	90.11	87.12	6.55	6.26	6.03
(5.0%)	2 (90)	1272.35	1269.28	1259.43	38.81	81.64	79.15	3.05	6.43	6.28
	3 (0)	1260.31	1284.51	1356.33	26.27	88.78	34.98	2.08	6.91	2.58
	3 (90)	1379.65	1402.81	1431.20	23.24	37.80	49.28	1.68	2.69	3.44

Table B.2 Resilient Modulus Results for 34 °F Tests, continued

Temp = 34F		Res. Mod			Std. Dev.			Coeficient of Variance (%)		
Freqency	ID (deg)	0.33	0.5	1	0.33	0.5	1	0.33	0.5	1
	1 (0)	791.27	824.33	856.41	54.52	47.47	40.21	6.89	5.76	4.70
	1 (90)	849.43	813.27	807.09	73.31	48.14	17.29	8.63	5.92	2.14
NUF	2 (0)	921.29	947.65	969.95	48.13	28.26	38.74	5.22	2.98	3.99
(58-40)	2 (90)	768.31	786.17	780.62	46.44	76.95	23.11	6.04	9.79	2.96
(4.9%)	3 (0)	894.92	920.48	966.41	25.84	39.96	22.47	2.89	4.34	2.33
	3 (90)	829.44	824.79	797.74	32.90	40.17	4.47	3.97	4.87	0.56
	1 (0)	832.51	838.55	828.51	26.36	33.46	31.44	3.17	3.99	3.80
	1 (90)	829.29	852.16	842.86	36.36	33.78	14.72	4.38	3.96	1.75
KLF	2 (0)	873.79	857.24	867.73	49.11	33.90	43.88	5.62	3.95	5.06
(58-40)	2 (90)	826.74	806.20	832.60	65.47	21.58	42.65	7.92	2.68	5.12
(4.9%)	3 (0)	763.24	750.92	793.58	34.30	18.60	30.54	4.49	2.48	3.85
	3 (90)	875.57	863.51	892.52	84.09	78.24	22.44	9.60	9.06	2.51

Key

Abbreviation	Mix Type	Binder
GFC	Granite Falls granite, coarse gradation,	PG 52-34
GFF	Granite Falls granite, fine gradation,	PG 52-34
NUC	New Ulm quartzite, coarse gradation	PG 52-34
NUF	New Ulm quartzite, fine gradation	PG 52-34
KLC	Kasota limestone, coarse gradation	PG 52-34
KLF	Kasota limestone, fine gradation	PG 52-34
CGC	Cedar Grove gravel, coarse gradation	PG 52-34
CGF	Cedar Grove gravel, fine gradation	PG 52-34
NUF (58-40)	New Ulm quartzite, fine gradation	PG 58-40
KLF (58-40)	Kasota limestone, fine gradation	PG 58-40

Table B.3 Resilient Modulus Results for 77 °F Tests

Temp = 77F			Res. Mod			Std. Dev.			Coeficient of Variance (%)	
Freqency	ID (deg)	0.33	0.5	1	0.33	0.5	1	0.33	0.5	1
	1 (0)	251.85	242.58	234.73	18.19	7.13	7.13	7.22	2.94	3.04
	1 (90)	239.87	221.38	221.83	3.21	8.78	4.67	1.34	3.97	2.11
GFC	2 (0)	238.41	242.51	239.24	7.54	3.55	7.70	3.16	1.46	3.22
(4.5%)	2 (90)	233.54	233.72	239.04	4.71	4.76	3.51	2.02	2.04	1.47
	3 (0)	270.17	271.58	274.13	8.46	1.79	4.08	3.13	0.66	1.49
	3 (90)	277.64	261.67	249.85	19.82	12.84	9.61	7.14	4.91	3.84
	1 (0)	251.49	249.56	246.45	5.33	6.55	3.35	2.12	2.63	1.36
	1 (90)	206.45	202.03	200.71	3.49	9.46	2.63	1.69	4.68	1.31
GFF	2 (0)	309.70	298.91	304.82	6.14	5.67	7.83	1.98	1.90	2.57
(5.1%)	2 (90)	283.92	283.94	281.28	11.70	5.21	8.01	4.12	1.83	2.85
	3 (0)	251.65	246.25	250.02	2.16	5.23	3.12	0.86	2.12	1.25
	3 (90)	235.10	237.68	238.90	11.78	4.33	2.66	5.01	1.82	1.11
	1 (0)	188.03	189.26	186.30	2.87	2.83	3.48	1.53	1.49	1.87
	1 (90)	199.29	205.21	199.97	15.44	5.61	2.26	7.75	2.73	1.13
NUC	2 (0)	220.47	223.47	222.45	3.69	4.13	7.91	1.67	1.85	3.56
(4.7%)	2 (90)	257.63	243.91	244.77	5.45	10.31	5.95	2.12	4.23	2.43
	3 (0)	217.12	215.11	217.56	2.16	4.42	2.96	0.99	2.05	1.36
	3 (90)	259.61	247.39	249.13	15.88	7.03	1.53	6.12	2.84	0.61
	1 (0)	283.76	273.31	273.77	3.72	8.38	6.22	1.31	3.07	2.27
	1 (90)	255.25	257.82	262.69	9.45	2.16	2.63	3.70	0.84	1.00
NUF	2 (0)	280.32	280.24	284.68	1.71	2.81	4.57	0.61	1.00	1.61
(5.0%)	2 (90)	280.21	281.28	277.37	10.59	5.67	6.55	3.78	2.02	2.36
	3 (0)	266.46	268.56	273.82	5.25	5.32	2.25	1.97	1.98	0.82
	3 (90)	298.43	297.23	298.41	1.44	4.15	3.72	0.48	1.40	1.25
	1 (0)	335.25	338.88	334.55	8.34	5.40	4.25	2.49	1.59	1.27
	1 (90)	314.42	315.10	316.09	6.83	29.69	4.97	2.17	9.42	1.57
KLC	2 (0)	339.71	344.83	349.74	6.98	7.17	7.74	2.05	2.08	2.21
(4.4%)	2 (90)	311.06	306.02	311.30	7.13	7.19	5.47	2.29	2.35	1.76
	3 (0)	303.25	310.25	310.72	4.05	9.20	10.65	1.34	2.97	3.43
	3 (90)	327.45	310.00	312.61	22.22	7.69	6.95	6.79	2.48	2.22
	1 (0)	265.97	269.21	273.93	3.78	2.40	5.92	1.42	0.89	2.16
	1 (90)	286.29	279.05	281.12	3.43	9.79	4.38	1.20	3.51	1.56
KLF	2 (0)	260.75	267.00	267.74	5.03	3.13	2.42	1.93	1.17	0.90
(5.1%)	2 (90)	274.41	269.92	260.68	2.98	4.25	5.93	1.09	1.57	2.27
	3 (0)	255.57	260.69	264.34	2.58	3.92	3.20	1.01	1.51	1.21
	3 (90)	292.41	285.36	282.71	4.01	3.30	5.52	1.37	1.16	1.95
	1 (0)	274.65	269.23	265.69	3.24	5.88	2.83	1.18	2.19	1.07
	1 (90)	279.13	281.54	281.14	10.41	6.73	8.29	3.73	2.39	2.95
CGC	2 (0)	296.50	286.83	274.82	3.82	2.55	7.39	1.29	0.89	2.69
(4.6%)	2 (90)	293.97	293.03	287.49	5.63	5.61	1.26	1.91	1.91	0.44
	3 (0)	252.81	246.89	245.83	7.00	4.59	6.36	2.77	1.86	2.59
	3 (90)	238.98	241.08	241.47	11.65	1.27	1.71	4.87	0.53	0.71
	1 (0)	255.92	263.13	264.80	6.18	4.15	5.84	2.41	1.58	2.20
	1 (90)	281.07	268.34	269.52	3.13	14.16	6.62	1.11	5.28	2.46
CGF	2 (0)	267.74	266.02	263.86	9.94	6.36	6.49	3.71	2.39	2.46
(5.0%)	2 (90)	262.33	260.23	259.35	9.17	3.10	2.42	3.49	1.19	0.93
	3 (0)	244.37	240.56	241.24	2.76	2.12	6.45	1.13	0.88	2.67
	3 (90)	251.85	245.98	247.44	3.83	4.11	2.38	1.52	1.67	0.96

Table B.3 Resilient Modulus Results for 77 °F Tests, continued

Temp = 77F			Res. Mod			Std. Dev.			Coeficient of Variance (%)	
Freqency	ID (deg)	0.33	0.5	1	0.33	0.5	1	0.33	0.5	1
	1 (0)	158.15	159.38	164.03	2.94	2.32	0.35	1.86	1.45	0.21
	1 (90)	166.26	164.04	165.88	1.27	2.94	1.04	0.76	1.79	0.62
NUF	2 (0)	169.20	172.30	169.70	6.21	0.80	1.52	3.67	0.46	0.89
(58-40)	2 (90)	161.25	165.93	164.69	2.87	2.96	2.46	1.78	1.78	1.49
(4.9%)	3 (0)	151.70	155.86	156.40	1.02	0.74	0.78	0.68	0.48	0.50
	3 (90)	163.38	164.07	167.23	9.08	3.65	3.18	5.56	2.22	1.90
	1 (0)	173.99	175.18	180.01	4.11	4.10	2.24	2.36	2.34	1.24
	1 (90)	176.72	176.03	177.59	3.16	2.63	2.45	1.79	1.49	1.38
KLF	2 (0)	193.18	197.13	197.78	7.06	2.00	1.48	3.66	1.01	0.75
(58-40)	2 (90)	194.56	191.79	192.88	1.93	3.31	2.31	0.99	1.73	1.20
(4.9%)	3 (0)	200.62	204.18	204.12	6.23	1.97	1.88	3.11	0.97	0.92
	3 (90)	191.50	187.49	192.46	3.25	4.67	1.21	1.70	2.49	0.63

Key

Abbreviation	Mix Type	Binder
GFC	Granite Falls granite, coarse gradation,	PG 52-34
GFF	Granite Falls granite, fine gradation,	PG 52-34
NUC	New Ulm quartzite, coarse gradation	PG 52-34
NUF	New Ulm quartzite, fine gradation	PG 52-34
KLC	Kasota limestone, coarse gradation	PG 52-34
KLF	Kasota limestone, fine gradation	PG 52-34
CGC	Cedar Grove gravel, coarse gradation	PG 52-34
CGF	Cedar Grove gravel, fine gradation	PG 52-34
NUF (58-40)	New Ulm quartzite, fine gradation	PG 58-40
KLF (58-40)	Kasota limestone, fine gradation	PG 58-40

Table B.4 Resilient Modulus Results for 104 °F Tests

Temp = 104F			Res. Mod			Std. Dev.			Coeficient of Variance (%)	
Freqency	ID (deg)	0.33	0.5	1	0.33	0.5	1	0.33	0.5	1
	1 (0)	63.86	61.74	60.36	6.83	3.89	1.93	10.70	6.30	3.20
	1 (90)	62.96	56.42	56.59	6.72	3.77	2.04	10.68	6.68	3.60
GFC	2 (0)	69.09	64.05	65.62	3.70	2.61	2.27	5.35	4.07	3.45
(4.5%)	2 (90)	67.14	62.59	65.17	8.96	6.19	1.60	13.34	9.89	2.46
	3 (0)	71.51	66.77	64.68	5.93	4.57	4.86	8.29	6.84	7.51
	3 (90)	67.80	69.41	65.82	6.29	3.37	1.34	9.28	4.85	2.03
	1 (0)	75.56	73.70	73.76	3.11	4.47	2.56	4.12	6.07	3.47
	1 (90)	96.09	89.32	85.87	11.36	8.20	1.62	11.82	9.18	1.89
GFF	2 (0)	85.18	93.68	92.34	15.96	6.16	5.69	18.74	6.57	6.16
(5.1%)	2 (90)	95.53	84.90	86.52	3.41	5.24	2.82	3.57	6.17	3.26
	3 (0)	69.78	65.65	70.01	8.76	4.38	2.38	12.55	6.67	3.40
	3 (90)	65.67	66.28	65.66	4.12	1.92	2.71	6.28	2.90	4.13
	1 (0)	60.77	62.52	59.66	6.57	1.06	1.08	10.81	1.70	1.81
	1 (90)	46.44	46.71	46.26	1.69	1.22	1.01	3.64	2.62	2.19
NUC	2 (0)	81.52	62.21	71.67	2.11	27.65	1.50	2.58	44.44	2.09
(4.7%)	2 (90)	76.29	67.69	67.42	1.72	2.33	2.18	2.26	3.44	3.23
	3 (0)	76.87	72.81	70.83	5.70	2.74	2.31	7.42	3.76	3.26
	3 (90)	75.46	68.25	69.09	8.60	4.33	2.46	11.40	6.34	3.56
	1 (0)	90.28	83.73	85.69	2.93	6.42	2.46	3.24	7.67	2.87
	1 (90)	80.95	75.03	77.47	11.37	8.41	2.88	14.05	11.20	3.71
NUF	2 (0)	91.06	70.88	84.73	6.58	32.21	2.66	7.23	45.43	3.14
(5.0%)	2 (90)	85.72	83.75	77.10	10.99	2.51	3.52	12.82	2.99	4.56
	3 (0)	94.72	85.13	85.97	5.21	5.23	2.67	5.50	6.14	3.11
	3 (90)	92.62	84.54	86.05	11.08	3.97	1.80	11.97	4.69	2.09
	1 (0)	112.32	105.64	105.66	13.94	4.44	4.64	12.41	4.20	4.39
	1 (90)	89.56	92.57	95.18	6.15	2.71	4.78	6.87	2.93	5.02
KLC	2 (0)	115.08	111.49	108.85	7.78	8.49	5.28	6.76	7.61	4.85
(4.4%)	2 (90)	119.82	102.29	100.72	8.97	5.89	4.20	7.49	5.76	4.17
	3 (0)	112.73	106.52	102.64	9.28	3.47	4.85	8.24	3.26	4.72
	3 (90)	112.37	98.18	100.83	7.65	5.49	5.92	6.81	5.59	5.87
	1 (0)	103.27	99.38	98.52	14.56	2.71	5.26	14.10	2.72	5.34
	1 (90)	97.87	87.48	87.97	3.63	4.12	5.06	3.71	4.71	5.75
KLF	2 (0)	84.01	80.08	80.29	2.73	1.69	4.00	3.25	2.12	4.98
(5.1%)	2 (90)	86.29	75.17	77.06	8.24	7.20	3.54	9.55	9.58	4.59
	3 (0)	88.28	90.40	88.82	5.98	4.29	2.50	6.77	4.74	2.81
	3 (90)	93.78	90.04	87.36	11.18	4.46	1.34	11.92	4.95	1.54
	1 (0)	89.48	85.11	84.09	7.67	4.22	1.52	8.58	4.96	1.81
	1 (90)	88.65	80.71	79.87	5.71	3.68	3.07	6.44	4.56	3.84
CGC	2 (0)	89.88	83.63	82.81	2.86	2.51	2.84	3.18	3.00	3.43
(4.6%)	2 (90)	93.86	87.11	79.64	1.88	1.46	2.98	2.00	1.68	3.75
	3 (0)	75.22	70.99	68.91	2.21	2.24	1.68	2.94	3.16	2.43
	3 (90)	72.32	69.62	62.23	9.31	2.98	3.59	12.88	4.27	5.76
	1 (0)	81.27	81.80	77.77	6.84	6.86	5.20	8.42	8.39	6.69
	1 (90)	86.36	80.05	77.01	9.76	7.30	2.12	11.31	9.12	2.75
CGF	2 (0)	75.70	76.68	73.10	5.97	2.57	3.15	7.89	3.36	4.31
(5.0%)	2 (90)	75.01	78.02	72.60	12.04	2.72	5.57	16.05	3.49	7.67
	3 (0)	80.64	74.12	73.25	2.70	2.65	3.54	3.35	3.57	4.84
	3 (90)	77.05	72.19	68.52	10.65	3.66	1.69	13.83	5.07	2.47

Table B.4 Resilient Modulus Results for 104 °F Tests, continued

Temp = 104F		Res. Mod			Std. Dev.			Coeficient of Variance (%)		
Freqency	ID (deg)	0.33	0.5	1	0.33	0.5	1	0.33	0.5	1
	1 (0)	85.97	89.70	87.32	4.89	4.49	2.10	5.69	5.01	2.40
	1 (90)	81.32	88.28	87.30	3.97	4.37	3.02	4.88	4.95	3.46
KLF	2 (0)	88.55	93.66	90.22	3.09	3.06	3.20	3.49	3.27	3.55
(58-40)	2 (90)	95.74	91.24	94.47	2.14	2.53	1.84	2.23	2.77	1.95
(4.9%)	3 (0)	99.34	95.91	98.31	7.41	4.40	1.79	7.46	4.59	1.82
	3 (90)	90.56	96.73	95.81	6.26	3.09	1.77	6.92	3.19	1.84
	1 (0)	75.17	77.63	76.49	5.17	3.24	2.58	6.88	4.18	3.38
	1 (90)	74.93	73.17	73.50	2.94	1.66	1.56	3.92	2.27	2.12
NUF	2 (0)	78.49	74.84	77.66	4.85	1.89	2.35	6.18	2.53	3.03
(58-40)	2 (90)	76.33	79.40	81.06	4.12	2.78	2.20	5.39	3.50	2.71
(4.9%)	3 (0)	82.63	88.11	86.60	5.72	1.93	1.37	6.92	2.19	1.58
	3 (90)	73.04	78.78	81.38	10.15	2.74	2.95	13.89	3.48	3.63

Key

Abbreviation	Mix Type	Binder
GFC	Granite Falls granite, coarse gradation,	PG 52-34
GFF	Granite Falls granite, fine gradation,	PG 52-34
NUC	New Ulm quartzite, coarse gradation	PG 52-34
NUF	New Ulm quartzite, fine gradation	PG 52-34
KLC	Kasota limestone, coarse gradation	PG 52-34
KLF	Kasota limestone, fine gradation	PG 52-34
CGC	Cedar Grove gravel, coarse gradation	PG 52-34
CGF	Cedar Grove gravel, fine gradation	PG 52-34
NUF (58-40)	New Ulm quartzite, fine gradation	PG 58-40
KLF (58-40)	Kasota limestone, fine gradation	PG 58-40

APPENDIX C

APA RUT TEST PROCEDURE

GDT-115M
METHOD OF TEST FOR DETERMINING RUTTING SUSCEPTIBILITY USING THE ASPHALT PAVEMENT ANALYZER

A. SCOPE:

The Asphalt Pavement Analyzer will be used to test the rutting susceptibility of asphalt concrete mixtures.

B. APPARATUS:

1. 16,000 gram scale, accurate to 0.1 gram.
2. Mixer.
3. Mixing utensils (bowls, spoon, spatula).
4. Astec Vibratory Compactor (Model AVC II).
5. 125 mm wide x 300 mm long beam mold with base plate and 150 mm diameter mold with base plate for AVC II.
6. 125 mm x 300 mm beam specimen compaction head and 150 mm diameter cylinder compaction head for AVC II.
7. 125 mm x 300 mm x 2 mm beam sample support plates for beam specimens and 150 mm diameter x 2 mm sample support plates for cylindrical specimens.
8. 75 mm high calibration blocks for beam and pill compaction heads for the AVC II
9. Astec Asphalt Pavement Analyzer II.
10. Heating ovens for aggregate and asphalt cement. Capable of maintaining at least 200 °C and holding a set temperature ± 2 °C.
11. Polyethylene restraint molds for sample testing.
12. Measuring template for rut measurement.
13. Digital Indicator (accurate to 0.1 mm).
14. 150 mm diameter paper disks for cylindrical AVC II Molds.

C. Preparation of Sample:

1. Asphalt mixes should be batched with asphalt and aggregate to meet actual laboratory density at optimum asphalt cement content according to Section F below. The target voids of the compacted mix should be 7.0% ± 1.0%, unless specified otherwise.

2. Preheat aggregate, liquid asphalt, compaction molds, and utensils to the specified temperatures. Temperatures for heating and mixing aggregate and asphalt cement should conform to the Superpave Performance Grade mixing and compaction binder requirement.

3. Dry mix, aggregates and hydrated lime or other admixtures, if required, then add the optimum percentage of asphalt cement and mix.

4. If additional heating is necessary, place entire mixture in one gallon cans, close lids and place in an oven set on approximately 176 °C. Heat until mixture meets required compaction temperature. The mixture shall not be heated at the compaction temperature for more than one (1) hour.

D. Sample Compaction:

1. Astec Vibratory Compactor (Model AVC II)

   a. The following steps should be completed before starting the specimen compaction operation:

      1) To set the height of specimen to be compacted at 75 mm, place the calibration block under the compaction head on the specimen supporting base. On the control unit, with the VIBRATION switch to OFF and the MODE switch to MANUAL, simultaneously press the GREEN PALM buttons to lower the compaction head onto the calibration block. For height calibration, the compaction head should be making full contact with the face of the block. Hand tighten the compaction head assembly bolts in this position. Raise the compaction head assembly for adequate clearance to tighten the bolts to the appropriate torque.

      2) Adjust the compaction force and the vibration time, depending on the type of mix. The amount of compaction effort that can be delivered by this compaction machine depends on the static compaction force and the duration of vibrating action which can be adjusted. The static compaction force can be controlled by the compaction pressure (system pressure on the right) and the counter balance pressure (on the left). The relationship between these two pressure readings and the net compaction pressure are shown in Table 3-1, below:

Table 3-1

SPECIMEN TYPE	SYSTEM PRESSURE	COUNTER BAL. PRESSURE	VIBRATING TIME, sec.*
150 mm dia. Cylinder specimen	700 kPa	420 kPa	30 - 60
125 mm x 300 mm beam specimen	700 kPa	210 kPa	30 - 60

* Vibrating time can be adjusted from the CYCLE TIME counter on the control unit. The VIBRATING TIME will be 50% of the maximum total CYCLE TIME.

3) Heat the specimen mold assembly in an oven to a temperature of 150 °C. The mold needs to be heated once at the beginning of the specimen compaction operation.

b. The following specimen compaction procedures can be used for compacting cylinder specimen and beam specimen:

1) Place the specimen mold on top of a counter adjacent to the compaction machine. Insert a preheated sample support plate into the mold. Apply a light coat of release agent on the inside surfaces of the mold and the sample support plate. If compacting a cylinder specimen, place a paper disk in the bottom of the mold.

2) Place the entire batch of mixture in the mold and spade the mixture vigorously with a heated spatula twenty (20) times evenly around the perimeter and twenty (20) times evenly in the interior of the beam mold, or, ten (10) times around the perimeter and ten (10) times evenly in the interior of the cylindrical mold. Then form the sample surface to a dome shape. Measure the temperature in the mixture. Temperature at the start of the compaction procedure should be within 3 °C of the specified compaction temperature for the mixture. If it is not, place the sample and mold in oven until the specified compaction temperature is reached.

3) Transfer the specimen mold to the supporting base of the machine and fit it in the recessed area. Apply a light coat of release agent on the compaction head.

4) On the control unit, set CYCLE TIME from one (1) minute to two (2) minutes (depending on the VIBRATING TIME), turn MODE switch to AUTO, VIBRATING switch to AUTO, and pull up (disable) the EMERGENCY STOP.

5) Depress both GREEN PALM buttons simultaneously (you do not need to hold down the palm buttons). This will cause the compaction head assembly to move downward automatically, and when it drops to a specified position, the vibrating action will be activated automatically. Under the static compression force and the vibrating actions, the compaction head will move downward to compact the loose asphalt mixture confined in the specimen mold for thirty (30) seconds to sixty (60) seconds. After the selected VIBRATING TIME (50% of the CYCLE TIME), turn the VIBRATING switch "OFF", allowing the specimens to remain under static compression force only, for the remaining 50% of the CYCLE TIME. At the end of the CYCLE TIME, the compaction head assembly will automatically retract. Additional vibrating compaction can be applied by increasing the vibrating time.

6) Lift the specimen mold from the compaction position, move forward and slide the edges of the specimen mold under the restraining brackets and position the specimen mold in the recessed area at the extruding support base.

7) On the control unit, turn the MODE switch to EJECT. Press and hold down both GREEN PALM buttons to raise the extrusion cylinder head to extrude the specimen out from the mold. Allow the specimen to cool for a few minutes, then remove the compacted specimen with the sample support plate together from the base plate of the mold and place them on a firm counter top. Press the OPEN button on the control unit to retract the extrusion cylinder head. Then remove the specimen mold from the supporting base plate.

E. <u>Rut Testing Procedure</u>

1. Method "A" - Laboratory Compacted Specimen

   a. Asphalt Pavement Analyzer II

      1) Rut Testing (Dry)

         a) Preset chamber temperature as follows: For SMA and Superpave mixes use 50 °C, for conventional mixes use 40 °C. During testing these temperatures are to be maintained within ± 1 °C.

         b) Open the front doors, unlock the toggle clamps and pull out the sample tray.

         c) Loosen and remove the bolts and the restraining brackets at the front ends of the three PVC molds that have been secured on the sample tray. Remove the molds from the sample tray and place them on a firm counter top for installing asphalt samples in the sample mold.

d) After installing the samples into the molds, transfer the sample molds to the sample tray, one at a time, making sure to fit the recessed area of the sample mold to the rear end restraining bracket. Do the same for all three molds. Place and tighten the restraining brackets on the front end of the sample molds, fitting the bracket into the recessed area of the sample mold to restrain the sample molds from lateral movement.

e) Allow the machine to stroke through a maximum of 100 cycles to assure that the specimen are seated well in the molds or between the restraint brackets and that there is no build-up asphalt binder film thickness on the sample surface.

f) Measure and record the initial gauge readings for each sample by taking indicator readings at all five slots for beam samples, or by taking indicator readings using the two end slots on each end of the template for cylindrical samples. Record the readings and average on the data sheet.

g) Perform the rutting test. It is assumed that the chamber temperature has been brought to the preset test temperature and the test samples have been conditioned under the test temperature for a minimum of four (4) hours.

h) After closing the front door, allow the test samples to be stabilized at the test temperature for ten (10) minutes before starting the rutting test. The STROKE ON DELAY timer can be used to set the delay start time.

i) Set the PRESET counter to the number of repetitions for the test to be run. Reset the TOTALIZING counters too zero, turn the cylinder operation mode control switch to AUTO, and check the pressure gauge readings to be corresponding to the wheel load. Do this for all three (3) cylinders.

j) Press the green rectangular STROKE TEST START button to start the rut testing. This will start the automatic rut testing sequence. After completing the preset number of repetitions, the machine automatically stops the reciprocating motion and retracts the wheels. A complete test will take approximately 3.5 hours.

k) Measure the rut depth and record the results on the data sheet as in step 1.e., above.

2) Rut Testing (Submerged)

a) Precondition samples by vacuum saturation in accordance with GDT-66. Calculate the percent saturation.

b) Place and secure specimen in the sample molds, same as the procedure used in 1.a). to 1.e)., above.

c) Perform the rutting test. It is important to remember that the water tray should be empty before raising or lowering to prevent spillage of water inside the cabinet.

d) After closing the front door, raise the water tray and turn on the water pump to flood the test samples. Use the STROKE ON DELAY timer and set the soaking time at 30 minutes to allow the test samples to be stabilized at the test temperature before starting the rut testing.

e) Set the PRESET counter to the number of repetitions for the test to be run. Reset the TOTALIZING counter to zero, turn the cylinder operation mode control switch to AUTO and check the pressure gauge reading which should correspond to the specified test wheel load.

f) Press the green rectangular STROKE TEST START button to start the rut testing. This will start the automatic rut testing sequence. After completing the preset number of repetitions, the machine will automatically stop the reciprocating motion and retract the wheels.

g) Drain the water in the water tray then lower the water tray.

h) Open the front doors, release the toggle clamps and pull out the sample tray.

i) Measure the rut depth and record the results on the data sheet as in step 1.e., above.

3) Method “B” - Roadway Specimen

a) 300 mm or 150 mm roadway cores are used in this method for evaluation.

b) 150 mm diameter cores must be sawed to a thickness of 75 mm high. 300 mm core must be sawed to give a sample specimen 75 mm thickness x 125 mm wide x 225 mm long.

F. Calculations:

1. Calculation of Specimen Mass:

a. Volume of Specimen [cm^3]:

1) Beam:

$V = L \times w \times h$

2) Cylindrical Specimen:
$$V = \frac{\pi D^2}{4} \times 0.001 \text{ cm}^3/\text{mm}^3 \times h$$

b. Target Mass of Specimen [g]:
1) Beam:
$W_{mb} = \rho_{opt} \times V$

2) Cylindrical Specimen:
$W_{mb} = G_{mm}$ ($1 g/cm^3$) x % G_{mm} x V

Where,

L	=	Length of beam specimen, cm
w	=	Width of beam specimen, cm
h	=	Height of specimen, cm (7.5 cm)
D	=	Diameter of cylindrical mold, mm (15.0 cm)
V	=	Volume of specimen, cm^3 (30.0 cm x 12.5 cm x 7.5 cm = 2812.5 cm^3 for laboratory beam specimen, 22.5 cm x 12.5 cm x 7.5 cm = 2109.4 cm^3 for field beam specimen, [π (15.0 cm)^2]/4 x 7.5 cm = 1325.4 cm^3 for cylindrical specimen)
ρ_{opt}	=	Density @ optimum asphalt content, g/cm^3
G_{mm}	=	Theoretical maximum specific gravity @ optimum asphalt content
% G_{mm}	=	$1.0 - \frac{\text{Target \% air voids}}{100}$
($1 g/cm^3$)	=	Density of water
W_{mb}	=	Target mass of specimen, g.

2. Calculation of Rut Depth:

a. The rut depth at each location is determined by subtracting the final measurement from the initial measurement.

b. Determine the average rut depth for each specimen.

c. The rut depth for the mixture is the average of the specimen rut depths as determined above in 2.b.

G. Report:

The test report shall include at least the following information:

a. The project name, location, date of sampling and date of testing.

b. The mixture type and description (or mix I.D. no.).

c. The specimen type and method of compaction.

d. The asphaltic cement binder performance grade, percentage in sample and source.

e. The aggregate source and location.

f. The average air void content of the test specimens.

g. The test temperature.

h. The maximum theoretical specific gravity, G_{mm}, of the mixture.

i. The average rut depth to the nearest 0.1 mm.

j. Description of any special conditioning or preparation for the test specimens (or references to a test procedure number).

If the average rut depth of the specimens exceeds 5.0 mm for Superpave or SMA asphalt mixes or 8.0 mm for conventional asphalt mixes, it shall be reported as failing.

APPENDIX D
APA RUT DATA

Table D.1 Summary of University of Minnesota APA Rut Depths (mm)
May 3, 2000 Koch Pavement Solutions

Cycles	KL 52-34 cores 4&1	KL 52-34 cores 9&6	KL 52-34 cores 8&3	NU 58-40 cores 6&2	NU 58-40 cores 5&1	NU 58-40 cores 4&3	NU 52-34 cores 2&1	NU 52-34 cores 5&4	NU 52-34 Cores 6&3	KL 58-40 cores 13&5	KL 58-40 cores 4&2	KL 58-40 cores 11&9
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.00012	0.00005	0.00008	0.00003	0.00000	0.00004	0.00009	0.00010	-0.00002	0.00005	0.00004	-0.00002
2	0.00023	0.00011	0.00015	0.00007	0.00000	0.00008	0.00018	0.00020	-0.00003	0.00009	0.00008	-0.00004
3	-0.01635	-0.01654	-0.01977	-0.00980	-0.00990	-0.00288	-0.01443	-0.01440	-0.00865	-0.00696	-0.00948	-0.00626
4	-0.02893	-0.02919	-0.04300	-0.01867	-0.01880	-0.00564	-0.02675	-0.02670	-0.01756	-0.01302	-0.01804	-0.01058
5	-0.04561	-0.04593	-0.06332	-0.02984	-0.03000	-0.01560	-0.03906	-0.03901	-0.02448	-0.01967	-0.02480	-0.01710
6	-0.05550	-0.05588	-0.08244	-0.03850	-0.03870	-0.02166	-0.04837	-0.04831	-0.03179	-0.02442	-0.03286	-0.02572
7	-0.06528	-0.06573	-0.09907	-0.04497	-0.04520	-0.03072	-0.05858	-0.05851	-0.03851	-0.02958	-0.03882	-0.03144
8	-0.07406	-0.07457	-0.11709	-0.05184	-0.05210	-0.03908	-0.06829	-0.06821	-0.04513	-0.03513	-0.04688	-0.03826
9	-0.08564	-0.08622	-0.13312	-0.06040	-0.06070	-0.04264	-0.07680	-0.07671	-0.05164	-0.04029	-0.05424	-0.04438
10	-0.09323	-0.09387	-0.15024	-0.06767	-0.06800	-0.04770	-0.08682	-0.08671	-0.05946	-0.04434	-0.06100	-0.05090
20	-0.18585	-0.18713	-0.29928	-0.11824	-0.11891	-0.10261	-0.14733	-0.14712	-0.12041	-0.09108	-0.12099	-0.09200
30	-0.26248	-0.26440	-0.43292	-0.14762	-0.14861	-0.14521	-0.19685	-0.19653	-0.16217	-0.12312	-0.15339	-0.12580
40	-0.32541	-0.32797	-0.53386	-0.17929	-0.18061	-0.18592	-0.24897	-0.24854	-0.19683	-0.14636	-0.18779	-0.14779
50	-0.36973	-0.37293	-0.64070	-0.20026	-0.20192	-0.21582	-0.29408	-0.29355	-0.24728	-0.17750	-0.23168	-0.16749
60	-0.41936	-0.42320	-0.74444	-0.21413	-0.21612	-0.24713	-0.32930	-0.32866	-0.28064	-0.19834	-0.26458	-0.17439
70	-0.46628	-0.47077	-0.83509	-0.22570	-0.22802	-0.28283	-0.36471	-0.36397	-0.31370	-0.22538	-0.29907	-0.19299
80	-0.51991	-0.52504	-0.91993	-0.25227	-0.25492	-0.30014	-0.39993	-0.39908	-0.33026	-0.25372	-0.31987	-0.20919
90	-0.56524	-0.57100	-0.99017	-0.27285	-0.27583	-0.30464	-0.42435	-0.42339	-0.32731	-0.28026	-0.33737	-0.22169
100	-0.59646	-0.60287	-1.07161	-0.30232	-0.30563	-0.32255	-0.45696	-0.45590	-0.33947	-0.30100	-0.34986	-0.23488
200	-0.91383	-0.92664	-1.71192	-0.48294	-0.48956	-0.39359	-0.60523	-0.60310	-0.54864	-0.37400	-0.46903	-0.30447
300	-1.12989	-1.14911	-2.17092	-0.57615	-0.58609	-0.47494	-0.76909	-0.76590	-0.62791	-0.49899	-0.53059	-0.35225
400	-1.29885	-1.32448	-2.51543	-0.61937	-0.63262	-0.42248	-0.90706	-0.90281	-0.71998	-0.55809	-0.58185	-0.35134
500	-1.47161	-1.50364	-2.78724	-0.62699	-0.64355	-0.44753	-0.93472	-0.92941	-0.80454	-0.58099	-0.62151	-0.49382
600	-1.56538	-1.60381	-3.02745	-0.77541	-0.79528	-0.44757	-1.01178	-1.00541	-0.87111	-0.59369	-0.67798	-0.53860
700	-1.69694	-1.74178	-3.24325	-0.77552	-0.79871	-0.57722	-1.12935	-1.12191	-1.03308	-0.60428	-0.83564	-0.57139
800	-1.85670	-1.90795	-3.46266	-0.77944	-0.80594	-0.61746	-1.12981	-1.12131	-1.08155	-0.61248	-0.83970	-0.59417
900	-2.00546	-2.06312	-3.66167	-0.79006	-0.81987	-0.64381	-1.17357	-1.16401	-1.10932	-0.69968	-0.84796	-0.59705
1000	-2.14953	-2.21359	-3.84218	-0.83288	-0.86600	-0.66735	-1.26874	-1.25811	-1.14719	-0.73388	-0.87023	-0.62774
1500	-2.82064	-2.91673	-4.50451	-0.90906	-0.95875	-0.70848	-1.49276	-1.47682	-1.46113	-0.77726	-0.91734	-0.76366
2000	-3.37605	-3.50418	-5.01285	-0.93745	-1.00370	-0.73920	-1.76538	-1.74413	-1.57188	-0.78145	-0.91135	-0.81318
2500	-3.84586	-4.00602	-5.34929	-1.01924	-1.10205	-0.75283	-1.94399	-1.91743	-1.81412	-0.77414	-0.93756	-0.81239
3000	-4.24768	-4.43986	-5.69313	-1.03103	-1.13040	-0.72885	-2.18281	-2.15094	-1.91826	-0.77383	-0.97608	-0.85931
3500	-4.53449	-4.75871	-5.97486	-1.05461	-1.17055	-0.87998	-2.44673	-2.40954	-2.25971	-0.76721	-0.93619	-0.90083
4000	-4.78240	-5.03865	-6.20980	-1.03910	-1.17160	-0.87530	-2.61275	-2.57025	-2.37015	-0.78660	-0.97170	-0.92285
4500	-4.94141	-5.22969	-6.51634	-1.04549	-1.19455	-0.87532	-2.78807	-2.74026	-2.55289	-0.74679	-0.98261	-0.93187
5000	-5.17513	-5.49544	-6.73788	-1.04918	-1.21480	-0.90295	-2.96199	-2.90886	-2.76324	-0.77768	-0.92673	-0.95789
5500	-5.21414	-5.56648	-6.95531	-1.04806	-1.23025	-0.89288	-3.11891	-3.06047	-2.91248	-0.74296	-0.92104	-0.99481
6000	-5.34255	-5.72693	-7.19685	-1.02155	-1.22030	-0.87730	-3.25093	-3.18718	-3.06423	-0.73665	-0.93935	-1.14033
6500	-5.43776	-5.85417	-7.34099	-1.00314	-1.21845	-0.87362	-3.32174	-3.25268	-3.30007	-0.70454	-0.90956	-1.15724
7000	-5.44038	-5.88881	-7.54933	-1.13753	-1.36940	-0.84925	-3.41016	-3.33579	-3.45301	-0.69013	-0.87958	-1.17436
7500	-5.56129	-6.04176	-7.73456	-1.14751	-1.39595	-0.84107	-3.49998	-3.42029	-3.69886	-0.70791	-0.90709	-1.22998
8000	-5.61250	-6.12500	-7.85500	-1.15500	-1.42000	-0.87000	-3.51500	-3.43000	-3.83500	-0.68000	-0.88250	-1.24250

APPENDIX E
IDT CREEP DATA

Table E.1 KL 52-34 Sample Data (0 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
2	76.88	150.4	-0.49
5	76.91	150.3	-2.27
7	76.87	150.4	-0.48
average	76.89	150.4	-1.08

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.2 KL 52-34 Sample Data (-10 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
2	76.88	150.4	-1.50
5	76.91	150.3	-4.92
7			
average	76.90	150.4	-3.21

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.3 KL 52-34 Sample Data (-20 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
2	76.88	150.4	-4.51
5	76.91	150.3	-7.44
7	76.87	150.4	-8.21
average	76.89	150.4	-6.72

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.4 KL 52-34 Test Data (0 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																	
	KL 52-34 Sample #2				KL 52-34 Sample #5				KL 52-34 Sample #7				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0.000
1	1.2	-5.9	0.0	3.2	-1.9	-1.1	0.5	0.8	-1.7	-0.6	0.6	0.7	-1.3	0.5	-0.42	-1.86	283	0.120
2	1.0	-8.4	0.1	4.1	-2.3	-1.3	0.6	1.0	-2.1	-0.9	0.8	0.9	-1.7	0.7	-0.43	-1.81	364	0.137
3	1.3	-9.3	0.2	4.9	-2.6	-1.5	0.7	1.2	-2.6	-1.1	0.9	0.9	-1.9	0.8	-0.40	-1.91	419	0.106
4	1.2	-10.3	0.3	5.7	-2.9	-1.7	0.8	1.3	-2.4	-0.9	0.9	1.1	-2.0	0.9	-0.45	-1.74	438	0.162
5	1.5	-11.5	0.3	6.3	-3.1	-1.9	0.8	1.4	-2.7	-1.1	1.1	1.2	-2.2	1.0	-0.45	-1.73	485	0.163
6	1.3	-12.4	0.4	6.8	-3.3	-2.1	0.9	1.5	-3.2	-1.5	1.0	1.2	-2.5	1.0	-0.41	-1.88	547	0.116
7	1.5	-13.4	0.5	7.3	-3.5	-2.2	0.9	1.6	-3.2	-1.2	1.1	1.3	-2.5	1.1	-0.45	-1.75	556	0.155
8	1.5	-14.3	0.6	7.8	-3.6	-2.3	1.0	1.7	-3.2	-1.2	1.2	1.4	-2.6	1.2	-0.47	-1.70	576	0.177
9	1.5	-15.2	0.6	8.2	-3.8	-2.5	1.0	1.7	-3.6	-1.4	1.3	1.4	-2.8	1.3	-0.44	-1.76	620	0.152
10	1.6	-15.9	0.7	8.6	-4.0	-2.6	1.0	1.8	-3.5	-1.4	1.3	1.5	-2.9	1.3	-0.47	-1.69	633	0.178
11	1.6	-16.5	0.7	9.1	-4.1	-2.7	1.1	1.9	-3.8	-1.5	1.3	1.6	-3.0	1.4	-0.46	-1.71	670	0.171
12	1.5	-17.1	0.8	9.6	-4.2	-2.8	1.1	2.0	-3.8	-1.5	1.4	1.6	-3.1	1.4	-0.47	-1.69	684	0.179
13	1.8	-17.8	0.9	9.9	-4.3	-2.8	1.2	2.1	-3.9	-1.7	1.5	1.7	-3.2	1.5	-0.47	-1.67	713	0.186
14	1.6	-18.5	0.9	10.3	-4.4	-2.9	1.2	2.1	-4.4	-1.7	1.5	1.7	-3.4	1.6	-0.47	-1.69	748	0.180
15	1.5	-19.1	0.9	10.7	-4.6	-3.0	1.2	2.2	-4.2	-1.7	1.5	1.8	-3.4	1.6	-0.48	-1.66	752	0.194
16	1.8	-19.7	1.0	11.0	-4.7	-3.1	1.3	2.3	-4.4	-2.0	1.6	1.9	-3.5	1.7	-0.48	-1.66	788	0.193
17	1.8	-20.3	1.1	11.4	-4.8	-3.1	1.3	2.3	-4.6	-1.7	1.6	1.9	-3.5	1.7	-0.49	-1.62	792	0.210
18	1.6	-21.0	1.1	11.8	-4.9	-3.2	1.3	2.4	-4.7	-2.1	1.7	1.9	-3.7	1.8	-0.47	-1.68	830	0.185
19	1.8	-21.5	1.2	12.2	-4.9	-3.3	1.3	2.5	-4.7	-2.0	1.7	1.9	-3.7	1.8	-0.49	-1.63	836	0.208
20	1.8	-21.9	1.3	12.4	-5.0	-3.3	1.4	2.5	-5.0	-2.1	1.7	2.1	-3.8	1.9	-0.50	-1.61	864	0.214
21	1.9	-22.2	1.3	12.8	-5.1	-3.4	1.4	2.6	-5.3	-2.4	1.8	2.0	-4.1	1.9	-0.47	-1.67	903	0.186
22	1.8	-23.1	1.4	13.0	-5.1	-3.5	1.4	2.7	-5.5	-2.6	1.7	2.1	-4.2	2.0	-0.48	-1.67	926	0.189
23	1.8	-23.5	1.4	13.4	-5.2	-3.5	1.4	2.7	-5.8	-2.6	1.8	2.1	-4.3	2.0	-0.47	-1.69	947	0.181
24	1.8	-24.0	1.5	13.8	-5.3	-3.6	1.5	2.8	-5.8	-2.6	1.8	2.2	-4.3	2.1	-0.48	-1.65	963	0.195
25	1.6	-24.4	1.5	14.1	-5.4	-3.7	1.5	2.8	-5.9	-2.9	1.8	2.4	-4.5	2.1	-0.48	-1.65	997	0.195
26	2.1	-25.0	1.6	14.3	-5.4	-3.6	1.5	2.9	-6.1	-2.9	1.9	2.2	-4.5	2.1	-0.48	-1.66	1000	0.194
27	1.8	-25.3	1.6	14.6	-5.5	-3.8	1.5	3.0	-6.2	-2.7	1.9	2.2	-4.5	2.2	-0.48	-1.66	1015	0.193
28	1.8	-25.9	1.7	14.9	-5.5	-3.8	1.6	3.0	-6.1	-2.9	1.9	2.3	-4.6	2.2	-0.49	-1.64	1026	0.204
29	1.9	-26.3	1.7	15.2	-5.6	-3.8	1.6	3.1	-6.4	-3.0	1.9	2.4	-4.7	2.3	-0.49	-1.64	1053	0.203
30	2.2	-26.9	1.8	15.6	-5.7	-3.9	1.6	3.1	-6.4	-3.2	1.9	2.4	-4.8	2.3	-0.48	-1.65	1072	0.196
31	1.9	-27.2	1.8	15.8	-5.8	-4.0	1.6	3.2	-6.7	-3.5	2.0	2.2	-5.0	2.3	-0.47	-1.70	1103	0.176
32	2.1	-27.8	1.9	16.0	-5.8	-4.0	1.6	3.3	-6.5	-3.2	2.1	2.5	-4.9	2.4	-0.50	-1.61	1098	0.215
33	2.2	-28.1	1.9	16.3	-5.9	-4.1	1.7	3.3	-6.7	-3.0	2.1	2.6	-4.9	2.5	-0.50	-1.59	1112	0.224

Table E.4 KL 52-34 Test Data (0 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays												Trimmed				Creep	Pois.
	KL 52-34 Sample #2				KL 52-34 Sample #5				KL 52-34 Sample #7				Mean		Ratio		Comp	Ratio
Time	vert front	vert back	horz front	horz back	vert front	vert back	horz front	horz back	vert front	vert back	horz front	horz back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm			1/kPa	
34	2.1	-28.7	1.9	16.6	-5.9	-4.1	1.7	3.4	-6.7	-3.3	2.1	2.6	-5.0	2.5	-0.50	-1.60	1130	0.222
35	2.1	-29.0	2.0	16.8	-6.0	-4.2	1.7	3.4	-6.8	-3.2	2.2	2.6	-5.0	2.6	-0.51	-1.59	1138	0.228
36	2.2	-29.6	2.1	17.1	-6.0	-4.2	1.7	3.5	-6.8	-3.2	2.2	2.8	-5.1	2.6	-0.52	-1.55	1150	0.246
37	1.9	-30.3	2.1	17.4	-6.1	-4.2	1.7	3.5	-6.7	-3.0	2.2	2.7	-5.0	2.6	-0.53	-1.54	1142	0.253
38	1.9	-30.5	2.2	17.7	-6.2	-4.3	1.8	3.6	-6.8	-3.2	2.3	2.8	-5.1	2.7	-0.52	-1.54	1168	0.251
39	2.1	-30.8	2.2	17.9	-6.2	-4.4	1.8	3.6	-6.7	-2.9	2.4	2.9	-5.0	2.8	-0.55	-1.49	1159	0.285
40	1.9	-31.2	2.3	18.1	-6.3	-4.4	1.8	3.7	-7.0	-3.0	2.4	2.8	-5.2	2.8	-0.54	-1.52	1185	0.268
41	1.9	-31.5	2.4	18.4	-6.3	-4.5	1.8	3.7	-6.8	-2.9	2.4	3.0	-5.1	2.9	-0.56	-1.47	1182	0.301
42	1.9	-31.9	2.4	18.6	-6.4	-4.5	1.8	3.7	-6.8	-2.9	2.4	3.0	-5.2	2.9	-0.56	-1.47	1190	0.296
43	1.9	-32.5	2.4	18.9	-6.4	-4.6	1.8	3.8	-6.8	-3.0	2.4	3.1	-5.2	2.9	-0.56	-1.46	1206	0.302
44	1.9	-32.8	2.5	19.2	-6.6	-4.7	1.9	3.8	-7.0	-2.4	2.5	3.1	-5.2	3.0	-0.58	-1.43	1202	0.331
45	2.1	-33.3	2.5	19.4	-6.6	-4.7	1.9	3.9	-6.8	-2.7	2.5	3.2	-5.2	3.0	-0.58	-1.42	1213	0.337
46	1.9	-33.7	2.5	19.6	-6.7	-4.7	1.9	3.9	-6.7	-2.6	2.6	3.3	-5.2	3.1	-0.60	-1.39	1212	0.359
47	1.9	-34.0	2.6	19.9	-6.7	-4.8	1.9	4.0	-6.7	-2.6	2.6	3.2	-5.2	3.1	-0.59	-1.41	1217	0.347
48	2.1	-34.4	2.6	20.1	-6.7	-4.9	1.9	4.0	-6.8	-2.6	2.6	3.3	-5.3	3.2	-0.60	-1.39	1236	0.359
49	2.1	-34.7	2.7	20.3	-6.9	-5.0	1.9	4.1	-6.8	-2.4	2.7	3.5	-5.3	3.2	-0.62	-1.37	1244	0.383
50	2.1	-35.0	2.7	20.6	-6.9	-5.0	2.0	4.1	-6.5	-2.3	2.8	3.5	-5.2	3.3	-0.63	-1.34	1234	0.408
51	2.1	-35.6	2.8	20.9	-7.0	-5.1	2.0	4.1	-6.5	-2.3	2.8	3.8	-5.2	3.4	-0.65	-1.32	1248	0.431
52	2.1	-36.2	2.8	21.0	-7.1	-5.1	2.0	4.2	-6.5	-2.1	2.8	3.7	-5.2	3.4	-0.65	-1.31	1244	0.435
53	1.9	-36.0	2.9	21.2	-7.1	-5.2	2.0	4.2	-6.4	-1.8	2.9	3.8	-5.1	3.4	-0.67	-1.28	1237	0.478
54	1.8	-37.1	2.9	21.5	-7.1	-5.2	2.0	4.3	-6.7	-2.1	2.8	3.8	-5.3	3.4	-0.65	-1.31	1267	0.441
55	2.1	-37.1	3.0	21.7	-7.3	-5.3	2.0	4.3	-6.4	-2.1	2.8	3.9	-5.3	3.5	-0.66	-1.29	1270	0.463
56	1.8	-37.7	3.0	22.0	-7.3	-5.4	2.0	4.3	-6.7	-2.0	2.9	3.8	-5.3	3.5	-0.66	-1.30	1280	0.451
57	1.9	-38.0	3.0	22.2	-7.4	-5.4	2.1	4.4	-6.7	-2.1	2.9	3.9	-5.4	3.6	-0.66	-1.30	1296	0.455
58	1.8	-38.5	3.1	22.4	-7.4	-5.5	2.1	4.4	-6.7	-2.3	3.0	3.9	-5.5	3.6	-0.66	-1.30	1312	0.453
59	1.8	-39.0	3.1	22.7	-7.6	-5.6	2.1	4.4	-6.8	-2.1	3.0	4.0	-5.5	3.6	-0.66	-1.30	1326	0.448
60	1.6	-39.3	3.2	22.9	-7.6	-5.6	2.1	4.5	-6.8	-2.1	2.9	3.9	-5.5	3.6	-0.66	-1.30	1328	0.450
61	1.3	-40.2	3.2	23.0	-7.7	-5.7	2.1	4.5	-7.0	-2.3	3.0	4.0	-5.7	3.7	-0.65	-1.31	1352	0.436
62	1.9	-39.9	3.3	23.4	-7.7	-5.7	2.1	4.6	-7.0	-2.1	3.0	4.1	-5.6	3.7	-0.66	-1.29	1355	0.462
63	1.6	-40.2	3.3	23.6	-7.8	-5.8	2.1	4.6	-7.3	-2.4	3.0	4.1	-5.8	3.8	-0.65	-1.32	1393	0.433
64	1.6	-40.5	3.4	23.8	-7.8	-5.8	2.2	4.6	-7.1	-2.4	3.1	4.0	-5.8	3.8	-0.65	-1.31	1385	0.443
65	1.6	-41.2	3.4	24.0	-8.0	-5.9	2.2	4.7	-7.1	-2.4	3.1	4.2	-5.9	3.8	-0.65	-1.30	1405	0.445
66	1.8	-41.1	3.5	24.2	-8.0	-6.0	2.2	4.7	-7.1	-2.6	3.1	4.2	-5.9	3.9	-0.65	-1.31	1422	0.444

Table E.4 KL 52-34 Test Data (0 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	KL 52-34 Sample #2				KL 52-34 Sample #5				KL 52-34 Sample #7				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
67	1.2	-42.1	3.4	24.3	-8.0	-6.0	2.2	4.7	-7.6	-2.6	3.1	4.1	-6.0	3.9	-0.64	-1.33	1439	0.421
68	1.8	-42.1	3.5	24.7	-8.1	-6.1	2.2	4.8	-7.4	-2.6	3.1	4.3	-6.0	4.0	-0.65	-1.30	1448	0.446
69	1.6	-42.4	3.6	24.8	-8.1	-6.1	2.2	4.8	-7.4	-2.6	3.2	4.3	-6.0	4.0	-0.66	-1.30	1449	0.450
70	1.8	-43.0	3.6	25.1	-8.1	-6.2	2.2	4.8	-7.9	-2.9	3.2	4.2	-6.3	4.0	-0.63	-1.34	1492	0.410
71	1.0	-43.7	3.6	25.2	-8.2	-6.3	2.2	4.9	-7.7	-2.7	3.2	4.4	-6.2	4.0	-0.64	-1.32	1490	0.426
72	1.6	-43.6	3.7	25.4	-8.2	-6.2	2.2	4.9	-7.9	-2.6	3.2	4.4	-6.2	4.1	-0.65	-1.31	1494	0.444
73	1.5	-44.0	3.7	25.6	-8.3	-6.3	2.3	5.0	-7.9	-2.9	3.2	4.4	-6.4	4.1	-0.64	-1.32	1515	0.425
74	1.6	-44.3	3.7	25.9	-8.4	-6.4	2.3	5.0	-8.0	-2.9	3.3	4.4	-6.4	4.1	-0.64	-1.32	1529	0.424
75	1.3	-44.4	3.8	26.0	-8.4	-6.4	2.3	5.0	-8.5	-3.0	3.3	4.4	-6.6	4.1	-0.63	-1.34	1561	0.406
76	1.5	-44.9	3.8	26.2	-8.5	-6.4	2.3	5.1	-8.2	-3.2	3.4	4.6	-6.6	4.2	-0.64	-1.32	1565	0.423
77	0.9	-45.9	3.8	26.3	-8.5	-6.5	2.3	5.1	-8.3	-3.0	3.4	4.5	-6.6	4.2	-0.64	-1.33	1566	0.421
78	1.5	-45.6	3.9	26.7	-8.5	-6.5	2.3	5.2	-8.8	-3.6	3.3	4.4	-6.9	4.2	-0.61	-1.37	1619	0.374
79	1.3	-46.1	3.9	26.8	-8.5	-6.6	2.3	5.2	-8.3	-3.3	3.4	4.6	-6.7	4.3	-0.64	-1.33	1594	0.422
80	1.3	-46.3	4.0	27.0	-8.6	-6.6	2.4	5.2	-8.5	-3.2	3.4	4.6	-6.7	4.3	-0.64	-1.32	1600	0.427
81	1.2	-46.8	4.0	27.2	-8.7	-6.6	2.4	5.3	-8.5	-3.3	3.5	4.6	-6.8	4.3	-0.64	-1.33	1616	0.419
82	1.0	-47.1	4.0	27.4	-8.7	-6.7	2.4	5.3	-9.0	-3.5	3.5	4.7	-7.0	4.4	-0.63	-1.34	1650	0.405
83	1.2	-47.5	4.0	27.5	-8.8	-6.7	2.4	5.3	-9.0	-3.3	3.4	4.6	-6.9	4.4	-0.63	-1.34	1644	0.403
84	0.9	-48.1	4.0	27.7	-8.8	-6.7	2.4	5.4	-8.7	-3.3	3.5	4.7	-6.9	4.4	-0.64	-1.32	1638	0.424
85	0.9	-48.1	4.1	27.9	-8.8	-6.8	2.4	5.4	-9.0	-3.2	3.5	4.6	-6.9	4.4	-0.63	-1.33	1646	0.413
86	0.9	-48.7	4.2	28.0	-8.8	-6.8	2.4	5.5	-9.0	-3.5	3.5	4.7	-7.0	4.4	-0.63	-1.33	1667	0.414
87	0.9	-48.8	4.2	28.2	-8.9	-6.8	2.4	5.5	-9.1	-3.5	3.5	4.7	-7.1	4.5	-0.64	-1.33	1682	0.415
88	0.9	-49.1	4.3	28.4	-9.0	-6.8	2.5	5.5	-9.1	-3.6	3.6	4.6	-7.1	4.5	-0.63	-1.34	1696	0.407
89	0.9	-49.7	4.3	28.7	-9.0	-6.9	2.5	5.6	-9.1	-3.6	3.5	4.7	-7.1	4.5	-0.64	-1.33	1701	0.416
90	0.9	-49.9	4.3	28.8	-9.0	-6.9	2.5	5.6	-9.4	-3.6	3.6	4.7	-7.2	4.6	-0.63	-1.34	1721	0.407
91	0.7	-50.2	4.4	29.0	-9.0	-7.0	2.5	5.6	-9.3	-3.5	3.6	5.0	-7.2	4.6	-0.65	-1.32	1718	0.433
92	0.6	-50.8	4.4	29.2	-9.0	-7.0	2.5	5.7	-9.3	-3.5	3.6	4.9	-7.2	4.7	-0.65	-1.32	1721	0.432
93	0.6	-50.9	4.4	29.3	-9.1	-7.0	2.5	5.7	-9.3	-3.6	3.7	4.9	-7.3	4.7	-0.64	-1.32	1732	0.428
94	0.7	-51.3	4.5	29.5	-9.1	-7.0	2.5	5.8	-9.3	-3.6	3.7	4.9	-7.2	4.7	-0.65	-1.31	1732	0.438
95	0.6	-51.6	4.5	29.8	-9.1	-7.1	2.5	5.8	-9.4	-3.6	3.7	4.9	-7.3	4.7	-0.65	-1.31	1749	0.437
96	0.6	-51.9	4.5	29.9	-9.1	-7.1	2.6	5.8	-9.4	-3.6	3.8	4.9	-7.3	4.8	-0.65	-1.31	1750	0.441
97	0.4	-52.4	4.5	30.1	-9.2	-7.1	2.6	5.9	-9.6	-3.6	3.7	5.2	-7.4	4.8	-0.66	-1.30	1766	0.448
98	0.3	-52.7	4.6	30.2	-9.1	-7.1	2.6	5.9	-9.6	-3.6	3.8	5.1	-7.4	4.8	-0.66	-1.30	1765	0.455
99	0.4	-52.8	4.7	30.4	-9.2	-7.1	2.6	6.0	-9.6	-3.3	3.8	5.2	-7.3	4.9	-0.67	-1.27	1761	0.481
100	0.3	-53.1	4.7	30.5	-9.2	-7.1	2.6	6.0	-9.6	-3.5	3.9	5.2	-7.4	4.9	-0.67	-1.28	1774	0.475

Table E.5 KL 52-34 Test Data (-10 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																	
	KL 52-34 Sample #2				KL 52-34 Sample #5				KL 52-34 Sample #7				Trimmed Mean				Creep Comp	Pois. Ratio
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz			Ratio			
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A	N/A	N/A	0.0	0.0	0.00	0.00	0	0.000
1	1.4	-7.6	-0.1	3.4	-1.7	-1.5	0.4	1.0	N/A	N/A	N/A	N/A	-1.6	0.4	-0.28	-2.64	110	0.000
2	1.6	-8.8	0.0	4.2	-1.9	-1.7	0.5	1.1	N/A	N/A	N/A	N/A	-1.8	0.5	-0.30	-2.48	127	0.012
3	1.6	-9.9	0.0	4.7	-2.1	-1.9	0.5	1.2	N/A	N/A	N/A	N/A	-2.0	0.6	-0.29	-2.51	138	0.009
4	1.6	-10.6	-0.1	5.1	-2.1	-2.0	0.6	1.3	N/A	N/A	N/A	N/A	-2.0	0.6	-0.30	-2.44	141	0.016
5	1.7	-11.4	0.0	5.6	-2.1	-2.0	0.6	1.3	N/A	N/A	N/A	N/A	-2.1	0.7	-0.33	-2.24	147	0.041
6	1.9	-11.9	0.0	5.9	-2.2	-2.1	0.6	1.4	N/A	N/A	N/A	N/A	-2.1	0.7	-0.33	-2.28	151	0.036
7	1.9	-12.5	0.0	6.2	-2.3	-2.2	0.6	1.4	N/A	N/A	N/A	N/A	-2.2	0.7	-0.33	-2.25	158	0.040
8	2.0	-13.1	0.1	6.5	-2.5	-2.4	0.7	1.5	N/A	N/A	N/A	N/A	-2.4	0.8	-0.31	-2.38	170	0.023
9	2.2	-13.5	0.1	6.8	-2.5	-2.4	0.7	1.5	N/A	N/A	N/A	N/A	-2.5	0.8	-0.33	-2.28	173	0.037
10	2.2	-14.0	0.1	6.9	-2.4	-2.4	0.7	1.5	N/A	N/A	N/A	N/A	-2.4	0.8	-0.35	-2.16	168	0.054
11	2.0	-14.4	0.0	7.2	-2.4	-2.3	0.7	1.6	N/A	N/A	N/A	N/A	-2.3	0.8	-0.35	-2.17	167	0.053
12	2.2	-14.7	0.1	7.4	-2.5	-2.4	0.7	1.6	N/A	N/A	N/A	N/A	-2.4	0.9	-0.36	-2.08	173	0.068
13	2.0	-15.2	0.2	7.6	-2.5	-2.4	0.7	1.7	N/A	N/A	N/A	N/A	-2.5	0.9	-0.37	-2.06	178	0.072
14	2.0	-15.4	0.1	7.8	-2.5	-2.3	0.7	1.7	N/A	N/A	N/A	N/A	-2.4	0.9	-0.37	-2.05	175	0.075
15	2.0	-15.8	0.2	8.0	-2.5	-2.5	0.8	1.7	N/A	N/A	N/A	N/A	-2.5	0.9	-0.38	-2.02	180	0.080
16	2.2	-16.0	0.3	8.2	-2.5	-2.5	0.8	1.8	N/A	N/A	N/A	N/A	-2.5	1.0	-0.40	-1.91	182	0.108
17	2.4	-16.4	0.3	8.5	-2.6	-2.5	0.8	1.8	N/A	N/A	N/A	N/A	-2.5	1.0	-0.40	-1.90	184	0.109
18	2.4	-16.4	0.3	8.7	-2.6	-2.5	0.8	1.8	N/A	N/A	N/A	N/A	-2.6	1.0	-0.40	-1.92	188	0.104
19	2.7	-16.5	0.3	8.9	-2.5	-2.5	0.8	1.9	N/A	N/A	N/A	N/A	-2.5	1.1	-0.44	-1.79	186	0.142
20	2.6	-16.8	0.3	9.2	-2.6	-2.6	0.8	1.9	N/A	N/A	N/A	N/A	-2.6	1.1	-0.43	-1.82	191	0.134
21	2.7	-17.0	0.4	9.3	-2.7	-2.6	0.8	1.9	N/A	N/A	N/A	N/A	-2.6	1.1	-0.43	-1.81	196	0.137
22	2.7	-17.3	0.4	9.4	-2.6	-2.6	0.8	1.9	N/A	N/A	N/A	N/A	-2.6	1.2	-0.44	-1.77	195	0.149
23	2.9	-17.1	0.4	9.7	-2.6	-2.6	0.9	1.9	N/A	N/A	N/A	N/A	-2.6	1.2	-0.45	-1.76	195	0.154
24	3.3	-17.6	0.4	9.8	-2.6	-2.6	0.9	2.0	N/A	N/A	N/A	N/A	-2.6	1.2	-0.46	-1.72	196	0.167
25	3.2	-17.8	0.4	10.0	-2.7	-2.6	0.9	2.0	N/A	N/A	N/A	N/A	-2.6	1.2	-0.45	-1.73	198	0.163
26	3.5	-17.8	0.5	10.1	-2.7	-2.8	0.9	2.0	N/A	N/A	N/A	N/A	-2.7	1.2	-0.45	-1.74	204	0.162
27	3.3	-18.1	0.5	10.3	-2.6	-2.7	0.9	2.0	N/A	N/A	N/A	N/A	-2.7	1.3	-0.48	-1.66	201	0.191
28	3.5	-18.1	0.5	10.4	-2.7	-2.7	0.9	2.1	N/A	N/A	N/A	N/A	-2.7	1.3	-0.49	-1.63	202	0.204
29	3.6	-18.6	0.6	10.6	-2.7	-2.7	0.9	2.1	N/A	N/A	N/A	N/A	-2.7	1.3	-0.49	-1.62	204	0.210
30	3.5	-18.7	0.6	10.8	-2.7	-2.7	0.9	2.1	N/A	N/A	N/A	N/A	-2.7	1.3	-0.50	-1.61	205	0.218
31	3.6	-18.8	0.6	11.0	-2.7	-2.7	0.9	2.1	N/A	N/A	N/A	N/A	-2.7	1.4	-0.51	-1.59	205	0.228
32	3.9	-18.8	0.6	11.0	-2.7	-2.7	0.9	2.1	N/A	N/A	N/A	N/A	-2.7	1.4	-0.50	-1.59	207	0.225
33	3.7	-19.3	0.6	11.2	-2.7	-2.8	1.0	2.2	N/A	N/A	N/A	N/A	-2.7	1.4	-0.52	-1.57	208	0.239

Table E.5 KL 52-34 Test Data (-10 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	KL 52-34 Sample #2				KL 52-34 Sample #5				KL 52-34 Sample #7				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
34	3.6	-19.6	0.7	11.4	-2.7	-2.8	1.0	2.2	N/A	N/A	N/A	N/A	-2.7	1.4	-0.52	-1.55	210	0.247
35	3.6	-19.6	0.7	11.5	-2.7	-2.8	1.0	2.2	N/A	N/A	N/A	N/A	-2.7	1.5	-0.54	-1.51	210	0.270
36	3.7	-19.7	0.7	11.6	-2.7	-2.8	1.0	2.2	N/A	N/A	N/A	N/A	-2.7	1.5	-0.54	-1.51	212	0.274
37	3.6	-20.0	0.8	11.8	-2.8	-2.8	1.0	2.3	N/A	N/A	N/A	N/A	-2.8	1.5	-0.54	-1.50	215	0.279
38	3.6	-20.4	0.7	11.9	-2.7	-2.8	1.0	2.3	N/A	N/A	N/A	N/A	-2.7	1.5	-0.56	-1.48	211	0.293
39	3.6	-20.6	0.8	12.0	-2.7	-2.8	1.0	2.3	N/A	N/A	N/A	N/A	-2.8	1.5	-0.55	-1.48	214	0.291
40	3.6	-20.9	0.8	12.1	-2.7	-2.8	1.0	2.3	N/A	N/A	N/A	N/A	-2.8	1.5	-0.56	-1.47	215	0.297
41	3.6	-21.1	0.8	12.1	-2.7	-2.8	1.0	2.4	N/A	N/A	N/A	N/A	-2.8	1.6	-0.58	-1.43	216	0.324
42	3.6	-21.1	0.8	12.3	-2.7	-2.8	1.0	2.4	N/A	N/A	N/A	N/A	-2.7	1.6	-0.59	-1.42	214	0.339
43	3.5	-21.4	0.8	12.4	-2.8	-2.8	1.0	2.4	N/A	N/A	N/A	N/A	-2.8	1.6	-0.56	-1.46	219	0.307
44	3.5	-21.9	0.8	12.5	-2.8	-2.8	1.0	2.4	N/A	N/A	N/A	N/A	-2.8	1.6	-0.57	-1.45	219	0.310
45	3.3	-22.2	0.8	12.6	-2.8	-2.9	1.1	2.4	N/A	N/A	N/A	N/A	-2.9	1.6	-0.57	-1.45	224	0.309
46	3.5	-22.3	0.8	12.7	-2.8	-2.9	1.1	2.4	N/A	N/A	N/A	N/A	-2.8	1.6	-0.58	-1.43	222	0.327
47	3.3	-22.6	0.8	12.8	-2.7	-2.9	1.1	2.5	N/A	N/A	N/A	N/A	-2.8	1.6	-0.59	-1.41	221	0.340
48	3.2	-22.6	0.8	12.8	-2.8	-2.9	1.1	2.5	N/A	N/A	N/A	N/A	-2.9	1.6	-0.57	-1.45	226	0.315
49	3.2	-23.0	0.9	12.9	-2.8	-2.9	1.1	2.5	N/A	N/A	N/A	N/A	-2.9	1.7	-0.58	-1.43	227	0.330
50	3.2	-23.2	0.9	13.1	-2.8	-3.0	1.1	2.5	N/A	N/A	N/A	N/A	-2.9	1.7	-0.58	-1.43	229	0.331
51	2.9	-23.5	0.9	13.2	-2.8	-3.0	1.1	2.5	N/A	N/A	N/A	N/A	-2.9	1.7	-0.59	-1.40	230	0.349
52	2.7	-23.5	0.9	13.3	-2.8	-3.0	1.1	2.5	N/A	N/A	N/A	N/A	-2.9	1.7	-0.59	-1.40	230	0.352
53	2.7	-23.7	1.0	13.3	-2.8	-2.9	1.1	2.6	N/A	N/A	N/A	N/A	-2.8	1.8	-0.62	-1.36	225	0.391
54	2.9	-23.7	1.0	13.4	-2.9	-3.1	1.1	2.6	N/A	N/A	N/A	N/A	-3.0	1.8	-0.60	-1.40	236	0.356
55	2.7	-24.0	1.0	13.5	-2.9	-3.0	1.1	2.6	N/A	N/A	N/A	N/A	-3.0	1.8	-0.60	-1.39	234	0.361
56	3.0	-24.0	1.0	13.7	-2.8	-3.1	1.1	2.6	N/A	N/A	N/A	N/A	-3.0	1.8	-0.61	-1.38	235	0.371
57	2.7	-24.6	1.1	13.7	-2.8	-3.1	1.1	2.6	N/A	N/A	N/A	N/A	-3.0	1.8	-0.62	-1.36	236	0.391
58	2.7	-24.9	1.0	13.8	-2.9	-3.1	1.1	2.6	N/A	N/A	N/A	N/A	-3.0	1.8	-0.61	-1.37	237	0.379
59	2.7	-25.0	1.1	13.8	-3.1	-3.2	1.1	2.6	N/A	N/A	N/A	N/A	-3.1	1.8	-0.59	-1.41	245	0.346
60	2.6	-25.2	1.1	14.0	-2.9	-3.1	1.1	2.6	N/A	N/A	N/A	N/A	-3.0	1.9	-0.61	-1.37	241	0.380
61	2.9	-25.2	1.1	14.1	-3.0	-3.2	1.1	2.6	N/A	N/A	N/A	N/A	-3.1	1.9	-0.61	-1.37	244	0.378
62	2.6	-25.5	1.1	14.3	-3.0	-3.1	1.1	2.6	N/A	N/A	N/A	N/A	-3.0	1.9	-0.62	-1.35	243	0.393
63	2.7	-25.8	1.2	14.4	-3.0	-3.1	1.1	2.7	N/A	N/A	N/A	N/A	-3.0	1.9	-0.63	-1.35	244	0.400
64	2.6	-25.6	1.2	14.5	-3.0	-3.1	1.2	2.7	N/A	N/A	N/A	N/A	-3.0	1.9	-0.63	-1.33	242	0.413
65	2.6	-26.0	1.2	14.5	-3.0	-3.2	1.2	2.7	N/A	N/A	N/A	N/A	-3.1	1.9	-0.63	-1.34	246	0.408
66	2.4	-26.2	1.2	14.6	-3.0	-3.2	1.2	2.7	N/A	N/A	N/A	N/A	-3.1	1.9	-0.63	-1.34	247	0.404

Table E.5 KL 52-34 Test Data (-10 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	KL 52-34 Sample #2				KL 52-34 Sample #5				KL 52-34 Sample #7				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
67	2.6	-26.3	1.2	14.8	-3.0	-3.2	1.2	2.7	N/A	N/A	N/A	N/A	-3.1	2.0	-0.64	-1.33	246	0.420
68	2.9	-26.3	1.2	14.8	-3.0	-3.3	1.2	2.7	N/A	N/A	N/A	N/A	-3.2	2.0	-0.63	-1.34	252	0.402
69	2.6	-26.6	1.2	14.9	-3.0	-3.2	1.2	2.7	N/A	N/A	N/A	N/A	-3.1	2.0	-0.63	-1.34	249	0.410
70	2.6	-26.8	1.2	14.9	-3.0	-3.3	1.2	2.7	N/A	N/A	N/A	N/A	-3.2	2.0	-0.63	-1.34	252	0.403
71	2.7	-26.8	1.3	15.0	-3.1	-3.3	1.2	2.8	N/A	N/A	N/A	N/A	-3.2	2.0	-0.63	-1.34	255	0.411
72	2.9	-26.9	1.3	15.1	-3.0	-3.3	1.2	2.8	N/A	N/A	N/A	N/A	-3.2	2.0	-0.64	-1.32	254	0.430
73	2.7	-27.0	1.3	15.2	-3.1	-3.3	1.2	2.8	N/A	N/A	N/A	N/A	-3.2	2.0	-0.64	-1.32	256	0.426
74	2.6	-27.0	1.3	15.4	-3.1	-3.3	1.2	2.8	N/A	N/A	N/A	N/A	-3.2	2.0	-0.64	-1.33	257	0.422
75	2.6	-27.5	1.3	15.4	-3.1	-3.3	1.2	2.8	N/A	N/A	N/A	N/A	-3.2	2.1	-0.65	-1.32	258	0.432
76	2.4	-27.5	1.3	15.5	-3.2	-3.3	1.2	2.8	N/A	N/A	N/A	N/A	-3.2	2.1	-0.64	-1.32	261	0.427
77	2.6	-27.6	1.4	15.5	-3.2	-3.5	1.2	2.8	N/A	N/A	N/A	N/A	-3.3	2.1	-0.63	-1.33	265	0.413
78	2.7	-28.1	1.3	15.6	-3.2	-3.4	1.2	2.8	N/A	N/A	N/A	N/A	-3.3	2.1	-0.64	-1.33	262	0.422
79	2.7	-27.9	1.3	15.8	-3.2	-3.4	1.2	2.9	N/A	N/A	N/A	N/A	-3.3	2.1	-0.64	-1.32	263	0.430
80	2.6	-28.2	1.4	15.8	-3.2	-3.4	1.2	2.8	N/A	N/A	N/A	N/A	-3.3	2.1	-0.64	-1.32	266	0.423
81	2.6	-28.3	1.4	15.9	-3.2	-3.4	1.3	2.9	N/A	N/A	N/A	N/A	-3.3	2.1	-0.65	-1.30	264	0.447
82	2.7	-28.5	1.5	15.9	-3.2	-3.5	1.3	2.9	N/A	N/A	N/A	N/A	-3.3	2.2	-0.65	-1.31	270	0.437
83	2.4	-28.3	1.5	16.1	-3.2	-3.4	1.3	2.9	N/A	N/A	N/A	N/A	-3.3	2.2	-0.66	-1.29	268	0.460
84	2.7	-28.8	1.5	16.3	-3.1	-3.3	1.3	2.9	N/A	N/A	N/A	N/A	-3.2	2.2	-0.70	-1.24	261	0.523
85	2.7	-28.9	1.5	16.4	-3.2	-3.4	1.3	2.9	N/A	N/A	N/A	N/A	-3.3	2.2	-0.68	-1.26	267	0.492
86	2.9	-28.8	1.5	16.4	-3.2	-3.5	1.3	2.9	N/A	N/A	N/A	N/A	-3.3	2.2	-0.66	-1.29	272	0.462
87	2.7	-29.3	1.5	16.5	-3.2	-3.5	1.3	3.0	N/A	N/A	N/A	N/A	-3.3	2.2	-0.66	-1.29	272	0.461
88	3.0	-29.2	1.5	16.7	-3.2	-3.5	1.3	3.0	N/A	N/A	N/A	N/A	-3.3	2.3	-0.67	-1.28	273	0.476
89	3.0	-29.1	1.6	16.7	-3.2	-3.5	1.3	3.0	N/A	N/A	N/A	N/A	-3.4	2.3	-0.68	-1.27	275	0.486
90	2.9	-29.3	1.6	16.9	-3.2	-3.5	1.3	3.0	N/A	N/A	N/A	N/A	-3.4	2.3	-0.68	-1.27	276	0.491
91	3.0	-29.2	1.7	16.9	-3.2	-3.5	1.3	3.0	N/A	N/A	N/A	N/A	-3.4	2.3	-0.69	-1.25	277	0.508
92	3.0	-29.2	1.7	17.1	-3.2	-3.5	1.3	3.0	N/A	N/A	N/A	N/A	-3.4	2.4	-0.70	-1.25	279	0.518
93	3.0	-29.6	1.7	17.1	-3.3	-3.5	1.3	3.0	N/A	N/A	N/A	N/A	-3.4	2.4	-0.69	-1.25	280	0.507
94	3.0	-29.6	1.7	17.2	-3.3	-3.6	1.3	3.0	N/A	N/A	N/A	N/A	-3.5	2.4	-0.69	-1.26	283	0.502
95	3.0	-29.6	1.7	17.3	-3.3	-3.5	1.3	3.1	N/A	N/A	N/A	N/A	-3.4	2.4	-0.70	-1.24	281	0.525
96	3.0	-29.9	1.7	17.3	-3.3	-3.5	1.3	3.0	N/A	N/A	N/A	N/A	-3.4	2.4	-0.70	-1.24	281	0.522
97	3.2	-29.9	1.8	17.5	-3.3	-3.6	1.3	3.1	N/A	N/A	N/A	N/A	-3.5	2.4	-0.70	-1.24	285	0.526
98	3.0	-29.9	1.8	17.5	-3.3	-3.6	1.3	3.1	N/A	N/A	N/A	N/A	-3.5	2.4	-0.70	-1.24	286	0.518
99	3.5	-29.9	1.8	17.6	-3.3	-3.6	1.3	3.1	N/A	N/A	N/A	N/A	-3.5	2.5	-0.71	-1.23	286	0.546
100	3.2	-30.2	1.9	17.6	-3.3	-3.6	1.4	3.1	N/A	N/A	N/A	N/A	-3.4	2.5	-0.72	-1.21	285	0.562

Table E.6 KL 52-34 Test Data (-20 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																	
	KL 52-34 Sample #2				KL 52-34 Sample #5				KL 52-34 Sample #7				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0.000
1	1.7	-8.3	0.0	3.4	-2.4	-2.1	0.6	1.3	-2.1	-2.5	0.5	1.1	-2.3	0.9	-0.40	-1.94	79	0.100
2	1.9	-9.0	0.0	3.9	-2.7	-2.4	0.7	1.4	-2.5	-2.8	0.6	1.3	-2.6	1.0	-0.39	-1.96	89	0.094
3	1.9	-9.7	-0.1	4.3	-2.9	-2.6	0.7	1.5	-2.6	-2.9	0.7	1.4	-2.7	1.1	-0.39	-1.95	95	0.097
4	2.0	-10.1	0.0	4.5	-3.1	-3.0	0.7	1.5	-2.8	-3.0	0.7	1.5	-3.0	1.1	-0.37	-2.05	102	0.074
5	2.1	-10.6	0.0	4.7	-3.1	-2.8	0.8	1.6	-2.8	-3.0	0.7	1.5	-2.9	1.1	-0.39	-1.95	101	0.096
6	2.1	-10.9	0.0	4.9	-3.2	-3.0	0.8	1.6	-2.9	-3.1	0.8	1.6	-3.0	1.2	-0.38	-1.98	105	0.089
7	2.3	-11.2	0.0	5.1	-3.3	-3.1	0.8	1.6	-2.9	-3.2	0.8	1.6	-3.1	1.2	-0.38	-2.00	108	0.085
8	2.2	-11.5	-0.1	5.2	-3.3	-3.0	0.8	1.7	-2.9	-3.1	0.8	1.6	-3.1	1.2	-0.40	-1.92	107	0.105
9	2.3	-11.7	0.0	5.3	-3.5	-3.1	0.8	1.7	-3.0	-3.2	0.8	1.6	-3.2	1.2	-0.38	-1.99	111	0.088
10	2.3	-11.8	-0.1	5.5	-3.5	-3.2	0.8	1.7	-3.0	-3.2	0.8	1.7	-3.2	1.3	-0.39	-1.97	112	0.092
11	2.5	-11.9	0.0	5.6	-3.6	-3.2	0.8	1.7	-3.1	-3.4	0.8	1.7	-3.3	1.3	-0.38	-2.01	114	0.084
12	2.4	-12.3	0.0	5.7	-3.6	-3.4	0.8	1.7	-3.0	-3.2	0.9	1.7	-3.3	1.3	-0.38	-1.98	114	0.089
13	2.6	-12.5	0.0	5.8	-3.6	-3.4	0.8	1.7	-3.1	-3.4	0.9	1.7	-3.4	1.3	-0.38	-2.00	117	0.086
14	2.6	-12.6	0.0	6.0	-3.7	-3.5	0.8	1.7	-3.1	-3.4	0.9	1.7	-3.4	1.3	-0.38	-2.02	118	0.080
15	2.5	-12.7	0.0	6.0	-3.7	-3.6	0.9	1.7	-3.1	-3.4	0.9	1.8	-3.4	1.3	-0.38	-1.98	119	0.089
16	2.4	-13.0	0.0	6.1	-3.6	-3.2	0.9	1.8	-3.1	-3.4	0.9	1.8	-3.3	1.3	-0.40	-1.91	117	0.106
17	2.7	-13.0	0.0	6.2	-3.8	-3.6	0.9	1.7	-3.1	-3.5	0.9	1.8	-3.5	1.3	-0.38	-2.00	121	0.086
18	2.7	-13.2	0.0	6.3	-3.8	-3.6	0.9	1.8	-3.2	-3.5	0.9	1.8	-3.5	1.4	-0.39	-1.97	121	0.092
19	2.5	-13.3	0.0	6.4	-3.7	-3.6	0.9	1.8	-3.2	-3.5	0.9	1.8	-3.5	1.4	-0.40	-1.94	121	0.101
20	2.7	-13.5	0.0	6.5	-3.8	-3.6	0.9	1.8	-3.2	-3.5	0.9	1.9	-3.5	1.4	-0.39	-1.94	122	0.098
21	2.6	-13.5	0.0	6.5	-3.8	-3.6	0.9	1.9	-3.2	-3.4	0.9	1.9	-3.5	1.4	-0.41	-1.90	122	0.110
22	2.7	-13.7	0.0	6.6	-3.8	-3.6	0.9	1.9	-3.2	-3.5	0.9	1.9	-3.5	1.4	-0.40	-1.91	123	0.107
23	2.7	-13.7	0.0	6.7	-3.8	-3.6	0.9	1.9	-3.2	-3.5	1.0	1.9	-3.5	1.4	-0.41	-1.87	122	0.117
24	2.7	-14.0	0.0	6.7	-3.8	-3.6	0.9	1.9	-3.3	-3.5	1.0	1.9	-3.6	1.4	-0.41	-1.89	124	0.112
25	2.7	-14.1	0.0	6.8	-3.8	-3.6	1.0	2.0	-3.3	-3.6	1.0	2.0	-3.6	1.5	-0.41	-1.89	125	0.113
26	2.7	-14.1	0.0	6.8	-3.9	-3.8	0.9	1.9	-3.3	-3.6	1.0	2.0	-3.7	1.5	-0.40	-1.93	127	0.102
27	2.8	-14.3	0.0	7.0	-3.8	-3.6	1.0	2.0	-3.3	-3.6	1.0	2.0	-3.6	1.5	-0.42	-1.86	124	0.121
28	2.7	-14.4	0.0	7.0	-3.7	-3.6	1.0	2.0	-3.3	-3.6	1.0	2.0	-3.5	1.5	-0.42	-1.83	125	0.128
29	2.7	-14.5	0.0	7.0	-3.7	-3.6	1.0	2.1	-3.4	-3.6	1.0	2.0	-3.6	1.5	-0.43	-1.82	125	0.133
30	2.8	-14.6	0.0	7.1	-3.6	-3.5	1.0	2.1	-3.3	-3.6	1.0	2.0	-3.5	1.5	-0.43	-1.80	124	0.140
31	2.7	-14.8	0.0	7.2	-3.7	-3.6	1.0	2.1	-3.4	-3.6	1.0	2.0	-3.5	1.5	-0.43	-1.81	125	0.137
32	2.8	-15.0	0.0	7.2	-3.7	-3.5	1.0	2.1	-3.4	-3.6	1.0	2.0	-3.5	1.5	-0.44	-1.79	125	0.144
33	2.7	-14.9	0.1	7.3	-3.7	-3.5	1.0	2.1	-3.4	-3.6	1.1	2.0	-3.6	1.6	-0.44	-1.79	126	0.143

Table E.6 KL 52-34 Test Data (-20 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	KL 52-34 Sample #2				KL 52-34 Sample #5				KL 52-34 Sample #7				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
34	2.7	-14.9	0.1	7.3	-3.6	-3.4	1.0	2.2	-3.4	-3.7	1.1	2.0	-3.5	1.6	-0.45	-1.76	125	0.154
35	2.7	-15.0	0.1	7.4	-3.6	-3.3	1.0	2.2	-3.4	-3.6	1.1	2.1	-3.5	1.6	-0.45	-1.73	124	0.164
36	3.0	-15.0	0.1	7.5	-3.6	-3.5	1.0	2.2	-3.4	-3.6	1.1	2.1	-3.5	1.6	-0.45	-1.74	125	0.162
37	2.8	-15.2	0.1	7.5	-3.6	-3.4	1.1	2.2	-3.4	-3.6	1.1	2.1	-3.5	1.6	-0.46	-1.70	125	0.174
38	2.9	-15.1	0.1	7.6	-3.6	-3.4	1.1	2.3	-3.4	-3.7	1.1	2.1	-3.5	1.6	-0.46	-1.71	126	0.171
39	2.9	-15.2	0.1	7.6	-3.5	-3.5	1.1	2.3	-3.4	-3.7	1.1	2.1	-3.5	1.6	-0.47	-1.69	126	0.178
40	2.9	-15.4	0.1	7.6	-3.6	-3.4	1.1	2.2	-3.5	-3.7	1.1	2.1	-3.5	1.6	-0.46	-1.71	126	0.172
41	3.0	-15.3	0.1	7.7	-3.6	-3.5	1.1	2.2	-3.4	-3.6	1.1	2.1	-3.5	1.6	-0.46	-1.72	126	0.168
42	3.0	-15.4	0.1	7.8	-3.6	-3.5	1.1	2.2	-3.4	-3.6	1.1	2.1	-3.5	1.6	-0.46	-1.71	126	0.171
43	2.9	-15.5	0.1	7.8	-3.6	-3.5	1.1	2.2	-3.5	-3.8	1.1	2.1	-3.6	1.6	-0.46	-1.72	128	0.166
44	2.7	-15.7	0.0	7.8	-3.8	-3.5	1.1	2.2	-3.5	-3.8	1.1	2.1	-3.6	1.6	-0.45	-1.75	129	0.157
45	3.1	-15.6	0.1	7.9	-3.7	-3.6	1.1	2.3	-3.5	-3.7	1.1	2.2	-3.6	1.7	-0.46	-1.72	129	0.168
46	3.2	-15.6	0.1	7.9	-3.8	-3.6	1.1	2.2	-3.4	-3.7	1.1	2.2	-3.6	1.6	-0.45	-1.73	129	0.163
47	3.1	-15.7	0.1	8.0	-3.8	-3.6	1.1	2.3	-3.5	-3.8	1.1	2.2	-3.7	1.7	-0.45	-1.74	131	0.160
48	3.0	-15.8	0.1	8.1	-3.8	-3.6	1.1	2.3	-3.4	-3.7	1.1	2.2	-3.7	1.7	-0.46	-1.71	130	0.170
49	2.9	-16.0	0.1	8.1	-3.8	-3.7	1.1	2.3	-3.5	-3.7	1.1	2.2	-3.7	1.7	-0.46	-1.72	131	0.168
50	3.1	-16.0	0.1	8.2	-3.9	-3.7	1.1	2.3	-3.4	-3.8	1.1	2.2	-3.7	1.7	-0.45	-1.73	131	0.163
51	3.0	-16.0	0.1	8.3	-3.9	-3.8	1.1	2.3	-3.4	-3.7	1.1	2.2	-3.7	1.7	-0.45	-1.74	132	0.161
52	3.0	-16.0	0.1	8.3	-4.1	-3.9	1.1	2.3	-3.4	-3.6	1.2	2.2	-3.7	1.7	-0.45	-1.73	133	0.162
53	2.8	-16.4	0.1	8.3	-4.1	-3.9	1.1	2.3	-3.4	-3.6	1.2	2.2	-3.7	1.7	-0.45	-1.74	133	0.161
54	3.1	-16.3	0.2	8.3	-4.1	-3.9	1.1	2.3	-3.4	-3.7	1.2	2.3	-3.8	1.7	-0.45	-1.74	134	0.160
55	3.1	-16.4	0.1	8.4	-4.2	-4.0	1.1	2.3	-3.4	-3.6	1.2	2.3	-3.8	1.7	-0.44	-1.76	135	0.151
56	3.1	-16.3	0.1	8.4	-4.2	-4.0	1.1	2.3	-3.5	-3.8	1.2	2.3	-3.9	1.7	-0.44	-1.79	138	0.142
57	3.0	-16.5	0.2	8.4	-4.2	-4.1	1.1	2.3	-3.4	-3.6	1.2	2.3	-3.8	1.7	-0.45	-1.73	135	0.162
58	3.0	-16.6	0.1	8.4	-4.3	-4.1	1.1	2.3	-3.4	-3.7	1.2	2.3	-3.9	1.7	-0.45	-1.75	137	0.156
59	3.0	-16.7	0.2	8.5	-4.2	-4.1	1.1	2.3	-3.4	-3.7	1.2	2.3	-3.8	1.7	-0.45	-1.76	136	0.154
60	2.8	-16.9	0.1	8.5	-4.4	-4.2	1.1	2.2	-3.4	-3.7	1.2	2.3	-3.9	1.7	-0.44	-1.78	138	0.147
61	2.9	-17.0	0.1	8.5	-4.4	-4.1	1.1	2.3	-3.4	-3.6	1.2	2.3	-3.9	1.7	-0.45	-1.76	138	0.153
62	2.8	-17.1	0.1	8.5	-4.4	-4.2	1.1	2.3	-3.4	-3.7	1.2	2.3	-3.9	1.7	-0.45	-1.76	138	0.154
63	2.8	-17.3	0.1	8.6	-4.4	-4.2	1.1	2.3	-3.4	-3.6	1.2	2.3	-3.9	1.7	-0.45	-1.74	138	0.159
64	2.7	-17.5	0.1	8.6	-4.3	-4.1	1.1	2.3	-3.4	-3.6	1.2	2.4	-3.9	1.8	-0.46	-1.71	138	0.172
65	2.6	-17.5	0.1	8.6	-4.2	-3.9	1.1	2.4	-3.4	-3.6	1.2	2.4	-3.8	1.8	-0.47	-1.69	136	0.180
66	2.6	-17.7	0.1	8.6	-4.4	-4.2	1.1	2.4	-3.4	-3.6	1.2	2.4	-3.9	1.8	-0.46	-1.71	138	0.170

Table E.6 KL 52-34 Test Data (-20 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	KL 52-34 Sample #2				KL 52-34 Sample #5				KL 52-34 Sample #7				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
67	2.6	-17.7	0.1	8.7	-4.3	-4.1	1.1	2.4	-3.4	-3.6	1.2	2.4	-3.9	1.8	-0.47	-1.69	138	0.180
68	2.5	-17.8	0.1	8.7	-4.4	-4.2	1.2	2.4	-3.4	-3.8	1.2	2.4	-3.9	1.8	-0.46	-1.72	140	0.167
69	2.6	-17.9	0.1	8.7	-4.4	-4.2	1.1	2.4	-3.4	-3.6	1.3	2.4	-3.9	1.8	-0.46	-1.71	139	0.171
70	2.6	-17.9	0.1	8.8	-4.4	-4.2	1.1	2.4	-3.4	-3.6	1.2	2.5	-3.9	1.8	-0.46	-1.70	139	0.175
71	2.6	-17.9	0.1	8.8	-4.4	-4.1	1.1	2.4	-3.4	-3.7	1.3	2.5	-3.9	1.8	-0.47	-1.69	139	0.181
72	2.3	-18.1	0.1	8.8	-4.2	-4.1	1.2	2.4	-3.5	-3.6	1.2	2.4	-3.9	1.8	-0.47	-1.68	139	0.184
73	2.4	-18.1	0.1	8.8	-4.2	-4.1	1.2	2.4	-3.4	-3.7	1.3	2.5	-3.9	1.8	-0.48	-1.66	138	0.191
74	2.5	-18.2	0.1	8.9	-4.2	-4.2	1.2	2.4	-3.4	-3.7	1.3	2.5	-3.9	1.8	-0.47	-1.68	139	0.184
75	2.5	-18.4	0.1	8.9	-4.1	-3.9	1.2	2.5	-3.5	-3.7	1.3	2.4	-3.8	1.8	-0.49	-1.63	137	0.204
76	2.5	-18.2	0.1	9.0	-4.1	-3.9	1.2	2.5	-3.4	-3.6	1.3	2.4	-3.7	1.9	-0.50	-1.61	136	0.213
77	2.6	-18.2	0.1	9.0	-4.1	-3.9	1.2	2.5	-3.4	-3.7	1.3	2.5	-3.8	1.9	-0.50	-1.61	137	0.214
78	2.5	-18.4	0.1	9.1	-3.9	-3.8	1.2	2.6	-3.4	-3.7	1.3	2.5	-3.7	1.9	-0.51	-1.57	135	0.234
79	2.5	-18.5	0.1	9.0	-3.9	-3.8	1.2	2.6	-3.5	-3.7	1.3	2.5	-3.7	1.9	-0.51	-1.58	136	0.229
80	2.6	-18.5	0.1	9.0	-3.9	-3.8	1.2	2.6	-3.4	-3.8	1.3	2.5	-3.7	1.9	-0.51	-1.58	136	0.228
81	2.5	-18.6	0.1	9.1	-3.9	-3.8	1.2	2.6	-3.5	-3.8	1.3	2.5	-3.8	1.9	-0.50	-1.59	136	0.224
82	2.5	-18.6	0.1	9.1	-3.9	-3.8	1.2	2.6	-3.5	-3.7	1.3	2.5	-3.7	1.9	-0.51	-1.57	135	0.237
83	2.4	-18.7	0.1	9.2	-4.1	-3.8	1.2	2.6	-3.5	-3.7	1.3	2.5	-3.8	1.9	-0.50	-1.60	137	0.220
84	2.5	-18.8	0.1	9.2	-3.9	-3.9	1.2	2.6	-3.5	-3.8	1.3	2.5	-3.8	1.9	-0.51	-1.58	137	0.229
85	2.5	-18.8	0.2	9.3	-3.9	-3.8	1.2	2.6	-3.5	-3.8	1.3	2.5	-3.8	1.9	-0.51	-1.59	138	0.226
86	2.6	-18.6	0.2	9.3	-4.1	-3.9	1.2	2.6	-3.5	-3.8	1.3	2.5	-3.8	1.9	-0.50	-1.60	138	0.220
87	2.6	-19.0	0.2	9.3	-4.1	-3.9	1.2	2.6	-3.6	-3.8	1.3	2.5	-3.9	1.9	-0.50	-1.61	140	0.216
88	2.7	-18.8	0.2	9.4	-4.1	-3.9	1.2	2.6	-3.6	-3.9	1.3	2.5	-3.9	1.9	-0.49	-1.62	141	0.212
89	2.7	-18.7	0.2	9.4	-4.1	-3.9	1.2	2.6	-3.5	-3.8	1.3	2.5	-3.8	1.9	-0.50	-1.61	139	0.216
90	2.7	-18.8	0.2	9.5	-4.1	-4.0	1.2	2.6	-3.6	-3.8	1.3	2.5	-3.9	1.9	-0.49	-1.62	141	0.210
91	2.9	-18.7	0.2	9.5	-4.1	-4.1	1.3	2.6	-3.6	-3.8	1.3	2.5	-3.9	1.9	-0.49	-1.62	142	0.211
92	3.0	-18.5	0.2	9.6	-4.3	-4.3	1.2	2.6	-3.7	-3.9	1.3	2.6	-4.0	1.9	-0.47	-1.67	145	0.187
93	3.0	-18.7	0.2	9.7	-4.2	-4.1	1.3	2.6	-3.6	-3.9	1.3	2.6	-4.0	1.9	-0.49	-1.63	143	0.205
94	3.0	-18.8	0.2	9.7	-4.4	-4.1	1.3	2.6	-3.6	-4.0	1.3	2.6	-4.0	1.9	-0.48	-1.65	145	0.196
95	3.1	-19.0	0.2	9.7	-4.4	-4.2	1.2	2.6	-3.7	-4.0	1.3	2.5	-4.1	1.9	-0.47	-1.67	146	0.186
96	3.2	-18.9	0.2	9.7	-4.4	-4.2	1.3	2.6	-3.8	-4.0	1.3	2.5	-4.1	1.9	-0.47	-1.69	147	0.181
97	3.3	-18.8	0.2	9.8	-4.5	-4.4	1.2	2.6	-3.7	-4.0	1.3	2.5	-4.2	1.9	-0.46	-1.72	149	0.169
98	3.1	-19.0	0.2	9.8	-4.6	-4.5	1.2	2.5	-3.8	-4.0	1.3	2.6	-4.2	1.9	-0.45	-1.74	150	0.161
99	3.3	-18.9	0.2	9.8	-4.6	-4.5	1.2	2.5	-3.8	-4.1	1.3	2.5	-4.3	1.9	-0.45	-1.74	151	0.158
100	3.1	-19.0	0.2	9.8	-4.5	-4.4	1.2	2.5	-3.8	-4.1	1.3	2.5	-4.2	1.9	-0.46	-1.72	149	0.167

Table E.7 KL 58-40 Sample Data (0 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
1	76.82	150.1	-3.20
10	76.74	150.2	-2.11
12	76.85	150.0	-2.80
8	76.80	150.0	-3.48
average	76.80	150.1	-2.90

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.8 KL 58-40 Sample Data (-10 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
1	76.82	150.1	-3.66
10	76.74	150.2	-3.59
12	76.85	150.0	-5.14
8	76.80	150.0	-3.24
average	76.80	150.1	-3.91

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.9 KL 58-40 Sample Data (-20 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
1	76.82	150.1	-10.82
10	76.74	150.2	-5.73
12	76.85	150.0	-9.10
8	76.80	150.0	-5.31
average	76.80	150.1	-7.74

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.10 KL 58-40 Test Data (0 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																Trimmed					
	KL 58/40 Sample #1				KL 58/40 Sample #10				KL 58/40 Sample #12				KL 58/40 Sample #8				Mean		Ratio		Creep Comp	Pois. Ratio
Time	vert front	vert back	horz front	horz back	vert front	vert back	horz front	horz back	vert front	vert back	horz front	horz back	vert front	vert back	horz front	horz back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0.000
1	-3.8	-3.0	1.0	1.8	-0.8	-6.0	0.5	3.5	-10.5	-1.9	2.6	1.4	-3.4	-3.6	0.9	2.5	-3.6	2.1	-0.57	-1.46	313	0.308
2	-5.0	-4.0	1.3	2.2	-1.0	-7.2	0.7	4.2	-13.3	-3.0	3.3	1.9	-4.4	-4.8	1.1	3.2	-4.7	2.5	-0.54	-1.52	402	0.268
3	-5.4	-4.1	1.5	2.6	-1.4	-8.0	0.8	4.6	-15.1	-3.9	3.9	2.3	-4.9	-5.3	1.2	3.7	-5.3	2.9	-0.55	-1.48	451	0.288
4	-5.9	-4.6	1.6	2.8	-1.7	-8.9	0.9	5.0	-16.6	-4.7	4.3	2.7	-5.2	-5.8	1.3	4.1	-5.9	3.2	-0.54	-1.50	500	0.277
5	-6.3	-4.9	1.8	3.0	-1.6	-9.1	1.0	5.2	-17.7	-5.1	4.6	3.1	-5.6	-6.4	1.4	4.5	-6.3	3.4	-0.55	-1.50	535	0.281
6	-6.7	-5.2	1.9	3.2	-1.8	-9.6	1.0	5.6	-18.7	-5.8	4.9	3.3	-6.0	-6.8	1.5	4.7	-6.7	3.6	-0.54	-1.50	570	0.277
7	-7.1	-5.7	2.0	3.3	-1.9	-10.1	1.1	5.8	-19.6	-6.2	5.2	3.7	-6.3	-7.1	1.5	5.0	-7.1	3.8	-0.54	-1.52	604	0.266
8	-7.3	-5.7	2.1	3.5	-2.1	-10.4	1.2	6.1	-20.5	-6.8	5.4	3.9	-6.7	-7.5	1.6	5.3	-7.4	4.0	-0.54	-1.51	633	0.273
9	-7.5	-5.8	2.2	3.6	-2.2	-10.6	1.2	6.3	-21.3	-7.3	5.7	4.2	-7.0	-7.8	1.7	5.5	-7.7	4.2	-0.54	-1.51	655	0.273
10	-7.8	-6.0	2.3	3.8	-2.3	-10.8	1.3	6.5	-21.9	-7.7	5.9	4.4	-7.1	-8.1	1.8	5.8	-7.9	4.3	-0.55	-1.50	678	0.280
11	-8.2	-6.3	2.3	3.9	-2.5	-11.2	1.4	6.7	-22.6	-8.2	6.1	4.7	-7.4	-8.3	1.8	5.9	-8.3	4.5	-0.54	-1.51	704	0.273
12	-8.5	-6.4	2.4	4.1	-2.5	-11.4	1.4	6.9	-23.3	-8.5	6.3	4.9	-7.6	-8.5	1.8	6.1	-8.5	4.6	-0.54	-1.50	724	0.276
13	-8.6	-6.6	2.5	4.2	-2.5	-11.5	1.5	7.0	-23.8	-8.8	6.5	5.2	-7.8	-8.8	1.9	6.3	-8.7	4.7	-0.55	-1.50	741	0.279
14	-8.9	-6.8	2.6	4.3	-2.5	-11.8	1.5	7.2	-24.4	-9.2	6.6	5.3	-8.0	-9.1	2.0	6.5	-9.0	4.9	-0.54	-1.50	764	0.275
15	-9.1	-6.9	2.6	4.4	-2.6	-12.1	1.6	7.3	-24.9	-9.7	6.8	5.5	-8.2	-9.3	2.0	6.6	-9.2	5.0	-0.54	-1.51	784	0.272
16	-9.3	-7.1	2.7	4.5	-2.7	-12.1	1.6	7.5	-25.5	-10.0	6.9	5.7	-8.3	-9.4	2.1	6.8	-9.4	5.1	-0.54	-1.50	801	0.276
17	-9.4	-7.1	2.8	4.6	-2.8	-12.4	1.7	7.7	-26.0	-10.3	7.1	6.0	-8.5	-9.7	2.1	7.0	-9.6	5.2	-0.54	-1.50	818	0.277
18	-9.7	-7.4	2.8	4.7	-2.9	-12.5	1.7	7.8	-26.5	-10.8	7.2	6.1	-8.7	-10.0	2.1	7.1	-9.8	5.3	-0.54	-1.51	838	0.269
19	-9.8	-7.5	2.9	4.8	-2.9	-12.7	1.8	7.9	-27.0	-11.0	7.4	6.3	-9.0	-10.3	2.2	7.3	-10.1	5.4	-0.54	-1.52	857	0.267
20	-10.0	-7.8	2.9	4.9	-2.9	-12.9	1.8	8.0	-27.4	-11.4	7.5	6.5	-9.0	-10.4	2.2	7.4	-10.3	5.5	-0.54	-1.52	874	0.266
21	-10.3	-7.9	3.0	5.0	-3.0	-13.0	1.8	8.2	-27.8	-11.6	7.6	6.7	-9.2	-10.6	2.3	7.5	-10.4	5.6	-0.54	-1.52	888	0.267
22	-10.3	-8.0	3.0	5.1	-3.2	-13.2	1.9	8.3	-28.3	-11.9	7.7	6.8	-9.4	-10.7	2.3	7.7	-10.6	5.7	-0.54	-1.51	902	0.269
23	-10.5	-8.2	3.1	5.2	-3.3	-13.5	1.9	8.4	-28.7	-12.3	7.9	7.0	-9.7	-10.9	2.4	7.8	-10.8	5.8	-0.53	-1.52	922	0.264
24	-10.7	-8.3	3.2	5.2	-3.4	-13.6	1.9	8.5	-29.1	-12.5	8.0	7.1	-9.7	-11.0	2.4	7.9	-11.0	5.9	-0.54	-1.52	934	0.266
25	-10.8	-8.4	3.2	5.3	-3.6	-13.9	2.0	8.6	-29.4	-12.8	8.1	7.3	-9.9	-11.2	2.4	8.1	-11.2	6.0	-0.53	-1.52	951	0.262
26	-11.0	-8.5	3.3	5.4	-3.6	-13.9	2.0	8.7	-29.8	-13.0	8.2	7.5	-10.1	-11.4	2.5	8.2	-11.3	6.1	-0.54	-1.52	961	0.267
27	-11.1	-8.6	3.3	5.5	-3.6	-14.0	2.1	8.8	-30.2	-13.3	8.3	7.6	-10.2	-11.6	2.5	8.3	-11.5	6.1	-0.53	-1.52	978	0.263
28	-11.3	-8.8	3.3	5.6	-3.9	-14.4	2.1	8.8	-30.5	-13.5	8.5	7.8	-10.3	-11.7	2.5	8.4	-11.7	6.2	-0.53	-1.53	991	0.261
29	-11.6	-8.9	3.4	5.7	-4.1	-14.7	2.1	8.9	-30.9	-13.9	8.6	8.0	-10.4	-11.8	2.6	8.6	-11.9	6.3	-0.53	-1.53	1010	0.257
30	-11.6	-8.9	3.4	5.7	-4.1	-14.8	2.2	9.0	-31.3	-14.2	8.7	8.1	-10.6	-12.0	2.6	8.7	-12.0	6.3	-0.53	-1.54	1020	0.255
31	-11.8	-9.0	3.5	5.8	-4.2	-15.2	2.2	9.1	-31.5	-14.4	8.7	8.2	-10.7	-12.1	2.6	8.8	-12.2	6.4	-0.53	-1.54	1033	0.253
32	-12.0	-9.2	3.5	5.9	-4.4	-15.4	2.2	9.1	-31.9	-14.7	8.8	8.3	-10.8	-12.3	2.7	8.9	-12.4	6.5	-0.52	-1.55	1051	0.248
33	-12.0	-9.3	3.6	5.9	-4.6	-15.5	2.2	9.2	-32.1	-14.8	9.0	8.6	-11.0	-12.5	2.7	9.0	-12.5	6.6	-0.52	-1.55	1061	0.250

Table E.10 KL 58-40 Test Data (0 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																						
	KL 58/40 Sample #1				KL 58/40 Sample #10				KL 58/40 Sample #12				KL 58/40 Sample #8				Trimmed Mean				Creep Comp	Pois. Ratio
Time	vert front	vert back	horz front	horz back	vert front	vert back	horz front	horz back	vert front	vert back	horz front	horz back	vert front	vert back	horz front	horz back	vert	horz	Ratio X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
34	-12.5	-9.9	3.6	5.9	-4.8	-15.8	2.3	9.3	-32.4	-15.1	9.1	8.6	-11.1	-12.6	2.7	9.1	-12.8	6.6	-0.52	-1.57	1082	0.239
35	-12.4	-9.6	3.6	6.0	-4.9	-15.9	2.3	9.4	-32.7	-15.3	9.1	8.8	-11.2	-12.7	2.8	9.2	-12.8	6.7	-0.52	-1.55	1087	0.246
36	-12.5	-9.7	3.7	6.1	-5.2	-15.9	2.3	9.5	-33.0	-15.6	9.2	8.9	-11.3	-12.8	2.8	9.3	-13.0	6.8	-0.52	-1.55	1098	0.247
37	-12.8	-9.9	3.7	6.2	-5.2	-16.3	2.3	9.5	-33.4	-15.8	9.3	9.0	-11.5	-12.9	2.8	9.4	-13.2	6.8	-0.52	-1.56	1114	0.242
38	-12.9	-9.9	3.7	6.2	-5.3	-16.4	2.4	9.6	-33.6	-16.0	9.4	9.2	-11.7	-13.3	2.8	9.4	-13.4	6.9	-0.51	-1.57	1128	0.238
39	-13.1	-10.2	3.8	6.3	-5.4	-16.5	2.4	9.7	-33.9	-16.2	9.5	9.3	-11.7	-13.3	2.9	9.6	-13.5	7.0	-0.52	-1.56	1139	0.240
40	-13.2	-10.3	3.8	6.3	-5.4	-16.5	2.4	9.8	-34.3	-16.4	9.6	9.5	-11.8	-13.4	2.9	9.7	-13.6	7.0	-0.52	-1.56	1149	0.240
41	-13.3	-10.3	3.8	6.4	-5.5	-16.8	2.4	9.8	-34.5	-16.6	9.7	9.6	-11.9	-13.5	2.9	9.7	-13.7	7.1	-0.51	-1.57	1160	0.238
42	-13.4	-10.5	3.9	6.5	-5.6	-17.0	2.5	9.9	-34.8	-16.9	9.8	9.7	-12.0	-13.6	3.0	9.8	-13.9	7.1	-0.51	-1.57	1173	0.236
43	-13.6	-10.6	3.9	6.5	-5.7	-17.1	2.5	10.0	-35.0	-16.9	9.8	9.8	-12.1	-13.7	3.0	10.0	-14.0	7.2	-0.51	-1.57	1182	0.238
44	-13.7	-10.6	4.0	6.6	-5.7	-17.2	2.5	10.1	-35.3	-17.2	9.9	10.0	-12.3	-13.8	3.0	10.0	-14.1	7.3	-0.51	-1.57	1193	0.236
45	-13.9	-10.8	4.0	6.6	-5.8	-17.3	2.6	10.0	-35.5	-17.3	10.0	10.1	-12.5	-14.0	3.0	10.1	-14.3	7.3	-0.51	-1.58	1205	0.233
46	-13.9	-10.9	4.0	6.7	-5.9	-17.4	2.6	10.1	-35.7	-17.8	10.1	10.2	-12.5	-14.0	3.1	10.2	-14.4	7.4	-0.51	-1.58	1216	0.233
47	-14.1	-11.1	4.1	6.7	-5.9	-17.5	2.6	10.2	-35.9	-17.8	10.2	10.3	-12.6	-14.1	3.1	10.3	-14.5	7.4	-0.51	-1.58	1224	0.233
48	-14.2	-11.1	4.1	6.8	-6.0	-17.6	2.6	10.3	-36.2	-18.0	10.2	10.5	-12.7	-14.4	3.2	10.4	-14.7	7.5	-0.51	-1.58	1237	0.233
49	-14.3	-11.3	4.1	6.9	-6.0	-17.6	2.7	10.4	-36.6	-18.4	10.3	10.5	-12.8	-14.4	3.1	10.5	-14.8	7.6	-0.51	-1.58	1247	0.233
50	-14.4	-11.4	4.2	6.9	-5.9	-17.6	2.7	10.5	-36.7	-18.4	10.4	10.7	-12.8	-14.4	3.2	10.6	-14.8	7.6	-0.51	-1.57	1252	0.237
51	-14.6	-11.4	4.2	7.0	-6.0	-17.7	2.7	10.5	-36.8	-18.5	10.4	10.8	-13.1	-14.7	3.2	10.6	-15.0	7.7	-0.51	-1.58	1266	0.231
52	-14.7	-11.6	4.2	7.0	-6.0	-17.6	2.8	10.6	-37.1	-18.8	10.5	10.9	-13.2	-14.7	3.2	10.7	-15.1	7.7	-0.51	-1.58	1273	0.233
53	-14.8	-11.6	4.3	7.1	-5.9	-17.7	2.8	10.8	-37.3	-19.0	10.6	11.0	-13.2	-14.8	3.3	10.8	-15.2	7.8	-0.51	-1.57	1281	0.236
54	-14.8	-11.6	4.3	7.1	-5.9	-17.8	2.8	10.8	-37.5	-19.2	10.7	11.1	-13.5	-15.1	3.3	10.8	-15.3	7.8	-0.51	-1.58	1293	0.233
55	-14.9	-11.7	4.3	7.2	-5.8	-17.8	2.9	10.9	-37.8	-19.3	10.7	11.2	-13.5	-15.0	3.3	11.0	-15.4	7.9	-0.51	-1.57	1297	0.237
56	-15.1	-11.8	4.3	7.2	-5.9	-17.8	2.9	10.9	-38.0	-19.5	10.8	11.4	-13.6	-15.2	3.3	11.0	-15.5	7.9	-0.51	-1.58	1308	0.233
57	-15.2	-12.0	4.4	7.3	-5.9	-17.9	3.0	11.0	-38.3	-19.6	10.9	11.4	-13.6	-15.4	3.4	11.1	-15.6	8.0	-0.51	-1.57	1318	0.234
58	-15.3	-12.0	4.4	7.4	-6.0	-17.9	3.0	11.1	-38.4	-19.9	10.9	11.6	-13.7	-15.5	3.4	11.2	-15.7	8.0	-0.51	-1.57	1324	0.235
59	-15.3	-12.0	4.4	7.4	-6.0	-18.1	3.0	11.2	-38.6	-20.1	11.0	11.6	-13.8	-15.5	3.4	11.3	-15.8	8.1	-0.51	-1.57	1333	0.236
60	-15.3	-12.1	4.5	7.4	-6.0	-18.1	3.0	11.2	-38.7	-20.1	11.1	11.8	-13.9	-15.6	3.4	11.3	-15.9	8.2	-0.51	-1.57	1338	0.237
61	-15.5	-12.2	4.5	7.5	-6.1	-18.3	3.0	11.2	-38.9	-20.3	11.1	11.9	-14.0	-15.7	3.4	11.4	-16.0	8.2	-0.51	-1.57	1350	0.235
62	-15.6	-12.3	4.5	7.5	-6.3	-18.4	3.0	11.3	-39.2	-20.5	11.2	12.0	-14.1	-15.8	3.4	11.4	-16.1	8.2	-0.51	-1.57	1358	0.235
63	-15.7	-12.3	4.6	7.6	-6.5	-18.5	3.1	11.4	-39.4	-20.5	11.3	12.1	-14.2	-16.0	3.5	11.5	-16.2	8.3	-0.51	-1.57	1367	0.235
64	-15.8	-12.4	4.6	7.7	-6.3	-18.5	3.1	11.5	-39.6	-20.8	11.3	12.2	-14.3	-16.0	3.5	11.6	-16.3	8.4	-0.51	-1.57	1374	0.236
65	-15.8	-12.3	4.6	7.7	-6.3	-18.8	3.1	11.6	-39.5	-20.7	11.4	12.3	-14.4	-16.2	3.5	11.7	-16.4	8.4	-0.51	-1.57	1381	0.238
66	-15.8	-12.5	4.7	7.8	-6.5	-18.8	3.2	11.6	-39.9	-21.1	11.4	12.3	-14.4	-16.2	3.6	11.7	-16.5	8.5	-0.51	-1.57	1389	0.237

Table E.10 KL 58-40 Test Data (0 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																					
	KL 58/40 Sample #1				KL 58/40 Sample #10				KL 58/40 Sample #12				KL 58/40 Sample #8				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
67	-16.1	-12.8	4.7	7.8	-6.6	-18.8	3.2	11.7	-40.0	-21.4	11.5	12.4	-14.6	-16.3	3.6	11.8	-16.7	8.5	-0.51	-1.58	1404	0.232
68	-16.0	-12.5	4.7	7.9	-6.6	-18.9	3.2	11.7	-40.3	-21.4	11.6	12.5	-14.7	-16.4	3.6	11.9	-16.7	8.6	-0.51	-1.57	1406	0.238
69	-16.1	-12.6	4.8	8.0	-6.7	-19.0	3.2	11.7	-40.5	-21.7	11.6	12.6	-14.8	-16.5	3.6	11.9	-16.8	8.6	-0.51	-1.57	1415	0.236
70	-16.1	-12.5	4.8	8.0	-6.8	-19.2	3.2	11.8	-40.7	-21.8	11.7	12.7	-14.9	-16.6	3.6	12.0	-16.9	8.6	-0.51	-1.57	1422	0.236
71	-16.2	-12.7	4.8	8.1	-6.7	-19.2	3.2	11.9	-40.8	-22.0	11.8	12.8	-15.0	-16.6	3.7	12.1	-16.9	8.7	-0.51	-1.57	1430	0.238
72	-16.2	-12.7	4.8	8.1	-6.9	-19.5	3.3	11.9	-41.0	-22.0	11.8	12.9	-15.0	-16.8	3.7	12.1	-17.0	8.7	-0.51	-1.57	1437	0.237
73	-16.2	-12.8	4.9	8.2	-7.0	-19.7	3.2	12.0	-41.2	-22.2	11.8	13.0	-15.1	-16.8	3.7	12.2	-17.2	8.8	-0.51	-1.57	1447	0.235
74	-16.2	-12.8	4.9	8.2	-7.2	-19.9	3.3	12.0	-41.4	-22.4	11.9	13.1	-15.2	-16.9	3.7	12.3	-17.2	8.8	-0.51	-1.57	1454	0.236
75	-16.3	-13.0	4.9	8.3	-7.2	-20.0	3.3	12.1	-41.5	-22.6	12.0	13.2	-15.3	-17.0	3.8	12.3	-17.3	8.9	-0.51	-1.57	1463	0.235
76	-16.4	-13.0	4.9	8.3	-7.3	-20.0	3.3	12.0	-41.8	-22.7	12.0	13.2	-15.5	-17.1	3.8	12.4	-17.5	8.9	-0.51	-1.58	1471	0.232
77	-16.4	-13.0	5.0	8.4	-7.5	-20.0	3.3	12.1	-42.0	-22.8	12.1	13.3	-15.5	-17.1	3.8	12.4	-17.5	9.0	-0.51	-1.57	1475	0.235
78	-16.5	-13.1	5.0	8.4	-7.6	-20.3	3.3	12.2	-42.1	-22.9	12.1	13.4	-15.6	-17.3	3.8	12.5	-17.6	9.0	-0.51	-1.57	1485	0.234
79	-16.5	-13.1	5.0	8.5	-7.8	-20.4	3.4	12.1	-42.3	-23.2	12.2	13.5	-15.6	-17.3	3.8	12.6	-17.7	9.0	-0.51	-1.58	1491	0.233
80	-16.7	-13.2	5.0	8.5	-7.7	-20.4	3.4	12.3	-42.5	-23.3	12.2	13.6	-15.7	-17.4	3.8	12.7	-17.8	9.1	-0.51	-1.57	1499	0.234
81	-16.7	-13.3	5.1	8.6	-7.8	-20.6	3.4	12.3	-42.6	-23.5	12.3	13.7	-15.9	-17.5	3.9	12.7	-17.9	9.1	-0.51	-1.58	1509	0.233
82	-16.9	-13.3	5.1	8.6	-7.9	-20.8	3.4	12.3	-42.8	-23.5	12.3	13.8	-16.0	-17.6	3.9	12.8	-18.0	9.2	-0.51	-1.58	1517	0.230
83	-16.8	-13.3	5.1	8.7	-7.9	-20.8	3.4	12.4	-42.9	-23.7	12.4	13.9	-16.1	-17.6	3.9	12.8	-18.0	9.2	-0.51	-1.57	1521	0.234
84	-17.0	-13.4	5.1	8.7	-8.1	-21.3	3.4	12.4	-43.2	-23.9	12.5	13.9	-16.1	-17.7	3.9	12.9	-18.2	9.3	-0.51	-1.58	1534	0.229
85	-16.9	-13.3	5.2	8.8	-8.0	-21.1	3.5	12.5	-43.3	-24.0	12.5	14.0	-16.1	-17.8	4.0	12.9	-18.2	9.3	-0.51	-1.57	1533	0.234
86	-17.0	-13.4	5.2	8.8	-8.1	-21.1	3.5	12.5	-43.4	-24.1	12.6	14.1	-16.2	-17.9	4.0	13.0	-18.3	9.3	-0.51	-1.58	1541	0.233
87	-17.1	-13.4	5.2	8.8	-8.4	-21.3	3.5	12.5	-43.6	-24.2	12.6	14.2	-16.4	-18.0	4.0	13.0	-18.4	9.4	-0.51	-1.58	1550	0.230
88	-17.1	-13.5	5.3	8.9	-8.2	-21.3	3.6	12.6	-43.7	-24.3	12.7	14.3	-16.4	-18.0	4.0	13.1	-18.4	9.4	-0.51	-1.58	1554	0.233
89	-17.2	-13.6	5.3	8.9	-8.3	-21.3	3.6	12.7	-43.9	-24.5	12.7	14.4	-16.5	-18.1	4.0	13.2	-18.5	9.5	-0.51	-1.58	1562	0.232
90	-17.3	-13.7	5.3	9.0	-8.3	-21.4	3.6	12.7	-44.2	-24.7	12.7	14.4	-16.5	-18.3	4.0	13.2	-18.6	9.5	-0.51	-1.58	1571	0.231
91	-17.3	-13.7	5.3	9.0	-8.3	-21.5	3.6	12.8	-44.2	-24.9	12.8	14.5	-16.6	-18.3	4.1	13.3	-18.7	9.5	-0.51	-1.58	1577	0.232
92	-17.4	-13.7	5.4	9.1	-8.5	-21.6	3.6	12.8	-44.4	-25.0	12.8	14.6	-16.7	-18.4	4.1	13.3	-18.8	9.6	-0.51	-1.58	1583	0.231
93	-17.5	-13.9	5.4	9.1	-8.6	-21.8	3.6	12.8	-44.5	-25.1	12.9	14.7	-16.7	-18.5	4.1	13.4	-18.9	9.6	-0.51	-1.58	1592	0.230
94	-17.6	-13.9	5.4	9.1	-8.7	-21.8	3.7	12.8	-44.7	-25.3	13.0	14.8	-16.8	-18.6	4.1	13.4	-19.0	9.6	-0.51	-1.59	1599	0.228
95	-17.6	-13.9	5.4	9.2	-8.6	-21.9	3.7	12.9	-44.9	-25.3	13.0	14.8	-16.9	-18.7	4.1	13.5	-19.1	9.7	-0.51	-1.58	1604	0.230
96	-17.9	-14.1	5.4	9.2	-8.5	-21.9	3.7	13.0	-44.9	-25.5	13.1	14.9	-17.0	-18.7	4.1	13.5	-19.2	9.7	-0.51	-1.58	1613	0.229
97	-17.8	-14.1	5.5	9.2	-8.7	-22.0	3.7	13.0	-45.1	-25.5	13.1	15.0	-17.1	-18.8	4.1	13.6	-19.2	9.8	-0.51	-1.58	1617	0.230
98	-17.9	-14.1	5.5	9.4	-8.7	-22.1	3.7	13.0	-45.4	-25.8	13.1	15.0	-17.1	-18.9	4.2	13.6	-19.3	9.8	-0.51	-1.58	1626	0.229
99	-17.9	-14.2	5.5	9.4	-8.7	-22.1	3.8	13.1	-45.5	-25.8	13.2	15.2	-17.3	-19.1	4.2	13.7	-19.4	9.9	-0.51	-1.58	1632	0.230
100	-17.9	-14.2	5.5	9.4	-8.7	-21.9	3.8	13.2	-45.8	-26.0	13.2	15.2	-17.3	-19.0	4.2	13.8	-19.4	9.9	-0.51	-1.58	1634	0.232

Table E.11 KL 58-40 Test Data (-10 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																					
	KL 58/40 Sample #1				KL 58/40 Sample #10				KL 58/40 Sample #12				KL 58/40 Sample #8				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0.000
1	-2.7	-2.3	0.6	1.3	-0.1	-4.6	0.3	2.7	-3.6	-1.8	0.9	1.0	-2.8	-3.3	0.7	2.3	-2.8	1.2	-0.44	-1.77	167	0.148
2	-3.0	-2.6	0.8	1.5	-0.5	-5.5	0.4	3.0	-4.2	-2.2	1.1	1.2	-3.4	-4.0	0.8	2.8	-3.2	1.4	-0.43	-1.80	196	0.139
3	-3.3	-2.9	0.8	1.6	-0.7	-5.8	0.5	3.3	-4.5	-2.5	1.2	1.4	-3.9	-4.9	0.9	3.1	-3.7	1.5	-0.42	-1.85	221	0.123
4	-3.4	-2.9	0.9	1.7	-0.7	-6.1	0.5	3.5	-4.8	-2.7	1.3	1.5	-4.0	-4.9	1.0	3.4	-3.8	1.6	-0.43	-1.80	229	0.140
5	-3.6	-3.2	0.9	1.8	-0.7	-6.3	0.6	3.7	-5.0	-2.9	1.3	1.6	-4.1	-5.1	1.1	3.6	-4.0	1.7	-0.43	-1.79	241	0.141
6	-3.7	-3.2	1.0	1.9	-1.0	-6.6	0.6	3.8	-5.2	-3.1	1.4	1.6	-4.5	-5.3	1.2	3.8	-4.1	1.8	-0.43	-1.79	250	0.141
7	-3.9	-3.3	1.0	1.9	-1.0	-6.7	0.7	3.9	-5.4	-3.2	1.4	1.7	-4.7	-5.6	1.1	4.0	-4.3	1.9	-0.43	-1.82	262	0.131
8	-3.9	-3.3	1.0	2.0	-1.2	-7.0	0.7	4.0	-5.5	-3.3	1.5	1.7	-4.8	-5.7	1.2	4.1	-4.4	1.9	-0.43	-1.80	267	0.139
9	-4.0	-3.4	1.1	2.1	-1.0	-7.0	0.7	4.2	-5.6	-3.5	1.5	1.8	-5.0	-6.1	1.2	4.2	-4.6	2.0	-0.43	-1.80	277	0.140
10	-4.2	-3.4	1.1	2.2	-1.1	-7.1	0.8	4.3	-5.7	-3.5	1.6	1.9	-5.1	-6.2	1.3	4.3	-4.7	2.1	-0.44	-1.78	283	0.146
11	-4.2	-3.5	1.1	2.2	-1.2	-7.2	0.8	4.3	-5.9	-3.7	1.6	1.9	-5.3	-6.3	1.3	4.5	-4.8	2.1	-0.44	-1.79	291	0.142
12	-4.3	-3.7	1.2	2.2	-1.1	-7.4	0.8	4.4	-5.9	-3.7	1.7	2.0	-5.3	-6.6	1.4	4.6	-4.9	2.1	-0.44	-1.79	297	0.144
13	-4.4	-3.7	1.2	2.3	-1.2	-7.5	0.8	4.5	-6.0	-3.8	1.7	2.0	-5.4	-6.5	1.4	4.7	-5.0	2.2	-0.44	-1.78	301	0.146
14	-4.5	-3.7	1.2	2.3	-1.2	-7.5	0.9	4.6	-6.1	-3.9	1.7	2.1	-5.5	-6.7	1.4	4.8	-5.1	2.2	-0.44	-1.78	307	0.147
15	-4.6	-3.8	1.2	2.3	-1.2	-7.7	0.9	4.7	-6.2	-4.0	1.8	2.2	-5.6	-6.8	1.5	5.0	-5.2	2.3	-0.44	-1.78	313	0.147
16	-4.6	-3.8	1.3	2.4	-1.2	-7.7	0.9	4.7	-6.3	-4.0	1.8	2.2	-5.7	-7.0	1.5	5.0	-5.2	2.3	-0.44	-1.77	317	0.148
17	-4.7	-3.9	1.3	2.4	-1.2	-7.6	1.0	4.8	-6.4	-4.1	1.8	2.3	-5.7	-7.0	1.5	5.2	-5.3	2.4	-0.44	-1.77	323	0.150
18	-4.8	-3.9	1.3	2.5	-1.4	-7.9	1.0	4.9	-6.6	-4.2	1.8	2.3	-6.1	-7.6	1.5	5.2	-5.5	2.4	-0.43	-1.81	334	0.134
19	-4.8	-3.9	1.3	2.5	-1.4	-7.9	1.0	5.0	-6.5	-4.2	1.9	2.3	-5.8	-7.4	1.6	5.3	-5.4	2.4	-0.45	-1.75	331	0.155
20	-4.9	-4.1	1.3	2.5	-1.5	-8.0	1.0	5.0	-6.6	-4.3	1.9	2.4	-6.0	-7.4	1.6	5.4	-5.5	2.4	-0.44	-1.77	337	0.149
21	-4.9	-4.0	1.4	2.6	-1.5	-8.1	1.0	5.1	-6.7	-4.3	1.9	2.4	-6.2	-7.6	1.6	5.4	-5.6	2.5	-0.44	-1.77	340	0.150
22	-4.9	-4.1	1.4	2.6	-1.5	-8.3	1.1	5.1	-6.7	-4.4	1.9	2.4	-6.2	-7.7	1.6	5.5	-5.7	2.5	-0.44	-1.76	345	0.152
23	-5.0	-4.1	1.4	2.6	-1.5	-8.3	1.1	5.2	-6.8	-4.4	2.0	2.5	-6.2	-7.8	1.6	5.6	-5.7	2.5	-0.44	-1.76	348	0.152
24	-5.1	-4.1	1.4	2.6	-1.5	-8.4	1.1	5.2	-6.9	-4.5	2.0	2.5	-6.4	-7.9	1.7	5.7	-5.8	2.6	-0.44	-1.77	354	0.148
25	-5.1	-4.4	1.4	2.7	-1.5	-8.4	1.1	5.2	-7.0	-4.6	2.0	2.5	-6.3	-7.9	1.7	5.7	-5.9	2.6	-0.44	-1.78	357	0.147
26	-5.2	-4.2	1.4	2.7	-1.7	-8.4	1.1	5.3	-7.0	-4.7	2.0	2.6	-6.3	-8.1	1.7	5.8	-5.9	2.6	-0.45	-1.76	360	0.153
27	-5.2	-4.3	1.5	2.8	-1.7	-8.7	1.1	5.4	-7.1	-4.7	2.1	2.6	-6.5	-8.1	1.8	5.9	-6.0	2.7	-0.45	-1.75	363	0.155
28	-5.3	-4.3	1.5	2.8	-1.6	-8.7	1.2	5.4	-7.3	-4.7	2.1	2.6	-6.6	-8.3	1.7	5.9	-6.1	2.7	-0.44	-1.77	369	0.148
29	-5.3	-4.2	1.5	2.8	-1.6	-8.8	1.2	5.5	-7.3	-4.9	2.1	2.6	-6.6	-8.3	1.8	6.0	-6.1	2.7	-0.45	-1.75	371	0.155
30	-5.4	-4.4	1.5	2.8	-1.8	-8.9	1.2	5.5	-7.3	-4.8	2.1	2.7	-6.8	-8.4	1.8	6.1	-6.2	2.7	-0.44	-1.76	375	0.151
31	-5.4	-4.4	1.5	2.9	-1.8	-8.9	1.2	5.6	-7.3	-4.9	2.1	2.7	-6.8	-8.4	1.8	6.2	-6.2	2.8	-0.45	-1.75	377	0.156
32	-5.3	-4.5	1.5	2.9	-1.8	-9.0	1.2	5.6	-7.4	-4.9	2.1	2.7	-6.9	-8.6	1.8	6.2	-6.3	2.8	-0.44	-1.76	381	0.152
33	-5.4	-4.5	1.6	2.9	-1.8	-9.1	1.2	5.6	-7.5	-5.0	2.2	2.7	-7.0	-8.7	1.9	6.3	-6.3	2.8	-0.44	-1.76	386	0.151

Table E.11 KL 58-40 Test Data (-10 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																						
	KL 58/40 Sample #1				KL 58/40 Sample #10				KL 58/40 Sample #12				KL 58/40 Sample #8				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
34	-5.4	-4.5	1.6	2.9	-1.8	-9.1	1.2	5.7	-7.5	-5.1	2.2	2.8	-7.0	-8.7	1.9	6.4	-6.4	2.8	-0.45	-1.75	387	0.155
35	-5.4	-4.5	1.6	3.0	-1.9	-9.2	1.3	5.8	-7.6	-5.2	2.2	2.8	-7.1	-8.8	1.9	6.4	-6.4	2.9	-0.45	-1.76	392	0.153
36	-5.5	-4.4	1.6	3.0	-1.9	-9.2	1.3	5.8	-7.7	-5.2	2.2	2.8	-7.2	-8.9	1.9	6.5	-6.5	2.9	-0.45	-1.75	394	0.156
37	-5.5	-4.6	1.6	3.0	-2.0	-9.4	1.3	5.8	-7.7	-5.3	2.2	2.9	-7.2	-9.0	1.9	6.5	-6.5	2.9	-0.45	-1.76	398	0.154
38	-5.6	-4.6	1.6	3.0	-2.1	-9.6	1.3	5.8	-7.8	-5.4	2.3	2.9	-7.4	-9.1	1.9	6.6	-6.6	2.9	-0.44	-1.77	403	0.149
39	-5.6	-4.7	1.6	3.0	-2.0	-9.4	1.3	5.9	-7.9	-5.5	2.3	2.9	-7.4	-9.1	2.0	6.6	-6.7	3.0	-0.44	-1.77	406	0.149
40	-5.7	-4.7	1.7	3.1	-2.0	-9.4	1.3	6.0	-7.9	-5.4	2.3	2.9	-7.4	-9.1	2.0	6.7	-6.7	3.0	-0.45	-1.75	406	0.156
41	-5.7	-4.7	1.7	3.1	-2.0	-9.5	1.3	6.0	-8.0	-5.6	2.3	2.9	-7.6	-9.3	2.0	6.7	-6.8	3.0	-0.44	-1.78	414	0.146
42	-5.7	-4.7	1.7	3.1	-2.2	-9.6	1.3	6.0	-8.0	-5.6	2.3	3.0	-7.8	-9.5	2.0	6.8	-6.9	3.0	-0.44	-1.78	416	0.147
43	-5.7	-4.7	1.7	3.2	-2.2	-9.6	1.4	6.0	-8.1	-5.5	2.3	3.0	-7.8	-9.5	2.0	6.8	-6.9	3.0	-0.44	-1.77	418	0.150
44	-5.8	-4.7	1.7	3.2	-2.4	-9.9	1.4	6.0	-8.1	-5.6	2.4	3.0	-8.0	-9.6	2.0	6.8	-7.0	3.1	-0.44	-1.78	423	0.145
45	-5.7	-4.8	1.7	3.2	-2.3	-9.8	1.4	6.1	-8.2	-5.7	2.4	3.1	-8.1	-9.8	2.0	6.9	-7.0	3.1	-0.44	-1.78	427	0.145
46	-5.8	-4.7	1.8	3.2	-2.3	-9.8	1.4	6.1	-8.2	-5.7	2.4	3.1	-8.0	-9.6	2.1	7.0	-7.0	3.1	-0.44	-1.77	426	0.151
47	-5.8	-4.9	1.8	3.2	-2.4	-9.9	1.4	6.1	-8.2	-5.8	2.4	3.1	-8.3	-9.9	2.1	7.0	-7.1	3.1	-0.44	-1.79	433	0.143
48	-5.8	-4.8	1.8	3.2	-2.4	-10.0	1.4	6.2	-8.2	-5.7	2.4	3.1	-8.3	-10.0	2.1	7.0	-7.1	3.1	-0.44	-1.78	433	0.147
49	-5.8	-4.8	1.8	3.3	-2.5	-10.0	1.4	6.2	-8.3	-5.8	2.4	3.2	-8.4	-10.3	2.1	7.0	-7.2	3.2	-0.44	-1.79	439	0.144
50	-5.9	-4.9	1.8	3.3	-2.6	-10.0	1.4	6.2	-8.4	-5.9	2.5	3.2	-8.3	-10.3	2.1	7.1	-7.3	3.2	-0.43	-1.79	441	0.141
51	-5.9	-5.0	1.8	3.3	-2.6	-10.2	1.4	6.3	-8.6	-6.1	2.5	3.2	-8.5	-10.4	2.1	7.1	-7.4	3.2	-0.43	-1.82	448	0.133
52	-5.9	-4.9	1.8	3.3	-2.6	-10.3	1.4	6.3	-8.6	-6.0	2.5	3.2	-8.6	-10.4	2.2	7.2	-7.4	3.2	-0.43	-1.80	448	0.139
53	-5.9	-5.0	1.8	3.3	-2.9	-10.5	1.4	6.3	-8.5	-6.1	2.5	3.2	-8.6	-10.4	2.1	7.2	-7.4	3.2	-0.43	-1.81	450	0.137
54	-6.0	-4.9	1.8	3.3	-2.6	-10.4	1.5	6.3	-8.7	-6.2	2.5	3.2	-8.7	-10.5	2.1	7.2	-7.5	3.2	-0.43	-1.81	454	0.137
55	-6.0	-4.9	1.8	3.4	-2.7	-10.5	1.5	6.4	-8.7	-6.2	2.5	3.3	-8.8	-10.7	2.2	7.3	-7.6	3.3	-0.43	-1.81	457	0.136
56	-6.1	-5.0	1.9	3.4	-2.7	-10.5	1.5	6.4	-8.8	-6.3	2.5	3.3	-8.8	-10.8	2.2	7.3	-7.6	3.3	-0.43	-1.82	461	0.134
57	-6.1	-5.0	1.9	3.4	-2.8	-10.6	1.5	6.4	-8.7	-6.3	2.5	3.3	-8.8	-10.6	2.2	7.4	-7.6	3.3	-0.43	-1.80	460	0.139
58	-6.1	-5.0	1.9	3.4	-2.8	-10.6	1.5	6.5	-8.9	-6.3	2.5	3.3	-8.9	-10.8	2.2	7.4	-7.7	3.3	-0.43	-1.80	463	0.138
59	-6.1	-5.0	1.9	3.5	-2.9	-10.7	1.5	6.5	-8.9	-6.5	2.6	3.3	-8.9	-10.8	2.2	7.5	-7.7	3.3	-0.43	-1.81	465	0.137
60	-6.2	-5.1	1.9	3.5	-2.9	-10.7	1.5	6.5	-9.0	-6.6	2.6	3.3	-9.0	-10.8	2.2	7.5	-7.8	3.3	-0.43	-1.82	470	0.134
61	-6.2	-5.2	1.9	3.5	-2.9	-10.7	1.5	6.5	-8.9	-6.5	2.6	3.4	-9.0	-10.8	2.3	7.6	-7.8	3.4	-0.43	-1.80	470	0.139
62	-6.2	-5.1	1.9	3.5	-3.1	-10.8	1.6	6.5	-9.0	-6.6	2.6	3.4	-9.1	-10.8	2.3	7.7	-7.8	3.4	-0.43	-1.80	472	0.140
63	-6.2	-5.0	2.0	3.5	-3.1	-10.9	1.5	6.5	-9.0	-6.6	2.6	3.4	-9.1	-11.0	2.3	7.7	-7.8	3.4	-0.43	-1.80	474	0.139
64	-6.2	-5.2	2.0	3.5	-3.4	-11.2	1.5	6.5	-9.1	-6.7	2.6	3.4	-9.1	-11.0	2.3	7.7	-7.9	3.4	-0.43	-1.81	477	0.137
65	-6.2	-5.2	2.0	3.6	-3.1	-11.0	1.6	6.6	-9.2	-6.7	2.6	3.4	-9.2	-11.2	2.3	7.8	-8.0	3.4	-0.43	-1.81	480	0.135
66	-6.3	-5.3	2.0	3.6	-3.1	-11.1	1.6	6.6	-9.1	-6.7	2.7	3.4	-9.1	-11.1	2.3	7.8	-8.0	3.4	-0.43	-1.80	481	0.138

Table E.11 KL 58-40 Test Data (-10 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																						
	KL 58/40 Sample #1				KL 58/40 Sample #10				KL 58/40 Sample #12				KL 58/40 Sample #8				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
67	-6.4	-5.3	2.0	3.6	-3.0	-10.8	1.6	6.7	-9.3	-6.8	2.7	3.5	-9.2	-11.1	2.3	7.9	-8.0	3.5	-0.43	-1.81	485	0.137
68	-6.4	-5.4	2.0	3.6	-3.2	-11.2	1.6	6.7	-9.3	-6.9	2.7	3.4	-9.2	-11.2	2.4	7.9	-8.1	3.5	-0.43	-1.81	487	0.136
69	-6.3	-5.2	2.0	3.6	-3.1	-11.2	1.6	6.7	-9.3	-6.9	2.7	3.5	-9.4	-11.2	2.4	8.0	-8.1	3.5	-0.43	-1.80	487	0.138
70	-6.4	-5.3	2.0	3.7	-3.2	-11.3	1.6	6.7	-9.3	-6.9	2.7	3.5	-9.1	-11.2	2.4	8.0	-8.0	3.5	-0.44	-1.79	487	0.142
71	-6.4	-5.3	2.0	3.7	-3.3	-11.4	1.6	6.7	-9.4	-6.9	2.7	3.5	-9.3	-11.2	2.4	8.1	-8.1	3.5	-0.43	-1.80	490	0.140
72	-6.4	-5.4	2.0	3.7	-3.3	-11.4	1.6	6.8	-9.4	-6.9	2.7	3.5	-9.2	-11.2	2.4	8.1	-8.1	3.5	-0.44	-1.79	491	0.142
73	-6.5	-5.4	2.0	3.7	-3.1	-11.3	1.7	6.9	-9.6	-7.0	2.7	3.6	-9.3	-11.2	2.5	8.2	-8.2	3.6	-0.44	-1.79	494	0.142
74	-6.4	-5.4	2.1	3.7	-3.2	-11.5	1.7	6.8	-9.6	-7.0	2.7	3.6	-9.3	-11.2	2.5	8.2	-8.2	3.6	-0.44	-1.79	495	0.144
75	-6.4	-5.4	2.1	3.7	-3.3	-11.6	1.7	6.8	-9.6	-7.0	2.8	3.6	-9.4	-11.3	2.5	8.2	-8.2	3.6	-0.44	-1.79	497	0.143
76	-6.5	-5.4	2.1	3.8	-3.4	-11.6	1.7	6.9	-9.6	-7.2	2.8	3.6	-9.3	-11.5	2.5	8.3	-8.3	3.6	-0.44	-1.78	500	0.145
77	-6.6	-5.4	2.1	3.8	-3.4	-11.6	1.7	6.9	-9.7	-7.1	2.8	3.7	-9.3	-11.3	2.5	8.3	-8.2	3.6	-0.44	-1.78	499	0.145
78	-6.5	-5.4	2.1	3.8	-3.4	-11.6	1.7	7.0	-9.7	-7.2	2.8	3.7	-9.3	-11.3	2.5	8.4	-8.2	3.7	-0.44	-1.76	500	0.152
79	-6.6	-5.4	2.1	3.8	-3.5	-11.7	1.7	6.9	-9.7	-7.2	2.8	3.7	-9.2	-11.5	2.5	8.4	-8.3	3.6	-0.44	-1.78	502	0.146
80	-6.6	-5.4	2.1	3.8	-3.5	-11.8	1.7	7.0	-9.7	-7.2	2.8	3.7	-9.1	-11.2	2.6	8.5	-8.2	3.7	-0.45	-1.76	500	0.154
81	-6.7	-5.4	2.1	3.8	-3.5	-11.7	1.7	7.0	-9.9	-7.4	2.8	3.7	-9.3	-11.6	2.6	8.5	-8.4	3.7	-0.44	-1.78	508	0.145
82	-6.6	-5.5	2.1	3.8	-3.4	-11.8	1.8	7.0	-9.8	-7.3	2.8	3.8	-9.3	-11.3	2.6	8.5	-8.3	3.7	-0.45	-1.76	504	0.154
83	-6.6	-5.5	2.1	3.9	-3.6	-11.8	1.7	7.1	-9.9	-7.3	2.8	3.8	-9.2	-11.3	2.6	8.6	-8.3	3.7	-0.45	-1.75	505	0.156
84	-6.6	-5.5	2.1	3.9	-3.6	-11.9	1.7	7.1	-9.8	-7.4	2.9	3.8	-9.1	-11.3	2.6	8.6	-8.3	3.7	-0.45	-1.74	506	0.159
85	-6.7	-5.5	2.1	3.9	-3.6	-11.9	1.8	7.1	-9.9	-7.4	2.9	3.8	-9.2	-11.3	2.7	8.7	-8.3	3.7	-0.45	-1.75	508	0.158
86	-6.7	-5.6	2.2	3.9	-3.6	-11.9	1.8	7.1	-9.9	-7.4	2.9	3.8	-9.3	-11.3	2.7	8.8	-8.3	3.8	-0.45	-1.74	509	0.160
87	-6.8	-5.6	2.2	3.9	-3.6	-12.1	1.8	7.1	-10.0	-7.5	2.9	3.8	-9.3	-11.6	2.7	8.8	-8.4	3.8	-0.45	-1.75	514	0.155
88	-6.7	-5.7	2.2	3.9	-3.7	-12.0	1.8	7.2	-10.0	-7.4	2.9	3.9	-9.2	-11.3	2.7	8.9	-8.4	3.8	-0.45	-1.74	512	0.161
89	-6.8	-5.7	2.2	4.0	-3.7	-12.0	1.8	7.2	-10.0	-7.5	2.9	3.9	-9.3	-11.5	2.7	8.9	-8.5	3.8	-0.45	-1.74	516	0.159
90	-6.8	-5.6	2.2	4.0	-3.7	-12.1	1.8	7.2	-10.0	-7.5	2.9	3.9	-9.4	-11.6	2.7	8.9	-8.5	3.8	-0.45	-1.74	517	0.161
91	-6.7	-5.6	2.2	4.0	-3.7	-12.1	1.8	7.2	-10.1	-7.5	2.9	3.9	-9.3	-11.6	2.7	8.9	-8.5	3.8	-0.45	-1.73	517	0.163
92	-6.9	-5.6	2.2	4.0	-3.7	-12.2	1.8	7.2	-10.2	-7.7	2.9	3.9	-9.3	-11.7	2.7	9.0	-8.5	3.8	-0.45	-1.75	521	0.157
93	-6.8	-5.6	2.2	4.1	-3.7	-12.1	1.8	7.3	-10.2	-7.6	3.0	4.0	-9.4	-11.7	2.7	9.0	-8.5	3.9	-0.45	-1.73	520	0.163
94	-6.8	-5.6	2.2	4.1	-3.8	-12.2	1.8	7.3	-10.2	-7.6	3.0	4.0	-9.5	-11.7	2.8	9.1	-8.5	3.9	-0.45	-1.73	522	0.162
95	-6.9	-5.7	2.2	4.1	-3.7	-12.3	1.8	7.3	-10.1	-7.6	3.0	4.0	-9.5	-11.7	2.8	9.1	-8.6	3.9	-0.45	-1.73	524	0.164
96	-6.8	-5.7	2.2	4.1	-3.8	-12.3	1.9	7.3	-10.2	-7.6	3.0	4.0	-9.4	-11.8	2.8	9.1	-8.6	3.9	-0.46	-1.73	524	0.164
97	-6.9	-5.7	2.3	4.1	-3.8	-12.2	1.9	7.4	-10.1	-7.6	3.0	4.0	-9.5	-11.9	2.8	9.2	-8.6	3.9	-0.46	-1.73	526	0.164
98	-6.8	-5.7	2.3	4.1	-3.6	-12.3	1.9	7.4	-10.2	-7.6	3.0	4.0	-9.5	-11.9	2.8	9.2	-8.6	3.9	-0.46	-1.72	527	0.166
99	-6.9	-5.8	2.3	4.1	-3.6	-12.2	1.9	7.4	-10.2	-7.7	3.0	4.1	-9.5	-11.9	2.8	9.2	-8.7	4.0	-0.46	-1.72	529	0.166
100	-6.9	-5.8	2.3	4.1	-3.7	-12.1	1.9	7.5	-10.2	-7.7	3.0	4.1	-9.6	-11.9	2.8	9.2	-8.7	4.0	-0.46	-1.72	531	0.166

Table E.12 KL 58-40 Test Data (-20 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																					
	KL 58/40 Sample #1				KL 58/40 Sample #10				KL 58/40 Sample #12				KL 58/40 Sample #8				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0.000
1	-2.4	-2.2	0.6	1.1	-1.2	-4.9	0.5	2.5	-3.8	-1.4	1.0	1.0	-2.8	-3.7	0.7	2.2	-2.7	1.1	-0.42	-1.85	83	0.123
2	-3.7	-3.1	1.0	1.8	-1.5	-5.3	0.6	2.7	-5.0	-2.3	1.2	1.4	-3.0	-4.1	0.8	2.5	-3.5	1.5	-0.42	-1.86	108	0.122
3	-3.9	-3.3	1.0	2.0	-1.5	-5.5	0.7	2.9	-5.3	-2.5	1.3	1.5	-3.3	-4.3	0.9	2.6	-3.8	1.6	-0.43	-1.81	115	0.135
4	-4.1	-3.5	1.1	2.1	-1.6	-5.7	0.7	3.0	-5.5	-2.8	1.4	1.6	-3.5	-4.6	0.9	2.8	-4.0	1.7	-0.42	-1.84	121	0.126
5	-4.3	-3.6	1.1	2.2	-1.9	-6.2	0.7	3.0	-5.7	-3.0	1.4	1.7	-3.5	-4.7	0.9	2.9	-4.1	1.7	-0.42	-1.85	125	0.125
6	-4.4	-3.7	1.2	2.3	-1.9	-6.0	0.8	3.2	-5.8	-3.0	1.4	1.7	-3.7	-4.9	0.9	3.0	-4.2	1.8	-0.42	-1.84	129	0.127
7	-4.5	-3.9	1.2	2.3	-1.8	-6.2	0.8	3.3	-5.8	-3.1	1.5	1.8	-3.7	-4.9	1.0	3.1	-4.3	1.8	-0.43	-1.82	132	0.132
8	-4.7	-4.0	1.2	2.3	-1.8	-6.2	0.8	3.3	-5.9	-3.2	1.5	1.8	-3.7	-5.1	1.0	3.1	-4.4	1.9	-0.42	-1.85	135	0.124
9	-4.8	-4.1	1.2	2.4	-2.2	-6.4	0.8	3.4	-6.1	-3.3	1.6	1.9	-3.9	-4.9	1.0	3.2	-4.5	1.9	-0.42	-1.84	137	0.127
10	-4.8	-4.2	1.3	2.4	-2.0	-6.4	0.9	3.5	-6.2	-3.4	1.6	1.9	-4.0	-5.2	1.0	3.3	-4.6	1.9	-0.42	-1.85	140	0.123
11	-4.9	-4.3	1.3	2.4	-2.0	-6.5	0.9	3.5	-6.2	-3.4	1.6	2.0	-3.9	-5.4	1.0	3.3	-4.7	2.0	-0.42	-1.85	143	0.125
12	-5.1	-4.4	1.3	2.4	-2.1	-6.5	0.9	3.6	-6.3	-3.5	1.6	2.0	-3.9	-5.1	1.1	3.4	-4.7	2.0	-0.43	-1.82	144	0.133
13	-5.2	-4.5	1.3	2.5	-2.0	-6.6	0.9	3.6	-6.3	-3.6	1.7	2.1	-4.0	-5.4	1.1	3.4	-4.8	2.0	-0.42	-1.84	147	0.127
14	-5.2	-4.5	1.3	2.5	-2.2	-6.8	0.9	3.7	-6.5	-3.7	1.7	2.1	-4.1	-5.5	1.1	3.5	-4.9	2.1	-0.42	-1.85	149	0.123
15	-5.4	-4.6	1.3	2.5	-2.3	-6.7	0.9	3.7	-6.5	-3.7	1.7	2.1	-4.1	-5.5	1.1	3.5	-5.0	2.1	-0.42	-1.83	151	0.128
16	-5.4	-4.7	1.4	2.5	-2.3	-6.8	0.9	3.8	-6.5	-3.7	1.7	2.1	-4.1	-5.6	1.1	3.6	-5.0	2.1	-0.42	-1.83	152	0.129
17	-5.5	-4.8	1.4	2.6	-2.3	-6.9	0.9	3.9	-6.6	-3.7	1.8	2.2	-4.2	-5.7	1.1	3.6	-5.1	2.1	-0.42	-1.84	154	0.127
18	-5.6	-4.8	1.4	2.6	-2.3	-6.9	1.0	3.9	-6.6	-3.8	1.8	2.2	-4.2	-5.8	1.2	3.7	-5.1	2.2	-0.42	-1.84	156	0.125
19	-5.6	-4.9	1.4	2.6	-2.3	-7.0	1.0	3.9	-6.7	-3.8	1.8	2.2	-4.3	-5.7	1.2	3.7	-5.2	2.2	-0.42	-1.83	157	0.128
20	-5.7	-4.9	1.4	2.7	-2.4	-7.0	1.0	3.9	-6.7	-3.8	1.8	2.2	-4.4	-5.8	1.2	3.7	-5.2	2.2	-0.42	-1.84	158	0.125
21	-5.7	-5.0	1.4	2.7	-2.4	-7.0	1.0	4.0	-6.8	-3.8	1.8	2.2	-4.4	-5.9	1.2	3.8	-5.3	2.2	-0.42	-1.84	160	0.126
22	-5.7	-5.0	1.4	2.7	-2.4	-7.1	1.0	4.0	-6.9	-3.9	1.8	2.2	-4.3	-5.9	1.2	3.8	-5.3	2.2	-0.42	-1.85	161	0.125
23	-5.9	-5.0	1.4	2.7	-2.4	-7.1	1.0	4.0	-7.0	-4.1	1.8	2.3	-4.4	-5.9	1.2	3.8	-5.4	2.2	-0.42	-1.85	163	0.122
24	-5.8	-5.0	1.4	2.7	-2.3	-7.2	1.0	4.1	-7.1	-4.3	1.8	2.2	-4.4	-5.9	1.2	3.9	-5.4	2.3	-0.42	-1.86	164	0.121
25	-5.9	-5.1	1.5	2.7	-2.4	-7.3	1.0	4.1	-7.0	-4.0	1.9	2.3	-4.4	-6.0	1.2	3.9	-5.4	2.3	-0.42	-1.83	164	0.129
26	-6.0	-5.1	1.5	2.8	-2.5	-7.3	1.0	4.1	-7.0	-4.1	1.9	2.3	-4.5	-6.2	1.2	3.9	-5.5	2.3	-0.42	-1.85	166	0.125
27	-5.9	-5.1	1.5	2.8	-2.4	-7.3	1.1	4.2	-7.0	-4.1	1.9	2.3	-4.6	-6.1	1.2	4.0	-5.5	2.3	-0.42	-1.83	166	0.130
28	-5.9	-5.0	1.5	2.8	-2.5	-7.3	1.1	4.2	-7.0	-4.2	1.9	2.4	-4.4	-6.2	1.3	4.1	-5.4	2.4	-0.43	-1.80	166	0.139
29	-5.9	-5.0	1.5	2.9	-2.4	-7.3	1.1	4.2	-7.1	-4.2	1.9	2.4	-4.5	-6.0	1.3	4.0	-5.4	2.4	-0.43	-1.80	166	0.140
30	-5.9	-5.0	1.5	2.9	-2.5	-7.4	1.1	4.2	-7.3	-4.3	1.9	2.4	-4.5	-6.2	1.3	4.1	-5.5	2.4	-0.43	-1.81	168	0.134
31	-5.9	-4.9	1.6	2.9	-2.5	-7.3	1.1	4.2	-7.4	-4.5	1.9	2.4	-4.6	-6.2	1.4	4.1	-5.6	2.4	-0.43	-1.82	170	0.134
32	-5.9	-5.1	1.6	3.0	-2.5	-7.5	1.1	4.2	-7.3	-4.3	2.0	2.4	-4.6	-6.3	1.3	4.1	-5.6	2.4	-0.43	-1.81	170	0.137
33	-5.9	-5.0	1.6	3.0	-2.5	-7.5	1.1	4.2	-7.3	-4.4	2.0	2.4	-4.6	-6.3	1.3	4.2	-5.6	2.4	-0.43	-1.80	170	0.139

Table E.12 KL 58-40 Test Data (-20 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																					
	KL 58/40 Sample #1				KL 58/40 Sample #10				KL 58/40 Sample #12				KL 58/40 Sample #8				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
34	-5.9	-5.1	1.6	3.0	-2.5	-7.6	1.1	4.3	-7.4	-4.4	2.0	2.5	-4.6	-6.4	1.3	4.1	-5.6	2.4	-0.43	-1.80	172	0.140
35	-5.9	-5.0	1.6	3.0	-2.5	-7.6	1.1	4.4	-7.4	-4.4	2.0	2.5	-4.9	-6.5	1.3	4.2	-5.7	2.5	-0.43	-1.79	174	0.141
36	-6.0	-5.0	1.6	3.1	-2.8	-7.7	1.1	4.4	-7.5	-4.4	2.0	2.5	-4.7	-6.4	1.4	4.2	-5.7	2.5	-0.44	-1.78	173	0.147
37	-6.0	-5.1	1.6	3.1	-2.6	-7.7	1.1	4.4	-7.5	-4.5	2.0	2.5	-4.9	-6.5	1.3	4.2	-5.7	2.5	-0.43	-1.80	175	0.140
38	-6.0	-5.1	1.6	3.1	-2.6	-7.7	1.1	4.4	-7.5	-4.5	2.0	2.5	-4.9	-6.4	1.3	4.2	-5.7	2.5	-0.43	-1.79	175	0.141
39	-6.0	-5.0	1.6	3.1	-2.6	-7.8	1.1	4.4	-7.5	-4.6	2.0	2.6	-4.9	-6.6	1.3	4.3	-5.7	2.5	-0.44	-1.78	176	0.146
40	-6.0	-5.1	1.7	3.1	-2.8	-7.8	1.1	4.4	-7.6	-4.6	2.0	2.5	-4.9	-6.5	1.4	4.3	-5.8	2.5	-0.43	-1.80	177	0.140
41	-6.1	-5.1	1.7	3.1	-2.8	-7.9	1.2	4.4	-7.6	-4.6	2.1	2.6	-5.0	-6.6	1.4	4.4	-5.8	2.5	-0.43	-1.80	178	0.140
42	-6.1	-5.2	1.7	3.2	-2.9	-7.9	1.2	4.4	-7.7	-4.7	2.1	2.6	-4.9	-6.6	1.4	4.3	-5.9	2.6	-0.44	-1.79	179	0.143
43	-6.1	-5.2	1.7	3.2	-2.9	-7.9	1.2	4.4	-7.8	-4.8	2.1	2.6	-5.0	-6.6	1.4	4.4	-5.9	2.6	-0.43	-1.81	181	0.137
44	-6.2	-5.2	1.7	3.2	-2.8	-8.0	1.2	4.5	-7.8	-5.0	2.1	2.6	-4.9	-6.7	1.4	4.4	-5.9	2.6	-0.43	-1.80	181	0.138
45	-6.1	-5.2	1.7	3.2	-2.7	-8.0	1.2	4.5	-7.7	-4.8	2.1	2.7	-5.0	-6.7	1.4	4.4	-5.9	2.6	-0.44	-1.78	181	0.144
46	-6.2	-5.2	1.7	3.2	-2.9	-8.2	1.2	4.5	-7.8	-4.7	2.1	2.6	-5.0	-6.7	1.4	4.4	-5.9	2.6	-0.44	-1.79	182	0.144
47	-6.3	-5.3	1.7	3.2	-2.9	-8.2	1.2	4.5	-7.7	-4.8	2.1	2.7	-5.0	-6.7	1.4	4.4	-6.0	2.6	-0.43	-1.79	183	0.141
48	-6.4	-5.4	1.7	3.2	-2.8	-7.9	1.2	4.6	-7.8	-4.9	2.1	2.7	-5.0	-6.7	1.4	4.5	-6.0	2.6	-0.43	-1.80	184	0.140
49	-6.5	-5.4	1.7	3.2	-3.0	-8.3	1.2	4.5	-7.8	-4.9	2.1	2.7	-5.2	-6.7	1.4	4.5	-6.1	2.6	-0.43	-1.81	185	0.136
50	-6.4	-5.5	1.7	3.2	-3.1	-8.3	1.2	4.6	-7.8	-4.8	2.2	2.7	-5.0	-6.8	1.4	4.5	-6.1	2.6	-0.43	-1.79	185	0.141
51	-6.5	-5.5	1.7	3.2	-3.0	-8.4	1.2	4.6	-8.0	-4.9	2.2	2.7	-5.1	-6.7	1.5	4.5	-6.1	2.6	-0.43	-1.80	187	0.138
52	-6.6	-5.6	1.7	3.2	-3.3	-8.8	1.2	4.5	-7.9	-5.0	2.2	2.7	-5.1	-6.8	1.4	4.6	-6.2	2.6	-0.43	-1.82	188	0.134
53	-6.7	-5.6	1.8	3.2	-3.0	-8.4	1.2	4.6	-8.0	-5.0	2.2	2.7	-5.1	-6.8	1.5	4.6	-6.2	2.7	-0.43	-1.82	189	0.134
54	-6.7	-5.7	1.8	3.3	-3.3	-8.8	1.2	4.6	-8.0	-5.0	2.2	2.8	-5.1	-6.8	1.5	4.6	-6.2	2.7	-0.43	-1.81	189	0.135
55	-6.7	-5.7	1.7	3.3	-3.0	-8.5	1.2	4.6	-8.2	-5.1	2.2	2.7	-5.1	-6.9	1.5	4.7	-6.3	2.7	-0.42	-1.83	192	0.129
56	-6.7	-5.7	1.8	3.3	-3.3	-8.6	1.2	4.6	-8.1	-5.1	2.2	2.8	-5.2	-6.9	1.5	4.6	-6.3	2.7	-0.43	-1.82	191	0.133
57	-6.9	-5.8	1.8	3.3	-3.0	-8.5	1.2	4.7	-8.1	-5.2	2.2	2.8	-5.1	-7.0	1.5	4.7	-6.3	2.7	-0.42	-1.83	193	0.130
58	-6.9	-5.8	1.8	3.3	-3.0	-8.5	1.2	4.7	-8.2	-5.1	2.2	2.8	-5.2	-6.9	1.5	4.7	-6.3	2.7	-0.43	-1.82	193	0.133
59	-6.9	-5.8	1.8	3.3	-3.1	-8.7	1.2	4.7	-8.2	-5.2	2.2	2.8	-5.2	-6.9	1.5	4.7	-6.4	2.7	-0.43	-1.82	194	0.132
60	-6.9	-5.8	1.8	3.3	-3.1	-8.8	1.2	4.7	-8.2	-5.2	2.2	2.8	-5.2	-7.0	1.5	4.8	-6.4	2.7	-0.43	-1.82	195	0.132
61	-7.0	-5.9	1.8	3.3	-3.2	-8.8	1.2	4.7	-8.3	-5.3	2.2	2.8	-5.3	-6.8	1.5	4.8	-6.4	2.7	-0.43	-1.83	195	0.131
62	-7.0	-5.8	1.8	3.3	-3.3	-8.6	1.2	4.8	-8.3	-5.3	2.2	2.8	-5.4	-7.0	1.5	4.7	-6.5	2.7	-0.42	-1.83	197	0.130
63	-7.0	-5.9	1.8	3.4	-3.3	-8.7	1.2	4.7	-8.3	-5.3	2.2	2.8	-5.3	-7.2	1.5	4.8	-6.5	2.7	-0.42	-1.84	198	0.127
64	-7.0	-5.9	1.8	3.4	-3.4	-8.8	1.2	4.7	-8.5	-5.4	2.2	2.9	-5.4	-7.1	1.5	4.8	-6.5	2.8	-0.42	-1.84	199	0.126
65	-7.0	-5.9	1.8	3.4	-3.3	-8.8	1.2	4.8	-8.5	-5.4	2.3	2.9	-5.3	-7.1	1.5	4.8	-6.5	2.8	-0.42	-1.83	199	0.129
66	-7.0	-5.9	1.8	3.4	-3.4	-9.0	1.3	4.8	-8.4	-5.4	2.3	2.8	-5.3	-7.1	1.6	4.9	-6.5	2.8	-0.42	-1.83	199	0.130

Table E.12 KL 58-40 Test Data (-20 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																					
	KL 58/40 Sample #1				KL 58/40 Sample #10				KL 58/40 Sample #12				KL 58/40 Sample #8				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
67	-7.1	-6.0	1.8	3.4	-3.4	-9.0	1.2	4.8	-8.5	-5.5	2.3	2.8	-5.2	-7.0	1.6	4.8	-6.5	2.8	-0.42	-1.83	199	0.130
68	-7.1	-6.0	1.8	3.4	-3.4	-9.1	1.2	4.8	-8.6	-5.5	2.3	2.9	-5.4	-7.1	1.6	4.9	-6.6	2.8	-0.42	-1.84	201	0.127
69	-7.1	-6.0	1.8	3.4	-3.6	-9.0	1.3	4.8	-8.6	-5.5	2.3	2.9	-5.3	-6.9	1.5	4.9	-6.6	2.8	-0.43	-1.82	200	0.131
70	-7.1	-6.0	1.8	3.4	-3.4	-8.9	1.3	4.8	-8.6	-5.6	2.3	2.9	-5.4	-7.1	1.6	4.9	-6.6	2.8	-0.42	-1.84	201	0.128
71	-7.2	-6.0	1.8	3.4	-3.5	-9.1	1.3	4.8	-8.7	-5.6	2.3	2.9	-5.4	-7.1	1.6	4.9	-6.7	2.8	-0.42	-1.83	202	0.128
72	-7.1	-5.9	1.9	3.5	-3.6	-9.1	1.3	4.8	-8.7	-5.7	2.3	2.9	-5.4	-7.2	1.6	4.9	-6.7	2.8	-0.42	-1.83	202	0.130
73	-7.1	-5.9	1.9	3.5	-3.6	-9.0	1.3	4.8	-8.7	-5.7	2.3	2.9	-5.4	-7.1	1.6	5.0	-6.7	2.8	-0.42	-1.83	203	0.129
74	-7.0	-5.8	1.9	3.5	-3.5	-9.2	1.3	4.9	-8.7	-5.7	2.3	2.9	-5.4	-7.1	1.6	5.0	-6.6	2.8	-0.43	-1.81	202	0.136
75	-7.1	-5.9	1.9	3.5	-3.8	-9.3	1.3	4.8	-8.7	-5.7	2.3	2.9	-5.5	-7.3	1.6	5.0	-6.7	2.8	-0.43	-1.83	204	0.131
76	-7.1	-5.9	1.9	3.5	-3.6	-9.3	1.3	4.8	-8.8	-5.8	2.3	2.9	-5.5	-7.3	1.6	5.1	-6.7	2.8	-0.42	-1.84	204	0.128
77	-7.0	-5.9	1.9	3.6	-3.6	-9.3	1.3	4.9	-8.9	-5.8	2.3	2.9	-5.5	-7.3	1.6	5.1	-6.7	2.9	-0.43	-1.83	205	0.131
78	-7.0	-5.9	1.9	3.6	-3.6	-9.3	1.3	4.9	-8.9	-5.8	2.3	2.9	-5.5	-7.3	1.6	5.0	-6.7	2.9	-0.43	-1.82	205	0.133
79	-7.0	-5.8	1.9	3.6	-3.8	-9.4	1.3	4.9	-8.8	-5.8	2.4	3.0	-5.6	-7.3	1.6	5.1	-6.7	2.9	-0.43	-1.80	205	0.138
80	-7.1	-5.9	1.9	3.6	-3.7	-9.4	1.3	4.9	-8.9	-5.8	2.3	3.0	-5.5	-7.4	1.6	5.1	-6.7	2.9	-0.43	-1.82	206	0.134
81	-7.1	-5.9	1.9	3.6	-3.7	-9.4	1.3	4.9	-8.8	-5.8	2.4	3.0	-5.5	-7.3	1.6	5.1	-6.7	2.9	-0.43	-1.80	205	0.138
82	-7.1	-5.9	1.9	3.6	-3.8	-9.5	1.3	4.9	-8.9	-5.9	2.4	3.0	-5.5	-7.3	1.6	5.2	-6.7	2.9	-0.43	-1.80	206	0.138
83	-7.0	-5.9	2.0	3.6	-3.8	-9.5	1.3	4.9	-9.0	-6.0	2.4	3.0	-5.5	-7.3	1.6	5.2	-6.8	2.9	-0.43	-1.81	207	0.137
84	-7.1	-5.9	2.0	3.7	-3.8	-9.5	1.3	4.9	-8.9	-5.9	2.4	3.0	-5.6	-7.3	1.6	5.1	-6.8	2.9	-0.43	-1.80	207	0.139
85	-7.0	-5.9	2.0	3.7	-3.9	-9.4	1.3	5.0	-9.0	-6.0	2.4	3.0	-5.5	-7.3	1.7	5.2	-6.8	2.9	-0.43	-1.79	207	0.141
86	-7.1	-5.9	2.0	3.7	-3.9	-9.5	1.3	5.0	-9.0	-6.1	2.4	3.0	-5.5	-7.4	1.6	5.2	-6.8	2.9	-0.43	-1.81	208	0.137
87	-7.1	-5.8	2.0	3.7	-3.8	-9.5	1.3	5.0	-9.0	-6.0	2.4	3.0	-5.6	-7.4	1.7	5.2	-6.8	3.0	-0.43	-1.80	208	0.140
88	-7.1	-5.9	2.0	3.7	-3.8	-9.6	1.3	4.9	-9.0	-5.9	2.4	3.0	-5.6	-7.4	1.6	5.3	-6.8	3.0	-0.43	-1.79	208	0.141
89	-7.2	-6.0	2.0	3.7	-4.0	-10.1	1.3	4.9	-9.0	-6.1	2.4	3.1	-5.6	-7.4	1.6	5.2	-6.9	2.9	-0.43	-1.81	209	0.136
90	-7.1	-5.9	2.0	3.7	-3.8	-9.7	1.3	4.9	-9.0	-6.1	2.4	3.1	-5.7	-7.6	1.7	5.3	-6.9	3.0	-0.43	-1.81	210	0.136
91	-7.2	-5.9	2.0	3.7	-3.8	-9.6	1.3	4.9	-9.1	-6.1	2.4	3.1	-5.7	-7.5	1.7	5.3	-6.9	3.0	-0.43	-1.80	210	0.138
92	-7.2	-5.9	2.0	3.7	-3.8	-9.7	1.3	5.0	-9.1	-6.1	2.4	3.1	-5.7	-7.5	1.7	5.3	-6.9	3.0	-0.43	-1.80	211	0.139
93	-7.2	-5.9	2.0	3.8	-3.8	-9.7	1.3	5.0	-9.1	-6.1	2.5	3.1	-5.6	-7.5	1.7	5.3	-6.9	3.0	-0.44	-1.79	211	0.144
94	-7.2	-5.9	2.0	3.8	-3.9	-9.5	1.3	5.0	-9.1	-6.1	2.5	3.1	-5.5	-7.5	1.7	5.3	-6.9	3.0	-0.44	-1.78	211	0.145
95	-7.2	-5.9	2.0	3.8	-4.0	-9.8	1.3	5.0	-9.2	-6.1	2.5	3.1	-5.9	-7.7	1.7	5.2	-7.0	3.0	-0.43	-1.81	214	0.137
96	-7.2	-6.0	2.0	3.8	-3.8	-9.6	1.4	5.1	-9.1	-6.2	2.5	3.1	-5.7	-7.6	1.7	5.3	-7.0	3.0	-0.44	-1.79	213	0.144
97	-7.3	-6.0	2.0	3.8	-3.7	-9.6	1.3	5.1	-9.2	-6.3	2.5	3.1	-5.8	-7.6	1.7	5.3	-7.0	3.0	-0.43	-1.80	214	0.141
98	-7.2	-6.0	2.0	3.8	-3.6	-9.3	1.4	5.2	-9.1	-6.2	2.5	3.1	-5.7	-7.5	1.7	5.3	-7.0	3.1	-0.44	-1.77	213	0.148
99	-7.2	-6.0	2.1	3.8	-3.7	-9.6	1.4	5.2	-9.2	-6.2	2.5	3.2	-5.7	-7.5	1.7	5.4	-7.0	3.1	-0.44	-1.77	213	0.149
100	-7.3	-6.1	2.1	3.8	-3.7	-9.6	1.4	5.2	-9.1	-6.2	2.5	3.2	-5.6	-7.6	1.7	5.4	-7.0	3.1	-0.44	-1.78	214	0.147

Table E.13 NU 52-34 Sample Data (0 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
6	76.85	150.2	-4.27
8	76.71	150.3	-2.33
9	76.72	150.1	-3.44
average	76.76	150.2	-3.35

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.14 NU 52-34 Sample Data (-10 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
6	76.85	150.2	-5.08
8	76.71	150.3	-4.31
9	76.72	150.1	-6.10
average	76.76	150.2	-5.16

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.15 NU 52-34 Sample Data (-20 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
6	76.85	150.2	-8.47
8	76.71	150.3	-7.91
9	76.72	150.1	-10.07
average	76.76	150.2	-8.82

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.16 NU 52-34 Test Data (0 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																			
	NU 52-34 Sample #6				NU 52-34 Sample #8				NU 52-34 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0.000
1	-2.7	-2.8	0.8	1.7	-1.5	-5.4	0.8	2.9	-2.8	-3.4	0.9	1.7	-2.6	1.3	-0.48	-1.66	190	0.191
2	-2.9	-4.0	0.9	2.3	-2.1	-6.2	1.0	3.5	-3.6	-4.0	1.1	2.0	-3.4	1.6	-0.47	-1.69	245	0.181
3	-3.2	-4.9	0.9	2.7	-2.6	-6.9	1.1	4.0	-4.0	-4.3	1.3	2.3	-3.9	1.8	-0.47	-1.69	283	0.179
4	-3.2	-5.4	1.0	3.1	-3.1	-7.7	1.3	4.2	-4.4	-4.5	1.4	2.4	-4.3	2.1	-0.48	-1.67	312	0.188
5	-3.4	-5.7	1.1	3.4	-3.3	-7.6	1.4	4.6	-5.0	-5.0	1.5	2.5	-4.8	2.2	-0.47	-1.70	340	0.176
6	-3.4	-6.2	1.1	3.6	-3.3	-8.1	1.5	4.9	-5.2	-5.1	1.6	2.7	-4.9	2.4	-0.48	-1.66	354	0.193
7	-3.6	-6.6	1.2	3.9	-3.9	-8.6	1.6	5.1	-5.4	-5.4	1.7	2.8	-5.3	2.5	-0.47	-1.69	381	0.181
8	-3.6	-6.9	1.2	4.1	-4.0	-8.8	1.7	5.4	-5.7	-5.6	1.8	2.9	-5.5	2.6	-0.47	-1.67	398	0.188
9	-3.8	-7.2	1.3	4.3	-4.2	-9.0	1.8	5.6	-6.0	-5.8	1.9	3.0	-5.8	2.7	-0.47	-1.69	417	0.180
10	-3.9	-7.5	1.3	4.5	-4.6	-9.5	1.8	5.8	-6.3	-6.1	1.9	3.1	-6.1	2.8	-0.46	-1.70	437	0.174
11	-4.2	-7.8	1.3	4.6	-4.5	-9.6	1.9	6.0	-6.5	-6.2	2.0	3.2	-6.3	2.9	-0.47	-1.69	450	0.179
12	-4.2	-8.1	1.4	4.8	-4.7	-9.7	2.0	6.1	-6.7	-6.4	2.1	3.2	-6.5	3.0	-0.47	-1.69	464	0.181
13	-4.2	-8.2	1.4	4.9	-4.9	-10.0	2.1	6.3	-6.9	-6.5	2.1	3.4	-6.6	3.1	-0.47	-1.68	477	0.182
14	-4.3	-8.4	1.4	5.1	-5.0	-10.2	2.2	6.5	-7.1	-6.7	2.2	3.5	-6.8	3.2	-0.47	-1.67	489	0.188
15	-4.5	-8.7	1.5	5.2	-5.3	-10.4	2.2	6.6	-7.4	-6.9	2.2	3.5	-7.1	3.3	-0.47	-1.69	506	0.179
16	-4.5	-8.8	1.5	5.3	-5.5	-10.7	2.3	6.8	-7.5	-6.9	2.3	3.6	-7.2	3.4	-0.47	-1.68	515	0.186
17	-4.6	-9.1	1.5	5.5	-5.5	-10.9	2.4	6.9	-7.6	-7.0	2.4	3.6	-7.3	3.5	-0.47	-1.67	524	0.188
18	-4.7	-9.2	1.6	5.6	-5.7	-11.0	2.4	7.1	-8.0	-7.2	2.4	3.7	-7.5	3.6	-0.47	-1.68	540	0.184
19	-4.8	-9.4	1.6	5.7	-5.9	-11.3	2.4	7.2	-8.1	-7.2	2.5	3.8	-7.7	3.6	-0.47	-1.68	550	0.185
20	-5.0	-9.5	1.6	5.8	-5.9	-11.4	2.5	7.4	-8.2	-7.4	2.5	3.9	-7.8	3.7	-0.48	-1.67	558	0.189
21	-5.2	-9.7	1.7	5.9	-6.1	-11.5	2.6	7.5	-8.4	-7.6	2.6	4.0	-8.0	3.8	-0.47	-1.67	571	0.186
22	-5.2	-10.0	1.7	6.0	-6.3	-11.8	2.6	7.6	-8.5	-7.7	2.7	4.0	-8.1	3.8	-0.47	-1.68	582	0.184
23	-5.3	-10.2	1.7	6.1	-6.5	-11.8	2.7	7.7	-8.6	-7.8	2.7	4.1	-8.3	3.9	-0.47	-1.68	592	0.184
24	-5.3	-10.3	1.8	6.2	-6.5	-11.8	2.7	7.8	-8.7	-7.9	2.7	4.1	-8.3	4.0	-0.47	-1.67	600	0.187
25	-5.5	-10.4	1.8	6.4	-6.7	-12.1	2.8	7.9	-8.9	-8.0	2.8	4.2	-8.5	4.0	-0.47	-1.67	612	0.187
26	-5.6	-10.7	1.8	6.5	-6.8	-12.2	2.8	8.1	-9.1	-8.0	2.8	4.2	-8.6	4.1	-0.47	-1.67	620	0.186
27	-5.8	-10.7	1.8	6.6	-6.9	-12.4	2.9	8.2	-9.2	-8.1	2.9	4.3	-8.7	4.2	-0.48	-1.66	627	0.191
28	-5.7	-11.0	1.9	6.7	-6.8	-12.4	3.0	8.4	-9.3	-8.2	2.9	4.4	-8.8	4.2	-0.48	-1.65	633	0.197
29	-5.8	-11.0	1.9	6.8	-7.0	-12.6	3.0	8.5	-9.4	-8.4	3.0	4.4	-8.9	4.3	-0.48	-1.66	644	0.193
30	-6.0	-11.3	1.9	6.8	-7.2	-12.7	3.0	8.6	-9.5	-8.4	3.0	4.5	-9.1	4.3	-0.48	-1.67	655	0.188
31	-6.1	-11.3	1.9	7.0	-7.2	-13.1	3.1	8.7	-9.7	-8.5	3.1	4.5	-9.2	4.4	-0.48	-1.66	661	0.194
32	-6.1	-11.5	2.0	7.0	-7.6	-13.1	3.1	8.7	-9.7	-8.5	3.1	4.6	-9.3	4.4	-0.48	-1.67	672	0.189
33	-6.2	-11.6	2.0	7.1	-7.8	-13.7	3.1	8.9	-9.9	-8.7	3.1	4.6	-9.5	4.5	-0.48	-1.67	683	0.189

Table E.16 NU 52-34 Test Data (0 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 52-34 Sample #6				NU 52-34 Sample #8				NU 52-34 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
34	-6.3	-11.7	2.0	7.2	-7.7	-13.4	3.2	8.9	-10.0	-8.7	3.2	4.7	-9.5	4.6	-0.48	-1.66	687	0.193
35	-6.3	-11.9	2.0	7.3	-8.1	-13.7	3.2	9.0	-10.1	-8.7	3.2	4.7	-9.7	4.6	-0.47	-1.67	698	0.188
36	-6.5	-12.0	2.1	7.4	-7.9	-13.6	3.3	9.2	-10.3	-8.9	3.3	4.8	-9.8	4.7	-0.48	-1.66	704	0.194
37	-6.5	-12.2	2.1	7.4	-8.2	-14.0	3.3	9.2	-10.4	-9.1	3.3	4.8	-10.0	4.7	-0.47	-1.67	716	0.186
38	-6.6	-12.3	2.1	7.6	-8.1	-13.9	3.4	9.4	-10.4	-9.1	3.4	4.9	-10.0	4.8	-0.48	-1.66	719	0.194
39	-6.7	-12.4	2.1	7.6	-8.3	-13.9	3.4	9.5	-10.6	-9.1	3.4	4.9	-10.1	4.8	-0.48	-1.66	727	0.193
40	-6.7	-12.5	2.1	7.7	-8.3	-14.0	3.5	9.6	-10.7	-9.3	3.4	5.0	-10.2	4.9	-0.48	-1.66	735	0.194
41	-6.8	-12.6	2.1	7.8	-8.4	-14.1	3.5	9.7	-10.8	-9.4	3.5	5.1	-10.3	5.0	-0.48	-1.65	743	0.196
42	-6.9	-12.7	2.2	7.9	-8.5	-14.3	3.5	9.7	-10.9	-9.5	3.5	5.1	-10.4	5.0	-0.48	-1.65	748	0.195
43	-7.0	-12.8	2.2	8.0	-8.8	-14.3	3.6	9.8	-11.1	-9.4	3.5	5.1	-10.5	5.1	-0.48	-1.66	758	0.194
44	-7.1	-13.1	2.2	8.0	-8.9	-14.5	3.6	9.9	-11.0	-9.5	3.6	5.2	-10.6	5.1	-0.48	-1.65	765	0.195
45	-7.2	-13.0	2.2	8.1	-9.0	-14.7	3.7	10.0	-11.3	-9.6	3.6	5.2	-10.7	5.1	-0.48	-1.66	772	0.193
46	-7.2	-13.2	2.3	8.2	-9.1	-14.6	3.7	10.1	-11.4	-9.7	3.6	5.2	-10.8	5.2	-0.48	-1.66	780	0.193
47	-7.3	-13.4	2.3	8.3	-9.2	-14.7	3.8	10.2	-11.5	-9.8	3.7	5.3	-11.0	5.2	-0.48	-1.66	788	0.192
48	-7.4	-13.4	2.3	8.3	-9.4	-14.9	3.8	10.3	-11.5	-9.9	3.7	5.3	-11.0	5.3	-0.48	-1.66	796	0.193
49	-7.3	-13.5	2.3	8.4	-9.6	-15.1	3.8	10.4	-11.6	-9.9	3.8	5.4	-11.1	5.3	-0.48	-1.66	802	0.194
50	-7.4	-13.6	2.3	8.5	-9.5	-15.0	3.9	10.4	-11.7	-9.9	3.8	5.4	-11.2	5.4	-0.48	-1.65	806	0.196
51	-7.4	-13.7	2.4	8.6	-9.6	-15.1	3.9	10.6	-11.8	-10.0	3.8	5.4	-11.3	5.4	-0.48	-1.65	813	0.196
52	-7.5	-13.9	2.4	8.6	-9.9	-15.5	3.9	10.6	-11.9	-10.2	3.8	5.5	-11.5	5.5	-0.48	-1.67	825	0.189
53	-7.7	-14.0	2.4	8.7	-9.8	-15.3	4.0	10.8	-11.9	-10.2	3.9	5.5	-11.5	5.5	-0.48	-1.65	827	0.195
54	-7.8	-14.1	2.4	8.8	-9.8	-15.3	4.0	10.8	-12.3	-10.4	3.9	5.5	-11.7	5.6	-0.48	-1.67	838	0.190
55	-7.8	-14.2	2.4	8.8	-9.9	-15.3	4.1	10.9	-12.3	-10.3	4.0	5.6	-11.7	5.6	-0.48	-1.65	841	0.195
56	-7.8	-14.2	2.5	8.9	-10.1	-15.6	4.1	11.0	-12.4	-10.4	4.0	5.6	-11.8	5.7	-0.48	-1.66	849	0.194
57	-8.0	-14.3	2.5	9.0	-10.0	-15.5	4.1	11.1	-12.4	-10.4	4.0	5.7	-11.8	5.7	-0.48	-1.64	851	0.200
58	-8.1	-14.5	2.5	9.0	-10.2	-15.7	4.2	11.2	-12.5	-10.5	4.0	5.7	-11.9	5.7	-0.48	-1.65	859	0.197
59	-8.1	-14.5	2.5	9.1	-10.3	-15.8	4.2	11.3	-12.5	-10.6	4.1	5.7	-12.0	5.8	-0.48	-1.65	865	0.197
60	-8.1	-14.5	2.5	9.2	-10.4	-15.8	4.2	11.3	-12.9	-11.0	4.1	5.7	-12.2	5.8	-0.48	-1.67	877	0.190
61	-8.3	-14.9	2.5	9.2	-10.6	-16.0	4.3	11.4	-12.8	-10.8	4.2	5.8	-12.3	5.9	-0.48	-1.66	883	0.192
62	-8.3	-14.8	2.6	9.3	-10.6	-15.9	4.3	11.5	-12.9	-10.7	4.2	5.9	-12.2	5.9	-0.48	-1.64	883	0.199
63	-8.3	-15.0	2.6	9.3	-10.6	-16.1	4.3	11.6	-12.9	-10.9	4.2	5.9	-12.3	6.0	-0.48	-1.65	890	0.197
64	-8.3	-15.0	2.6	9.4	-10.7	-16.3	4.4	11.6	-13.1	-10.9	4.2	5.9	-12.4	6.0	-0.48	-1.65	895	0.199
65	-8.4	-15.2	2.6	9.5	-10.7	-16.3	4.4	11.7	-13.2	-11.0	4.3	6.0	-12.5	6.0	-0.48	-1.65	904	0.196
66	-8.4	-15.2	2.7	9.6	-10.8	-16.5	4.5	11.8	-13.4	-11.1	4.3	6.0	-12.6	6.1	-0.48	-1.65	910	0.197

Table E.16 NU 52-34 Test Data (0 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 52-34 Sample #6				NU 52-34 Sample #8				NU 52-34 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
67	-8.5	-15.2	2.7	9.6	-11.0	-16.5	4.5	11.9	-13.4	-11.1	4.3	6.1	-12.7	6.1	-0.48	-1.65	914	0.198
68	-8.5	-15.3	2.7	9.7	-11.0	-16.8	4.5	12.0	-13.6	-11.2	4.4	6.1	-12.8	6.2	-0.48	-1.64	921	0.200
69	-8.6	-15.4	2.7	9.8	-11.2	-16.8	4.5	12.0	-13.6	-11.2	4.4	6.1	-12.9	6.2	-0.48	-1.65	927	0.197
70	-8.6	-15.5	2.8	9.8	-11.2	-16.8	4.6	12.1	-13.6	-11.3	4.4	6.2	-12.9	6.3	-0.49	-1.64	932	0.201
71	-8.7	-15.6	2.8	9.9	-11.2	-16.9	4.6	12.2	-13.8	-11.4	4.5	6.2	-13.0	6.3	-0.48	-1.64	937	0.199
72	-8.7	-15.6	2.8	10.0	-11.3	-16.9	4.6	12.3	-13.8	-11.4	4.5	6.3	-13.0	6.3	-0.49	-1.64	941	0.202
73	-8.7	-15.7	2.8	10.0	-11.4	-17.1	4.7	12.4	-13.9	-11.5	4.5	6.3	-13.1	6.4	-0.49	-1.64	947	0.201
74	-8.8	-15.7	2.8	10.1	-11.4	-17.2	4.7	12.4	-14.1	-11.5	4.5	6.3	-13.2	6.4	-0.49	-1.64	953	0.201
75	-8.9	-15.9	2.8	10.2	-11.5	-17.3	4.8	12.5	-14.0	-11.6	4.6	6.3	-13.3	6.5	-0.49	-1.64	958	0.203
76	-9.0	-16.0	2.9	10.2	-11.7	-17.3	4.8	12.6	-14.2	-11.6	4.6	6.4	-13.4	6.5	-0.48	-1.64	966	0.200
77	-8.8	-15.9	2.9	10.3	-11.7	-17.5	4.8	12.7	-14.2	-11.7	4.6	6.4	-13.4	6.5	-0.49	-1.63	966	0.205
78	-9.1	-16.2	2.9	10.3	-11.8	-17.6	4.8	12.7	-14.4	-11.9	4.6	6.4	-13.5	6.6	-0.48	-1.65	977	0.199
79	-9.1	-16.3	2.9	10.4	-11.9	-17.6	4.8	12.8	-14.4	-11.9	4.7	6.5	-13.6	6.6	-0.48	-1.64	983	0.199
80	-9.1	-16.1	2.9	10.5	-12.0	-17.7	4.9	12.9	-14.5	-11.9	4.7	6.5	-13.6	6.6	-0.49	-1.63	984	0.205
81	-9.2	-16.4	2.9	10.5	-12.0	-17.8	4.9	13.0	-14.5	-11.9	4.7	6.5	-13.7	6.7	-0.49	-1.64	990	0.203
82	-9.2	-16.4	3.0	10.6	-12.1	-17.8	4.9	13.0	-14.7	-12.1	4.8	6.6	-13.8	6.7	-0.49	-1.64	997	0.201
83	-9.3	-16.5	3.0	10.6	-12.0	-17.8	5.0	13.1	-14.6	-11.9	4.8	6.6	-13.8	6.7	-0.49	-1.63	995	0.207
84	-9.4	-16.6	3.0	10.7	-12.2	-18.1	5.0	13.2	-14.7	-12.1	4.8	6.6	-13.9	6.8	-0.49	-1.63	1005	0.204
85	-9.4	-16.6	3.0	10.8	-12.3	-18.2	5.0	13.3	-14.9	-12.1	4.9	6.7	-14.0	6.8	-0.49	-1.63	1011	0.205
86	-9.5	-16.7	3.0	10.8	-12.3	-18.3	5.0	13.4	-15.0	-12.3	4.9	6.7	-14.1	6.9	-0.49	-1.63	1017	0.204
87	-9.5	-16.9	3.0	10.9	-12.4	-18.4	5.1	13.4	-15.1	-12.3	4.9	6.8	-14.2	6.9	-0.49	-1.63	1023	0.204
88	-9.6	-17.0	3.1	10.9	-12.4	-18.4	5.1	13.5	-15.3	-12.7	4.9	6.7	-14.3	6.9	-0.48	-1.65	1034	0.197
89	-9.6	-17.0	3.1	11.0	-12.5	-18.5	5.1	13.6	-15.3	-12.4	5.0	6.8	-14.3	7.0	-0.49	-1.64	1033	0.203
90	-9.6	-17.0	3.1	11.0	-12.5	-18.6	5.2	13.7	-15.3	-12.6	5.0	6.8	-14.4	7.0	-0.49	-1.63	1038	0.204
91	-9.7	-17.1	3.1	11.1	-12.5	-18.7	5.2	13.7	-15.3	-12.6	5.0	6.8	-14.4	7.0	-0.49	-1.63	1041	0.205
92	-9.7	-17.2	3.1	11.1	-12.7	-18.7	5.2	13.8	-15.5	-12.7	5.0	6.9	-14.5	7.1	-0.49	-1.64	1049	0.202
93	-9.8	-17.3	3.1	11.2	-12.7	-18.9	5.2	13.9	-15.7	-12.8	5.1	6.9	-14.6	7.1	-0.49	-1.64	1056	0.201
94	-10.0	-17.5	3.2	11.2	-12.9	-19.0	5.3	13.9	-15.7	-12.8	5.1	6.9	-14.7	7.1	-0.48	-1.64	1063	0.200
95	-9.9	-17.5	3.2	11.3	-12.9	-19.0	5.3	14.0	-15.8	-12.9	5.1	6.9	-14.8	7.2	-0.48	-1.64	1068	0.199
96	-9.9	-17.5	3.2	11.4	-13.0	-19.2	5.3	14.0	-16.0	-13.1	5.1	6.9	-14.9	7.2	-0.48	-1.65	1074	0.198
97	-10.0	-17.6	3.2	11.4	-13.1	-19.4	5.3	14.1	-15.9	-13.0	5.2	7.0	-14.9	7.2	-0.49	-1.64	1076	0.202
98	-10.0	-17.7	3.3	11.5	-13.2	-21.9	5.4	14.1	-16.0	-13.0	5.2	7.0	-15.0	7.3	-0.48	-1.64	1081	0.200
99	-10.1	-17.8	3.2	11.5	-13.3	-20.7	5.4	14.2	-16.1	-13.2	5.2	7.0	-15.1	7.3	-0.48	-1.65	1089	0.198
100	-10.2	-17.9	3.3	11.6	-13.3	-20.7	5.5	14.3	-16.2	-13.2	5.2	7.1	-15.2	7.3	-0.48	-1.65	1094	0.198

Table E.17 NU 52-34 Test Data (-10 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 52-34 Sample #6				NU 52-34 Sample #8				NU 52-34 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0.000
1	-1.6	-3.3	0.5	1.7	-1.7	-4.2	0.6	2.0	-2.4	-2.3	0.7	1.3	-2.4	1.1	-0.45	-1.76	111	0.154
2	-1.8	-3.8	0.6	2.0	-1.9	-4.8	0.8	2.4	-3.0	-2.8	0.8	1.5	-2.9	1.3	-0.44	-1.78	132	0.145
3	-2.0	-4.0	0.6	2.2	-1.9	-5.1	0.8	2.6	-3.2	-3.0	0.9	1.6	-3.0	1.4	-0.45	-1.75	140	0.158
4	-2.1	-4.2	0.7	2.3	-2.2	-5.3	0.9	2.8	-3.4	-3.1	1.0	1.7	-3.2	1.5	-0.45	-1.74	148	0.160
5	-2.1	-4.4	0.7	2.4	-2.2	-5.5	0.9	3.0	-3.6	-3.2	1.1	1.7	-3.3	1.5	-0.46	-1.72	155	0.169
6	-2.3	-4.7	0.7	2.4	-2.2	-5.5	1.0	3.1	-3.7	-3.3	1.1	1.8	-3.5	1.6	-0.45	-1.74	161	0.162
7	-2.2	-4.6	0.7	2.6	-2.3	-5.8	1.0	3.2	-3.7	-3.5	1.1	1.9	-3.5	1.7	-0.47	-1.69	164	0.180
8	-2.4	-4.9	0.7	2.6	-2.2	-5.7	1.1	3.3	-3.9	-3.5	1.2	1.9	-3.6	1.7	-0.47	-1.69	169	0.181
9	-2.4	-4.9	0.8	2.7	-2.3	-6.0	1.1	3.4	-4.0	-3.6	1.2	2.0	-3.7	1.7	-0.47	-1.68	172	0.185
10	-2.4	-5.1	0.8	2.8	-2.3	-6.0	1.1	3.5	-4.0	-3.6	1.2	2.0	-3.8	1.8	-0.48	-1.67	175	0.189
11	-2.5	-5.1	0.8	2.9	-2.4	-6.1	1.2	3.6	-4.1	-3.7	1.3	2.0	-3.8	1.8	-0.48	-1.66	179	0.193
12	-2.4	-5.2	0.8	2.9	-2.5	-6.1	1.2	3.7	-4.1	-3.7	1.3	2.1	-3.9	1.9	-0.48	-1.64	182	0.200
13	-2.5	-5.3	0.8	3.0	-2.4	-6.3	1.2	3.8	-4.2	-3.8	1.3	2.1	-3.9	1.9	-0.48	-1.64	184	0.200
14	-2.8	-5.6	0.8	3.0	-2.5	-6.4	1.3	3.9	-4.3	-3.8	1.3	2.2	-4.1	2.0	-0.48	-1.65	189	0.196
15	-2.7	-5.5	0.9	3.1	-2.6	-6.4	1.3	3.9	-4.4	-3.9	1.3	2.2	-4.1	2.0	-0.48	-1.64	190	0.199
16	-2.7	-5.6	0.9	3.1	-2.7	-6.7	1.3	4.0	-4.4	-3.9	1.4	2.2	-4.2	2.0	-0.48	-1.65	194	0.196
17	-2.8	-5.7	0.9	3.2	-2.7	-6.5	1.3	4.1	-4.4	-4.0	1.4	2.3	-4.2	2.0	-0.49	-1.63	196	0.206
18	-2.8	-5.7	0.9	3.2	-2.7	-6.8	1.3	4.1	-4.6	-4.0	1.4	2.3	-4.3	2.1	-0.48	-1.64	199	0.200
19	-2.9	-5.8	0.9	3.3	-2.7	-6.8	1.4	4.1	-4.6	-4.0	1.4	2.3	-4.3	2.1	-0.49	-1.64	201	0.202
20	-2.9	-5.8	0.9	3.3	-2.8	-7.0	1.4	4.2	-4.6	-4.1	1.5	2.3	-4.3	2.1	-0.49	-1.63	203	0.206
21	-2.9	-5.9	0.9	3.4	-2.9	-7.1	1.4	4.2	-4.6	-4.0	1.5	2.4	-4.4	2.2	-0.49	-1.62	205	0.211
22	-2.9	-5.9	1.0	3.4	-2.8	-7.2	1.4	4.3	-4.7	-4.1	1.5	2.4	-4.4	2.2	-0.50	-1.61	207	0.214
23	-3.0	-6.1	1.0	3.5	-3.0	-7.1	1.4	4.3	-4.9	-4.3	1.5	2.4	-4.6	2.2	-0.48	-1.65	213	0.196
24	-3.0	-6.1	1.0	3.5	-3.0	-7.2	1.4	4.4	-4.9	-4.3	1.5	2.4	-4.6	2.2	-0.49	-1.64	214	0.202
25	-3.1	-6.1	1.0	3.5	-2.9	-7.2	1.5	4.5	-4.9	-4.3	1.6	2.5	-4.6	2.3	-0.50	-1.61	214	0.215
26	-3.1	-6.2	1.0	3.6	-3.0	-7.6	1.5	4.5	-4.8	-4.1	1.6	2.5	-4.5	2.3	-0.51	-1.59	214	0.228
27	-3.1	-6.2	1.0	3.6	-3.0	-7.5	1.5	4.5	-5.1	-4.3	1.6	2.5	-4.6	2.3	-0.50	-1.61	218	0.215
28	-3.1	-6.4	1.0	3.7	-3.1	-7.6	1.5	4.6	-5.0	-4.4	1.6	2.5	-4.7	2.3	-0.49	-1.62	221	0.212
29	-3.2	-6.4	1.0	3.7	-3.1	-7.6	1.5	4.6	-5.1	-4.4	1.6	2.5	-4.8	2.3	-0.49	-1.62	223	0.209
30	-3.3	-6.6	1.0	3.7	-3.1	-7.6	1.6	4.7	-5.1	-4.4	1.6	2.6	-4.8	2.4	-0.49	-1.62	226	0.211
31	-3.3	-6.6	1.1	3.7	-3.2	-7.8	1.6	4.7	-5.2	-4.5	1.7	2.6	-4.9	2.4	-0.49	-1.62	228	0.209
32	-3.3	-6.6	1.1	3.8	-3.3	-7.8	1.6	4.8	-5.1	-4.5	1.7	2.7	-4.9	2.4	-0.50	-1.61	229	0.215
33	-3.3	-6.8	1.1	3.8	-3.3	-8.0	1.6	4.8	-5.2	-4.5	1.7	2.7	-4.9	2.4	-0.49	-1.62	232	0.210

Table E.17 NU 52-34 Test Data (-10 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 52-34 Sample #6				NU 52-34 Sample #8				NU 52-34 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
34	-3.3	-6.8	1.1	3.8	-3.3	-8.0	1.6	4.9	-5.3	-4.6	1.7	2.7	-5.0	2.5	-0.49	-1.62	234	0.210
35	-3.4	-6.8	1.1	3.9	-3.4	-8.0	1.6	4.9	-5.3	-4.6	1.7	2.7	-5.0	2.5	-0.49	-1.63	236	0.206
36	-3.3	-6.8	1.1	3.9	-3.4	-8.1	1.6	4.9	-5.3	-4.5	1.7	2.7	-5.0	2.5	-0.50	-1.61	236	0.218
37	-3.3	-6.8	1.1	3.9	-3.5	-8.2	1.7	5.0	-5.4	-4.6	1.7	2.7	-5.1	2.5	-0.50	-1.61	238	0.215
38	-3.4	-6.9	1.1	4.0	-3.5	-8.2	1.6	5.0	-5.3	-4.6	1.8	2.8	-5.1	2.5	-0.50	-1.60	239	0.218
39	-3.4	-6.9	1.1	4.0	-3.5	-8.3	1.7	5.0	-5.4	-4.7	1.8	2.8	-5.1	2.5	-0.50	-1.61	241	0.216
40	-3.4	-6.9	1.1	4.0	-3.5	-8.3	1.7	5.1	-5.4	-4.6	1.8	2.8	-5.1	2.6	-0.51	-1.59	240	0.226
41	-3.4	-7.0	1.1	4.0	-3.5	-8.4	1.7	5.1	-5.5	-4.8	1.8	2.8	-5.2	2.6	-0.50	-1.60	243	0.221
42	-3.4	-7.0	1.1	4.0	-3.5	-8.4	1.7	5.1	-5.5	-4.7	1.8	2.8	-5.2	2.6	-0.50	-1.60	244	0.223
43	-3.6	-7.0	1.1	4.1	-3.7	-8.5	1.7	5.2	-5.5	-4.7	1.8	2.9	-5.2	2.6	-0.50	-1.60	247	0.219
44	-3.6	-7.2	1.2	4.2	-3.8	-8.6	1.7	5.2	-5.6	-4.7	1.8	2.9	-5.3	2.7	-0.50	-1.60	250	0.218
45	-3.6	-7.2	1.2	4.2	-3.8	-8.6	1.8	5.2	-5.5	-4.7	1.9	2.9	-5.3	2.7	-0.50	-1.59	250	0.225
46	-3.6	-7.2	1.2	4.2	-3.9	-8.7	1.8	5.2	-5.6	-4.8	1.9	2.9	-5.3	2.7	-0.50	-1.60	252	0.223
47	-3.5	-7.2	1.2	4.2	-3.9	-8.8	1.8	5.3	-5.6	-4.9	1.9	3.0	-5.4	2.7	-0.50	-1.60	255	0.223
48	-3.6	-7.2	1.2	4.3	-3.9	-8.8	1.8	5.3	-5.7	-4.8	1.9	2.9	-5.4	2.7	-0.50	-1.60	255	0.221
49	-3.6	-7.3	1.2	4.3	-3.9	-8.9	1.8	5.3	-5.7	-4.9	1.9	3.0	-5.5	2.7	-0.50	-1.60	258	0.220
50	-3.6	-7.3	1.2	4.3	-4.0	-8.9	1.8	5.4	-5.7	-4.9	1.9	3.0	-5.5	2.8	-0.50	-1.60	258	0.222
51	-3.7	-7.4	1.2	4.3	-4.0	-9.0	1.8	5.4	-5.8	-5.1	1.9	3.0	-5.6	2.8	-0.49	-1.62	262	0.211
52	-3.6	-7.3	1.2	4.4	-4.0	-9.2	1.8	5.4	-5.8	-4.9	1.9	3.0	-5.5	2.8	-0.50	-1.60	260	0.222
53	-3.6	-7.4	1.2	4.4	-4.2	-9.2	1.8	5.4	-5.8	-4.9	1.9	3.0	-5.6	2.8	-0.50	-1.60	263	0.221
54	-3.6	-7.4	1.2	4.4	-4.3	-9.4	1.8	5.5	-5.7	-4.9	2.0	3.0	-5.6	2.8	-0.50	-1.60	263	0.221
55	-3.6	-7.3	1.3	4.4	-4.3	-9.4	1.9	5.5	-5.8	-5.0	2.0	3.1	-5.6	2.8	-0.51	-1.59	264	0.227
56	-3.7	-7.4	1.3	4.4	-4.3	-9.5	1.9	5.5	-6.0	-5.2	2.0	3.0	-5.7	2.8	-0.49	-1.62	269	0.210
57	-3.6	-7.5	1.2	4.5	-4.5	-9.6	1.9	5.5	-5.8	-4.9	2.0	3.1	-5.7	2.9	-0.50	-1.60	269	0.221
58	-3.7	-7.4	1.3	4.5	-4.3	-9.7	1.9	5.5	-5.9	-5.1	2.0	3.1	-5.7	2.9	-0.50	-1.60	268	0.223
59	-3.6	-7.4	1.3	4.6	-4.5	-9.5	1.9	5.5	-5.9	-5.1	2.0	3.1	-5.7	2.9	-0.50	-1.59	271	0.225
60	-3.7	-7.6	1.3	4.6	-4.5	-9.7	1.9	5.6	-6.0	-5.1	2.0	3.1	-5.8	2.9	-0.50	-1.60	273	0.219
61	-3.7	-7.5	1.3	4.6	-4.3	-9.6	2.0	5.7	-6.0	-5.1	2.0	3.2	-5.7	2.9	-0.51	-1.57	271	0.234
62	-3.8	-7.6	1.3	4.6	-4.6	-9.7	2.0	5.7	-6.0	-5.1	2.0	3.2	-5.8	2.9	-0.51	-1.59	275	0.227
63	-3.7	-7.7	1.3	4.6	-4.5	-9.8	2.0	5.8	-6.0	-5.1	2.1	3.2	-5.8	3.0	-0.51	-1.58	275	0.229
64	-3.7	-7.7	1.3	4.7	-4.6	-9.7	2.0	5.8	-6.1	-5.1	2.1	3.2	-5.9	3.0	-0.51	-1.58	277	0.229
65	-3.7	-7.7	1.3	4.7	-4.5	-9.7	2.0	5.8	-6.1	-5.1	2.1	3.2	-5.8	3.0	-0.51	-1.58	276	0.233
66	-3.7	-7.7	1.3	4.7	-4.7	-9.9	2.0	5.9	-6.0	-5.2	2.1	3.2	-5.9	3.0	-0.51	-1.58	279	0.232

Table E.17 NU 52-34 Test Data (-10 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 52-34 Sample #6				NU 52-34 Sample #8				NU 52-34 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
67	-3.8	-7.9	1.3	4.7	-4.6	-9.8	2.0	5.9	-6.1	-5.2	2.1	3.2	-5.9	3.0	-0.51	-1.58	280	0.230
68	-3.7	-7.8	1.3	4.8	-4.6	-9.9	2.0	5.9	-6.1	-5.2	2.1	3.2	-5.9	3.0	-0.51	-1.57	281	0.235
69	-3.8	-7.8	1.3	4.8	-4.7	-10.0	2.1	6.0	-6.2	-5.2	2.1	3.3	-6.0	3.1	-0.51	-1.57	282	0.234
70	-3.8	-7.9	1.3	4.8	-4.6	-9.9	2.1	6.0	-6.1	-5.3	2.1	3.3	-6.0	3.1	-0.51	-1.57	283	0.238
71	-3.8	-7.9	1.3	4.8	-4.6	-10.1	2.1	6.0	-6.2	-5.2	2.2	3.3	-5.9	3.1	-0.52	-1.56	282	0.241
72	-3.9	-8.0	1.4	4.8	-4.7	-10.1	2.1	6.1	-6.2	-5.2	2.2	3.3	-6.0	3.1	-0.51	-1.57	285	0.236
73	-3.8	-7.8	1.4	4.9	-4.7	-10.1	2.1	6.1	-6.2	-5.3	2.2	3.3	-6.0	3.1	-0.52	-1.56	285	0.241
74	-3.9	-7.9	1.4	4.9	-4.7	-10.1	2.1	6.1	-6.2	-5.3	2.2	3.3	-6.0	3.1	-0.52	-1.56	286	0.241
75	-3.9	-8.1	1.4	4.9	-4.7	-10.1	2.1	6.2	-6.2	-5.3	2.2	3.3	-6.1	3.1	-0.51	-1.58	289	0.233
76	-3.8	-8.0	1.4	4.9	-4.7	-10.1	2.1	6.2	-6.3	-5.3	2.2	3.3	-6.1	3.1	-0.51	-1.57	289	0.239
77	-3.9	-8.0	1.4	4.9	-4.7	-10.2	2.1	6.2	-6.3	-5.4	2.2	3.4	-6.1	3.2	-0.52	-1.56	290	0.243
78	-4.0	-8.0	1.4	5.0	-4.7	-10.2	2.1	6.2	-6.3	-5.3	2.2	3.4	-6.1	3.2	-0.52	-1.54	289	0.251
79	-3.9	-8.1	1.4	4.9	-4.7	-10.1	2.2	6.2	-6.4	-5.5	2.2	3.4	-6.2	3.2	-0.52	-1.56	292	0.240
80	-3.8	-8.1	1.4	5.0	-4.7	-10.3	2.2	6.2	-6.4	-5.4	2.2	3.4	-6.1	3.2	-0.52	-1.54	291	0.251
81	-4.0	-8.3	1.4	5.0	-4.7	-10.2	2.2	6.3	-6.3	-5.4	2.2	3.4	-6.2	3.2	-0.52	-1.56	294	0.243
82	-4.0	-8.1	1.4	5.0	-4.8	-10.3	2.2	6.3	-6.4	-5.5	2.3	3.5	-6.2	3.2	-0.52	-1.55	295	0.247
83	-3.9	-8.1	1.4	5.1	-4.7	-10.3	2.2	6.3	-6.4	-5.5	2.3	3.5	-6.2	3.3	-0.53	-1.53	293	0.257
84	-3.9	-8.1	1.4	5.1	-4.7	-10.3	2.2	6.4	-6.5	-5.6	2.3	3.5	-6.2	3.3	-0.52	-1.55	297	0.247
85	-3.9	-8.1	1.4	5.1	-4.7	-10.3	2.2	6.4	-6.5	-5.5	2.3	3.5	-6.2	3.3	-0.53	-1.53	295	0.258
86	-3.8	-8.2	1.5	5.1	-4.7	-10.4	2.2	6.4	-6.5	-5.5	2.3	3.5	-6.2	3.3	-0.53	-1.53	296	0.260
87	-4.0	-8.2	1.5	5.2	-4.8	-10.3	2.3	6.5	-6.5	-5.5	2.3	3.5	-6.3	3.3	-0.53	-1.53	298	0.261
88	-3.9	-8.1	1.5	5.2	-4.7	-10.2	2.3	6.5	-6.5	-5.6	2.3	3.5	-6.2	3.3	-0.53	-1.52	298	0.264
89	-3.9	-8.2	1.5	5.2	-4.8	-10.3	2.3	6.5	-6.6	-5.6	2.3	3.6	-6.3	3.3	-0.53	-1.53	301	0.257
90	-3.9	-8.2	1.5	5.2	-4.7	-10.5	2.3	6.5	-6.6	-5.6	2.3	3.6	-6.3	3.4	-0.53	-1.52	300	0.265
91	-3.9	-8.3	1.5	5.2	-4.8	-10.4	2.3	6.6	-6.5	-5.6	2.3	3.6	-6.3	3.4	-0.53	-1.53	301	0.262
92	-3.9	-8.3	1.5	5.2	-4.7	-10.3	2.3	6.6	-6.6	-5.6	2.3	3.6	-6.3	3.4	-0.54	-1.52	302	0.266
93	-4.0	-8.3	1.5	5.3	-4.7	-10.5	2.3	6.6	-6.7	-5.6	2.3	3.6	-6.3	3.4	-0.53	-1.52	302	0.265
94	-3.9	-8.3	1.5	5.3	-4.7	-10.4	2.3	6.6	-6.6	-5.7	2.4	3.6	-6.3	3.4	-0.54	-1.51	303	0.269
95	-4.0	-8.4	1.5	5.3	-4.7	-10.4	2.3	6.7	-6.6	-5.6	2.4	3.6	-6.4	3.4	-0.54	-1.52	304	0.266
96	-3.9	-8.3	1.5	5.3	-4.7	-10.5	2.3	6.7	-6.7	-5.7	2.4	3.6	-6.3	3.4	-0.54	-1.51	304	0.272
97	-4.0	-8.4	1.5	5.3	-4.6	-10.5	2.4	6.8	-6.7	-5.7	2.4	3.6	-6.4	3.4	-0.54	-1.51	304	0.273
98	-3.9	-8.4	1.5	5.4	-4.8	-10.6	2.3	6.7	-6.7	-5.7	2.4	3.6	-6.4	3.4	-0.54	-1.52	307	0.266
99	-4.0	-8.5	1.5	5.4	-4.7	-10.5	2.4	6.8	-6.8	-5.8	2.4	3.7	-6.4	3.5	-0.54	-1.51	307	0.270
100	-4.1	-8.5	1.5	5.4	-4.7	-10.5	2.4	6.8	-6.8	-5.7	2.4	3.7	-6.4	3.5	-0.54	-1.51	307	0.271

Table E.18 NU 52-34 Test Data (-20 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 52-34 Sample #6				NU 52-34 Sample #8				NU 52-34 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0.000
1	-1.6	-3.4	0.5	1.6	-1.4	-4.6	0.6	1.8	-2.1	-2.3	0.6	1.2	-1.8	1.0	-0.54	-1.51	51	0.270
2	-2.1	-4.1	0.6	2.0	-1.6	-5.1	0.6	2.1	-2.8	-3.2	0.8	1.6	-2.4	1.3	-0.53	-1.53	67	0.256
3	-2.2	-4.3	0.6	2.1	-1.8	-5.5	0.7	2.2	-3.1	-3.5	0.9	1.7	-2.6	1.3	-0.52	-1.55	71	0.247
4	-2.2	-4.4	0.7	2.2	-1.8	-5.6	0.7	2.3	-3.2	-3.6	0.9	1.8	-2.6	1.4	-0.53	-1.53	73	0.260
5	-2.3	-4.5	0.7	2.2	-1.9	-5.8	0.7	2.4	-3.3	-3.8	1.0	1.8	-2.7	1.4	-0.52	-1.54	76	0.252
6	-2.3	-4.6	0.7	2.3	-1.9	-5.8	0.7	2.5	-3.3	-3.8	1.0	1.8	-2.7	1.5	-0.54	-1.51	77	0.269
7	-2.4	-4.8	0.7	2.4	-1.9	-6.0	0.8	2.6	-3.4	-3.9	1.0	1.9	-2.8	1.5	-0.53	-1.52	79	0.264
8	-2.5	-4.8	0.7	2.4	-2.2	-6.1	0.8	2.6	-3.5	-3.9	1.0	1.9	-2.9	1.5	-0.53	-1.54	81	0.253
9	-2.5	-4.8	0.7	2.4	-2.0	-6.1	0.8	2.7	-3.6	-4.0	1.0	1.9	-2.9	1.5	-0.53	-1.53	82	0.257
10	-2.5	-4.9	0.7	2.4	-2.2	-6.2	0.8	2.7	-3.6	-4.0	1.0	2.0	-3.0	1.6	-0.53	-1.53	83	0.260
11	-2.5	-5.0	0.8	2.5	-2.0	-6.3	0.8	2.8	-3.8	-4.0	1.1	2.0	-3.0	1.6	-0.53	-1.53	84	0.262
12	-2.6	-5.0	0.7	2.5	-2.2	-6.3	0.8	2.8	-3.8	-4.1	1.1	2.0	-3.0	1.6	-0.53	-1.53	85	0.258
13	-2.6	-5.1	0.8	2.5	-2.2	-6.4	0.8	2.8	-3.8	-4.2	1.1	2.0	-3.1	1.6	-0.53	-1.53	86	0.257
14	-2.7	-5.2	0.7	2.5	-2.2	-6.4	0.9	2.9	-3.9	-4.2	1.1	2.0	-3.1	1.6	-0.52	-1.55	87	0.250
15	-2.6	-5.2	0.8	2.6	-2.2	-6.5	0.9	3.0	-3.9	-4.2	1.1	2.1	-3.1	1.7	-0.53	-1.53	88	0.259
16	-2.6	-5.2	0.8	2.6	-2.3	-6.5	0.9	3.0	-4.0	-4.3	1.1	2.1	-3.2	1.7	-0.53	-1.54	89	0.254
17	-2.7	-5.3	0.8	2.7	-2.2	-6.4	0.9	3.0	-4.0	-4.3	1.2	2.1	-3.2	1.7	-0.53	-1.52	89	0.263
18	-2.7	-5.3	0.8	2.7	-2.2	-6.6	0.9	3.0	-4.0	-4.3	1.2	2.1	-3.2	1.7	-0.53	-1.52	90	0.264
19	-2.7	-5.3	0.8	2.7	-2.2	-6.6	0.9	3.0	-4.0	-4.3	1.2	2.1	-3.2	1.7	-0.54	-1.50	90	0.275
20	-2.6	-5.4	0.8	2.8	-2.4	-6.8	0.9	3.1	-4.2	-4.4	1.2	2.2	-3.3	1.8	-0.54	-1.52	92	0.267
21	-2.7	-5.3	0.8	2.8	-2.3	-6.7	0.9	3.1	-4.3	-4.6	1.2	2.1	-3.3	1.8	-0.53	-1.54	93	0.255
22	-2.6	-5.3	0.9	2.8	-2.4	-6.8	0.9	3.1	-4.2	-4.4	1.2	2.2	-3.2	1.8	-0.55	-1.49	91	0.287
23	-2.6	-5.3	0.8	2.9	-2.3	-6.9	0.9	3.1	-4.2	-4.6	1.2	2.2	-3.3	1.8	-0.54	-1.51	93	0.274
24	-2.6	-5.3	0.9	2.9	-2.3	-6.9	0.9	3.2	-4.3	-4.5	1.2	2.2	-3.3	1.8	-0.55	-1.48	93	0.289
25	-2.6	-5.3	0.9	2.9	-2.4	-7.0	0.9	3.2	-4.3	-4.5	1.2	2.2	-3.3	1.8	-0.56	-1.47	93	0.298
26	-2.8	-5.5	0.9	2.9	-2.5	-7.1	0.9	3.3	-4.2	-4.6	1.2	2.2	-3.4	1.8	-0.54	-1.50	95	0.276
27	-2.6	-5.3	0.9	2.9	-2.5	-7.0	1.0	3.3	-4.3	-4.5	1.3	2.2	-3.3	1.8	-0.56	-1.46	93	0.303
28	-2.6	-5.3	0.9	3.0	-2.5	-7.0	1.0	3.3	-4.3	-4.5	1.3	2.2	-3.3	1.9	-0.57	-1.45	93	0.311
29	-2.5	-5.3	0.9	3.0	-2.6	-7.2	1.0	3.3	-4.3	-4.6	1.3	2.2	-3.3	1.9	-0.56	-1.46	94	0.304
30	-2.5	-5.3	0.9	3.0	-2.7	-7.2	1.0	3.3	-4.4	-4.7	1.3	2.3	-3.4	1.9	-0.56	-1.48	95	0.294
31	-2.5	-5.3	0.9	3.1	-2.8	-7.2	1.0	3.3	-4.3	-4.7	1.3	2.3	-3.4	1.9	-0.56	-1.46	95	0.307
32	-2.5	-5.5	0.9	3.0	-2.8	-7.3	1.0	3.3	-4.4	-4.6	1.3	2.3	-3.4	1.9	-0.56	-1.47	96	0.297
33	-2.5	-5.3	0.9	3.1	-2.8	-7.3	1.0	3.3	-4.4	-4.6	1.3	2.3	-3.3	1.9	-0.57	-1.45	95	0.316

Table E.18 NU 52-34 Test Data (-20 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 52-34 Sample #6				NU 52-34 Sample #8				NU 52-34 Sample #9				Trimmed Mean				Creep Comp	Pois. Ratio
Time	vert front	vert back	horz front	horz back	vert front	vert back	horz front	horz back	vert front	vert back	horz front	horz back	vert	horz	Ratio X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
34	-2.7	-5.7	0.9	3.0	-2.8	-7.4	1.0	3.3	-4.4	-4.7	1.3	2.3	-3.5	1.9	-0.55	-1.49	98	0.285
35	-2.5	-5.4	0.9	3.1	-2.8	-7.5	1.0	3.4	-4.5	-4.7	1.3	2.3	-3.4	1.9	-0.56	-1.46	96	0.305
36	-2.5	-5.3	1.0	3.1	-2.8	-7.4	1.0	3.4	-4.4	-4.6	1.3	2.3	-3.4	1.9	-0.58	-1.43	95	0.326
37	-2.5	-5.3	1.0	3.1	-3.0	-7.6	1.0	3.4	-4.5	-4.6	1.3	2.3	-3.4	1.9	-0.58	-1.43	96	0.325
38	-2.5	-5.4	1.0	3.1	-2.9	-7.6	1.0	3.4	-4.4	-4.6	1.3	2.4	-3.4	2.0	-0.58	-1.42	96	0.332
39	-2.6	-5.4	1.0	3.1	-3.0	-7.7	1.0	3.4	-4.5	-4.7	1.3	2.4	-3.4	2.0	-0.58	-1.43	97	0.329
40	-2.5	-5.5	1.0	3.2	-3.0	-7.7	1.0	3.4	-4.5	-4.7	1.4	2.4	-3.4	2.0	-0.58	-1.42	97	0.334
41	-2.5	-5.5	1.0	3.2	-3.0	-7.7	1.0	3.4	-4.5	-4.6	1.4	2.4	-3.4	2.0	-0.59	-1.41	97	0.341
42	-2.4	-5.5	1.0	3.2	-3.1	-7.8	1.0	3.4	-4.4	-4.7	1.4	2.4	-3.4	2.0	-0.59	-1.40	97	0.349
43	-2.5	-5.5	1.0	3.2	-3.1	-7.8	1.0	3.4	-4.5	-4.6	1.4	2.5	-3.4	2.0	-0.59	-1.41	98	0.344
44	-2.5	-5.5	1.0	3.2	-3.1	-7.9	1.0	3.4	-4.5	-4.6	1.4	2.5	-3.4	2.0	-0.59	-1.40	98	0.349
45	-2.5	-5.6	1.0	3.3	-3.0	-7.8	1.0	3.5	-4.5	-4.6	1.4	2.5	-3.4	2.0	-0.60	-1.40	98	0.354
46	-2.5	-5.6	1.0	3.3	-3.1	-7.9	1.0	3.5	-4.4	-4.6	1.4	2.5	-3.4	2.0	-0.60	-1.39	98	0.360
47	-2.5	-5.6	1.0	3.3	-3.1	-7.9	1.0	3.5	-4.4	-4.6	1.4	2.5	-3.4	2.1	-0.60	-1.39	98	0.365
48	-2.5	-5.5	1.0	3.3	-3.1	-7.8	1.0	3.5	-4.4	-4.6	1.4	2.5	-3.4	2.1	-0.62	-1.36	97	0.386
49	-2.5	-5.7	1.0	3.3	-3.1	-7.9	1.0	3.6	-4.4	-4.6	1.4	2.5	-3.4	2.1	-0.61	-1.37	99	0.376
50	-2.6	-5.7	1.0	3.4	-3.1	-7.9	1.1	3.6	-4.3	-4.6	1.4	2.5	-3.4	2.1	-0.62	-1.35	98	0.397
51	-2.6	-5.6	1.0	3.3	-3.1	-7.9	1.1	3.6	-4.4	-4.7	1.4	2.6	-3.4	2.1	-0.61	-1.37	99	0.382
52	-2.6	-5.7	1.0	3.4	-3.1	-7.9	1.1	3.6	-4.4	-4.6	1.5	2.6	-3.4	2.1	-0.62	-1.35	99	0.397
53	-2.5	-5.7	1.0	3.4	-3.2	-8.0	1.1	3.6	-4.4	-4.5	1.5	2.6	-3.4	2.1	-0.63	-1.35	98	0.399
54	-2.6	-5.7	1.0	3.3	-3.1	-8.0	1.1	3.6	-4.3	-4.6	1.5	2.6	-3.4	2.1	-0.62	-1.36	99	0.390
55	-2.7	-5.7	1.0	3.3	-3.1	-8.0	1.1	3.7	-4.4	-4.6	1.5	2.6	-3.4	2.1	-0.62	-1.35	99	0.393
56	-2.7	-6.0	1.0	3.3	-3.1	-8.1	1.1	3.7	-4.4	-4.6	1.5	2.6	-3.5	2.1	-0.61	-1.37	100	0.381
57	-2.8	-6.0	1.0	3.3	-3.2	-8.1	1.1	3.7	-4.3	-4.6	1.5	2.6	-3.5	2.1	-0.62	-1.36	100	0.384
58	-2.9	-6.0	1.0	3.3	-3.1	-8.0	1.1	3.7	-4.4	-4.5	1.5	2.6	-3.5	2.1	-0.61	-1.37	101	0.382
59	-2.9	-6.0	1.0	3.3	-3.1	-8.0	1.1	3.7	-4.4	-4.6	1.5	2.6	-3.5	2.1	-0.62	-1.36	101	0.386
60	-2.9	-6.1	1.0	3.4	-3.1	-8.0	1.1	3.7	-4.4	-4.5	1.5	2.6	-3.5	2.2	-0.62	-1.36	101	0.391
61	-2.9	-6.0	1.0	3.3	-3.1	-8.1	1.1	3.7	-4.4	-4.6	1.5	2.7	-3.5	2.2	-0.62	-1.36	101	0.388
62	-3.1	-6.3	1.0	3.3	-3.2	-8.1	1.1	3.8	-4.3	-4.5	1.5	2.7	-3.5	2.2	-0.61	-1.37	102	0.375
63	-3.0	-6.2	1.0	3.4	-3.2	-8.1	1.1	3.8	-4.3	-4.6	1.5	2.7	-3.5	2.2	-0.61	-1.37	102	0.382
64	-3.0	-6.2	1.0	3.4	-3.1	-8.2	1.1	3.8	-4.3	-4.6	1.5	2.7	-3.5	2.2	-0.62	-1.35	102	0.394
65	-3.2	-6.4	1.0	3.3	-3.2	-8.1	1.1	3.8	-4.4	-4.6	1.5	2.7	-3.6	2.2	-0.61	-1.38	103	0.372
66	-2.9	-6.4	1.0	3.4	-3.1	-8.1	1.1	3.8	-4.4	-4.6	1.5	2.7	-3.6	2.2	-0.61	-1.37	103	0.381

Table E.18 NU 52-34 Test Data (-20 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays												Trimmed				Creep	Pois.
	NU 52-34 Sample #6				NU 52-34 Sample #8				NU 52-34 Sample #9				Mean		Ratio		Comp	Ratio
Time sec	vert front µm	vert back µm	horz front µm	horz back µm	vert front µm	vert back µm	horz front µm	horz back µm	vert front µm	vert back µm	horz front µm	horz back µm	vert µm	horz µm	X/Y	C_{empl}	D(t) 1/kPa	ν
67	-3.0	-6.3	1.0	3.4	-3.1	-8.1	1.1	3.8	-4.4	-4.6	1.5	2.7	-3.6	2.2	-0.62	-1.36	103	0.386
68	-3.0	-6.4	1.1	3.4	-3.1	-8.0	1.1	3.9	-4.5	-4.7	1.5	2.8	-3.6	2.2	-0.61	-1.37	104	0.377
69	-3.2	-6.4	1.1	3.4	-3.2	-8.2	1.1	3.8	-4.5	-4.6	1.6	2.8	-3.6	2.2	-0.62	-1.36	104	0.390
70	-3.0	-6.4	1.1	3.4	-3.1	-8.2	1.1	3.9	-4.5	-4.7	1.6	2.7	-3.6	2.2	-0.61	-1.38	105	0.369
71	-3.2	-6.5	1.1	3.4	-3.4	-8.5	1.1	3.8	-4.6	-4.7	1.5	2.7	-3.7	2.2	-0.60	-1.39	106	0.361
72	-3.1	-6.4	1.1	3.5	-3.2	-8.3	1.1	3.9	-4.5	-4.7	1.6	2.7	-3.6	2.2	-0.61	-1.37	105	0.378
73	-3.2	-6.4	1.1	3.5	-3.1	-8.1	1.2	3.9	-4.6	-4.8	1.6	2.8	-3.7	2.2	-0.61	-1.38	106	0.373
74	-3.2	-6.5	1.1	3.4	-3.1	-8.1	1.2	3.9	-4.6	-4.7	1.6	2.7	-3.7	2.2	-0.60	-1.38	106	0.365
75	-3.2	-6.5	1.1	3.4	-3.2	-8.2	1.2	4.0	-4.6	-4.8	1.6	2.7	-3.7	2.2	-0.60	-1.39	107	0.363
76	-3.2	-6.6	1.1	3.5	-3.1	-8.2	1.2	4.0	-4.7	-4.8	1.6	2.7	-3.7	2.2	-0.60	-1.39	107	0.360
77	-3.2	-6.7	1.1	3.4	-3.1	-8.2	1.2	4.0	-4.6	-4.9	1.6	2.7	-3.8	2.2	-0.59	-1.41	108	0.345
78	-3.2	-6.5	1.1	3.4	-3.1	-8.3	1.2	4.0	-4.7	-4.9	1.6	2.8	-3.8	2.2	-0.60	-1.40	108	0.354
79	-3.2	-6.5	1.1	3.4	-3.1	-8.2	1.2	4.0	-4.6	-4.8	1.6	2.8	-3.7	2.2	-0.60	-1.39	107	0.365
80	-3.1	-6.6	1.1	3.4	-3.2	-8.2	1.2	4.0	-4.7	-4.8	1.6	2.8	-3.8	2.3	-0.60	-1.39	108	0.362
81	-3.2	-6.5	1.1	3.5	-3.2	-8.2	1.2	4.0	-4.8	-4.9	1.6	2.8	-3.8	2.3	-0.60	-1.39	109	0.358
82	-3.2	-6.6	1.1	3.4	-3.1	-8.1	1.2	4.1	-4.8	-5.0	1.6	2.8	-3.8	2.2	-0.59	-1.41	109	0.341
83	-3.2	-6.6	1.1	3.5	-3.1	-8.1	1.2	4.1	-4.9	-5.0	1.6	2.8	-3.9	2.3	-0.59	-1.42	110	0.339
84	-3.2	-6.6	1.1	3.5	-3.1	-8.1	1.2	4.1	-4.9	-5.1	1.6	2.8	-3.9	2.3	-0.58	-1.42	111	0.336
85	-3.2	-6.7	1.1	3.5	-3.1	-8.2	1.2	4.1	-4.9	-5.1	1.6	2.8	-3.9	2.3	-0.58	-1.42	111	0.333
86	-3.2	-6.7	1.1	3.5	-3.0	-8.2	1.2	4.1	-4.9	-5.0	1.6	2.8	-3.9	2.3	-0.59	-1.41	111	0.342
87	-3.1	-6.6	1.1	3.6	-2.9	-8.1	1.2	4.2	-5.0	-5.0	1.6	2.8	-3.9	2.3	-0.59	-1.41	111	0.343
88	-3.2	-6.7	1.1	3.5	-2.8	-8.1	1.2	4.2	-4.9	-5.2	1.6	2.8	-3.9	2.3	-0.58	-1.42	112	0.334
89	-3.2	-6.7	1.1	3.6	-2.9	-8.1	1.2	4.2	-5.0	-5.0	1.6	2.8	-3.9	2.3	-0.59	-1.41	112	0.342
90	-3.2	-6.7	1.1	3.6	-2.8	-8.1	1.2	4.2	-5.0	-5.2	1.6	2.8	-3.9	2.3	-0.58	-1.42	113	0.334
91	-3.1	-6.7	1.1	3.6	-2.9	-8.2	1.2	4.2	-5.0	-5.2	1.6	2.8	-3.9	2.3	-0.59	-1.41	113	0.342
92	-3.1	-6.7	1.1	3.6	-2.8	-8.1	1.3	4.3	-5.0	-5.1	1.7	2.8	-3.9	2.3	-0.59	-1.40	112	0.348
93	-3.2	-6.6	1.1	3.6	-2.7	-7.9	1.3	4.3	-5.0	-5.2	1.6	2.8	-3.9	2.3	-0.59	-1.40	113	0.351
94	-3.1	-6.7	1.1	3.6	-2.8	-7.9	1.3	4.3	-5.1	-5.2	1.6	2.8	-4.0	2.3	-0.59	-1.41	113	0.348
95	-3.0	-6.7	1.1	3.7	-2.8	-7.9	1.3	4.3	-5.0	-5.2	1.7	2.8	-3.9	2.4	-0.60	-1.39	113	0.360
96	-3.2	-6.5	1.1	3.7	-2.7	-7.9	1.3	4.3	-5.1	-5.2	1.7	2.8	-3.9	2.4	-0.60	-1.39	113	0.360
97	-3.0	-6.5	1.1	3.7	-2.9	-8.2	1.3	4.3	-5.1	-5.3	1.7	2.8	-3.9	2.4	-0.60	-1.40	113	0.356
98	-3.0	-6.5	1.1	3.7	-2.7	-7.9	1.3	4.3	-5.0	-5.1	1.7	2.8	-3.9	2.4	-0.61	-1.37	112	0.377
99	-3.1	-6.6	1.1	3.7	-2.7	-7.9	1.3	4.4	-5.2	-5.4	1.7	2.8	-4.0	2.4	-0.59	-1.40	115	0.348
100	-3.0	-6.5	1.1	3.7	-2.8	-7.9	1.3	4.4	-5.2	-5.3	1.7	2.8	-4.0	2.4	-0.60	-1.39	114	0.359

Table E.19 NU 58-40 Sample Data (0 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
11	76.94	150.1	-2.93
12	76.81	150.0	-2.60
9	76.79	150.1	-2.39
average	76.85	150.1	-2.64

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.20 NU 58-40 Sample Data (-10 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
11	76.94	150.1	-4.70
12	76.81	150.0	-3.65
9	76.79	150.1	-3.80
average	76.85	150.1	-4.05

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.21 NU 58-40 Sample Data (-20 °C Tests)

	Thickness	Diameter	Creep Load
Sample	mm	mm	kN
11	76.94	150.1	-10.21
12	76.81	150.0	-6.53
9	76.79	150.1	-7.71
average	76.85	150.1	-8.15

Gage length, m	0.038
C_{empl} low	0.595
C_{empl} high	1.466

Table E.22 NU 58-40 Test Data (0 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 58-40 Sample #11				NU 58-40 Sample #12				NU 58-40 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0.000
1	-4.5	-2.5	1.2	1.5	-2.8	-4.8	0.9	2.6	-4.6	-6.4	1.7	3.7	-4.2	1.7	-0.42	-1.86	372	0.122
2	-5.8	-3.3	1.5	1.9	-3.5	-6.0	1.1	3.4	-5.8	-8.4	2.3	4.9	-5.3	2.2	-0.42	-1.83	473	0.129
3	-6.8	-3.8	1.7	2.2	-4.0	-7.0	1.3	3.9	-6.8	-9.9	2.7	5.8	-6.2	2.6	-0.42	-1.84	550	0.127
4	-7.4	-4.1	1.9	2.4	-4.6	-7.7	1.4	4.3	-7.6	-11.1	3.0	6.5	-6.8	2.9	-0.42	-1.83	609	0.130
5	-8.0	-4.4	2.1	2.7	-4.9	-8.4	1.6	4.7	-8.1	-12.1	3.3	7.1	-7.4	3.2	-0.43	-1.81	659	0.137
6	-8.5	-4.7	2.3	2.8	-5.2	-8.9	1.7	5.0	-8.7	-13.0	3.5	7.7	-7.8	3.4	-0.43	-1.80	703	0.138
7	-9.0	-5.0	2.4	3.0	-5.5	-9.5	1.8	5.3	-9.2	-13.7	3.7	8.1	-8.3	3.6	-0.43	-1.79	743	0.141
8	-9.5	-5.2	2.5	3.2	-5.9	-9.9	1.9	5.6	-9.6	-14.4	3.9	8.5	-8.7	3.8	-0.43	-1.79	782	0.141
9	-9.8	-5.6	2.6	3.3	-6.1	-10.3	2.0	5.8	-10.1	-15.2	4.1	8.9	-9.1	3.9	-0.44	-1.79	815	0.141
10	-10.2	-5.7	2.8	3.5	-6.2	-10.4	2.1	6.0	-10.5	-15.8	4.2	9.3	-9.3	4.1	-0.44	-1.77	841	0.149
11	-10.6	-5.8	2.9	3.6	-6.7	-11.0	2.2	6.2	-10.9	-16.3	4.4	9.6	-9.8	4.3	-0.44	-1.79	880	0.142
12	-10.9	-6.1	3.0	3.8	-6.8	-11.3	2.2	6.5	-11.2	-16.9	4.5	9.9	-10.1	4.4	-0.44	-1.77	905	0.149
13	-11.3	-6.3	3.1	3.9	-7.0	-11.7	2.3	6.7	-11.5	-17.3	4.7	10.3	-10.4	4.6	-0.44	-1.77	935	0.149
14	-11.7	-6.5	3.1	4.0	-7.2	-12.0	2.4	6.8	-11.8	-17.8	4.8	10.6	-10.7	4.7	-0.44	-1.78	960	0.147
15	-12.0	-6.7	3.2	4.1	-7.5	-12.3	2.5	7.0	-12.1	-18.4	4.9	10.8	-11.0	4.8	-0.44	-1.77	987	0.148
16	-12.2	-6.8	3.3	4.2	-7.6	-12.7	2.5	7.2	-12.4	-18.7	5.1	11.1	-11.2	5.0	-0.44	-1.77	1010	0.148
17	-12.5	-7.2	3.4	4.3	-7.8	-12.9	2.6	7.4	-12.6	-19.1	5.2	11.4	-11.5	5.1	-0.44	-1.77	1032	0.150
18	-12.9	-7.3	3.5	4.5	-8.0	-13.2	2.7	7.5	-12.8	-19.5	5.3	11.6	-11.7	5.2	-0.44	-1.76	1053	0.151
19	-13.0	-7.4	3.6	4.6	-8.2	-13.5	2.7	7.7	-13.1	-19.9	5.4	11.9	-12.0	5.3	-0.45	-1.76	1077	0.154
20	-13.4	-7.5	3.6	4.7	-8.3	-13.8	2.8	7.9	-13.3	-20.2	5.5	12.1	-12.2	5.4	-0.44	-1.76	1097	0.152
21	-13.6	-7.8	3.7	4.8	-8.5	-14.0	2.9	8.0	-13.5	-20.6	5.6	12.3	-12.4	5.5	-0.45	-1.76	1118	0.154
22	-14.0	-7.9	3.8	4.8	-8.7	-14.3	2.9	8.2	-13.8	-21.0	5.7	12.5	-12.7	5.6	-0.44	-1.77	1145	0.150
23	-14.2	-8.1	3.9	5.0	-8.9	-14.5	3.0	8.3	-14.0	-21.2	5.8	12.7	-12.9	5.7	-0.44	-1.76	1161	0.152
24	-14.3	-8.1	3.9	5.1	-9.1	-14.7	3.0	8.4	-14.2	-21.5	5.9	12.9	-13.1	5.8	-0.45	-1.76	1179	0.154
25	-14.6	-8.3	4.0	5.2	-9.1	-14.9	3.1	8.6	-14.4	-22.0	6.0	13.1	-13.3	5.9	-0.45	-1.75	1197	0.155
26	-14.8	-8.4	4.1	5.3	-9.3	-15.2	3.1	8.7	-14.5	-22.1	6.1	13.3	-13.5	6.0	-0.45	-1.75	1214	0.157
27	-15.0	-8.5	4.1	5.4	-9.5	-15.5	3.2	8.9	-14.7	-22.4	6.2	13.5	-13.7	6.1	-0.45	-1.75	1235	0.156
28	-15.3	-8.7	4.2	5.4	-9.7	-15.7	3.2	8.9	-14.8	-22.7	6.2	13.7	-13.9	6.2	-0.45	-1.75	1250	0.156
29	-15.5	-8.8	4.3	5.5	-9.9	-15.9	3.3	9.1	-15.0	-22.9	6.3	13.9	-14.1	6.3	-0.45	-1.75	1269	0.156
30	-15.7	-9.0	4.3	5.6	-9.9	-16.2	3.3	9.2	-15.3	-23.4	6.4	14.0	-14.3	6.4	-0.45	-1.75	1288	0.156
31	-15.9	-9.1	4.4	5.7	-10.2	-16.4	3.4	9.3	-15.2	-23.5	6.5	14.2	-14.4	6.5	-0.45	-1.75	1302	0.157
32	-16.0	-9.2	4.4	5.8	-10.3	-16.7	3.4	9.5	-15.5	-23.8	6.6	14.4	-14.6	6.6	-0.45	-1.75	1320	0.157
33	-16.2	-9.3	4.5	5.9	-10.4	-16.8	3.5	9.6	-15.6	-23.9	6.7	14.6	-14.8	6.6	-0.45	-1.74	1333	0.159

Table E.22 NU 58-40 Test Data (0 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 58-40 Sample #11				NU 58-40 Sample #12				NU 58-40 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
34	-16.4	-9.4	4.6	6.0	-10.6	-17.0	3.5	9.7	-15.9	-24.3	6.7	14.7	-15.0	6.7	-0.45	-1.74	1350	0.159
35	-16.7	-9.6	4.6	6.0	-10.6	-17.2	3.6	9.8	-16.0	-24.4	6.8	14.9	-15.1	6.8	-0.45	-1.75	1367	0.157
36	-16.7	-9.5	4.7	6.1	-11.0	-17.4	3.6	9.9	-16.1	-24.7	6.9	15.0	-15.3	6.9	-0.45	-1.75	1383	0.158
37	-17.0	-9.6	4.7	6.2	-11.0	-17.6	3.7	10.0	-16.3	-24.9	6.9	15.2	-15.5	7.0	-0.45	-1.74	1397	0.158
38	-17.3	-9.8	4.8	6.3	-11.1	-17.8	3.7	10.1	-16.7	-25.4	7.0	15.3	-15.7	7.0	-0.45	-1.75	1416	0.155
39	-17.4	-9.9	4.8	6.3	-11.2	-18.1	3.7	10.2	-16.6	-25.3	7.1	15.5	-15.8	7.1	-0.45	-1.75	1428	0.158
40	-17.5	-10.1	4.9	6.5	-11.3	-18.1	3.8	10.3	-16.7	-25.5	7.1	15.6	-15.9	7.2	-0.45	-1.74	1439	0.161
41	-17.7	-10.2	4.9	6.5	-11.4	-18.4	3.8	10.4	-16.8	-25.8	7.2	15.8	-16.1	7.3	-0.45	-1.74	1453	0.160
42	-17.8	-10.2	5.0	6.6	-11.6	-18.5	3.9	10.5	-17.0	-25.9	7.3	15.9	-16.2	7.3	-0.45	-1.74	1466	0.161
43	-18.0	-10.2	5.1	6.7	-11.7	-18.7	3.9	10.6	-17.1	-26.2	7.3	16.1	-16.4	7.4	-0.45	-1.74	1480	0.162
44	-18.1	-10.4	5.1	6.7	-11.8	-18.8	4.0	10.6	-17.2	-26.4	7.4	16.2	-16.5	7.5	-0.45	-1.73	1489	0.162
45	-18.3	-10.5	5.2	6.8	-11.9	-19.0	4.0	10.8	-17.3	-26.6	7.5	16.4	-16.6	7.5	-0.45	-1.73	1505	0.163
46	-18.4	-10.6	5.2	6.9	-12.0	-19.2	4.0	10.9	-17.5	-26.7	7.5	16.5	-16.8	7.6	-0.45	-1.73	1516	0.164
47	-18.6	-10.7	5.3	7.0	-12.1	-19.4	4.1	10.9	-17.6	-27.0	7.6	16.6	-16.9	7.7	-0.45	-1.73	1531	0.163
48	-18.7	-10.8	5.3	7.1	-12.2	-19.5	4.1	11.0	-17.8	-27.2	7.6	16.7	-17.0	7.8	-0.46	-1.73	1542	0.165
49	-18.9	-10.9	5.3	7.1	-12.3	-19.7	4.1	11.1	-17.8	-27.2	7.7	16.9	-17.2	7.8	-0.46	-1.73	1553	0.165
50	-19.0	-11.0	5.4	7.2	-12.5	-19.9	4.2	11.2	-17.9	-27.4	7.8	17.0	-17.3	7.9	-0.46	-1.73	1567	0.165
51	-19.2	-11.0	5.5	7.3	-12.5	-20.1	4.2	11.3	-18.1	-27.7	7.8	17.1	-17.5	8.0	-0.46	-1.73	1582	0.165
52	-19.3	-11.1	5.5	7.3	-12.7	-20.2	4.3	11.4	-18.1	-27.9	7.9	17.3	-17.6	8.0	-0.46	-1.72	1592	0.166
53	-19.5	-11.2	5.5	7.4	-12.8	-20.3	4.3	11.5	-18.3	-28.1	7.9	17.4	-17.7	8.1	-0.46	-1.72	1604	0.166
54	-19.6	-11.3	5.6	7.5	-12.9	-20.5	4.3	11.6	-18.4	-28.2	8.0	17.5	-17.9	8.2	-0.46	-1.72	1619	0.166
55	-19.8	-11.3	5.6	7.5	-13.1	-20.6	4.4	11.6	-18.4	-28.4	8.1	17.6	-18.0	8.2	-0.46	-1.72	1627	0.166
56	-19.9	-11.5	5.7	7.6	-13.2	-20.7	4.4	11.7	-18.6	-28.4	8.1	17.7	-18.1	8.3	-0.46	-1.72	1639	0.166
57	-19.9	-11.5	5.7	7.7	-13.4	-21.0	4.4	11.8	-18.7	-28.6	8.1	17.9	-18.2	8.3	-0.46	-1.72	1652	0.167
58	-20.2	-11.6	5.8	7.7	-13.4	-21.1	4.5	11.9	-18.7	-28.8	8.2	18.0	-18.3	8.4	-0.46	-1.72	1662	0.167
59	-20.4	-11.6	5.8	7.8	-13.5	-21.3	4.5	11.9	-18.8	-29.0	8.3	18.1	-18.5	8.4	-0.46	-1.72	1675	0.166
60	-20.4	-11.8	5.9	7.9	-13.6	-21.4	4.5	12.0	-19.0	-29.1	8.3	18.2	-18.6	8.5	-0.46	-1.72	1685	0.167
61	-20.6	-11.8	5.9	7.9	-13.7	-21.5	4.6	12.1	-19.1	-29.2	8.3	18.3	-18.7	8.6	-0.46	-1.72	1697	0.168
62	-20.7	-11.9	5.9	8.0	-13.8	-21.7	4.6	12.2	-19.1	-29.4	8.4	18.4	-18.8	8.6	-0.46	-1.72	1705	0.168
63	-20.7	-11.8	6.0	8.1	-14.0	-21.9	4.6	12.2	-19.2	-29.5	8.4	18.5	-18.9	8.7	-0.46	-1.72	1717	0.169
64	-21.0	-12.1	6.0	8.1	-14.0	-22.0	4.7	12.3	-19.3	-29.8	8.5	18.6	-19.1	8.7	-0.46	-1.72	1728	0.168
65	-21.1	-12.1	6.1	8.2	-14.0	-22.1	4.7	12.4	-19.4	-29.8	8.5	18.8	-19.2	8.8	-0.46	-1.72	1736	0.169
66	-21.2	-12.2	6.1	8.2	-14.2	-22.2	4.7	12.5	-19.5	-29.9	8.6	18.9	-19.3	8.9	-0.46	-1.71	1747	0.170

Table E.22 NU 58-40 Test Data (0 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 58-40 Sample #11				NU 58-40 Sample #12				NU 58-40 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
67	-21.3	-12.2	6.2	8.3	-14.3	-22.4	4.8	12.6	-19.8	-30.3	8.6	18.9	-19.4	8.9	-0.46	-1.72	1761	0.167
68	-21.5	-12.4	6.2	8.4	-14.4	-22.6	4.8	12.6	-19.8	-30.3	8.7	19.0	-19.5	8.9	-0.46	-1.72	1770	0.168
69	-21.6	-12.4	6.2	8.4	-14.6	-22.8	4.8	12.7	-19.7	-30.4	8.7	19.2	-19.7	9.0	-0.46	-1.72	1781	0.169
70	-21.6	-12.5	6.3	8.5	-14.6	-22.8	4.9	12.7	-19.8	-30.4	8.8	19.2	-19.7	9.1	-0.46	-1.71	1786	0.172
71	-21.8	-12.6	6.3	8.5	-14.5	-22.7	4.9	12.9	-19.8	-30.6	8.8	19.3	-19.7	9.1	-0.46	-1.70	1790	0.174
72	-21.9	-12.6	6.4	8.6	-14.9	-23.1	4.9	12.9	-20.0	-30.7	8.9	19.4	-20.0	9.2	-0.46	-1.71	1811	0.170
73	-22.2	-12.9	6.4	8.6	-14.9	-23.3	4.9	13.0	-20.0	-31.1	8.9	19.6	-20.1	9.2	-0.46	-1.72	1823	0.168
74	-22.1	-12.8	6.4	8.7	-14.9	-23.3	5.0	13.1	-20.1	-31.0	9.0	19.7	-20.1	9.3	-0.46	-1.70	1823	0.173
75	-22.3	-12.9	6.5	8.8	-15.1	-23.5	5.0	13.1	-20.2	-31.2	9.0	19.8	-20.3	9.3	-0.46	-1.71	1838	0.170
76	-22.4	-13.0	6.5	8.9	-15.1	-23.7	5.0	13.2	-20.1	-31.2	9.0	19.9	-20.4	9.4	-0.46	-1.71	1847	0.172
77	-22.5	-13.0	6.6	8.9	-15.1	-23.8	5.1	13.2	-20.3	-31.5	9.1	20.0	-20.4	9.4	-0.46	-1.71	1853	0.173
78	-22.7	-13.1	6.6	8.9	-15.3	-23.9	5.1	13.3	-20.5	-31.5	9.1	20.0	-20.6	9.5	-0.46	-1.71	1866	0.172
79	-22.7	-13.2	6.6	9.0	-15.4	-23.9	5.1	13.4	-20.5	-31.8	9.2	20.1	-20.6	9.5	-0.46	-1.71	1873	0.173
80	-22.9	-13.3	6.7	9.0	-15.5	-24.1	5.2	13.4	-20.6	-31.8	9.2	20.2	-20.8	9.6	-0.46	-1.71	1883	0.172
81	-23.0	-13.3	6.7	9.1	-15.5	-24.2	5.2	13.5	-20.6	-31.9	9.3	20.3	-20.8	9.6	-0.46	-1.70	1892	0.173
82	-23.0	-13.2	6.8	9.2	-15.6	-24.3	5.2	13.6	-20.7	-32.1	9.3	20.4	-20.9	9.7	-0.46	-1.70	1900	0.174
83	-23.3	-13.5	6.8	9.2	-15.7	-24.5	5.3	13.6	-20.8	-32.1	9.3	20.5	-21.1	9.7	-0.46	-1.71	1914	0.173
84	-23.5	-13.6	6.8	9.3	-15.8	-24.5	5.3	13.7	-20.8	-32.3	9.4	20.6	-21.2	9.8	-0.46	-1.70	1920	0.174
85	-23.5	-13.6	6.9	9.3	-15.8	-24.6	5.3	13.8	-20.9	-32.3	9.4	20.7	-21.2	9.9	-0.46	-1.70	1928	0.175
86	-23.6	-13.8	6.9	9.4	-15.9	-24.7	5.3	13.9	-21.0	-32.6	9.5	20.8	-21.3	9.9	-0.46	-1.70	1938	0.175
87	-23.7	-13.9	6.9	9.4	-16.0	-24.9	5.4	13.9	-21.1	-32.6	9.5	20.9	-21.4	9.9	-0.46	-1.70	1947	0.175
88	-23.9	-13.9	7.0	9.5	-16.1	-25.0	5.4	14.0	-21.2	-32.8	9.5	20.9	-21.6	10.0	-0.46	-1.70	1958	0.175
89	-23.9	-14.0	7.0	9.5	-16.2	-25.1	5.5	14.0	-21.2	-32.8	9.6	21.1	-21.6	10.0	-0.46	-1.70	1964	0.175
90	-24.1	-14.1	7.0	9.6	-16.4	-25.2	5.5	14.1	-21.3	-33.0	9.6	21.1	-21.8	10.1	-0.46	-1.70	1975	0.173
91	-24.2	-14.1	7.1	9.7	-16.4	-25.4	5.5	14.2	-21.4	-33.1	9.7	21.2	-21.8	10.1	-0.46	-1.70	1984	0.175
92	-24.2	-14.1	7.1	9.7	-16.5	-25.4	5.5	14.2	-21.4	-33.2	9.7	21.3	-21.9	10.2	-0.47	-1.70	1988	0.177
93	-24.4	-14.2	7.1	9.7	-16.5	-25.6	5.5	14.3	-21.4	-33.2	9.7	21.4	-22.0	10.2	-0.47	-1.70	1995	0.177
94	-24.4	-14.4	7.2	9.8	-16.6	-25.7	5.6	14.3	-21.6	-33.4	9.8	21.5	-22.1	10.3	-0.46	-1.70	2007	0.176
95	-24.6	-14.4	7.2	9.9	-16.7	-25.7	5.6	14.4	-21.6	-33.5	9.8	21.5	-22.1	10.3	-0.47	-1.69	2013	0.178
96	-24.6	-14.4	7.3	9.9	-16.8	-25.8	5.6	14.4	-21.8	-33.6	9.8	21.6	-22.2	10.4	-0.47	-1.70	2022	0.177
97	-24.7	-14.5	7.3	10.0	-16.8	-26.0	5.6	14.5	-21.8	-33.6	9.9	21.7	-22.3	10.4	-0.47	-1.69	2030	0.178
98	-24.8	-14.5	7.3	10.0	-16.8	-26.0	5.7	14.6	-21.8	-33.8	9.9	21.8	-22.4	10.5	-0.47	-1.69	2034	0.180
99	-24.9	-14.8	7.3	10.0	-17.1	-26.3	5.7	14.6	-21.9	-33.9	9.9	21.9	-22.6	10.5	-0.46	-1.70	2050	0.176
100	-24.9	-14.7	7.4	10.1	-17.0	-26.3	5.7	14.7	-21.9	-33.8	10.0	21.9	-22.5	10.5	-0.47	-1.69	2051	0.179

Table E.23 NU 58-40 Test Data (-10 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 58-40 Sample #11				NU 58-40 Sample #12				NU 58-40 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0.000
1	-3.5	-1.7	0.9	1.1	-2.1	-3.5	0.7	1.9	-2.9	-3.1	1.0	1.9	-3.0	1.2	-0.40	-1.91	173	0.108
2	-4.3	-2.1	1.2	1.3	-2.5	-4.1	0.8	2.2	-3.6	-3.9	1.2	2.3	-3.6	1.5	-0.40	-1.91	210	0.107
3	-4.8	-2.3	1.3	1.4	-2.8	-4.5	0.9	2.5	-3.9	-4.3	1.3	2.6	-4.0	1.6	-0.41	-1.90	233	0.111
4	-5.2	-2.5	1.4	1.6	-3.0	-4.8	1.0	2.7	-4.1	-4.7	1.5	2.8	-4.3	1.8	-0.42	-1.85	247	0.123
5	-5.3	-2.7	1.5	1.7	-3.2	-4.9	1.1	2.8	-4.4	-4.9	1.6	3.0	-4.5	1.9	-0.43	-1.83	259	0.130
6	-5.7	-3.0	1.6	1.8	-3.2	-4.8	1.1	3.1	-4.6	-5.3	1.6	3.1	-4.6	2.0	-0.44	-1.78	269	0.146
7	-5.9	-3.0	1.6	1.9	-3.4	-5.4	1.2	3.1	-4.7	-5.4	1.7	3.3	-4.9	2.1	-0.43	-1.81	283	0.136
8	-6.1	-3.1	1.7	2.0	-3.5	-5.5	1.2	3.2	-5.0	-5.8	1.8	3.5	-5.0	2.2	-0.43	-1.80	293	0.138
9	-6.4	-3.3	1.7	2.0	-3.7	-5.7	1.3	3.4	-5.1	-6.1	1.9	3.6	-5.2	2.2	-0.43	-1.81	305	0.135
10	-6.5	-3.4	1.8	2.1	-3.8	-5.8	1.3	3.5	-5.2	-6.2	1.9	3.7	-5.3	2.3	-0.44	-1.79	311	0.142
11	-6.6	-3.4	1.9	2.1	-3.9	-5.8	1.3	3.6	-5.4	-6.4	2.0	3.8	-5.4	2.4	-0.44	-1.77	317	0.149
12	-6.8	-3.6	1.9	2.2	-3.9	-6.0	1.4	3.7	-5.4	-6.6	2.1	3.9	-5.6	2.5	-0.44	-1.77	326	0.149
13	-6.9	-3.7	1.9	2.2	-4.2	-6.4	1.4	3.7	-5.6	-6.8	2.1	4.0	-5.8	2.5	-0.43	-1.80	337	0.138
14	-7.1	-3.7	2.0	2.3	-4.1	-6.4	1.4	3.8	-5.7	-6.9	2.2	4.2	-5.8	2.6	-0.44	-1.77	341	0.149
15	-7.3	-3.8	2.0	2.4	-4.2	-6.5	1.5	3.9	-5.9	-7.1	2.2	4.3	-6.0	2.6	-0.44	-1.77	349	0.147
16	-7.4	-3.8	2.1	2.4	-4.3	-6.8	1.5	4.0	-5.9	-7.0	2.3	4.4	-6.1	2.7	-0.44	-1.77	357	0.148
17	-7.5	-3.9	2.1	2.4	-4.3	-6.7	1.5	4.0	-6.1	-7.3	2.3	4.4	-6.2	2.7	-0.44	-1.77	361	0.148
18	-7.7	-4.1	2.1	2.5	-4.5	-6.8	1.6	4.1	-6.1	-7.6	2.3	4.5	-6.3	2.8	-0.44	-1.77	369	0.149
19	-7.9	-4.2	2.2	2.5	-4.7	-6.9	1.6	4.2	-6.4	-7.9	2.4	4.6	-6.5	2.8	-0.43	-1.80	378	0.140
20	-7.9	-4.1	2.2	2.6	-4.8	-7.1	1.6	4.2	-6.4	-7.9	2.4	4.7	-6.5	2.9	-0.44	-1.78	382	0.147
21	-8.1	-4.5	2.2	2.7	-4.8	-7.1	1.6	4.3	-6.4	-7.9	2.5	4.8	-6.6	2.9	-0.44	-1.78	387	0.146
22	-8.1	-4.3	2.3	2.7	-4.9	-7.2	1.7	4.4	-6.6	-8.1	2.5	4.9	-6.7	3.0	-0.44	-1.77	393	0.149
23	-8.2	-4.3	2.3	2.8	-4.8	-7.3	1.7	4.4	-6.6	-8.2	2.5	4.9	-6.7	3.0	-0.45	-1.76	396	0.154
24	-8.3	-4.3	2.3	2.8	-5.1	-7.5	1.7	4.5	-6.6	-8.1	2.6	5.0	-6.9	3.0	-0.44	-1.77	404	0.150
25	-8.3	-4.5	2.4	2.8	-5.2	-7.9	1.7	4.4	-6.7	-8.4	2.6	5.1	-7.0	3.1	-0.44	-1.79	412	0.142
26	-8.5	-4.6	2.4	2.9	-5.3	-7.7	1.7	4.5	-6.9	-8.5	2.6	5.2	-7.1	3.1	-0.44	-1.78	416	0.144
27	-8.6	-4.6	2.4	2.9	-5.2	-7.9	1.8	4.6	-6.8	-8.6	2.7	5.2	-7.1	3.1	-0.44	-1.77	417	0.149
28	-8.6	-4.6	2.5	2.9	-5.4	-7.8	1.8	4.7	-6.9	-8.7	2.7	5.3	-7.2	3.2	-0.45	-1.76	421	0.154
29	-8.8	-4.6	2.5	3.0	-5.4	-8.0	1.8	4.7	-7.0	-8.8	2.8	5.4	-7.3	3.2	-0.45	-1.76	427	0.153
30	-8.8	-4.6	2.5	3.0	-5.5	-8.0	1.8	4.8	-7.1	-8.9	2.8	5.4	-7.4	3.3	-0.45	-1.76	432	0.153
31	-8.9	-4.8	2.6	3.1	-5.6	-8.1	1.9	4.8	-7.1	-8.9	2.8	5.5	-7.4	3.3	-0.45	-1.76	436	0.154
32	-9.0	-4.6	2.6	3.1	-5.6	-8.2	1.9	4.9	-7.2	-9.1	2.8	5.6	-7.5	3.4	-0.45	-1.75	440	0.155
33	-9.0	-4.8	2.6	3.2	-5.7	-8.3	1.9	4.9	-7.5	-9.4	2.9	5.6	-7.6	3.4	-0.44	-1.76	447	0.151

Table E.23 NU 58-40 Test Data (-10 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays												Trimmed					
	NU 58-40 Sample #11				NU 58-40 Sample #12				NU 58-40 Sample #9				Mean		Ratio		Creep Comp	Pois. Ratio
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz						
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm			1/kPa	
34	-9.1	-4.8	2.6	3.2	-5.9	-8.9	1.9	4.9	-7.4	-9.4	2.9	5.7	-7.8	3.4	-0.44	-1.78	456	0.144
35	-9.2	-5.0	2.7	3.2	-5.8	-8.6	1.9	5.0	-7.3	-9.4	2.9	5.8	-7.7	3.5	-0.45	-1.76	454	0.154
36	-9.2	-4.8	2.7	3.3	-5.8	-8.7	1.9	5.0	-7.6	-9.5	3.0	5.8	-7.8	3.5	-0.44	-1.76	459	0.152
37	-9.3	-4.9	2.7	3.3	-6.1	-8.9	2.0	5.0	-7.6	-9.8	3.0	5.8	-8.0	3.5	-0.44	-1.77	467	0.148
38	-9.3	-4.9	2.7	3.4	-6.0	-8.8	2.0	5.1	-7.6	-9.7	3.0	5.9	-7.9	3.6	-0.45	-1.74	467	0.158
39	-9.4	-4.9	2.8	3.4	-6.4	-9.1	2.0	5.1	-7.6	-9.8	3.0	6.0	-8.1	3.6	-0.44	-1.78	476	0.147
40	-9.3	-4.9	2.8	3.4	-6.3	-8.9	2.0	5.2	-7.8	-9.9	3.1	6.1	-8.1	3.6	-0.45	-1.75	475	0.157
41	-9.5	-4.9	2.8	3.5	-6.3	-9.0	2.0	5.2	-7.8	-10.0	3.1	6.1	-8.1	3.7	-0.45	-1.75	479	0.157
42	-9.6	-5.1	2.8	3.5	-6.4	-9.2	2.0	5.2	-7.9	-10.1	3.1	6.1	-8.2	3.7	-0.45	-1.76	484	0.154
43	-9.7	-5.1	2.9	3.5	-6.4	-9.2	2.1	5.3	-7.9	-10.3	3.1	6.2	-8.3	3.7	-0.45	-1.76	487	0.154
44	-9.7	-5.2	2.9	3.5	-6.4	-9.4	2.1	5.3	-8.0	-10.3	3.2	6.2	-8.4	3.7	-0.45	-1.76	492	0.153
45	-9.7	-5.1	2.9	3.6	-6.6	-9.3	2.1	5.3	-8.1	-10.3	3.2	6.3	-8.4	3.8	-0.45	-1.76	494	0.154
46	-9.8	-5.2	2.9	3.6	-6.6	-9.5	2.1	5.4	-8.1	-10.4	3.2	6.3	-8.5	3.8	-0.45	-1.75	499	0.155
47	-9.9	-5.2	3.0	3.6	-6.6	-9.6	2.1	5.4	-8.3	-10.7	3.2	6.3	-8.6	3.8	-0.44	-1.77	504	0.150
48	-9.9	-5.3	3.0	3.7	-6.8	-9.8	2.1	5.4	-8.1	-10.5	3.3	6.4	-8.6	3.8	-0.44	-1.76	506	0.151
49	-10.0	-5.3	3.0	3.7	-6.7	-9.8	2.2	5.5	-8.2	-10.7	3.3	6.5	-8.7	3.9	-0.45	-1.76	509	0.154
50	-10.1	-5.4	3.0	3.7	-6.8	-9.8	2.2	5.5	-8.3	-10.8	3.3	6.5	-8.7	3.9	-0.44	-1.76	513	0.152
51	-10.1	-5.4	3.0	3.7	-6.8	-9.9	2.2	5.5	-8.3	-10.7	3.4	6.6	-8.8	3.9	-0.44	-1.76	516	0.153
52	-10.1	-5.4	3.0	3.8	-6.9	-9.9	2.2	5.6	-8.4	-10.9	3.4	6.6	-8.8	3.9	-0.45	-1.75	519	0.154
53	-10.4	-5.6	3.0	3.8	-6.9	-10.1	2.2	5.6	-8.4	-10.9	3.4	6.7	-9.0	3.9	-0.44	-1.77	525	0.148
54	-10.3	-5.5	3.1	3.8	-7.0	-10.1	2.2	5.7	-8.4	-10.9	3.4	6.8	-9.0	4.0	-0.45	-1.76	527	0.154
55	-10.5	-5.6	3.1	3.8	-7.1	-10.2	2.2	5.7	-8.6	-11.1	3.4	6.8	-9.1	4.0	-0.44	-1.78	534	0.145
56	-10.4	-5.6	3.1	3.9	-7.1	-10.2	2.3	5.7	-8.6	-11.2	3.4	6.8	-9.1	4.0	-0.44	-1.76	534	0.151
57	-10.5	-5.7	3.2	3.9	-7.1	-10.2	2.3	5.8	-8.7	-11.2	3.5	6.8	-9.1	4.1	-0.45	-1.76	536	0.153
58	-10.5	-5.7	3.2	3.9	-7.1	-10.3	2.3	5.8	-8.6	-11.2	3.5	6.9	-9.1	4.1	-0.45	-1.75	537	0.158
59	-10.7	-5.7	3.2	3.9	-7.1	-10.1	2.3	5.9	-8.7	-11.3	3.5	7.0	-9.2	4.1	-0.45	-1.74	539	0.158
60	-10.7	-5.7	3.2	4.0	-7.1	-10.3	2.3	5.9	-8.7	-11.4	3.5	7.0	-9.2	4.1	-0.45	-1.74	542	0.158
61	-10.8	-5.9	3.2	4.0	-7.1	-10.2	2.4	6.0	-8.6	-11.4	3.6	7.1	-9.2	4.2	-0.46	-1.73	541	0.165
62	-10.8	-5.9	3.2	4.0	-7.1	-10.5	2.4	6.0	-8.8	-11.5	3.6	7.1	-9.3	4.2	-0.45	-1.74	548	0.160
63	-11.0	-6.0	3.2	4.0	-7.2	-10.5	2.4	6.0	-8.8	-11.5	3.6	7.2	-9.4	4.2	-0.45	-1.75	551	0.157
64	-11.0	-6.0	3.3	4.1	-7.3	-10.5	2.4	6.0	-8.9	-11.6	3.6	7.2	-9.4	4.2	-0.45	-1.74	554	0.160
65	-11.0	-6.1	3.3	4.1	-7.3	-10.6	2.4	6.0	-8.9	-11.7	3.7	7.2	-9.5	4.3	-0.45	-1.74	556	0.160
66	-11.1	-6.1	3.3	4.1	-7.4	-10.7	2.4	6.1	-9.0	-11.7	3.7	7.2	-9.6	4.3	-0.45	-1.75	562	0.156

Table E.23 NU 58-40 Test Data (-10 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 58-40 Sample #11				NU 58-40 Sample #12				NU 58-40 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
67	-11.2	-6.2	3.3	4.1	-7.4	-10.7	2.4	6.1	-9.0	-11.8	3.7	7.3	-9.6	4.3	-0.45	-1.75	564	0.158
68	-11.1	-6.2	3.3	4.2	-7.7	-11.0	2.4	6.1	-8.9	-11.8	3.7	7.3	-9.7	4.3	-0.45	-1.76	569	0.154
69	-11.3	-6.2	3.3	4.2	-7.4	-10.8	2.5	6.2	-9.1	-11.9	3.7	7.4	-9.7	4.4	-0.45	-1.74	568	0.159
70	-11.4	-6.3	3.3	4.2	-7.5	-10.9	2.5	6.2	-9.1	-12.0	3.7	7.4	-9.7	4.4	-0.45	-1.74	572	0.159
71	-11.5	-6.3	3.4	4.2	-7.4	-10.9	2.5	6.3	-9.1	-11.9	3.8	7.5	-9.7	4.4	-0.45	-1.73	573	0.162
72	-11.6	-6.4	3.4	4.2	-7.5	-10.9	2.5	6.3	-9.1	-12.1	3.8	7.5	-9.8	4.4	-0.45	-1.73	575	0.162
73	-11.6	-6.5	3.4	4.3	-7.6	-10.9	2.5	6.3	-9.1	-12.1	3.8	7.5	-9.8	4.5	-0.45	-1.73	578	0.163
74	-11.6	-6.5	3.4	4.2	-7.6	-11.0	2.5	6.3	-9.2	-12.2	3.8	7.6	-9.9	4.5	-0.45	-1.74	581	0.161
75	-11.8	-6.6	3.4	4.3	-7.6	-11.0	2.6	6.4	-9.1	-12.2	3.8	7.6	-9.9	4.5	-0.45	-1.73	583	0.162
76	-11.8	-6.5	3.4	4.3	-7.6	-10.9	2.6	6.4	-9.2	-12.2	3.9	7.6	-9.9	4.5	-0.46	-1.73	583	0.164
77	-11.9	-6.7	3.5	4.3	-7.8	-11.3	2.6	6.4	-9.2	-12.4	3.9	7.7	-10.1	4.5	-0.45	-1.75	592	0.157
78	-11.9	-6.7	3.5	4.3	-7.7	-11.1	2.6	6.5	-9.4	-12.5	3.9	7.7	-10.1	4.5	-0.45	-1.74	592	0.161
79	-12.1	-6.8	3.5	4.3	-7.6	-11.1	2.6	6.6	-9.4	-12.4	3.9	7.8	-10.0	4.6	-0.46	-1.73	592	0.165
80	-12.1	-6.8	3.5	4.3	-7.5	-11.2	2.6	6.6	-9.4	-12.4	3.9	7.8	-10.0	4.6	-0.46	-1.72	593	0.167
81	-12.2	-6.8	3.5	4.4	-7.5	-11.1	2.7	6.6	-9.4	-12.5	4.0	7.8	-10.1	4.6	-0.46	-1.71	594	0.170
82	-12.2	-7.0	3.5	4.4	-7.6	-11.1	2.7	6.7	-9.5	-12.6	4.0	7.9	-10.1	4.6	-0.46	-1.71	596	0.170
83	-12.3	-7.0	3.5	4.4	-7.6	-11.2	2.7	6.7	-9.5	-12.6	4.0	7.9	-10.1	4.6	-0.46	-1.72	598	0.168
84	-12.3	-7.0	3.5	4.4	-7.6	-11.2	2.7	6.7	-9.5	-12.7	4.0	8.0	-10.2	4.7	-0.46	-1.71	600	0.170
85	-12.4	-7.1	3.6	4.4	-7.6	-11.2	2.7	6.8	-9.6	-12.7	4.0	8.0	-10.2	4.7	-0.46	-1.71	602	0.171
86	-12.4	-7.0	3.6	4.5	-7.6	-11.1	2.7	6.8	-9.5	-12.8	4.0	8.0	-10.1	4.7	-0.47	-1.69	601	0.178
87	-12.4	-7.1	3.6	4.5	-7.6	-11.2	2.8	6.8	-9.7	-12.7	4.1	8.1	-10.2	4.8	-0.47	-1.69	604	0.177
88	-12.5	-7.1	3.6	4.5	-7.7	-11.2	2.8	6.9	-9.7	-12.9	4.1	8.1	-10.3	4.8	-0.46	-1.70	608	0.175
89	-12.6	-7.1	3.6	4.5	-7.7	-11.3	2.8	6.9	-9.7	-12.9	4.1	8.1	-10.3	4.8	-0.46	-1.71	611	0.172
90	-12.6	-7.2	3.7	4.6	-7.7	-11.2	2.8	6.9	-9.7	-13.2	4.1	8.1	-10.3	4.8	-0.47	-1.69	611	0.179
91	-12.7	-7.2	3.7	4.6	-7.7	-11.3	2.8	7.0	-9.8	-13.2	4.1	8.2	-10.4	4.8	-0.47	-1.70	614	0.177
92	-12.7	-7.2	3.7	4.6	-7.7	-11.2	2.8	7.0	-9.8	-13.2	4.1	8.2	-10.3	4.9	-0.47	-1.68	613	0.183
93	-12.7	-7.3	3.7	4.6	-7.7	-11.3	2.9	7.0	-9.8	-13.2	4.2	8.3	-10.4	4.9	-0.47	-1.69	616	0.181
94	-12.7	-7.3	3.7	4.7	-7.7	-11.4	2.8	7.1	-9.9	-13.3	4.2	8.3	-10.5	4.9	-0.47	-1.69	620	0.181
95	-12.8	-7.3	3.7	4.7	-7.7	-11.5	2.9	7.1	-9.9	-13.3	4.2	8.3	-10.5	4.9	-0.47	-1.68	622	0.182
96	-12.7	-7.2	3.7	4.7	-7.7	-11.5	2.9	7.1	-9.9	-13.4	4.2	8.4	-10.5	4.9	-0.47	-1.68	622	0.184
97	-12.9	-7.2	3.8	4.7	-7.9	-11.4	2.9	7.1	-9.9	-13.4	4.2	8.4	-10.5	5.0	-0.47	-1.68	624	0.184
98	-12.9	-7.3	3.8	4.8	-7.8	-11.5	2.9	7.1	-9.9	-13.4	4.2	8.4	-10.5	5.0	-0.47	-1.68	625	0.185
99	-12.9	-7.4	3.8	4.8	-7.7	-11.5	2.9	7.2	-9.9	-13.5	4.3	8.5	-10.5	5.0	-0.47	-1.67	626	0.187
100	-12.9	-7.4	3.8	4.8	-7.9	-11.5	3.0	7.2	-10.0	-13.5	4.3	8.5	-10.6	5.0	-0.47	-1.67	628	0.186

Table E.24 NU 58-40 Test Data (-20 °C Tests)

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 58-40 Sample #11				NU 58-40 Sample #12				NU 58-40 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0.000
1	-3.2	-1.6	0.7	0.9	-2.2	-4.5	0.6	2.0	-2.7	-3.9	0.7	1.8	-3.3	1.0	-0.31	-2.39	91	0.022
2	-4.6	-2.5	1.1	1.4	-2.4	-5.0	0.8	2.3	-2.9	-4.3	0.9	2.1	-3.7	1.4	-0.38	-2.01	104	0.082
3	-4.9	-2.7	1.2	1.5	-2.7	-5.2	0.8	2.5	-3.0	-4.5	1.0	2.3	-3.9	1.5	-0.39	-1.97	110	0.093
4	-5.2	-2.8	1.3	1.6	-2.7	-5.4	0.9	2.7	-3.3	-4.8	1.0	2.4	-4.0	1.6	-0.39	-1.94	115	0.099
5	-5.2	-2.8	1.4	1.7	-2.8	-5.5	0.9	2.7	-3.3	-4.9	1.1	2.6	-4.2	1.7	-0.41	-1.90	119	0.110
6	-5.5	-3.1	1.4	1.7	-3.0	-5.8	0.9	2.8	-3.4	-5.1	1.1	2.7	-4.3	1.7	-0.40	-1.91	124	0.106
7	-5.6	-3.1	1.4	1.8	-3.0	-5.8	1.0	2.9	-3.5	-5.2	1.2	2.7	-4.4	1.8	-0.41	-1.89	125	0.113
8	-6.0	-3.2	1.5	1.8	-3.1	-5.9	1.0	2.9	-3.5	-5.4	1.2	2.8	-4.5	1.8	-0.41	-1.89	129	0.111
9	-6.0	-3.2	1.5	1.9	-3.2	-6.0	1.0	3.0	-3.5	-5.4	1.2	2.9	-4.5	1.9	-0.41	-1.87	131	0.119
10	-6.1	-3.3	1.6	1.9	-3.3	-6.2	1.0	3.0	-3.5	-5.5	1.3	2.9	-4.6	1.9	-0.41	-1.87	133	0.118
11	-6.2	-3.3	1.6	2.0	-3.4	-6.3	1.0	3.1	-3.6	-5.5	1.3	3.0	-4.7	2.0	-0.42	-1.86	136	0.120
12	-6.2	-3.4	1.6	2.0	-3.4	-6.2	1.1	3.2	-3.8	-5.5	1.3	3.0	-4.7	2.0	-0.42	-1.84	137	0.128
13	-6.4	-3.4	1.6	2.0	-3.5	-6.4	1.1	3.2	-3.8	-5.5	1.3	3.1	-4.8	2.0	-0.42	-1.83	139	0.128
14	-6.5	-3.5	1.7	2.1	-3.5	-6.4	1.1	3.3	-3.8	-5.7	1.3	3.2	-4.8	2.1	-0.43	-1.82	140	0.131
15	-6.6	-3.5	1.7	2.1	-3.7	-6.4	1.1	3.3	-3.8	-5.7	1.4	3.2	-4.9	2.1	-0.43	-1.81	142	0.136
16	-6.6	-3.6	1.7	2.1	-3.6	-6.5	1.2	3.4	-3.7	-5.7	1.4	3.3	-4.9	2.1	-0.44	-1.79	142	0.142
17	-6.7	-3.5	1.8	2.2	-3.6	-6.6	1.1	3.4	-3.8	-5.7	1.4	3.3	-4.9	2.2	-0.44	-1.77	143	0.148
18	-6.9	-3.7	1.8	2.2	-3.7	-6.6	1.2	3.4	-3.8	-5.9	1.4	3.4	-5.0	2.2	-0.44	-1.78	145	0.145
19	-6.9	-3.6	1.8	2.2	-3.7	-6.7	1.2	3.5	-3.8	-5.9	1.4	3.4	-5.0	2.2	-0.44	-1.77	146	0.150
20	-6.9	-3.6	1.8	2.3	-3.9	-6.8	1.2	3.5	-3.8	-5.9	1.5	3.4	-5.1	2.2	-0.44	-1.77	148	0.148
21	-7.0	-3.8	1.8	2.3	-3.9	-6.8	1.2	3.6	-3.8	-6.0	1.5	3.5	-5.1	2.3	-0.45	-1.75	148	0.155
22	-7.0	-3.8	1.8	2.3	-3.9	-6.6	1.2	3.6	-3.8	-6.0	1.5	3.5	-5.1	2.3	-0.45	-1.74	149	0.159
23	-7.0	-3.8	1.9	2.3	-3.9	-6.9	1.2	3.7	-3.9	-6.2	1.5	3.5	-5.2	2.3	-0.45	-1.76	152	0.153
24	-7.1	-3.8	1.9	2.4	-4.1	-7.2	1.2	3.6	-3.9	-6.1	1.6	3.6	-5.3	2.4	-0.44	-1.76	155	0.151
25	-7.2	-4.0	1.9	2.4	-4.0	-7.1	1.2	3.7	-3.9	-6.2	1.6	3.7	-5.3	2.4	-0.45	-1.75	155	0.157
26	-7.3	-3.9	1.9	2.4	-4.0	-7.1	1.3	3.7	-3.9	-6.2	1.6	3.7	-5.3	2.4	-0.45	-1.74	156	0.160
27	-7.3	-4.0	1.9	2.4	-4.0	-7.3	1.3	3.7	-3.8	-6.2	1.6	3.8	-5.3	2.4	-0.45	-1.73	156	0.162
28	-7.3	-4.0	2.0	2.5	-4.0	-7.3	1.3	3.8	-3.9	-6.2	1.6	3.8	-5.4	2.4	-0.46	-1.72	157	0.166
29	-7.5	-4.0	2.0	2.4	-4.0	-7.3	1.3	3.8	-4.0	-6.4	1.6	3.8	-5.4	2.4	-0.45	-1.74	159	0.159
30	-7.5	-4.1	2.0	2.5	-4.2	-7.4	1.3	3.8	-4.0	-6.3	1.6	3.8	-5.5	2.5	-0.46	-1.73	160	0.165
31	-7.5	-4.0	2.0	2.5	-4.2	-7.4	1.3	3.9	-4.0	-6.4	1.6	3.8	-5.5	2.5	-0.45	-1.73	161	0.164
32	-7.6	-4.2	2.0	2.5	-4.1	-7.3	1.3	3.9	-4.0	-6.5	1.6	3.9	-5.5	2.5	-0.46	-1.72	160	0.167
33	-7.6	-4.1	2.0	2.5	-4.2	-7.5	1.3	3.9	-4.0	-6.5	1.7	3.9	-5.5	2.5	-0.46	-1.72	162	0.166

Table E.24 NU 58-40 Test Data (-20 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 58-40 Sample #11				NU 58-40 Sample #12				NU 58-40 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
34	-7.6	-4.1	2.0	2.6	-4.3	-7.6	1.3	3.9	-4.0	-6.6	1.7	3.9	-5.6	2.6	-0.45	-1.73	165	0.163
35	-7.6	-4.1	2.1	2.6	-4.2	-7.5	1.4	4.0	-4.1	-6.6	1.7	3.9	-5.6	2.6	-0.46	-1.73	164	0.165
36	-7.7	-4.2	2.1	2.6	-4.1	-7.6	1.4	4.0	-4.1	-6.7	1.7	4.0	-5.6	2.6	-0.46	-1.72	165	0.168
37	-7.7	-4.2	2.1	2.6	-4.4	-7.6	1.4	4.0	-4.0	-6.6	1.7	4.0	-5.7	2.6	-0.46	-1.72	166	0.169
38	-7.7	-4.2	2.1	2.7	-4.3	-7.7	1.4	4.0	-4.3	-6.7	1.7	4.0	-5.7	2.6	-0.46	-1.72	168	0.166
39	-7.8	-4.2	2.1	2.7	-4.4	-7.6	1.4	4.0	-4.3	-6.7	1.7	4.0	-5.8	2.6	-0.46	-1.72	169	0.166
40	-7.9	-4.2	2.1	2.7	-4.4	-7.6	1.4	4.0	-4.4	-7.0	1.7	4.0	-5.8	2.6	-0.45	-1.74	170	0.160
41	-7.8	-4.3	2.1	2.7	-4.4	-7.7	1.4	4.1	-4.5	-7.0	1.7	4.0	-5.9	2.6	-0.45	-1.75	171	0.158
42	-7.9	-4.2	2.2	2.7	-4.4	-7.7	1.4	4.0	-4.3	-6.8	1.7	4.1	-5.8	2.7	-0.46	-1.71	170	0.170
43	-7.9	-4.3	2.2	2.7	-4.5	-7.8	1.4	4.1	-4.3	-7.0	1.8	4.1	-5.9	2.7	-0.46	-1.73	173	0.164
44	-7.9	-4.3	2.2	2.8	-4.4	-7.8	1.4	4.1	-4.4	-7.0	1.8	4.1	-5.9	2.7	-0.46	-1.71	172	0.172
45	-8.0	-4.3	2.2	2.8	-4.4	-7.8	1.4	4.1	-4.3	-7.0	1.8	4.1	-5.9	2.7	-0.46	-1.70	173	0.173
46	-8.0	-4.3	2.2	2.8	-4.4	-7.9	1.5	4.1	-4.4	-7.0	1.8	4.1	-5.9	2.7	-0.46	-1.72	174	0.168
47	-8.0	-4.4	2.2	2.8	-4.5	-8.0	1.5	4.2	-4.4	-7.1	1.8	4.2	-6.0	2.7	-0.46	-1.73	176	0.165
48	-8.2	-4.4	2.2	2.8	-4.5	-7.9	1.5	4.2	-4.4	-7.0	1.8	4.2	-6.0	2.8	-0.46	-1.70	175	0.175
49	-8.2	-4.4	2.2	2.8	-4.5	-7.9	1.5	4.2	-4.6	-7.2	1.8	4.2	-6.0	2.8	-0.46	-1.71	177	0.170
50	-8.3	-4.4	2.2	2.8	-4.5	-8.0	1.5	4.2	-4.6	-7.2	1.8	4.3	-6.1	2.8	-0.46	-1.71	178	0.169
51	-8.2	-4.5	2.3	2.8	-4.7	-8.1	1.5	4.2	-4.5	-7.2	1.8	4.3	-6.1	2.8	-0.46	-1.73	180	0.164
52	-8.3	-4.5	2.3	2.9	-4.7	-8.0	1.5	4.3	-4.5	-7.3	1.8	4.3	-6.1	2.8	-0.46	-1.72	180	0.167
53	-8.3	-4.4	2.3	2.9	-4.6	-8.0	1.5	4.3	-4.7	-7.3	1.9	4.3	-6.2	2.8	-0.46	-1.72	180	0.166
54	-8.3	-4.5	2.3	2.9	-4.6	-8.0	1.5	4.3	-4.7	-7.4	1.9	4.3	-6.2	2.8	-0.46	-1.72	182	0.167
55	-8.4	-4.5	2.3	2.9	-4.5	-8.0	1.5	4.4	-4.7	-7.4	1.9	4.3	-6.2	2.8	-0.46	-1.71	181	0.171
56	-8.4	-4.5	2.3	2.9	-4.5	-8.2	1.5	4.3	-4.6	-7.4	1.9	4.4	-6.2	2.9	-0.46	-1.70	182	0.174
57	-8.4	-4.5	2.3	2.9	-4.7	-8.1	1.5	4.4	-4.7	-7.5	1.9	4.4	-6.3	2.9	-0.46	-1.71	183	0.170
58	-8.5	-4.5	2.3	3.0	-4.6	-8.2	1.5	4.4	-4.8	-7.5	1.9	4.4	-6.3	2.9	-0.46	-1.71	185	0.171
59	-8.5	-4.6	2.3	3.0	-4.7	-8.2	1.5	4.4	-4.7	-7.5	1.9	4.4	-6.3	2.9	-0.46	-1.70	184	0.174
60	-8.5	-4.5	2.3	3.0	-4.7	-8.3	1.5	4.4	-4.8	-7.7	1.9	4.4	-6.3	2.9	-0.46	-1.72	186	0.169
61	-8.7	-4.6	2.4	3.0	-4.7	-8.3	1.5	4.4	-4.7	-7.6	1.9	4.4	-6.3	2.9	-0.46	-1.70	186	0.175
62	-8.6	-4.7	2.4	3.0	-4.7	-8.2	1.5	4.5	-4.7	-7.6	1.9	4.5	-6.3	2.9	-0.47	-1.69	185	0.179
63	-8.7	-4.6	2.4	3.0	-4.7	-8.3	1.6	4.5	-4.9	-7.9	1.9	4.4	-6.5	2.9	-0.46	-1.73	189	0.164
64	-8.7	-4.7	2.4	3.0	-4.7	-8.3	1.6	4.5	-4.8	-7.7	2.0	4.5	-6.4	3.0	-0.46	-1.70	188	0.174
65	-8.8	-4.7	2.4	3.1	-4.7	-8.3	1.6	4.5	-5.0	-7.8	2.0	4.5	-6.4	3.0	-0.46	-1.71	189	0.173
66	-8.8	-4.7	2.4	3.1	-4.8	-8.2	1.6	4.5	-4.9	-7.8	1.9	4.5	-6.4	3.0	-0.46	-1.70	189	0.174

Table E.24 NU 58-40 Test Data (-20 °C Tests), continued

	Normalized Vertical and Horizontal Deformation Arrays																	
	NU 58-40 Sample #11				NU 58-40 Sample #12				NU 58-40 Sample #9				Trimmed				Creep	Pois.
	vert	vert	horz	horz	vert	vert	horz	horz	vert	vert	horz	horz	Mean		Ratio		Comp	Ratio
Time	front	back	front	back	front	back	front	back	front	back	front	back	vert	horz	X/Y	C_{empl}	D(t)	ν
sec	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm			1/kPa	
67	-8.8	-4.7	2.4	3.1	-4.8	-8.3	1.6	4.6	-5.0	-8.0	1.9	4.5	-6.5	3.0	-0.46	-1.72	191	0.169
68	-8.9	-4.7	2.4	3.1	-4.8	-8.5	1.6	4.6	-5.1	-7.9	2.0	4.6	-6.6	3.0	-0.46	-1.73	193	0.165
69	-9.0	-4.9	2.4	3.1	-4.8	-8.5	1.6	4.5	-5.0	-8.0	2.0	4.6	-6.6	3.0	-0.46	-1.71	192	0.170
70	-9.0	-4.8	2.4	3.1	-4.9	-8.5	1.6	4.6	-5.0	-8.2	2.0	4.6	-6.6	3.0	-0.45	-1.73	194	0.164
71	-9.0	-4.7	2.4	3.1	-5.0	-8.5	1.6	4.6	-5.2	-8.2	2.0	4.6	-6.7	3.0	-0.45	-1.74	196	0.160
72	-9.0	-4.8	2.5	3.1	-4.9	-8.5	1.6	4.6	-5.1	-8.3	2.0	4.6	-6.7	3.0	-0.45	-1.74	197	0.161
73	-9.0	-4.8	2.5	3.2	-4.8	-8.5	1.6	4.7	-5.1	-8.3	2.0	4.6	-6.7	3.1	-0.46	-1.72	195	0.169
74	-9.1	-4.8	2.5	3.2	-4.9	-8.5	1.6	4.7	-5.1	-8.4	2.0	4.6	-6.7	3.1	-0.46	-1.72	196	0.166
75	-9.1	-4.8	2.5	3.2	-4.9	-8.6	1.6	4.6	-5.1	-8.3	2.0	4.6	-6.7	3.1	-0.46	-1.72	197	0.166
76	-9.1	-4.8	2.5	3.2	-4.9	-8.6	1.6	4.7	-5.2	-8.4	2.0	4.6	-6.8	3.1	-0.45	-1.73	198	0.164
77	-9.1	-4.8	2.5	3.2	-4.9	-8.5	1.7	4.7	-5.3	-8.4	2.0	4.6	-6.8	3.1	-0.45	-1.73	199	0.163
78	-9.2	-4.9	2.5	3.2	-4.9	-8.6	1.7	4.7	-5.2	-8.4	2.0	4.7	-6.8	3.1	-0.46	-1.73	199	0.165
79	-9.2	-4.9	2.5	3.2	-4.9	-8.7	1.7	4.7	-5.2	-8.5	2.0	4.7	-6.9	3.1	-0.45	-1.73	201	0.164
80	-9.2	-4.8	2.5	3.2	-4.9	-8.7	1.7	4.7	-5.2	-8.4	2.0	4.7	-6.8	3.1	-0.46	-1.73	200	0.165
81	-9.2	-4.9	2.5	3.2	-5.0	-8.7	1.7	4.8	-5.3	-8.6	2.0	4.7	-6.9	3.1	-0.45	-1.73	202	0.162
82	-9.2	-4.9	2.6	3.2	-5.0	-8.8	1.7	4.8	-5.3	-8.6	2.0	4.7	-6.9	3.1	-0.45	-1.74	203	0.161
83	-9.2	-4.9	2.6	3.3	-5.1	-9.0	1.7	4.8	-5.3	-8.6	2.0	4.7	-7.0	3.1	-0.45	-1.75	204	0.156
84	-9.3	-4.9	2.6	3.3	-5.0	-8.8	1.7	4.8	-5.3	-8.6	2.0	4.7	-6.9	3.1	-0.45	-1.73	203	0.164
85	-9.3	-5.0	2.6	3.3	-5.0	-8.8	1.7	4.8	-5.4	-8.7	2.1	4.8	-7.0	3.2	-0.45	-1.73	204	0.163
86	-9.3	-5.0	2.6	3.3	-5.0	-8.8	1.7	4.8	-5.5	-8.9	2.1	4.7	-7.0	3.2	-0.45	-1.75	205	0.157
87	-9.3	-5.0	2.6	3.3	-5.1	-8.9	1.7	4.9	-5.4	-8.7	2.1	4.8	-7.0	3.2	-0.45	-1.73	206	0.162
88	-9.4	-5.0	2.6	3.3	-5.0	-8.8	1.7	4.9	-5.4	-8.8	2.1	4.8	-7.0	3.2	-0.45	-1.73	205	0.164
89	-9.3	-5.0	2.6	3.3	-5.1	-9.0	1.7	4.9	-5.4	-8.8	2.1	4.8	-7.1	3.2	-0.45	-1.73	207	0.164
90	-9.4	-5.0	2.6	3.3	-5.1	-8.9	1.7	4.9	-5.5	-8.8	2.1	4.9	-7.1	3.2	-0.46	-1.73	207	0.165
91	-9.5	-5.0	2.6	3.3	-5.1	-9.0	1.8	4.9	-5.5	-8.9	2.1	4.9	-7.1	3.2	-0.46	-1.73	208	0.165
92	-9.6	-5.0	2.6	3.4	-5.2	-9.0	1.8	4.9	-5.5	-8.9	2.1	4.9	-7.1	3.2	-0.45	-1.73	209	0.162
93	-9.5	-5.0	2.6	3.4	-5.0	-8.7	1.8	5.0	-5.4	-8.9	2.1	4.9	-7.0	3.3	-0.46	-1.70	206	0.176
94	-9.5	-5.0	2.6	3.4	-5.1	-9.0	1.8	5.0	-5.5	-8.9	2.1	4.9	-7.1	3.3	-0.46	-1.72	209	0.168
95	-9.4	-5.1	2.6	3.4	-5.2	-9.0	1.8	5.0	-5.6	-8.9	2.1	4.9	-7.2	3.3	-0.46	-1.73	210	0.165
96	-9.6	-5.1	2.7	3.4	-5.3	-9.1	1.8	5.0	-5.5	-8.9	2.1	4.9	-7.2	3.3	-0.45	-1.73	211	0.163
97	-9.6	-5.1	2.7	3.4	-5.3	-9.1	1.8	5.0	-5.4	-8.9	2.2	4.9	-7.2	3.3	-0.46	-1.72	211	0.167
98	-9.6	-5.2	2.7	3.4	-5.1	-9.0	1.8	5.0	-5.5	-8.9	2.2	5.0	-7.1	3.3	-0.46	-1.70	209	0.175
99	-9.7	-5.3	2.7	3.4	-5.1	-9.0	1.8	5.0	-5.4	-8.9	2.2	4.9	-7.1	3.3	-0.46	-1.70	209	0.174
100	-9.6	-5.2	2.7	3.4	-5.2	-9.0	1.8	5.1	-5.5	-8.8	2.2	5.0	-7.1	3.3	-0.47	-1.69	209	0.180

APPENDIX F
IDT STRENGTH DATA

Table F.1 IDT Specimen Geometry

Mix	Sample #	Thickness mm	Diameter mm	Failure Load kN
KL 52-34	2	76.88	150.38	-57.9
KL 52-34	5	76.91	150.33	-67.7
KL 58-40	1	76.82	150.10	-70.3
KL 58-40	10	76.74	150.23	-70.3
KL 58-40	12	76.85	150.00	-75.3
KL 58-40	8	76.80	150.03	-61.5
NU 52-34	6	76.85	150.24	-72.6
NU 52-34	8	76.71	150.29	-71.4
NU 52-34	9	76.72	150.13	-71.7
NU 58-40	11	76.94	150.11	-68.4
NU 58-40	12	76.81	150.02	-70.4
NU 58-40	9	76.79	150.10	-66.8

Gage Length = 38 mm   Test Temperature = -10 °C

Displacement Rate = 12.5 mm/min.

Table F.2 IDT Strength Data (KL 52-34 #2)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
0.00	-0.2	-0.93	0.34	0.67	0.20	-0.08
0.05	-0.3	-0.94	0.34	0.34	0.18	0.03
0.10	-0.5	-0.95	0.47	0.13	0.18	0.15
0.15	-0.8	-0.96	0.54	-0.27	0.18	0.37
0.20	-1.0	-0.97	0.74	-0.74	0.18	0.52
0.25	-1.2	-0.98	0.87	-1.07	0.19	0.72
0.30	-1.5	-0.99	0.87	-1.61	0.17	0.92
0.35	-1.7	-1.00	0.87	-2.08	0.19	1.16
0.40	-2.1	-1.01	1.01	-2.55	0.20	1.43
0.45	-2.7	-1.02	0.81	-3.36	0.22	1.75
0.50	-3.0	-1.03	0.94	-3.83	0.27	2.00
0.55	-3.4	-1.04	1.01	-4.57	0.30	2.38
0.60	-3.8	-1.05	0.87	-5.30	0.32	2.65
0.65	-4.1	-1.06	0.94	-5.84	0.34	2.92
0.70	-4.7	-1.08	0.94	-6.51	0.40	3.37
0.75	-5.1	-1.09	0.87	-7.52	0.44	3.69
0.80	-5.5	-1.09	0.87	-8.06	0.50	4.06
0.85	-5.9	-1.10	0.67	-8.86	0.51	4.38
0.90	-6.4	-1.11	0.60	-9.80	0.54	4.82
0.95	-6.7	-1.13	0.81	-10.07	0.61	5.20
1.00	-7.1	-1.14	0.60	-11.08	0.65	5.61
1.05	-7.5	-1.15	0.74	-11.62	0.71	5.93
1.10	-7.7	-1.16	0.54	-12.42	0.75	6.28
1.15	-8.3	-1.17	0.34	-13.23	0.81	6.66
1.20	-8.8	-1.18	0.40	-13.97	0.90	7.13
1.25	-9.1	-1.19	0.20	-14.70	0.97	7.49
1.30	-9.7	-1.20	0.00	-15.51	1.04	7.97
1.35	-10.1	-1.21	-0.13	-16.32	1.12	8.38
1.40	-10.5	-1.22	-0.27	-17.12	1.19	8.81
1.45	-10.9	-1.23	-0.54	-17.73	1.28	9.18
1.50	-11.2	-1.24	-0.67	-18.53	1.35	9.58
1.55	-11.6	-1.25	-0.81	-19.14	1.43	10.00
1.60	-12.1	-1.26	-1.07	-19.94	1.53	10.41
1.65	-12.5	-1.27	-1.28	-20.75	1.61	10.84
1.70	-13.0	-1.28	-1.61	-21.49	1.74	11.28
1.75	-13.5	-1.29	-1.88	-22.36	1.85	11.75
1.80	-13.8	-1.31	-2.22	-22.96	1.95	12.15
1.85	-14.2	-1.31	-2.55	-23.70	2.06	12.59
1.90	-14.6	-1.32	-2.69	-24.37	2.17	13.03
1.95	-15.1	-1.34	-3.16	-25.18	2.32	13.51
2.00	-15.7	-1.35	-3.56	-26.05	2.44	14.00
2.05	-16.1	-1.36	-3.96	-26.79	2.60	14.47
2.10	-16.6	-1.37	-4.30	-27.59	2.74	14.92
2.15	-17.1	-1.38	-4.70	-28.40	2.89	15.41
2.20	-17.4	-1.38	-5.04	-29.00	3.04	15.86
2.25	-18.2	-1.40	-5.64	-30.01	3.23	16.45

Table F.2 IDT Strength Data (KL 52-34 #2), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
2.30	-18.7	-1.41	-6.11	-30.82	3.39	16.97
2.35	-19.0	-1.42	-6.65	-31.62	3.55	17.46
2.40	-19.4	-1.43	-6.92	-32.36	3.71	17.93
2.45	-19.8	-1.44	-7.52	-33.10	3.86	18.41
2.50	-20.2	-1.45	-7.99	-33.84	4.05	18.93
2.55	-20.8	-1.46	-8.59	-34.78	4.25	19.47
2.60	-21.3	-1.47	-9.06	-35.58	4.45	20.01
2.65	-21.8	-1.48	-9.60	-36.39	4.62	20.53
2.70	-22.1	-1.49	-10.14	-37.20	4.83	21.05
2.75	-22.5	-1.50	-10.74	-37.93	5.01	21.59
2.80	-23.0	-1.51	-11.35	-38.87	5.21	22.12
2.85	-23.3	-1.52	-11.75	-39.55	5.40	22.61
2.90	-24.0	-1.53	-12.49	-40.49	5.62	23.23
2.95	-24.2	-1.55	-13.03	-41.22	5.81	23.73
3.00	-24.7	-1.55	-13.63	-42.16	6.03	24.32
3.05	-25.4	-1.56	-14.23	-43.10	6.28	24.93
3.10	-25.9	-1.58	-15.11	-44.04	6.52	25.56
3.15	-26.5	-1.59	-15.85	-45.12	6.77	26.22
3.20	-26.7	-1.59	-16.45	-45.92	6.98	26.76
3.25	-27.0	-1.61	-17.05	-46.60	7.22	27.34
3.30	-27.4	-1.62	-17.73	-47.60	7.44	27.93
3.35	-28.0	-1.63	-18.46	-48.54	7.70	28.57
3.40	-28.3	-1.64	-19.20	-49.55	7.93	29.17
3.45	-28.8	-1.65	-19.81	-50.29	8.20	29.81
3.50	-29.2	-1.66	-20.61	-51.23	8.46	30.48
3.55	-29.8	-1.67	-21.49	-52.24	8.75	31.12
3.60	-30.3	-1.68	-22.29	-53.38	9.01	31.82
3.65	-30.5	-1.69	-22.96	-54.32	9.27	32.43
3.70	-30.8	-1.70	-23.70	-55.12	9.53	33.05
3.75	-31.3	-1.71	-24.51	-56.20	9.79	33.74
3.80	-31.9	-1.72	-25.45	-57.14	10.10	34.46
3.85	-32.2	-1.73	-26.25	-58.21	10.38	35.11
3.90	-32.8	-1.74	-27.06	-59.22	10.69	35.85
3.95	-33.4	-1.75	-28.00	-60.49	11.04	36.66
4.00	-33.9	-1.76	-29.00	-61.57	11.36	37.43
4.05	-34.2	-1.77	-29.88	-62.51	11.64	38.10
4.10	-34.5	-1.78	-30.68	-63.52	11.95	38.82
4.15	-34.8	-1.79	-31.42	-64.46	12.26	39.53
4.20	-35.2	-1.80	-32.43	-65.53	12.57	40.30
4.25	-35.8	-1.82	-33.50	-66.81	12.93	41.11
4.30	-36.0	-1.82	-34.31	-67.74	13.24	41.80
4.35	-36.3	-1.83	-35.32	-68.68	13.56	42.53
4.40	-36.8	-1.85	-36.19	-69.89	13.91	43.34
4.45	-37.5	-1.86	-37.40	-71.17	14.29	44.20
4.50	-37.9	-1.86	-38.40	-72.31	14.66	45.02

Table F.2 IDT Strength Data (KL 52-34 #2), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
4.55	-38.2	-1.88	-39.41	-73.52	15.01	45.84
4.60	-38.3	-1.89	-40.35	-74.53	15.35	46.58
4.65	-38.6	-1.90	-41.29	-75.53	15.71	47.37
4.70	-39.1	-1.91	-42.50	-76.81	16.11	48.22
4.75	-39.8	-1.92	-43.51	-78.08	16.53	49.18
4.80	-40.0	-1.93	-44.58	-79.23	16.90	49.95
4.85	-40.2	-1.94	-45.59	-80.23	17.26	50.81
4.90	-40.5	-1.95	-46.66	-81.37	17.66	51.63
4.95	-40.9	-1.96	-47.74	-82.58	18.05	52.52
5.00	-41.2	-1.97	-48.74	-83.86	18.46	53.36
5.05	-41.4	-1.98	-49.95	-84.93	18.86	54.22
5.10	-41.8	-1.99	-51.03	-86.07	19.23	55.07
5.16	-42.3	-2.00	-52.17	-87.55	19.70	56.03
5.21	-42.6	-2.01	-53.38	-88.69	20.12	56.94
5.26	-43.0	-2.02	-54.52	-89.97	20.55	57.86
5.31	-43.1	-2.03	-55.66	-91.18	20.97	58.76
5.36	-43.6	-2.04	-57.07	-92.59	21.41	59.65
5.41	-43.8	-2.05	-58.08	-93.66	21.87	60.63
5.46	-44.4	-2.06	-59.69	-95.34	22.32	61.65
5.51	-44.6	-2.08	-60.63	-96.35	22.79	62.64
5.56	-44.6	-2.09	-61.84	-97.69	23.22	63.48
5.61	-44.8	-2.09	-63.05	-98.83	23.68	64.42
5.66	-45.2	-2.10	-64.32	-100.17	24.15	65.48
5.71	-45.7	-2.12	-65.60	-101.65	24.65	66.50
5.76	-46.1	-2.13	-67.07	-103.13	25.18	67.59
5.81	-46.0	-2.14	-68.15	-104.20	25.64	68.48
5.86	-46.3	-2.15	-69.36	-105.55	26.13	69.49
5.91	-46.5	-2.16	-70.83	-107.02	26.60	70.46
5.96	-47.1	-2.17	-72.04	-108.50	27.17	71.66
6.01	-47.0	-2.18	-73.45	-109.78	27.65	72.60
6.06	-47.7	-2.19	-74.86	-111.25	28.22	73.77
6.11	-48.0	-2.20	-76.34	-112.86	28.77	74.90
6.16	-48.1	-2.21	-77.75	-114.14	29.28	75.95
6.21	-48.6	-2.22	-79.23	-115.75	29.88	77.16
6.26	-48.7	-2.23	-80.70	-117.16	30.39	78.24
6.31	-48.8	-2.24	-81.98	-118.50	30.96	79.34
6.36	-49.1	-2.25	-83.52	-120.05	31.52	80.48
6.41	-49.4	-2.26	-85.00	-121.52	32.12	81.69
6.46	-49.8	-2.27	-86.61	-123.20	32.72	82.90
6.51	-49.9	-2.28	-88.09	-124.61	33.29	84.06
6.56	-50.1	-2.30	-89.57	-126.22	33.89	85.25
6.61	-50.1	-2.30	-91.04	-127.63	34.45	86.39
6.66	-50.3	-2.31	-92.65	-129.18	35.06	87.59
6.71	-50.7	-2.32	-94.20	-130.86	35.67	88.86
6.76	-50.7	-2.34	-95.61	-132.27	36.26	90.02

Table F.2 IDT Strength Data (KL 52-34 #2), continued

Time	Axial Force	Axial Displ.	Vert front A	Vert back B	Horz front C	Horz back D
Sec	kN	mm	µm	µm	µm	µm
6.81	-50.8	-2.34	-97.15	-133.81	36.85	91.23
6.86	-51.1	-2.36	-98.83	-135.42	37.50	92.54
6.91	-51.1	-2.37	-100.17	-136.90	38.10	93.73
6.96	-51.3	-2.37	-101.72	-138.38	38.75	95.04
7.01	-51.8	-2.38	-103.53	-140.39	39.41	96.38
7.06	-52.2	-2.40	-105.28	-142.00	40.12	97.79
7.11	-52.4	-2.41	-106.89	-143.82	40.81	99.20
7.16	-52.6	-2.42	-108.63	-145.43	41.50	100.58
7.21	-52.6	-2.43	-110.25	-147.04	42.18	101.94
7.26	-52.7	-2.44	-111.92	-148.72	42.86	103.23
7.31	-52.7	-2.45	-113.47	-150.33	43.51	104.55
7.36	-52.9	-2.46	-115.15	-151.94	44.23	105.91
7.41	-53.3	-2.47	-116.96	-153.89	44.97	107.41
7.46	-53.4	-2.48	-118.70	-155.50	45.67	108.84
7.51	-53.5	-2.50	-120.38	-157.31	46.39	110.21
7.56	-53.4	-2.50	-121.99	-158.79	47.10	111.59
7.61	-53.7	-2.51	-123.81	-160.73	47.86	113.08
7.66	-53.8	-2.52	-125.75	-162.75	48.62	114.54
7.71	-54.0	-2.53	-127.50	-164.56	49.39	116.02
7.76	-54.0	-2.55	-129.18	-165.90	50.15	117.58
7.81	-54.3	-2.55	-130.72	-167.72	50.95	119.07
7.86	-54.5	-2.57	-132.80	-169.73	51.73	120.64
7.91	-54.7	-2.58	-134.62	-171.68	52.58	122.26
7.96	-54.8	-2.58	-136.50	-173.42	53.39	123.84
8.01	-55.0	-2.60	-138.31	-175.37	54.23	125.47
8.06	-55.3	-2.60	-140.32	-177.52	55.13	127.20
8.11	-55.4	-2.62	-142.14	-179.40	55.98	128.84
8.16	-55.5	-2.63	-144.02	-181.28	56.85	130.56
8.21	-55.6	-2.64	-145.90	-183.16	57.72	132.18
8.26	-55.7	-2.65	-147.91	-185.17	58.62	133.91
8.31	-55.8	-2.66	-149.86	-187.19	59.52	135.66
8.36	-56.0	-2.67	-151.87	-189.27	60.46	137.44
8.41	-56.0	-2.68	-153.89	-191.22	61.39	139.17
8.46	-56.3	-2.69	-155.90	-193.30	62.37	141.08
8.51	-56.4	-2.70	-157.98	-195.45	63.32	142.93
8.56	-56.3	-2.71	-159.79	-197.26	64.28	144.72
8.61	-56.4	-2.72	-161.81	-199.41	65.24	146.53
8.66	-56.5	-2.73	-163.89	-201.42	66.25	148.46
8.71	-56.6	-2.74	-165.77	-203.57	67.24	150.34
8.76	-56.7	-2.76	-167.85	-205.65	68.27	152.36
8.81	-56.5	-2.76	-169.80	-207.46	69.23	154.19
8.86	-56.5	-2.77	-171.75	-209.48	70.24	156.07
8.91	-56.7	-2.78	-173.76	-211.76	71.29	158.05
8.96	-56.8	-2.80	-175.91	-213.84	72.34	160.10
9.01	-56.9	-2.80	-177.99	-215.99	73.40	162.14

Table F.2 IDT Strength Data (KL 52-34 #2), continued

Time	Axial Force	Axial Displ.	Vert front A	Vert back B	Horz front C	Horz back D
Sec	kN	mm	µm	µm	µm	µm
9.06	-57.1	-2.82	-180.21	-218.27	74.51	164.28
9.11	-57.3	-2.82	-182.42	-220.56	75.63	166.48
9.16	-57.7	-2.84	-184.64	-222.91	76.76	168.77
9.21	-57.6	-2.85	-186.85	-225.26	77.91	170.97
9.26	-57.4	-2.85	-188.93	-227.41	79.02	173.12
9.31	-57.8	-2.87	-191.28	-229.82	80.22	175.49
9.36	-57.7	-2.88	-193.30	-231.97	81.42	177.81
9.41	-57.6	-2.89	-195.51	-234.19	82.61	180.09
9.46	-57.6	-2.90	-197.80	-236.60	83.79	182.45
9.51	-57.5	-2.91	-199.95	-238.75	84.95	184.69
9.56	-57.5	-2.92	-202.16	-241.10	86.20	187.07
9.61	-57.6	-2.93	-204.44	-243.45	87.43	189.49
9.66	-57.5	-2.94	-206.59	-245.67	88.68	191.96
9.71	-57.5	-2.95	-208.67	-247.95	89.96	194.41
9.76	-57.8	-2.96	-211.09	-250.50	91.29	197.07
9.81	-57.8	-2.97	-213.51	-253.05	92.66	199.69
9.86	-57.9	-2.99	-215.86	-255.47	94.05	202.40
9.91	-57.6	-3.00	-217.94	-257.82	95.34	204.91
9.96	-57.7	-3.01	-220.29	-260.24	96.72	207.63
10.01	-57.6	-3.02	-222.71	-262.79	98.12	210.35
10.06	-57.6	-3.03	-224.99	-265.34	99.52	213.10
10.11	-57.5	-3.03	-227.41	-267.89	100.94	215.87
10.16	-57.6	-3.05	-229.49	-270.11	102.47	218.88
10.21	-57.7	-3.06	-231.97	-272.59	103.97	221.85
10.26	-57.5	-3.07	-234.59	-275.75	105.43	224.69
10.31	-57.6	-3.08	-236.87	-277.96	106.99	227.76
10.36	-57.5	-3.09	-239.29	-280.38	108.56	230.86
10.41	-57.8	-3.10	-241.84	-283.27	110.20	234.14
10.46	-57.8	-3.11	-244.26	-286.02	111.86	237.44
10.51	-57.7	-3.12	-246.54	-288.71	113.48	240.72
10.56	-57.3	-3.13	-248.89	-291.19	115.11	244.01
10.61	-57.4	-3.14	-251.37	-293.94	116.82	247.45
10.66	-57.5	-3.15	-253.79	-296.76	118.59	250.99
10.71	-57.4	-3.16	-256.21	-301.06	120.32	254.50
10.76	-57.7	-3.17	-258.83	-303.81	122.25	258.44
10.81	-57.7	-3.18	-261.31	-306.90	124.11	262.23
10.86	-57.6	-3.19	-263.86	-310.26	126.03	266.21
10.91	-57.5	-3.20	-266.28	-313.35	127.94	270.16
10.96	-57.5	-3.22	-268.83	-316.84	129.94	274.34
11.01	-57.4	-3.22	-271.45	-320.13	131.96	278.60
11.06	-57.5	-3.23	-274.07	-323.75	134.04	283.12
11.11	-57.3	-3.25	-276.89	-326.17	135.99	288.77
11.16	-57.3	-3.26	-279.64	-327.92	137.75	298.76
11.21	-53.7	-3.27	-284.74	-332.75	159.74	418.92

Table F.3 IDT Strength Data (KL 52-34 #5)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	N	mm	µm	µm	µm	µm
0.00	-0.1	-0.92	0.27	0.13	0.25	0.08
0.05	-0.4	-0.93	0.00	-0.13	0.27	0.08
0.10	-0.7	-0.94	-0.07	0.00	0.31	0.15
0.15	-1.0	-0.95	-0.27	-0.20	0.37	0.18
0.20	-1.3	-0.96	-0.47	-0.40	0.41	0.27
0.25	-2.0	-0.97	-0.81	-0.60	0.50	0.40
0.30	-2.5	-0.98	-1.14	-0.81	0.56	0.55
0.35	-3.2	-0.99	-1.41	-1.14	0.62	0.72
0.40	-3.9	-1.00	-1.68	-1.48	0.71	0.94
0.45	-4.5	-1.02	-2.01	-1.81	0.77	1.09
0.50	-5.3	-1.02	-2.15	-2.15	0.88	1.34
0.55	-5.9	-1.04	-2.55	-2.55	0.97	1.54
0.60	-6.7	-1.05	-2.75	-2.95	1.07	1.83
0.65	-7.6	-1.06	-3.16	-3.42	1.16	2.06
0.70	-8.4	-1.07	-3.49	-3.96	1.27	2.37
0.75	-9.2	-1.08	-3.76	-4.50	1.36	2.64
0.80	-9.9	-1.09	-4.03	-4.90	1.44	2.89
0.85	-11.1	-1.09	-4.63	-5.57	1.58	3.26
0.90	-11.8	-1.11	-5.04	-6.11	1.69	3.59
0.95	-12.7	-1.12	-5.30	-6.58	1.79	3.88
1.00	-13.5	-1.13	-5.71	-7.25	1.91	4.23
1.05	-14.0	-1.15	-5.98	-7.59	1.98	4.45
1.10	-14.7	-1.15	-6.31	-7.99	2.10	4.77
1.15	-15.7	-1.16	-6.71	-8.80	2.22	5.10
1.20	-16.4	-1.17	-7.05	-9.27	2.33	5.44
1.25	-17.1	-1.18	-7.59	-9.94	2.42	5.71
1.30	-17.9	-1.19	-7.92	-10.27	2.53	6.08
1.35	-18.6	-1.20	-8.33	-11.15	2.62	6.38
1.40	-19.2	-1.21	-8.46	-11.48	2.75	6.70
1.45	-20.3	-1.23	-8.93	-12.09	2.90	7.17
1.50	-21.0	-1.24	-9.33	-12.62	3.00	7.47
1.55	-21.7	-1.24	-9.74	-13.23	3.11	7.84
1.60	-22.6	-1.25	-9.94	-13.97	3.25	8.19
1.65	-23.3	-1.27	-10.47	-14.50	3.35	8.54
1.70	-24.1	-1.28	-10.74	-15.11	3.50	8.96
1.75	-24.9	-1.29	-11.28	-15.78	3.59	9.33
1.80	-25.9	-1.30	-11.75	-16.45	3.76	9.80
1.85	-26.8	-1.31	-12.09	-17.12	3.89	10.24
1.90	-27.3	-1.32	-12.49	-17.86	4.01	10.59
1.95	-28.1	-1.33	-12.89	-18.53	4.14	11.03
2.00	-28.7	-1.34	-13.29	-19.07	4.26	11.41
2.05	-29.4	-1.35	-13.70	-19.74	4.36	11.80
2.10	-30.3	-1.36	-14.03	-20.48	4.50	12.25
2.15	-30.9	-1.37	-14.37	-21.02	4.62	12.66
2.20	-32.0	-1.38	-14.97	-21.82	4.77	13.16
2.25	-32.5	-1.39	-15.31	-22.49	4.88	13.56

Table F.3 IDT Strength Data (KL 52-34 #5), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	N	mm	μm	μm	μm	μm
2.30	-33.2	-1.40	-15.71	-23.16	5.01	14.03
2.35	-34.0	-1.41	-16.25	-23.83	5.15	14.47
2.40	-34.8	-1.42	-16.65	-24.71	5.28	14.96
2.45	-35.5	-1.43	-17.05	-25.38	5.42	15.43
2.50	-36.3	-1.44	-17.59	-26.18	5.56	15.93
2.55	-37.1	-1.45	-17.93	-26.86	5.69	16.42
2.60	-37.7	-1.46	-18.40	-27.53	5.84	16.92
2.65	-38.5	-1.47	-18.93	-28.53	5.98	17.42
2.70	-39.2	-1.49	-19.40	-29.14	6.13	17.89
2.75	-40.0	-1.49	-19.94	-29.94	6.29	18.46
2.80	-40.9	-1.50	-20.34	-30.75	6.45	19.07
2.85	-41.6	-1.51	-20.88	-31.56	6.61	19.59
2.90	-42.4	-1.53	-21.42	-32.50	6.75	20.14
2.95	-43.0	-1.54	-21.96	-33.17	6.91	20.70
3.00	-43.7	-1.55	-22.43	-33.97	7.07	21.23
3.05	-44.2	-1.56	-22.89	-34.85	7.23	21.75
3.10	-45.0	-1.57	-23.50	-35.65	7.49	22.32
3.15	-45.6	-1.58	-23.70	-36.19	7.70	22.93
3.20	-46.3	-1.59	-24.44	-37.20	7.87	23.50
3.25	-47.0	-1.59	-25.11	-38.07	8.04	24.05
3.30	-47.9	-1.61	-25.65	-39.01	8.26	24.77
3.35	-48.6	-1.62	-26.25	-39.88	8.43	25.41
3.40	-49.2	-1.63	-26.65	-40.75	8.62	26.03
3.45	-49.8	-1.64	-27.33	-41.69	8.80	26.67
3.50	-50.4	-1.65	-27.80	-42.50	8.98	27.31
3.55	-50.6	-1.66	-28.27	-43.17	9.15	27.86
3.60	-51.3	-1.67	-28.87	-44.11	9.32	28.55
3.65	-52.1	-1.68	-29.47	-44.98	9.53	29.24
3.70	-52.7	-1.69	-30.08	-45.92	9.71	29.93
3.75	-53.1	-1.70	-30.55	-46.80	9.89	30.57
3.80	-53.8	-1.71	-31.15	-47.74	10.08	31.29
3.85	-54.4	-1.72	-31.76	-48.68	10.28	32.04
3.90	-55.1	-1.73	-32.43	-49.68	10.50	32.80
3.95	-55.7	-1.74	-32.97	-50.56	10.70	33.60
4.00	-56.2	-1.76	-33.64	-51.56	10.90	34.36
4.05	-56.6	-1.76	-34.17	-52.50	11.08	35.11
4.10	-57.3	-1.77	-34.85	-53.44	11.30	35.92
4.15	-58.0	-1.79	-35.58	-54.45	11.52	36.81
4.20	-58.4	-1.80	-36.32	-55.53	11.73	37.63
4.25	-58.8	-1.81	-36.86	-56.40	11.98	38.44
4.30	-59.4	-1.81	-37.60	-57.47	12.23	39.31
4.35	-60.1	-1.82	-38.34	-58.68	12.45	40.27
4.40	-60.6	-1.84	-39.21	-59.62	12.70	41.22
4.45	-61.0	-1.84	-39.68	-60.70	12.90	42.11
4.50	-61.4	-1.86	-40.35	-61.70	13.17	43.12

Table F.3 IDT Strength Data (KL 52-34 #5), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	N	mm	µm	µm	µm	µm
4.55	-61.9	-1.86	-41.22	-62.91	13.44	44.13
4.60	-62.3	-1.88	-41.83	-63.99	13.65	45.14
4.65	-63.0	-1.89	-42.70	-65.13	13.91	46.29
4.70	-63.6	-1.90	-43.51	-66.34	14.19	47.42
4.75	-64.0	-1.91	-44.25	-67.48	14.46	48.56
4.80	-64.2	-1.92	-44.98	-68.35	14.72	49.87
4.85	-64.7	-1.93	-45.72	-69.69	14.98	51.31
4.90	-65.0	-1.94	-46.60	-70.83	15.24	52.64
4.95	-65.6	-1.95	-47.40	-72.11	15.53	54.10
5.00	-65.9	-1.96	-48.27	-73.18	15.79	55.44
5.05	-66.3	-1.97	-49.15	-74.46	16.13	56.87
5.10	-66.8	-1.98	-50.22	-75.60	16.60	58.38
5.16	-66.8	-1.99	-51.63	-76.81	17.37	59.79
5.21	-67.2	-2.00	-52.77	-79.02	18.15	61.55
5.26	-67.6	-2.02	-54.12	-80.97	18.85	63.92
5.31	-67.4	-2.03	-56.94	-83.32	19.06	92.99
5.36	-66.8	-2.04	-61.30	-89.36	22.18	129.58
5.41	-65.2	-2.05	-70.90	-106.75	36.79	190.19
5.46	-61.4	-2.06	-81.58	-132.40	70.88	268.29

Table F.4 IDT Strength Data (KL 58-40 #1)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
0.00	-0.2	-0.81	0.81	0.47	0.16	0.03
0.05	-0.4	-0.82	0.67	0.27	0.19	0.12
0.10	-0.7	-0.83	0.54	0.20	0.22	0.17
0.15	-1.1	-0.84	0.34	0.00	0.28	0.27
0.20	-1.8	-0.85	0.00	-0.27	0.36	0.45
0.25	-2.4	-0.86	-0.34	-0.54	0.44	0.60
0.30	-3.0	-0.87	-0.67	-0.81	0.52	0.79
0.35	-3.5	-0.88	-1.01	-1.07	0.63	0.96
0.40	-4.2	-0.89	-1.48	-1.41	0.76	1.21
0.45	-4.9	-0.90	-1.88	-1.75	0.86	1.36
0.50	-5.6	-0.91	-2.35	-2.15	0.97	1.61
0.55	-6.4	-0.92	-2.69	-2.28	1.11	1.90
0.60	-7.1	-0.93	-3.36	-3.02	1.23	2.11
0.65	-7.9	-0.94	-3.83	-3.49	1.36	2.37
0.70	-8.7	-0.95	-4.30	-3.89	1.50	2.69
0.75	-9.5	-0.97	-4.83	-4.43	1.65	3.00
0.80	-10.1	-0.97	-5.24	-4.83	1.77	3.24
0.85	-11.3	-0.99	-5.98	-5.51	1.96	3.66
0.90	-12.0	-1.00	-6.58	-6.11	2.11	3.98
0.95	-12.9	-1.01	-7.18	-6.65	2.28	4.36
1.00	-13.4	-1.02	-7.72	-7.12	2.42	4.63
1.05	-14.1	-1.02	-8.26	-7.65	2.56	4.93
1.10	-14.6	-1.04	-8.73	-8.06	2.69	5.25
1.15	-15.5	-1.04	-9.27	-8.66	2.89	5.64
1.20	-16.2	-1.06	-9.80	-9.27	3.02	5.94
1.25	-17.1	-1.07	-10.54	-9.94	3.23	6.36
1.30	-17.8	-1.08	-11.21	-10.47	3.40	6.75
1.35	-18.6	-1.09	-11.82	-11.01	3.60	7.12
1.40	-19.1	-1.10	-12.42	-11.62	3.76	7.44
1.45	-19.8	-1.11	-12.89	-12.29	3.93	7.87
1.50	-20.6	-1.12	-13.70	-12.69	4.13	8.24
1.55	-21.1	-1.12	-14.37	-13.36	4.30	8.59
1.60	-21.7	-1.14	-14.97	-13.90	4.46	8.96
1.65	-22.4	-1.15	-15.58	-14.57	4.65	9.33
1.70	-23.2	-1.16	-16.32	-15.17	4.86	9.75
1.75	-23.9	-1.17	-16.85	-15.85	5.06	10.19
1.80	-24.4	-1.18	-17.59	-16.45	5.25	10.59
1.85	-25.1	-1.19	-18.33	-17.12	5.46	11.01
1.90	-25.8	-1.20	-19.00	-17.73	5.66	11.45
1.95	-26.5	-1.21	-19.74	-18.40	5.88	11.88
2.00	-27.5	-1.22	-20.55	-19.07	6.11	12.42
2.05	-28.0	-1.24	-21.22	-19.87	6.34	12.89
2.10	-28.8	-1.25	-22.22	-20.68	6.56	13.34
2.15	-29.2	-1.26	-22.76	-21.22	6.78	13.78
2.20	-29.9	-1.27	-23.50	-21.82	7.01	14.23
2.25	-30.4	-1.28	-24.30	-22.63	7.21	14.70

Table F.4 IDT Strength Data (KL 58-40 #1), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
2.30	-31.2	-1.29	-25.04	-23.36	7.48	15.22
2.35	-31.9	-1.30	-25.98	-24.10	7.71	15.71
2.40	-32.7	-1.31	-26.92	-24.91	7.99	16.26
2.45	-33.3	-1.32	-27.73	-25.65	8.25	16.80
2.50	-33.9	-1.33	-28.47	-26.12	8.51	17.37
2.55	-34.6	-1.34	-29.47	-27.39	8.76	17.84
2.60	-35.3	-1.35	-30.28	-28.00	9.03	18.43
2.65	-36.0	-1.36	-31.35	-28.80	9.32	19.03
2.70	-36.2	-1.37	-32.16	-29.47	9.53	19.45
2.75	-36.9	-1.38	-32.97	-30.35	9.81	20.06
2.80	-37.6	-1.39	-33.77	-31.09	10.10	20.63
2.85	-38.1	-1.40	-34.78	-31.96	10.38	21.18
2.90	-38.7	-1.41	-35.72	-32.90	10.68	21.77
2.95	-39.2	-1.43	-36.59	-33.64	10.94	22.36
3.00	-39.8	-1.43	-37.60	-34.44	11.25	22.93
3.05	-40.0	-1.44	-38.34	-35.18	11.50	23.47
3.10	-40.8	-1.45	-39.34	-36.19	11.82	24.10
3.15	-41.5	-1.46	-40.35	-36.93	12.14	24.76
3.20	-42.3	-1.47	-41.63	-38.07	12.50	25.50
3.25	-43.1	-1.48	-42.70	-39.01	12.85	26.22
3.30	-43.3	-1.49	-43.57	-39.88	13.13	26.81
3.35	-43.6	-1.51	-44.51	-40.62	13.44	27.41
3.40	-44.2	-1.52	-45.59	-41.49	13.77	28.08
3.45	-44.6	-1.52	-46.73	-42.63	14.07	28.69
3.50	-45.1	-1.54	-47.60	-43.24	14.43	29.39
3.55	-45.9	-1.54	-48.74	-44.31	14.80	30.13
3.60	-46.4	-1.56	-49.95	-45.32	15.17	30.85
3.65	-47.1	-1.57	-51.09	-46.33	15.56	31.62
3.70	-47.4	-1.58	-52.24	-47.33	15.91	32.33
3.75	-47.8	-1.59	-53.31	-48.27	16.27	33.05
3.80	-48.3	-1.60	-54.45	-49.15	16.63	33.79
3.85	-48.7	-1.61	-55.59	-50.09	17.04	34.53
3.90	-49.4	-1.62	-56.80	-51.30	17.43	35.33
3.95	-49.8	-1.63	-58.01	-52.24	17.83	36.14
4.00	-50.3	-1.64	-59.22	-53.24	18.24	36.93
4.05	-50.8	-1.65	-60.43	-54.32	18.67	37.75
4.10	-51.4	-1.66	-61.77	-55.46	19.08	38.59
4.15	-51.8	-1.67	-62.98	-56.47	19.50	39.41
4.20	-52.3	-1.69	-64.32	-57.67	19.97	40.28
4.25	-52.6	-1.69	-65.60	-58.68	20.39	41.09
4.30	-53.1	-1.70	-66.94	-59.76	20.83	41.96
4.35	-53.5	-1.71	-68.28	-60.90	21.29	42.84
4.40	-54.0	-1.72	-69.83	-62.24	21.75	43.69
4.45	-54.1	-1.73	-70.90	-63.11	22.20	44.55
4.50	-54.8	-1.74	-72.31	-64.25	22.72	45.50

Table F.4 IDT Strength Data (KL 58-40 #1), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
4.55	-55.1	-1.76	-73.65	-65.46	23.20	46.39
4.60	-55.5	-1.77	-75.00	-66.60	23.70	47.35
4.65	-55.9	-1.78	-76.41	-67.68	24.20	48.27
4.70	-56.0	-1.78	-77.82	-68.75	24.67	49.15
4.75	-56.6	-1.80	-79.23	-70.03	25.20	50.14
4.80	-57.0	-1.81	-80.77	-71.10	25.71	51.09
4.85	-57.3	-1.82	-82.25	-72.51	26.23	52.05
4.90	-57.6	-1.83	-83.66	-73.52	26.76	53.04
4.95	-58.0	-1.84	-85.07	-74.53	27.33	54.07
5.00	-58.5	-1.85	-86.81	-76.00	27.89	55.07
5.05	-59.0	-1.86	-88.29	-77.28	28.49	56.20
5.10	-59.0	-1.87	-89.77	-78.49	29.03	57.19
5.16	-59.5	-1.88	-91.38	-79.76	29.62	58.24
5.21	-60.0	-1.89	-93.06	-81.11	30.26	59.40
5.26	-60.1	-1.90	-94.60	-82.52	30.85	60.48
5.31	-60.7	-1.91	-96.28	-83.72	31.54	61.64
5.36	-60.9	-1.93	-97.96	-85.07	32.17	62.78
5.41	-61.2	-1.93	-99.57	-86.48	32.82	63.93
5.46	-61.5	-1.94	-101.32	-87.75	33.47	65.13
5.51	-61.7	-1.95	-102.99	-89.23	34.17	66.28
5.56	-62.2	-1.96	-104.81	-90.64	34.88	67.59
5.61	-62.4	-1.97	-106.55	-91.92	35.60	68.82
5.66	-62.9	-1.98	-108.50	-93.53	36.35	70.13
5.71	-63.2	-1.99	-110.18	-94.94	37.10	71.49
5.76	-63.7	-2.01	-112.19	-96.48	37.90	72.90
5.81	-63.8	-2.02	-113.87	-97.96	38.69	74.27
5.86	-63.8	-2.03	-115.75	-99.23	39.45	75.62
5.91	-64.2	-2.04	-117.83	-101.05	40.24	76.99
5.96	-64.6	-2.05	-119.64	-102.46	41.12	78.54
6.01	-64.8	-2.06	-121.52	-104.00	41.98	80.10
6.06	-64.8	-2.07	-123.34	-105.41	42.78	81.54
6.11	-65.2	-2.08	-125.28	-107.09	43.67	83.07
6.16	-65.3	-2.09	-127.16	-108.70	44.56	84.65
6.21	-65.6	-2.10	-129.18	-110.51	45.48	86.28
6.26	-66.0	-2.11	-131.13	-112.13	46.45	87.95
6.31	-66.2	-2.12	-133.27	-113.94	47.40	89.68
6.36	-66.3	-2.13	-135.15	-115.62	48.40	91.41
6.41	-66.3	-2.14	-137.03	-117.23	49.39	93.09
6.46	-66.4	-2.15	-139.12	-119.17	50.38	94.75
6.51	-66.7	-2.16	-141.13	-120.85	51.45	96.65
6.56	-66.9	-2.17	-143.14	-122.53	52.54	98.50
6.61	-67.1	-2.18	-145.16	-124.34	53.64	100.41
6.66	-67.4	-2.19	-147.44	-126.29	54.83	102.47
6.71	-67.6	-2.20	-149.46	-128.37	56.00	104.49
6.76	-67.8	-2.21	-151.60	-130.32	57.25	106.59

Table F.4 IDT Strength Data (KL 58-40 #1), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
6.81	-68.1	-2.23	-153.89	-132.47	58.52	108.78
6.86	-68.2	-2.24	-156.17	-134.55	59.81	111.00
6.91	-68.3	-2.25	-158.25	-136.56	61.15	113.23
6.96	-68.5	-2.25	-160.47	-138.58	62.51	115.53
7.01	-68.6	-2.26	-162.82	-140.59	63.92	117.95
7.06	-68.8	-2.28	-164.96	-142.67	65.35	120.37
7.11	-69.0	-2.29	-167.31	-145.09	66.86	122.88
7.16	-69.2	-2.30	-169.66	-147.17	68.42	125.55
7.21	-69.4	-2.31	-172.15	-149.52	70.04	128.36
7.26	-69.6	-2.32	-174.63	-151.87	71.71	131.18
7.31	-69.5	-2.33	-176.92	-154.09	73.42	134.03
7.36	-69.8	-2.34	-179.47	-156.37	75.21	137.12
7.41	-69.7	-2.35	-181.88	-158.72	77.05	140.16
7.46	-69.8	-2.36	-184.37	-161.07	78.97	143.33
7.51	-70.0	-2.37	-186.92	-163.62	81.01	146.75
7.56	-69.8	-2.38	-189.54	-166.04	83.09	150.16
7.61	-70.0	-2.39	-192.22	-168.46	85.31	153.80
7.66	-70.2	-2.41	-195.11	-171.34	87.68	157.58
7.71	-70.1	-2.42	-197.86	-173.96	90.15	161.52
7.76	-70.0	-2.42	-200.82	-176.71	92.73	165.55
7.81	-70.2	-2.43	-203.84	-179.53	95.53	169.83
7.86	-70.2	-2.44	-206.73	-182.62	98.49	174.26
7.91	-70.3	-2.45	-209.75	-185.58	101.67	178.95
7.96	-70.0	-2.47	-212.63	-188.73	105.00	183.75
8.01	-70.1	-2.48	-215.86	-192.09	108.62	188.83
8.06	-69.8	-2.49	-218.81	-195.38	112.44	194.07
8.11	-70.0	-2.50	-221.97	-198.94	116.72	199.81
8.16	-69.9	-2.51	-224.99	-202.56	121.35	205.90
8.21	-69.8	-2.52	-228.08	-206.39	126.38	212.40
8.26	-69.5	-2.53	-230.70	-210.35	131.94	219.58
8.31	-69.1	-2.54	-233.31	-214.51	138.01	227.10
8.36	-68.7	-2.55	-235.80	-219.68	144.84	237.66
8.41	-68.3	-2.56	-238.08	-225.26	152.81	248.64
8.46	-67.5	-2.57	-240.30	-232.84	161.83	271.95
8.51	-64.4	-2.59	-244.86	-253.12	179.95	373.30

Table F.5 IDT Strength Data (KL 58-40 #10)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
0.00	-0.4	-0.36	1.07	0.60	0.18	0.15
0.05	-0.7	-0.37	0.94	0.20	0.20	0.30
0.10	-1.1	-0.38	1.07	-0.13	0.24	0.50
0.15	-1.7	-0.39	0.94	-0.74	0.27	0.79
0.20	-2.2	-0.40	0.81	-1.14	0.33	1.04
0.25	-2.6	-0.41	0.74	-1.61	0.38	1.24
0.30	-3.3	-0.42	0.47	-2.22	0.45	1.54
0.35	-4.0	-0.44	0.13	-2.69	0.54	1.86
0.40	-4.7	-0.45	-0.07	-3.36	0.63	2.18
0.45	-5.4	-0.46	-0.40	-3.83	0.74	2.53
0.50	-6.2	-0.47	-0.67	-4.77	0.84	2.95
0.55	-7.0	-0.48	-1.21	-5.44	0.96	3.31
0.60	-7.8	-0.49	-1.41	-6.04	1.10	3.68
0.65	-8.5	-0.50	-1.68	-6.65	1.23	4.10
0.70	-9.0	-0.51	-2.15	-7.25	1.34	4.46
0.75	-9.7	-0.51	-2.62	-8.06	1.50	4.87
0.80	-10.5	-0.53	-3.09	-8.73	1.61	5.25
0.85	-11.2	-0.53	-3.36	-9.40	1.76	5.64
0.90	-11.8	-0.55	-3.76	-10.07	1.91	6.04
0.95	-12.7	-0.56	-4.23	-10.88	2.08	6.55
1.00	-13.4	-0.57	-4.90	-11.75	2.22	6.93
1.05	-14.1	-0.58	-5.24	-12.35	2.39	7.39
1.10	-14.8	-0.59	-5.77	-13.09	2.58	7.89
1.15	-15.5	-0.60	-6.24	-13.90	2.75	8.38
1.20	-16.3	-0.61	-6.78	-14.70	2.93	8.83
1.25	-16.8	-0.62	-7.25	-15.51	3.09	9.30
1.30	-17.5	-0.63	-7.79	-16.32	3.28	9.77
1.35	-18.2	-0.64	-8.39	-17.05	3.47	10.27
1.40	-19.2	-0.65	-9.00	-17.93	3.68	10.83
1.45	-20.0	-0.66	-9.60	-18.67	3.94	11.45
1.50	-20.8	-0.67	-10.27	-19.81	4.15	11.97
1.55	-21.4	-0.69	-11.01	-20.61	4.34	12.49
1.60	-21.9	-0.70	-11.55	-21.49	4.56	12.99
1.65	-22.7	-0.70	-12.22	-22.43	4.78	13.56
1.70	-23.3	-0.71	-12.76	-23.16	5.01	14.08
1.75	-24.3	-0.72	-13.70	-24.37	5.25	14.79
1.80	-24.8	-0.74	-14.30	-25.24	5.49	15.27
1.85	-25.2	-0.75	-14.84	-25.92	5.69	15.79
1.90	-26.1	-0.76	-15.64	-26.99	5.97	16.50
1.95	-26.8	-0.76	-16.38	-27.86	6.22	17.07
2.00	-27.6	-0.78	-17.19	-29.00	6.50	17.74
2.05	-28.0	-0.79	-17.86	-29.61	6.74	18.31
2.10	-28.6	-0.80	-18.53	-30.75	6.98	18.93
2.15	-29.4	-0.81	-19.34	-31.69	7.28	19.62
2.20	-30.1	-0.82	-20.28	-32.76	7.54	20.29
2.25	-31.1	-0.82	-21.02	-33.91	7.86	21.05

Table F.5 IDT Strength Data (KL 58-40 #10), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
2.30	-31.6	-0.84	-21.89	-34.98	8.16	21.70
2.35	-32.2	-0.85	-22.69	-35.99	8.44	22.41
2.40	-32.5	-0.86	-23.70	-37.26	8.67	22.95
2.45	-33.3	-0.87	-24.44	-38.00	8.99	23.70
2.50	-33.9	-0.88	-25.04	-38.94	9.29	24.44
2.55	-34.7	-0.89	-26.05	-40.15	9.63	25.23
2.60	-35.4	-0.90	-27.06	-41.29	9.94	26.00
2.65	-35.9	-0.92	-27.80	-42.37	10.26	26.72
2.70	-36.4	-0.92	-28.74	-43.37	10.57	27.43
2.75	-36.9	-0.94	-29.61	-44.58	10.87	28.15
2.80	-37.7	-0.94	-30.62	-45.79	11.23	28.99
2.85	-38.3	-0.95	-31.56	-46.86	11.57	29.81
2.90	-38.8	-0.97	-32.50	-48.14	11.88	30.60
2.95	-39.2	-0.97	-33.23	-49.01	12.22	31.34
3.00	-39.7	-0.99	-34.17	-50.15	12.54	32.11
3.05	-40.4	-1.00	-35.18	-51.43	12.92	32.95
3.10	-41.0	-1.01	-36.19	-52.77	13.29	33.82
3.15	-41.5	-1.02	-37.20	-53.85	13.62	34.68
3.20	-42.1	-1.03	-38.27	-55.19	14.01	35.53
3.25	-42.6	-1.04	-39.28	-56.60	14.38	36.42
3.30	-43.2	-1.05	-40.28	-58.28	14.75	37.31
3.35	-43.7	-1.06	-41.49	-59.55	15.12	38.14
3.40	-44.3	-1.07	-42.43	-60.83	15.53	39.08
3.45	-44.8	-1.08	-43.44	-62.11	15.92	40.03
3.50	-45.5	-1.09	-44.58	-63.45	16.34	41.02
3.55	-45.9	-1.10	-45.59	-64.72	16.74	41.95
3.60	-46.3	-1.11	-46.80	-66.07	17.13	42.87
3.65	-46.7	-1.12	-47.80	-67.34	17.52	43.79
3.70	-47.2	-1.13	-49.01	-68.68	17.94	44.78
3.75	-47.4	-1.14	-50.02	-69.89	18.32	45.64
3.80	-48.1	-1.15	-51.30	-71.57	18.74	46.65
3.85	-48.5	-1.16	-52.37	-72.78	19.18	47.65
3.90	-49.0	-1.17	-53.44	-74.19	19.60	48.66
3.95	-49.6	-1.19	-54.72	-75.60	20.05	49.70
4.00	-50.0	-1.20	-55.79	-76.94	20.50	50.76
4.05	-50.5	-1.21	-57.00	-78.35	20.95	51.80
4.10	-51.0	-1.22	-58.28	-79.90	21.39	52.92
4.15	-51.4	-1.23	-59.49	-81.37	21.86	54.01
4.20	-51.8	-1.24	-60.70	-82.85	22.31	55.07
4.25	-52.0	-1.24	-61.90	-84.26	22.74	56.16
4.30	-52.7	-1.26	-63.11	-85.60	23.25	57.37
4.35	-53.0	-1.27	-64.46	-87.28	23.70	58.50
4.40	-53.4	-1.27	-65.73	-88.83	24.16	59.62
4.45	-54.1	-1.29	-67.07	-90.44	24.67	60.93
4.50	-54.2	-1.30	-68.35	-91.85	25.14	62.11

Table F.5 IDT Strength Data (KL 58-40 #10), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
4.55	-54.4	-1.31	-69.49	-93.26	25.60	63.25
4.60	-55.0	-1.32	-70.90	-94.87	26.11	64.52
4.65	-55.4	-1.33	-72.38	-96.48	26.60	65.83
4.70	-55.7	-1.34	-73.59	-98.16	27.10	67.06
4.75	-56.1	-1.35	-74.93	-99.64	27.63	68.40
4.80	-56.6	-1.36	-76.47	-101.52	28.16	69.73
4.85	-56.7	-1.37	-77.75	-102.99	28.65	71.00
4.90	-56.9	-1.38	-79.09	-104.47	29.16	72.31
4.95	-57.3	-1.39	-80.30	-106.02	29.68	73.67
5.00	-57.7	-1.40	-81.78	-107.76	30.23	75.05
5.05	-58.3	-1.41	-83.32	-109.64	30.81	76.54
5.10	-58.7	-1.42	-84.80	-111.39	31.39	78.08
5.16	-59.0	-1.43	-86.28	-113.20	31.96	79.54
5.21	-59.5	-1.44	-87.75	-115.01	32.55	81.14
5.26	-59.8	-1.45	-89.30	-116.82	33.14	82.70
5.31	-60.2	-1.46	-90.91	-118.84	33.74	84.28
5.36	-60.4	-1.47	-92.39	-120.58	34.33	85.81
5.41	-60.5	-1.48	-93.80	-122.20	34.91	87.33
5.46	-60.9	-1.50	-95.34	-124.01	35.53	88.96
5.51	-61.2	-1.51	-96.95	-125.89	36.15	90.62
5.56	-61.5	-1.52	-98.50	-127.84	36.78	92.27
5.61	-61.8	-1.52	-100.04	-129.72	37.41	93.96
5.66	-62.1	-1.54	-101.65	-131.60	38.08	95.74
5.71	-62.5	-1.55	-103.40	-133.61	38.75	97.51
5.76	-62.8	-1.56	-105.08	-135.56	39.41	99.32
5.81	-62.9	-1.57	-106.69	-137.44	40.07	101.13
5.86	-63.2	-1.58	-108.37	-139.52	40.76	102.98
5.91	-63.4	-1.59	-109.91	-141.26	41.42	104.79
5.96	-63.7	-1.60	-111.52	-143.35	42.15	106.72
6.01	-64.1	-1.61	-113.27	-145.43	42.87	108.70
6.06	-64.2	-1.62	-115.08	-147.44	43.57	110.68
6.11	-64.5	-1.63	-116.69	-149.46	44.32	112.71
6.16	-64.7	-1.64	-118.57	-151.60	45.05	114.74
6.21	-65.1	-1.65	-120.45	-153.95	45.82	116.89
6.26	-65.3	-1.66	-122.13	-156.04	46.60	119.09
6.31	-65.7	-1.67	-124.21	-158.38	47.38	121.29
6.36	-66.0	-1.69	-126.02	-160.73	48.21	123.66
6.41	-66.1	-1.70	-127.77	-162.75	49.01	125.92
6.46	-66.0	-1.71	-129.45	-164.76	49.76	128.09
6.51	-66.3	-1.71	-131.39	-166.91	50.61	130.49
6.56	-66.5	-1.73	-133.27	-169.26	51.41	132.89
6.61	-66.3	-1.73	-135.09	-171.28	52.20	135.12
6.66	-66.6	-1.75	-136.83	-173.49	53.05	137.59
6.71	-66.8	-1.75	-138.78	-175.71	53.89	140.06
6.76	-67.0	-1.77	-140.79	-178.06	54.76	142.66

Table F.5 IDT Strength Data (KL 58-40 #10), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
6.81	-67.1	-1.78	-142.61	-180.27	55.64	145.24
6.86	-67.5	-1.79	-144.76	-182.62	56.56	147.94
6.91	-67.4	-1.80	-146.64	-184.91	57.45	150.61
6.96	-67.6	-1.81	-148.58	-187.26	58.38	153.40
7.01	-67.8	-1.82	-150.53	-189.61	59.32	156.24
7.06	-68.1	-1.83	-152.68	-192.09	60.31	159.22
7.11	-68.1	-1.84	-154.76	-194.51	61.28	162.23
7.16	-68.3	-1.85	-156.91	-196.99	62.26	165.28
7.21	-68.5	-1.86	-158.99	-199.48	63.27	168.47
7.26	-68.6	-1.87	-161.07	-201.96	64.30	171.66
7.31	-68.8	-1.88	-163.35	-204.51	65.34	175.00
7.36	-68.9	-1.89	-165.64	-207.13	66.40	178.41
7.41	-68.9	-1.91	-167.58	-209.48	67.47	181.88
7.46	-69.1	-1.91	-169.73	-212.03	68.60	185.53
7.51	-69.2	-1.92	-172.01	-214.65	69.70	189.24
7.56	-69.3	-1.93	-174.23	-217.33	70.84	193.05
7.61	-69.2	-1.95	-176.45	-219.82	71.94	196.87
7.66	-69.4	-1.95	-178.73	-222.44	73.13	200.85
7.71	-69.6	-1.96	-181.08	-225.19	74.36	205.05
7.76	-69.7	-1.98	-183.43	-227.88	75.59	209.38
7.81	-69.7	-1.98	-185.85	-230.63	76.84	213.79
7.86	-69.9	-2.00	-188.46	-233.45	78.10	218.43
7.91	-69.7	-2.01	-190.81	-236.00	79.39	223.09
7.96	-69.8	-2.01	-193.10	-238.75	80.69	227.96
8.01	-69.7	-2.03	-195.58	-241.24	82.01	232.94
8.06	-70.0	-2.04	-198.13	-244.19	83.41	238.25
8.11	-70.0	-2.05	-200.68	-247.01	84.81	243.77
8.16	-70.0	-2.06	-203.23	-249.63	86.23	249.39
8.21	-70.1	-2.07	-205.92	-252.52	87.68	255.39
8.26	-70.2	-2.08	-208.61	-255.34	89.18	261.75
8.31	-70.1	-2.09	-211.36	-258.09	90.65	268.18
8.36	-70.0	-2.10	-214.11	-260.71	92.14	275.06
8.41	-70.0	-2.11	-216.80	-263.33	93.69	282.41
8.46	-69.9	-2.13	-219.55	-265.88	95.24	290.30
8.51	-69.7	-2.14	-222.44	-268.50	96.78	298.69
8.56	-69.7	-2.14	-225.32	-271.11	98.37	308.01
8.61	-69.5	-2.15	-228.41	-273.73	99.92	318.21
8.66	-69.5	-2.16	-231.50	-276.62	101.47	329.90
8.71	-69.3	-2.18	-234.66	-279.44	102.98	343.31
8.76	-69.3	-2.19	-238.15	-282.80	104.47	358.90
8.81	-69.2	-2.20	-241.71	-285.95	105.95	376.64
8.86	-68.7	-2.21	-245.60	-288.44	107.32	396.10
8.91	-68.4	-2.22	-249.63	-287.43	108.63	417.93
8.96	-67.6	-2.23	-253.46	-285.75	109.85	441.77
9.01	-67.1	-2.24	-257.62	-286.36	111.08	467.64

Table F.5 IDT Strength Data (KL 58-40 #10), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	μm	μm	μm	μm
9.06	-66.5	-2.26	-262.05	-287.63	112.46	495.73
9.11	-65.7	-2.27	-266.68	-289.65	114.00	525.09
9.16	-64.9	-2.27	-271.38	-291.46	115.71	556.55
9.21	-64.2	-2.28	-276.35	-295.89	117.62	590.39
9.26	-63.2	-2.30	-281.45	-302.00	119.65	626.20

Table F.6 IDT Strength Data (KL 58-40 #12)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
0.00	-0.5	-0.92	0.54	0.54	0.24	0.20
0.05	-0.8	-0.93	0.27	0.60	0.30	0.23
0.10	-1.2	-0.94	-0.07	0.47	0.39	0.32
0.15	-1.7	-0.95	-0.40	0.34	0.48	0.39
0.20	-2.2	-0.96	-0.81	0.20	0.58	0.50
0.25	-2.8	-0.97	-1.28	-0.07	0.68	0.65
0.30	-3.4	-0.98	-1.68	-0.40	0.79	0.79
0.35	-4.2	-0.99	-2.28	-0.94	0.93	1.02
0.40	-5.0	-1.00	-2.75	-1.28	1.06	1.24
0.45	-5.5	-1.01	-3.22	-1.68	1.17	1.44
0.50	-6.4	-1.02	-3.83	-2.35	1.33	1.73
0.55	-7.1	-1.03	-4.36	-2.82	1.47	1.96
0.60	-8.0	-1.04	-4.90	-3.36	1.64	2.28
0.65	-8.8	-1.05	-5.51	-4.03	1.79	2.62
0.70	-9.7	-1.06	-6.11	-4.70	1.96	2.89
0.75	-10.4	-1.07	-6.71	-5.30	2.11	3.22
0.80	-11.3	-1.08	-7.25	-6.04	2.30	3.56
0.85	-12.1	-1.09	-7.86	-6.71	2.46	3.89
0.90	-13.1	-1.10	-8.59	-7.45	2.67	4.28
0.95	-13.6	-1.11	-9.20	-8.06	2.83	4.60
1.00	-14.5	-1.12	-9.80	-8.86	2.99	4.97
1.05	-15.4	-1.13	-10.54	-9.74	3.21	5.42
1.10	-16.1	-1.15	-11.21	-10.34	3.38	5.72
1.15	-16.8	-1.16	-11.88	-11.15	3.56	6.09
1.20	-17.5	-1.16	-12.42	-11.75	3.77	6.48
1.25	-18.3	-1.18	-13.16	-12.62	3.96	6.85
1.30	-19.1	-1.19	-13.90	-13.43	4.15	7.30
1.35	-19.9	-1.20	-14.64	-14.23	4.36	7.70
1.40	-20.5	-1.21	-15.31	-15.04	4.57	8.11
1.45	-21.2	-1.22	-16.11	-15.71	4.77	8.49
1.50	-21.9	-1.23	-16.85	-16.65	4.97	8.91
1.55	-22.6	-1.24	-17.52	-17.46	5.19	9.37
1.60	-23.6	-1.25	-18.33	-18.53	5.41	9.87
1.65	-24.1	-1.26	-19.00	-19.20	5.61	10.29
1.70	-24.9	-1.27	-19.81	-20.21	5.86	10.78
1.75	-25.4	-1.28	-20.61	-21.15	6.03	11.16
1.80	-26.2	-1.29	-21.28	-22.02	6.29	11.72
1.85	-26.8	-1.30	-22.02	-22.83	6.50	12.19
1.90	-27.8	-1.31	-22.89	-23.97	6.76	12.72
1.95	-28.6	-1.32	-23.70	-24.98	7.03	13.29
2.00	-29.3	-1.33	-24.57	-25.98	7.26	13.83
2.05	-29.9	-1.34	-25.31	-26.99	7.51	14.32
2.10	-30.7	-1.35	-26.12	-28.06	7.76	14.87
2.15	-31.3	-1.36	-26.92	-29.07	8.01	15.43
2.20	-32.0	-1.37	-27.93	-30.35	8.22	15.91
2.25	-32.5	-1.39	-28.47	-31.09	8.50	16.47

Table F.6 IDT Strength Data (KL 58-40 #12), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
2.30	-33.1	-1.40	-29.27	-32.09	8.73	16.99
2.35	-34.0	-1.40	-30.15	-33.10	9.04	17.71
2.40	-34.7	-1.42	-31.22	-34.58	9.30	18.26
2.45	-35.2	-1.43	-31.96	-35.58	9.55	18.85
2.50	-36.0	-1.44	-32.90	-36.66	9.84	19.49
2.55	-36.7	-1.45	-33.91	-37.87	10.13	20.09
2.60	-37.2	-1.46	-34.78	-39.01	10.38	20.71
2.65	-37.9	-1.47	-35.72	-40.15	10.68	21.37
2.70	-38.4	-1.48	-36.46	-41.36	10.96	21.97
2.75	-39.0	-1.49	-37.40	-42.50	11.23	22.61
2.80	-39.7	-1.50	-38.34	-43.71	11.53	23.28
2.85	-40.4	-1.51	-39.21	-44.98	11.85	23.99
2.90	-40.7	-1.52	-40.08	-46.13	12.11	24.57
2.95	-41.5	-1.53	-41.22	-47.54	12.42	25.26
3.00	-42.2	-1.54	-42.16	-48.74	12.73	26.02
3.05	-42.8	-1.55	-43.17	-50.02	13.04	26.72
3.10	-43.4	-1.56	-44.25	-51.43	13.36	27.44
3.15	-43.8	-1.57	-45.05	-52.57	13.64	28.15
3.20	-44.5	-1.58	-46.19	-53.91	13.97	29.24
3.25	-44.9	-1.59	-47.13	-55.19	14.28	29.94
3.30	-45.6	-1.60	-48.14	-56.40	14.61	30.75
3.35	-46.5	-1.61	-49.42	-58.14	14.96	31.59
3.40	-46.9	-1.62	-50.49	-59.35	15.29	32.36
3.45	-47.4	-1.63	-51.50	-60.70	15.63	33.62
3.50	-48.1	-1.64	-52.64	-62.24	15.98	34.86
3.55	-48.7	-1.65	-53.78	-63.78	16.33	35.80
3.60	-49.1	-1.66	-54.92	-65.19	16.68	36.63
3.65	-49.7	-1.67	-56.00	-66.54	17.03	37.48
3.70	-50.0	-1.69	-57.20	-68.08	17.36	38.27
3.75	-50.4	-1.70	-58.21	-69.42	17.68	39.08
3.80	-51.0	-1.71	-59.42	-70.90	18.04	39.93
3.85	-51.5	-1.72	-60.49	-72.44	18.40	40.77
3.90	-52.2	-1.72	-61.77	-73.99	18.80	41.73
3.95	-52.7	-1.74	-62.91	-75.60	19.18	42.62
4.00	-53.2	-1.75	-64.19	-77.14	19.55	43.47
4.05	-53.6	-1.76	-65.46	-78.55	19.92	44.31
4.10	-54.0	-1.76	-66.67	-80.17	20.29	45.15
4.15	-54.5	-1.78	-67.81	-81.58	20.67	46.02
4.20	-55.1	-1.79	-69.15	-83.32	21.11	47.00
4.25	-55.7	-1.80	-70.50	-85.00	21.51	47.90
4.30	-56.2	-1.81	-71.77	-86.95	21.92	48.90
4.35	-56.6	-1.82	-72.98	-88.36	22.35	49.89
4.40	-56.9	-1.83	-74.26	-89.90	22.75	50.76
4.45	-57.5	-1.84	-75.67	-91.71	23.18	51.80
4.50	-57.8	-1.85	-76.94	-93.39	23.62	52.76

Table F.6 IDT Strength Data (KL 58-40 #12), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
4.55	-58.4	-1.86	-78.29	-95.14	24.07	53.80
4.60	-58.9	-1.87	-79.70	-96.88	24.51	54.87
4.65	-59.2	-1.89	-80.97	-98.56	24.94	55.88
4.70	-59.4	-1.90	-82.25	-100.24	25.38	56.90
4.75	-59.7	-1.91	-83.46	-101.85	25.81	57.89
4.80	-60.2	-1.91	-84.66	-103.73	26.29	58.98
4.85	-60.7	-1.92	-85.94	-105.41	26.76	60.09
4.90	-61.0	-1.94	-87.22	-107.22	27.23	61.18
4.95	-61.4	-1.95	-88.42	-108.97	27.70	62.29
5.00	-61.6	-1.96	-89.97	-110.92	28.13	63.28
5.05	-62.1	-1.96	-91.04	-112.59	28.68	64.56
5.10	-62.5	-1.98	-92.52	-114.47	29.17	65.68
5.16	-62.9	-1.99	-93.86	-116.42	29.68	66.87
5.21	-63.4	-2.00	-95.34	-118.30	30.22	68.08
5.26	-63.7	-2.01	-96.68	-120.18	30.75	69.27
5.31	-64.0	-2.02	-98.09	-121.93	31.28	70.48
5.36	-64.4	-2.03	-99.70	-123.94	31.82	71.66
5.41	-64.8	-2.04	-101.32	-126.02	32.38	72.93
5.46	-65.0	-2.05	-102.79	-127.77	32.94	74.17
5.51	-65.4	-2.06	-104.34	-129.78	33.51	75.43
5.56	-65.8	-2.07	-106.15	-132.07	34.10	76.71
5.61	-65.8	-2.08	-107.36	-133.61	34.67	77.97
5.66	-66.1	-2.10	-108.97	-135.62	35.24	79.24
5.71	-66.5	-2.10	-110.65	-137.77	35.84	80.55
5.76	-67.0	-2.11	-112.33	-139.85	36.50	81.98
5.81	-67.3	-2.12	-114.00	-142.00	37.12	83.39
5.86	-67.5	-2.14	-115.55	-143.95	37.78	84.83
5.91	-67.7	-2.14	-117.23	-146.03	38.42	86.18
5.96	-67.9	-2.16	-118.70	-147.98	39.09	87.62
6.01	-68.1	-2.17	-120.38	-150.06	39.72	88.98
6.06	-68.2	-2.17	-121.99	-152.21	40.39	90.39
6.11	-68.5	-2.19	-123.67	-154.22	41.06	91.85
6.16	-68.8	-2.19	-125.35	-156.37	41.78	93.39
6.21	-69.2	-2.21	-127.30	-158.65	42.52	94.97
6.26	-69.4	-2.22	-128.98	-160.87	43.23	96.51
6.31	-69.7	-2.23	-130.72	-163.02	43.97	98.08
6.36	-69.9	-2.24	-132.54	-165.17	44.73	99.69
6.41	-70.1	-2.25	-134.28	-167.31	45.52	101.35
6.46	-70.4	-2.26	-135.69	-169.66	46.29	103.01
6.51	-70.7	-2.27	-135.49	-172.15	47.12	104.72
6.56	-70.9	-2.28	-130.12	-174.63	47.94	106.50
6.61	-71.3	-2.28	-132.27	-177.12	48.78	108.26
6.66	-71.4	-2.30	-134.42	-179.74	49.63	110.09
6.71	-71.7	-2.31	-136.50	-182.35	50.55	111.96
6.76	-71.8	-2.32	-138.65	-184.91	51.41	113.80

Table F.6 IDT Strength Data (KL 58-40 #12), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
6.81	-71.8	-2.33	-140.73	-187.39	52.26	115.63
6.86	-72.2	-2.35	-142.94	-190.14	53.24	117.66
6.91	-72.4	-2.35	-145.16	-192.76	54.19	119.64
6.96	-72.5	-2.36	-147.37	-195.45	55.14	121.63
7.01	-72.7	-2.37	-149.79	-198.20	56.11	123.72
7.06	-73.1	-2.38	-152.14	-201.15	57.18	125.92
7.11	-73.2	-2.39	-154.49	-203.97	58.20	128.10
7.16	-73.3	-2.40	-156.77	-206.66	59.28	130.32
7.21	-73.5	-2.42	-159.32	-209.61	60.37	132.57
7.26	-73.4	-2.42	-161.81	-212.50	61.43	134.75
7.31	-73.7	-2.44	-164.16	-215.39	62.60	137.20
7.36	-73.8	-2.45	-166.71	-218.27	63.77	139.55
7.41	-73.8	-2.45	-169.19	-221.23	64.95	141.97
7.46	-74.1	-2.47	-171.68	-224.32	66.18	144.52
7.51	-74.5	-2.48	-174.57	-227.67	67.53	147.26
7.56	-74.6	-2.49	-177.18	-230.70	68.86	150.01
7.61	-74.6	-2.50	-179.94	-233.85	70.20	152.73
7.66	-74.6	-2.51	-182.42	-237.01	71.61	155.53
7.71	-74.7	-2.52	-184.97	-240.23	73.04	158.42
7.76	-74.7	-2.53	-186.38	-243.45	74.51	161.42
7.81	-74.8	-2.54	-182.09	-246.74	76.05	164.53
7.86	-74.8	-2.55	-185.04	-250.17	77.63	167.75
7.91	-74.9	-2.56	-187.99	-253.66	79.28	171.07
7.96	-74.9	-2.57	-190.81	-257.15	80.96	174.52
8.01	-75.1	-2.58	-193.10	-260.71	82.74	178.06
8.06	-75.2	-2.59	-195.78	-264.33	84.63	181.82
8.11	-75.0	-2.60	-198.80	-267.96	86.53	185.53
8.16	-75.0	-2.62	-201.69	-271.45	88.55	189.42
8.21	-75.0	-2.63	-204.64	-275.28	90.66	193.43
8.26	-75.1	-2.63	-207.87	-279.24	92.89	197.81
8.31	-75.1	-2.65	-210.89	-283.27	95.25	202.36
8.36	-75.1	-2.65	-213.91	-287.30	97.77	207.13
8.41	-74.9	-2.67	-217.00	-291.32	100.39	212.10
8.46	-75.1	-2.68	-220.15	-295.62	103.27	217.55
8.51	-75.1	-2.69	-223.44	-300.19	106.35	223.46
8.56	-74.9	-2.70	-226.67	-304.55	109.62	229.72
8.61	-74.7	-2.71	-230.16	-309.18	113.21	236.55
8.66	-74.6	-2.72	-233.38	-313.88	117.32	244.14
8.71	-74.2	-2.74	-236.67	-318.65	121.84	252.58
8.76	-73.9	-2.74	-239.96	-323.42	126.92	262.13
8.81	-73.7	-2.75	-243.86	-328.65	132.79	273.26
8.86	-73.2	-2.77	-248.62	-333.62	139.35	285.97
8.91	-72.8	-2.77	-254.13	-338.86	146.64	301.16
8.96	-72.4	-2.79	-260.04	-344.16	154.69	320.60
9.01	-71.6	-2.79	-266.62	-349.67	163.74	344.10

Table F.6 IDT Strength Data (KL 58-40 #12), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
9.06	-70.7	-2.81	-274.14	-355.38	174.41	369.81
9.11	-69.3	-2.82	-281.92	-360.68	185.56	397.10
9.16	-68.3	-2.83	-290.18	-366.12	197.57	427.01

Table F.7 IDT Strength Data (KL 58-40 #8)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
0.00	-0.1	-1.57	1.41	0.81	0.53	0.25
0.05	-0.1	-1.58	1.48	0.94	0.54	0.25
0.10	-0.1	-1.59	1.34	0.81	0.55	0.27
0.15	-0.2	-1.61	1.34	0.67	0.56	0.29
0.20	-0.4	-1.61	1.28	0.81	0.56	0.34
0.25	-0.6	-1.62	1.21	0.47	0.61	0.44
0.30	-1.0	-1.63	0.87	0.27	0.67	0.54
0.35	-1.3	-1.64	0.60	0.07	0.72	0.70
0.40	-1.8	-1.65	0.34	-0.20	0.79	0.91
0.45	-2.4	-1.67	-0.07	-0.60	0.87	1.19
0.50	-3.0	-1.67	-0.40	-1.01	0.98	1.43
0.55	-3.5	-1.69	-0.74	-1.48	1.05	1.75
0.60	-4.0	-1.69	-1.07	-1.95	1.12	2.00
0.65	-4.7	-1.70	-1.48	-2.55	1.28	2.40
0.70	-5.6	-1.72	-2.08	-3.29	1.38	2.82
0.75	-6.2	-1.73	-2.62	-3.96	1.52	3.21
0.80	-6.8	-1.74	-3.22	-4.63	1.64	3.58
0.85	-7.5	-1.75	-3.56	-5.17	1.79	4.08
0.90	-8.0	-1.76	-4.03	-5.71	1.88	4.48
0.95	-8.9	-1.77	-4.70	-6.65	2.06	4.95
1.00	-9.6	-1.78	-5.24	-7.39	2.24	5.46
1.05	-10.1	-1.79	-5.71	-7.86	2.38	5.94
1.10	-10.9	-1.80	-6.45	-8.66	2.57	6.46
1.15	-11.5	-1.81	-6.98	-9.40	2.75	6.92
1.20	-12.1	-1.82	-7.52	-10.14	2.93	7.44
1.25	-12.7	-1.83	-8.19	-10.94	3.08	7.99
1.30	-13.3	-1.84	-8.86	-11.68	3.26	8.48
1.35	-14.1	-1.85	-9.67	-12.56	3.50	9.10
1.40	-14.6	-1.86	-10.14	-13.29	3.68	9.60
1.45	-15.1	-1.87	-10.81	-14.17	3.85	10.17
1.50	-15.8	-1.88	-11.55	-14.97	4.07	10.76
1.55	-16.6	-1.90	-12.29	-16.05	4.30	11.43
1.60	-17.2	-1.91	-13.09	-16.92	4.50	12.03
1.65	-17.4	-1.91	-13.50	-17.52	4.66	12.54
1.70	-18.0	-1.92	-14.17	-18.40	4.86	13.13
1.75	-18.8	-1.94	-14.91	-19.47	5.10	13.88
1.80	-19.4	-1.95	-15.71	-20.48	5.31	14.54
1.85	-20.0	-1.96	-16.38	-21.49	5.53	15.19
1.90	-20.6	-1.97	-17.12	-22.43	5.77	15.91
1.95	-21.1	-1.97	-17.93	-23.30	5.98	16.58
2.00	-21.9	-1.99	-18.73	-24.57	6.25	17.41
2.05	-22.3	-2.00	-19.47	-25.45	6.45	18.06
2.10	-22.9	-2.01	-20.28	-26.45	6.69	18.78
2.15	-23.6	-2.02	-21.02	-27.66	6.95	19.62
2.20	-24.2	-2.03	-21.89	-28.74	7.18	20.44
2.25	-24.5	-2.04	-22.49	-29.68	7.41	21.15

Table F.7 IDT Strength Data (KL 58-40 #8), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
2.30	-24.8	-2.05	-23.16	-30.75	7.62	21.80
2.35	-25.7	-2.06	-24.24	-31.89	7.90	22.64
2.40	-26.5	-2.07	-25.18	-33.30	8.21	23.65
2.45	-26.8	-2.08	-25.98	-34.44	8.44	24.41
2.50	-27.6	-2.09	-26.99	-35.72	8.73	25.38
2.55	-27.9	-2.10	-27.66	-36.73	8.98	26.18
2.60	-28.7	-2.11	-28.60	-38.14	9.27	27.18
2.65	-29.2	-2.12	-29.54	-39.14	9.57	28.06
2.70	-29.5	-2.13	-30.55	-40.49	9.82	28.94
2.75	-30.2	-2.14	-31.35	-41.83	10.13	29.89
2.80	-30.8	-2.15	-32.36	-43.10	10.40	30.88
2.85	-31.4	-2.17	-33.30	-44.65	10.73	31.91
2.90	-31.9	-2.17	-34.31	-45.92	11.04	32.90
2.95	-32.2	-2.18	-35.25	-47.13	11.33	33.82
3.00	-33.0	-2.20	-36.32	-48.74	11.67	34.96
3.05	-33.4	-2.21	-37.40	-49.95	11.96	35.97
3.10	-33.8	-2.22	-38.27	-51.43	12.26	36.91
3.15	-34.3	-2.23	-39.34	-52.71	12.59	37.97
3.20	-34.7	-2.24	-40.28	-54.18	12.91	39.03
3.25	-35.2	-2.25	-41.56	-55.73	13.23	40.05
3.30	-35.5	-2.26	-42.30	-56.80	13.55	41.11
3.35	-36.3	-2.27	-43.44	-58.55	13.95	42.35
3.40	-36.8	-2.28	-44.58	-60.02	14.28	43.49
3.45	-37.0	-2.29	-45.45	-61.30	14.63	44.55
3.50	-37.5	-2.30	-46.73	-62.84	14.97	45.69
3.55	-37.9	-2.31	-47.80	-64.32	15.32	46.85
3.60	-38.3	-2.32	-48.95	-65.87	15.68	47.99
3.65	-38.8	-2.33	-50.09	-67.34	16.05	49.20
3.70	-39.0	-2.34	-51.23	-69.02	16.38	50.27
3.75	-39.7	-2.35	-52.37	-70.50	16.78	51.55
3.80	-40.0	-2.36	-53.58	-72.18	17.15	52.71
3.85	-40.6	-2.37	-54.85	-73.72	17.53	54.01
3.90	-40.9	-2.38	-55.86	-75.26	17.93	55.24
3.95	-41.2	-2.39	-57.00	-76.74	18.31	56.47
4.00	-41.8	-2.40	-58.35	-78.49	18.73	57.82
4.05	-42.1	-2.41	-59.49	-80.10	19.14	59.10
4.10	-42.7	-2.42	-60.83	-81.98	19.57	60.49
4.15	-43.1	-2.44	-62.17	-83.66	20.01	61.85
4.20	-43.5	-2.45	-63.45	-85.40	20.44	63.18
4.25	-43.8	-2.45	-64.72	-87.01	20.84	64.54
4.30	-44.1	-2.47	-65.93	-88.56	21.30	65.88
4.35	-44.4	-2.48	-67.41	-90.37	21.70	67.17
4.40	-44.9	-2.49	-68.82	-92.18	22.16	68.62
4.45	-45.3	-2.50	-70.09	-94.00	22.62	70.09
4.50	-45.5	-2.51	-71.44	-95.68	23.06	71.47

Table F.7 IDT Strength Data (KL 58-40 #8), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
4.55	-45.9	-2.52	-72.91	-97.42	23.53	72.85
4.60	-46.1	-2.53	-74.12	-99.17	23.96	74.26
4.65	-46.5	-2.54	-75.60	-100.98	24.44	75.73
4.70	-46.8	-2.55	-76.94	-102.66	24.93	77.18
4.75	-47.0	-2.56	-78.22	-104.47	25.39	78.62
4.80	-47.6	-2.57	-79.76	-106.15	25.89	80.25
4.85	-47.9	-2.58	-81.37	-108.37	26.38	81.79
4.90	-48.3	-2.59	-82.92	-110.38	26.87	83.37
4.95	-48.8	-2.60	-84.53	-112.33	27.41	85.03
5.00	-49.0	-2.61	-86.14	-114.21	27.92	86.58
5.05	-49.3	-2.62	-87.69	-116.09	28.45	88.24
5.10	-49.3	-2.63	-89.03	-117.83	28.95	89.75
5.16	-49.8	-2.64	-90.64	-119.85	29.51	91.43
5.21	-50.1	-2.65	-92.18	-121.86	30.04	93.16
5.26	-50.2	-2.67	-93.73	-123.74	30.57	94.72
5.31	-50.5	-2.67	-95.27	-125.69	31.10	96.38
5.36	-51.0	-2.68	-97.09	-127.90	31.67	98.16
5.41	-51.1	-2.70	-98.63	-129.72	32.22	99.87
5.46	-51.7	-2.71	-100.38	-131.93	32.84	101.79
5.51	-51.9	-2.72	-102.05	-133.88	33.40	103.51
5.56	-52.2	-2.73	-103.87	-136.03	34.02	105.34
5.61	-52.5	-2.74	-105.61	-138.24	34.62	107.21
5.66	-53.0	-2.75	-107.43	-140.46	35.27	109.19
5.71	-53.1	-2.76	-109.10	-142.27	35.88	111.07
5.76	-53.1	-2.77	-110.98	-144.49	36.47	112.85
5.81	-53.5	-2.78	-112.80	-146.77	37.11	114.76
5.86	-53.5	-2.79	-114.54	-148.72	37.72	116.64
5.91	-53.6	-2.80	-116.29	-150.73	38.35	118.47
5.96	-53.8	-2.81	-118.17	-152.81	38.96	120.30
6.01	-54.1	-2.82	-119.78	-154.96	39.62	122.30
6.06	-54.6	-2.83	-121.79	-157.31	40.31	124.36
6.11	-54.8	-2.84	-123.67	-159.53	41.00	126.43
6.16	-55.0	-2.85	-125.69	-161.81	41.67	128.42
6.21	-55.1	-2.86	-127.50	-163.82	42.36	130.47
6.26	-55.4	-2.87	-129.45	-166.24	43.05	132.54
6.31	-55.6	-2.88	-131.46	-168.52	43.78	134.65
6.36	-55.9	-2.90	-133.41	-170.87	44.51	136.83
6.41	-56.0	-2.90	-135.42	-173.22	45.22	138.93
6.46	-56.3	-2.92	-137.37	-175.57	45.97	140.88
6.51	-56.5	-2.93	-139.38	-177.86	46.75	142.67
6.56	-56.7	-2.93	-141.53	-180.34	47.47	144.82
6.61	-56.9	-2.95	-143.41	-182.62	48.27	147.11
6.66	-56.9	-2.96	-145.36	-184.91	49.02	149.22
6.71	-57.2	-2.97	-147.51	-187.39	49.84	151.47
6.76	-57.2	-2.98	-149.59	-189.61	50.64	153.74

Table F.7 IDT Strength Data (KL 58-40 #8), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	μm	μm	μm	μm
6.81	-57.4	-2.99	-151.60	-191.96	51.43	156.05
6.86	-57.1	-3.00	-153.55	-194.17	52.18	158.18
6.91	-57.3	-3.01	-155.57	-196.45	52.97	160.40
6.96	-57.6	-3.02	-157.71	-198.94	53.80	162.72
7.01	-57.9	-3.03	-160.06	-201.56	54.67	165.12
7.06	-58.1	-3.04	-162.14	-203.97	55.55	167.53
7.11	-58.3	-3.05	-164.49	-206.52	56.46	169.93
7.16	-58.5	-3.06	-166.71	-209.08	57.36	172.38
7.21	-58.7	-3.07	-168.99	-211.90	58.28	174.92
7.26	-58.7	-3.08	-171.75	-214.38	59.18	177.34
7.31	-58.8	-3.09	-174.03	-217.07	60.16	179.85
7.36	-59.0	-3.10	-176.38	-219.75	61.11	182.44
7.41	-58.9	-3.11	-178.59	-222.10	62.05	184.86
7.46	-59.3	-3.12	-181.15	-225.06	63.05	187.51
7.51	-59.6	-3.14	-183.70	-227.88	64.12	190.38
7.56	-59.5	-3.15	-186.11	-230.56	65.11	192.93
7.61	-59.8	-3.16	-188.67	-233.45	66.16	195.70
7.66	-60.0	-3.16	-191.28	-236.34	67.28	198.57
7.71	-60.4	-3.17	-193.90	-239.36	68.42	201.47
7.76	-60.4	-3.19	-196.52	-242.24	69.53	204.43
7.81	-60.2	-3.19	-199.01	-245.13	70.65	207.23
7.86	-60.4	-3.21	-201.62	-247.95	71.79	210.18
7.91	-60.2	-3.22	-204.11	-250.70	72.91	212.99
7.96	-60.5	-3.23	-206.79	-253.72	74.11	216.13
8.01	-60.5	-3.24	-209.61	-257.01	75.26	219.15
8.06	-60.7	-3.25	-212.23	-259.90	76.52	222.42
8.11	-60.8	-3.26	-214.92	-262.86	77.77	225.61
8.16	-60.7	-3.27	-217.47	-265.74	79.02	228.83
8.21	-60.9	-3.28	-220.22	-268.83	80.34	232.19
8.26	-60.7	-3.29	-222.97	-271.72	81.62	235.45
8.31	-60.9	-3.30	-225.79	-274.94	82.94	238.95
8.36	-61.0	-3.32	-228.55	-278.03	84.31	242.41
8.41	-60.9	-3.32	-231.23	-281.12	85.69	245.92
8.46	-61.0	-3.34	-234.05	-284.21	87.10	249.56
8.51	-61.0	-3.34	-236.94	-287.43	88.53	253.17
8.56	-61.1	-3.36	-239.76	-290.59	90.01	257.01
8.61	-61.1	-3.36	-242.85	-293.94	91.53	260.99
8.66	-61.0	-3.38	-245.80	-296.96	93.00	264.87
8.71	-61.2	-3.38	-248.69	-300.32	94.60	268.98
8.76	-61.5	-3.40	-251.84	-303.81	96.25	273.40
8.81	-61.4	-3.41	-255.00	-307.24	97.92	277.81
8.86	-61.3	-3.42	-258.09	-310.53	99.59	282.26
8.91	-61.3	-3.43	-261.24	-313.95	101.32	286.91
8.96	-61.4	-3.44	-264.60	-317.44	103.09	291.78
9.01	-61.2	-3.45	-267.82	-320.73	104.82	296.49

Table F.7 IDT Strength Data (KL 58-40 #8), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	μm	μm	μm	μm
9.06	-61.1	-3.46	-271.05	-324.16	106.66	301.50
9.11	-61.1	-3.47	-274.27	-327.65	108.54	306.65
9.16	-60.9	-3.48	-277.69	-331.14	110.44	311.95
9.21	-60.9	-3.49	-281.12	-334.63	112.39	317.44
9.26	-60.8	-3.50	-284.61	-338.25	114.37	323.15
9.31	-61.1	-3.51	-288.17	-342.08	116.55	329.51
9.36	-60.7	-3.52	-291.86	-345.91	118.65	335.74
9.41	-60.7	-3.53	-295.42	-349.67	120.87	342.42
9.46	-60.6	-3.54	-299.25	-353.63	123.18	349.45
9.51	-60.5	-3.55	-303.01	-357.46	125.54	356.74
9.56	-60.4	-3.57	-306.83	-361.42	128.00	364.52
9.61	-60.3	-3.57	-310.73	-365.45	130.50	372.68
9.66	-60.2	-3.59	-314.76	-369.74	133.15	381.41
9.71	-60.1	-3.60	-318.85	-374.11	135.84	390.71
9.76	-60.0	-3.61	-323.22	-378.54	138.65	400.63
9.81	-59.6	-3.62	-327.31	-382.90	141.50	410.99
9.86	-59.3	-3.63	-331.74	-387.33	144.40	422.03
9.91	-59.0	-3.64	-336.31	-392.10	147.41	433.88
9.96	-59.0	-3.65	-340.94	-397.07	150.59	446.80
10.01	-58.8	-3.66	-345.77	-402.71	153.87	460.69
10.06	-58.4	-3.67	-350.74	-408.15	157.26	475.41
10.11	-57.8	-3.68	-355.44	-413.12	160.68	490.38
10.16	-57.5	-3.69	-360.61	-417.95	164.28	506.21
10.21	-57.1	-3.70	-365.85	-422.58	168.02	522.74
10.26	-56.8	-3.71	-371.42	-426.88	171.96	540.10
10.31	-56.3	-3.72	-376.93	-430.77	176.08	545.37
10.36	-55.9	-3.73	-382.50	-433.66	180.42	545.37
10.41	-55.4	-3.74	-388.07	-435.81	184.98	545.37

Table F.8 IDT Strength Data (NU 52-34 #6)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
0.00	0.0	-0.73	0.47	0.81	0.18	0.00
0.05	-0.1	-0.74	0.54	0.87	0.19	0.00
0.10	-0.1	-0.75	0.47	0.81	0.19	0.02
0.15	-0.3	-0.76	0.47	0.81	0.22	0.03
0.20	-0.6	-0.77	0.34	0.67	0.23	0.12
0.25	-1.1	-0.78	0.27	0.47	0.28	0.25
0.30	-1.6	-0.79	0.27	0.13	0.30	0.40
0.35	-2.0	-0.80	-0.07	-0.13	0.34	0.50
0.40	-2.6	-0.81	-0.13	-0.40	0.39	0.69
0.45	-3.3	-0.82	-0.34	-1.01	0.44	0.84
0.50	-4.1	-0.83	-0.54	-1.41	0.52	1.11
0.55	-4.9	-0.84	-0.81	-1.88	0.58	1.34
0.60	-5.7	-0.85	-1.07	-2.35	0.65	1.58
0.65	-6.5	-0.86	-1.21	-2.89	0.74	1.83
0.70	-7.4	-0.88	-1.61	-3.42	0.83	2.11
0.75	-8.1	-0.89	-1.95	-3.83	0.89	2.35
0.80	-8.9	-0.89	-2.22	-4.23	0.97	2.62
0.85	-9.7	-0.90	-2.48	-4.83	1.07	2.89
0.90	-10.9	-0.91	-2.82	-5.51	1.17	3.26
0.95	-11.8	-0.93	-3.22	-6.11	1.29	3.51
1.00	-12.9	-0.94	-3.42	-6.71	1.41	3.89
1.05	-13.6	-0.95	-3.76	-7.18	1.49	4.16
1.10	-14.6	-0.96	-4.23	-7.99	1.60	4.55
1.15	-15.3	-0.97	-4.57	-8.39	1.70	4.83
1.20	-16.2	-0.98	-4.90	-9.06	1.80	5.14
1.25	-17.0	-0.99	-5.37	-9.53	1.91	5.47
1.30	-17.6	-1.00	-5.57	-10.14	1.99	5.74
1.35	-18.7	-1.01	-6.04	-10.81	2.11	6.11
1.40	-19.4	-1.02	-6.38	-11.28	2.22	6.43
1.45	-20.4	-1.03	-6.78	-12.09	2.32	6.78
1.50	-21.0	-1.04	-6.85	-12.42	2.45	7.17
1.55	-21.9	-1.05	-7.45	-13.36	2.54	7.47
1.60	-22.8	-1.06	-7.86	-13.83	2.67	7.84
1.65	-23.5	-1.08	-8.19	-14.44	2.76	8.19
1.70	-24.4	-1.08	-8.53	-15.17	2.89	8.56
1.75	-25.3	-1.09	-9.00	-15.78	3.03	9.00
1.80	-26.2	-1.10	-9.40	-16.52	3.14	9.38
1.85	-27.2	-1.11	-9.87	-17.26	3.27	9.82
1.90	-28.1	-1.12	-10.21	-17.99	3.40	10.26
1.95	-29.0	-1.14	-10.61	-18.73	3.53	10.69
2.00	-29.8	-1.14	-11.15	-19.54	3.65	11.08
2.05	-30.6	-1.15	-11.48	-20.14	3.79	11.51
2.10	-31.3	-1.16	-11.95	-20.95	3.91	11.92
2.15	-32.3	-1.17	-12.35	-21.62	4.06	12.39
2.20	-33.0	-1.19	-12.76	-22.36	4.15	12.82
2.25	-33.6	-1.20	-13.29	-22.96	4.29	13.21

Table F.8 IDT Strength Data (NU 52-34 #6), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
2.30	-34.5	-1.21	-13.70	-23.77	4.41	13.66
2.35	-35.6	-1.21	-14.10	-24.57	4.57	14.22
2.40	-36.6	-1.23	-14.57	-25.45	4.72	14.74
2.45	-37.3	-1.24	-15.04	-26.25	4.86	15.22
2.50	-38.0	-1.25	-15.44	-26.92	4.98	15.71
2.55	-38.6	-1.26	-15.91	-27.73	5.09	16.13
2.60	-39.4	-1.27	-16.38	-28.40	5.25	16.63
2.65	-40.5	-1.28	-16.92	-29.47	5.40	17.22
2.70	-41.2	-1.29	-17.39	-30.21	5.54	17.74
2.75	-41.9	-1.30	-17.79	-30.95	5.68	18.21
2.80	-42.6	-1.31	-18.26	-31.76	5.82	18.78
2.85	-43.3	-1.32	-18.73	-32.63	5.94	19.27
2.90	-44.1	-1.33	-19.27	-33.44	6.10	19.86
2.95	-44.8	-1.34	-19.74	-34.38	6.24	20.43
3.00	-45.9	-1.35	-20.41	-35.38	6.40	21.08
3.05	-46.4	-1.36	-20.81	-36.12	6.55	21.64
3.10	-47.1	-1.37	-21.28	-36.99	6.68	22.22
3.15	-47.8	-1.38	-21.82	-37.73	6.83	22.81
3.20	-48.6	-1.39	-22.22	-38.67	6.99	23.42
3.25	-49.1	-1.40	-22.89	-39.61	7.13	24.04
3.30	-49.8	-1.41	-23.30	-40.49	7.26	24.64
3.35	-50.5	-1.42	-23.57	-41.09	7.45	25.35
3.40	-51.1	-1.43	-24.51	-42.43	7.57	25.93
3.45	-51.6	-1.45	-24.77	-43.04	7.74	26.57
3.50	-53.0	-1.46	-25.38	-44.25	7.93	27.38
3.55	-53.5	-1.46	-26.05	-45.05	8.07	28.12
3.60	-54.0	-1.48	-26.59	-46.13	8.23	28.77
3.65	-54.7	-1.48	-27.12	-47.00	8.41	29.49
3.70	-55.5	-1.50	-27.80	-48.01	8.56	30.30
3.75	-56.1	-1.51	-28.33	-48.95	8.75	31.07
3.80	-56.9	-1.52	-29.00	-50.09	8.90	31.94
3.85	-57.4	-1.53	-29.61	-51.09	9.08	32.80
3.90	-57.8	-1.54	-30.01	-51.90	9.22	33.54
3.95	-58.6	-1.55	-30.68	-53.04	9.40	34.43
4.00	-59.1	-1.56	-31.22	-54.05	9.57	35.32
4.05	-59.9	-1.57	-31.89	-55.12	9.75	36.19
4.10	-60.5	-1.58	-32.50	-56.26	9.93	37.10
4.15	-61.1	-1.59	-33.17	-57.41	10.12	38.04
4.20	-61.5	-1.60	-33.77	-58.28	10.27	38.91
4.25	-61.8	-1.61	-34.38	-59.35	10.45	39.80
4.30	-62.4	-1.62	-35.05	-60.36	10.62	40.70
4.35	-62.9	-1.63	-35.58	-61.50	10.80	41.66
4.40	-63.7	-1.64	-36.32	-62.64	11.01	42.70
4.45	-64.2	-1.65	-37.06	-63.92	11.19	43.74
4.50	-64.7	-1.66	-37.73	-64.99	11.38	44.78

Table F.8 IDT Strength Data (NU 52-34 #6), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
4.55	-65.3	-1.67	-38.47	-66.20	11.57	45.87
4.60	-65.8	-1.68	-39.14	-67.41	11.77	46.93
4.65	-66.0	-1.70	-39.81	-68.55	11.96	48.02
4.70	-66.6	-1.70	-40.55	-69.62	12.17	49.16
4.75	-67.2	-1.71	-41.36	-71.03	12.35	50.36
4.80	-67.6	-1.73	-42.16	-72.18	12.56	51.60
4.85	-68.0	-1.74	-42.77	-73.32	12.76	52.81
4.90	-68.3	-1.75	-43.51	-74.66	12.94	54.08
4.95	-68.6	-1.75	-44.25	-75.67	13.14	55.34
5.00	-69.1	-1.76	-45.12	-77.21	13.34	56.72
5.05	-69.3	-1.77	-45.86	-78.29	13.55	58.06
5.10	-69.8	-1.78	-46.53	-79.63	13.76	59.52
5.16	-70.3	-1.80	-47.47	-81.11	13.97	61.06
5.21	-70.9	-1.81	-48.34	-82.65	14.22	62.73
5.26	-71.1	-1.82	-49.15	-83.99	14.43	64.37
5.31	-71.5	-1.83	-50.09	-85.54	14.63	66.03
5.36	-71.8	-1.84	-50.96	-86.95	14.84	67.90
5.41	-72.0	-1.85	-51.97	-88.36	15.27	69.79
5.46	-72.5	-1.86	-53.11	-89.77	15.45	74.26
5.51	-72.5	-1.87	-55.32	-91.78	15.31	99.84
5.56	-72.2	-1.88	-59.82	-93.73	17.67	118.57
5.61	-71.8	-1.89	-64.72	-95.74	22.86	138.34
5.66	-71.0	-1.91	-69.15	-98.50	30.73	164.73
5.71	-69.5	-1.92	-76.61	-101.65	50.37	196.39
5.76	-67.6	-1.93	-84.46	-103.46	69.14	234.69
5.81	-65.7	-1.94	-93.26	-103.80	84.87	278.20

Table F.9 IDT Strength Data (NU 52-34 #8)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
0.00	-0.4	-0.97	1.48	1.41	0.26	0.35
0.05	-0.9	-0.98	1.41	1.14	0.30	0.47
0.10	-1.4	-0.99	1.21	0.67	0.34	0.64
0.15	-2.2	-1.00	1.07	0.13	0.41	0.86
0.20	-2.9	-1.01	0.94	-0.20	0.50	1.09
0.25	-3.6	-1.02	0.60	-0.81	0.58	1.34
0.30	-4.5	-1.04	0.34	-1.34	0.68	1.58
0.35	-5.0	-1.05	0.07	-1.75	0.74	1.78
0.40	-6.0	-1.05	-0.13	-2.42	0.86	2.08
0.45	-6.7	-1.06	-0.34	-2.95	0.95	2.33
0.50	-7.6	-1.07	-0.81	-3.56	1.06	2.64
0.55	-8.5	-1.09	-1.01	-4.16	1.19	2.95
0.60	-9.4	-1.09	-1.54	-4.77	1.29	3.27
0.65	-10.2	-1.10	-1.75	-5.44	1.39	3.58
0.70	-11.1	-1.11	-2.15	-6.18	1.53	3.93
0.75	-12.1	-1.13	-2.48	-6.85	1.65	4.31
0.80	-13.1	-1.14	-2.89	-7.79	1.80	4.73
0.85	-13.8	-1.15	-3.22	-8.33	1.92	5.02
0.90	-14.7	-1.16	-3.63	-9.06	2.05	5.39
0.95	-15.4	-1.17	-3.96	-9.67	2.17	5.69
1.00	-16.1	-1.18	-4.30	-10.34	2.27	6.03
1.05	-16.7	-1.19	-4.57	-10.81	2.39	6.34
1.10	-17.8	-1.20	-5.04	-11.75	2.55	6.73
1.15	-18.7	-1.21	-5.44	-12.56	2.69	7.17
1.20	-19.7	-1.22	-5.91	-13.29	2.85	7.57
1.25	-20.3	-1.23	-6.24	-14.03	2.98	7.92
1.30	-21.0	-1.24	-6.58	-14.64	3.09	8.29
1.35	-21.7	-1.25	-6.85	-15.31	3.24	8.64
1.40	-22.6	-1.26	-7.32	-16.11	3.38	9.06
1.45	-23.3	-1.27	-7.79	-16.79	3.52	9.48
1.50	-24.1	-1.29	-8.26	-17.59	3.68	9.89
1.55	-24.9	-1.29	-8.66	-18.06	3.84	10.31
1.60	-25.5	-1.30	-9.20	-19.00	3.95	10.66
1.65	-26.3	-1.31	-9.53	-19.67	4.10	11.06
1.70	-27.1	-1.32	-10.07	-20.55	4.28	11.55
1.75	-28.2	-1.34	-10.54	-21.35	4.47	12.03
1.80	-28.7	-1.35	-11.01	-22.02	4.63	12.44
1.85	-29.7	-1.36	-11.48	-23.03	4.80	12.96
1.90	-30.4	-1.37	-12.09	-23.70	4.98	13.38
1.95	-31.4	-1.38	-12.62	-24.64	5.16	13.91
2.00	-32.0	-1.39	-13.16	-25.31	5.33	14.35
2.05	-32.6	-1.40	-13.56	-25.78	5.52	14.85
2.10	-33.4	-1.41	-14.23	-26.86	5.67	15.31
2.15	-34.1	-1.42	-14.70	-27.66	5.86	15.79
2.20	-34.9	-1.43	-15.31	-28.47	6.05	16.33
2.25	-35.7	-1.44	-15.85	-29.34	6.24	16.84

Table F.9 IDT Strength Data (NU 52-34 #8), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
2.30	-36.4	-1.45	-16.52	-30.08	6.43	17.34
2.35	-37.1	-1.46	-16.99	-30.95	6.61	17.86
2.40	-38.0	-1.47	-17.66	-31.82	6.84	18.48
2.45	-38.7	-1.48	-18.20	-32.63	7.02	19.02
2.50	-39.9	-1.49	-19.14	-33.84	7.27	19.66
2.55	-40.6	-1.50	-19.47	-34.38	7.49	20.28
2.60	-41.3	-1.51	-20.28	-35.45	7.70	20.83
2.65	-41.9	-1.52	-20.81	-36.39	7.91	21.42
2.70	-42.4	-1.53	-21.49	-36.99	8.09	21.94
2.75	-43.0	-1.54	-22.02	-38.00	8.29	22.54
2.80	-43.9	-1.55	-22.69	-38.87	8.53	23.15
2.85	-44.6	-1.56	-23.43	-39.75	8.75	23.80
2.90	-45.3	-1.58	-24.04	-40.55	8.97	24.46
2.95	-46.1	-1.58	-24.71	-41.56	9.20	25.14
3.00	-46.7	-1.59	-25.51	-42.57	9.42	25.73
3.05	-47.6	-1.61	-26.12	-43.24	9.70	26.50
3.10	-47.9	-1.61	-26.86	-44.38	9.91	27.09
3.15	-48.5	-1.63	-27.46	-45.32	10.10	27.70
3.20	-49.3	-1.64	-28.33	-46.19	10.37	28.38
3.25	-49.7	-1.65	-28.87	-47.13	10.58	29.06
3.30	-50.8	-1.66	-29.88	-48.27	10.88	29.89
3.35	-51.5	-1.67	-30.68	-49.28	11.12	30.72
3.40	-51.9	-1.68	-31.29	-50.15	11.36	31.42
3.45	-52.4	-1.69	-32.09	-51.09	11.60	32.18
3.50	-53.1	-1.70	-32.97	-52.24	11.85	32.98
3.55	-53.7	-1.71	-33.84	-53.51	12.09	33.72
3.60	-54.3	-1.72	-34.51	-54.32	12.37	34.59
3.65	-55.0	-1.73	-35.25	-55.46	12.64	35.47
3.70	-55.6	-1.74	-36.05	-56.47	12.92	36.29
3.75	-56.2	-1.75	-36.93	-57.61	13.18	37.16
3.80	-56.8	-1.77	-37.73	-58.68	13.46	38.07
3.85	-57.0	-1.77	-38.61	-59.76	13.71	38.89
3.90	-57.7	-1.78	-39.34	-61.03	13.99	39.76
3.95	-58.1	-1.79	-40.22	-62.24	14.26	40.69
4.00	-58.7	-1.80	-41.22	-63.72	14.53	41.59
4.05	-59.3	-1.81	-41.96	-64.79	14.85	42.58
4.10	-59.8	-1.83	-42.84	-66.20	15.13	43.62
4.15	-60.4	-1.83	-43.78	-67.48	15.45	44.67
4.20	-60.7	-1.85	-44.65	-68.82	15.72	45.64
4.25	-61.3	-1.86	-45.52	-70.23	16.02	46.71
4.30	-61.9	-1.86	-46.46	-71.57	16.33	47.82
4.35	-62.2	-1.88	-47.33	-73.05	16.63	48.95
4.40	-62.4	-1.89	-48.27	-74.26	16.92	49.95
4.45	-62.7	-1.90	-49.21	-76.00	17.18	51.01
4.50	-63.4	-1.91	-50.15	-77.21	17.56	52.27

Table F.9 IDT Strength Data (NU 52-34 #8), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	μm	μm	μm	μm
4.55	-63.9	-1.92	-51.16	-78.69	17.91	53.46
4.60	-64.4	-1.93	-52.17	-80.30	18.25	54.72
4.65	-64.7	-1.94	-53.18	-81.84	18.59	55.93
4.70	-65.0	-1.95	-54.18	-83.46	18.93	57.22
4.75	-65.4	-1.96	-55.19	-84.87	19.27	58.55
4.80	-65.7	-1.97	-56.06	-86.54	19.61	59.89
4.85	-66.2	-1.97	-57.14	-88.22	19.93	61.30
4.90	-66.7	-1.99	-58.21	-89.97	20.31	62.76
4.95	-67.0	-2.00	-59.29	-91.78	20.66	64.27
5.00	-67.4	-2.01	-60.36	-93.66	21.02	65.75
5.05	-67.8	-2.02	-61.57	-95.47	21.42	67.33
5.10	-68.1	-2.03	-62.64	-97.29	21.78	68.90
5.16	-68.4	-2.04	-63.78	-98.97	22.18	70.60
5.21	-68.6	-2.05	-64.86	-100.85	22.56	72.33
5.26	-69.0	-2.06	-66.13	-102.79	22.95	74.11
5.31	-69.1	-2.07	-67.21	-104.67	23.34	75.90
5.36	-69.6	-2.08	-68.42	-106.69	23.78	77.85
5.41	-69.9	-2.09	-69.69	-108.77	24.21	79.90
5.46	-70.2	-2.11	-71.03	-110.92	24.64	81.96
5.51	-70.2	-2.12	-72.24	-112.93	25.07	84.09
5.56	-70.5	-2.12	-73.38	-115.15	25.51	86.33
5.61	-70.8	-2.14	-74.79	-117.43	26.01	88.64
5.66	-71.2	-2.15	-76.34	-119.85	26.54	91.40
5.71	-71.4	-2.16	-77.61	-122.60	27.05	94.50
5.76	-71.4	-2.17	-80.50	-122.93	27.54	117.95
5.81	-70.2	-2.18	-84.40	-127.57	39.77	160.67
5.86	-68.1	-2.19	-96.15	-123.74	60.97	220.61
5.91	-65.2	-2.20	-110.04	-119.85	86.35	281.60

Table F.10 IDT Strength Data (NU 52-34 #9)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	μm	μm	μm	μm
0.00	-0.4	-1.01	1.14	0.67	0.19	0.13
0.05	-0.7	-1.02	0.94	0.47	0.23	0.22
0.10	-1.3	-1.03	0.74	0.27	0.29	0.29
0.15	-1.8	-1.04	0.54	0.07	0.35	0.42
0.20	-2.5	-1.05	0.20	-0.20	0.44	0.54
0.25	-3.0	-1.06	-0.07	-0.34	0.52	0.67
0.30	-3.6	-1.06	-0.40	-0.60	0.59	0.79
0.35	-4.7	-1.08	-0.94	-1.14	0.70	0.97
0.40	-5.4	-1.09	-1.21	-1.34	0.81	1.16
0.45	-6.1	-1.10	-1.61	-1.68	0.90	1.33
0.50	-6.9	-1.11	-1.95	-2.01	1.02	1.53
0.55	-7.9	-1.12	-2.42	-2.55	1.16	1.78
0.60	-8.6	-1.13	-2.69	-2.95	1.26	2.00
0.65	-9.6	-1.14	-3.22	-3.56	1.39	2.20
0.70	-10.4	-1.15	-3.56	-3.96	1.53	2.42
0.75	-11.8	-1.16	-4.30	-4.50	1.69	2.74
0.80	-12.4	-1.17	-4.70	-4.90	1.80	2.97
0.85	-13.4	-1.18	-5.17	-5.37	1.95	3.24
0.90	-14.5	-1.19	-5.64	-6.04	2.11	3.52
0.95	-15.4	-1.20	-6.11	-6.51	2.24	3.78
1.00	-16.5	-1.21	-6.71	-6.98	2.40	4.10
1.05	-17.1	-1.22	-7.05	-7.59	2.54	4.33
1.10	-17.9	-1.23	-7.59	-7.99	2.69	4.58
1.15	-18.8	-1.25	-8.12	-8.53	2.83	4.87
1.20	-19.6	-1.26	-8.66	-9.00	2.99	5.14
1.25	-20.4	-1.26	-9.13	-9.60	3.14	5.40
1.30	-21.4	-1.27	-9.87	-10.34	3.26	5.66
1.35	-22.2	-1.29	-10.21	-10.68	3.45	5.99
1.40	-23.0	-1.30	-10.74	-11.21	3.58	6.26
1.45	-23.8	-1.31	-11.21	-11.75	3.76	6.55
1.50	-24.9	-1.32	-11.82	-12.29	3.94	6.92
1.55	-25.9	-1.33	-12.49	-12.96	4.11	7.25
1.60	-26.4	-1.34	-12.82	-13.29	4.28	7.52
1.65	-27.5	-1.35	-13.50	-14.10	4.44	7.82
1.70	-28.3	-1.36	-14.03	-14.70	4.62	8.14
1.75	-29.3	-1.37	-14.70	-15.38	4.80	8.51
1.80	-29.8	-1.38	-15.31	-15.85	4.95	8.80
1.85	-31.0	-1.39	-15.98	-16.58	5.16	9.15
1.90	-31.6	-1.40	-16.38	-16.99	5.35	9.52
1.95	-32.8	-1.41	-17.12	-17.93	5.55	9.85
2.00	-33.2	-1.42	-17.66	-18.26	5.69	10.12
2.05	-34.1	-1.43	-18.33	-18.93	5.88	10.47
2.10	-35.2	-1.44	-19.00	-19.67	6.12	10.91
2.15	-35.9	-1.45	-19.67	-20.21	6.28	11.26
2.20	-37.0	-1.46	-20.48	-21.15	6.49	11.62
2.25	-37.9	-1.47	-21.08	-21.75	6.71	12.07

Table F.10 IDT Strength Data (NU 52-34 #9), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
2.30	-38.7	-1.48	-21.75	-22.36	6.92	12.44
2.35	-39.6	-1.50	-22.49	-23.16	7.14	12.84
2.40	-40.3	-1.50	-23.10	-23.70	7.35	13.21
2.45	-41.2	-1.51	-23.83	-24.51	7.58	13.65
2.50	-42.0	-1.52	-24.64	-25.11	7.77	14.02
2.55	-42.7	-1.54	-25.31	-25.78	7.99	14.45
2.60	-43.5	-1.55	-25.85	-26.45	8.22	14.84
2.65	-44.1	-1.55	-26.65	-27.12	8.43	15.22
2.70	-45.0	-1.56	-27.33	-27.86	8.66	15.63
2.75	-45.9	-1.58	-28.06	-28.53	8.91	16.06
2.80	-46.4	-1.58	-28.80	-29.27	9.11	16.47
2.85	-47.4	-1.59	-29.68	-30.01	9.34	16.80
2.90	-48.2	-1.61	-30.41	-30.82	9.60	17.26
2.95	-49.1	-1.62	-31.22	-31.56	9.87	17.73
3.00	-49.7	-1.63	-31.96	-32.36	10.10	18.14
3.05	-50.4	-1.64	-32.70	-32.97	10.35	18.56
3.10	-51.2	-1.65	-33.50	-33.91	10.59	19.08
3.15	-51.6	-1.65	-34.11	-34.44	10.83	19.47
3.20	-52.4	-1.67	-35.05	-35.25	11.09	19.99
3.25	-53.2	-1.68	-35.92	-36.05	11.36	20.46
3.30	-54.1	-1.69	-36.79	-36.93	11.64	21.03
3.35	-54.5	-1.70	-37.53	-37.60	11.91	21.50
3.40	-55.1	-1.71	-38.34	-38.27	12.18	21.99
3.45	-55.9	-1.72	-39.28	-39.21	12.43	22.49
3.50	-56.7	-1.73	-40.15	-39.88	12.74	23.05
3.55	-57.6	-1.74	-41.02	-40.96	13.05	23.68
3.60	-58.0	-1.75	-41.90	-41.76	13.34	24.22
3.65	-58.6	-1.76	-42.84	-42.57	13.60	24.77
3.70	-59.3	-1.77	-43.57	-43.24	13.90	25.38
3.75	-59.9	-1.79	-44.51	-44.04	14.20	26.00
3.80	-60.3	-1.80	-45.52	-44.85	14.47	26.57
3.85	-60.9	-1.81	-46.39	-45.66	14.76	27.16
3.90	-61.3	-1.82	-47.20	-46.39	15.04	27.76
3.95	-62.2	-1.82	-48.14	-47.47	15.37	28.59
4.00	-62.7	-1.83	-49.21	-48.34	15.65	29.36
4.05	-63.2	-1.84	-50.15	-49.21	15.98	30.15
4.10	-63.8	-1.86	-51.16	-50.15	16.27	30.94
4.15	-64.1	-1.87	-52.03	-50.83	16.58	31.67
4.20	-64.6	-1.88	-53.04	-51.83	16.90	32.48
4.25	-65.2	-1.89	-54.05	-52.71	17.25	33.37
4.30	-65.6	-1.90	-55.06	-53.58	17.57	34.14
4.35	-66.3	-1.91	-56.06	-54.52	17.93	35.01
4.40	-66.9	-1.92	-57.14	-55.53	18.28	35.92
4.45	-67.5	-1.93	-58.21	-56.47	18.66	36.93
4.50	-68.0	-1.94	-59.49	-57.41	19.00	37.87

Table F.10 IDT Strength Data (NU 52-34 #9), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
4.55	-68.2	-1.95	-60.36	-58.35	19.35	38.81
4.60	-68.5	-1.97	-61.43	-59.22	19.70	39.81
4.65	-69.0	-1.97	-62.51	-60.23	20.08	40.89
4.70	-69.5	-1.98	-63.65	-61.17	20.49	42.03
4.75	-69.8	-1.99	-64.86	-62.24	20.86	43.21
4.80	-70.2	-2.00	-66.07	-63.31	21.23	44.41
4.85	-70.7	-2.01	-67.21	-64.25	21.65	45.77
4.90	-71.1	-2.02	-68.42	-65.40	22.06	47.13
4.95	-71.6	-2.03	-69.76	-66.47	22.48	48.58
5.00	-71.7	-2.04	-70.90	-67.41	22.87	50.34
5.05	-70.4	-2.06	-78.08	-74.39	21.91	136.01
5.10	-67.8	-2.07	-85.27	-93.06	32.11	220.83
5.16	-65.3	-2.09	-90.84	-108.37	48.50	278.77

Table F.11 IDT Strength Data (NU 58-40 #11)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
0.00	-0.1	-1.00	3.02	1.61	0.13	0.34
0.05	-0.3	-1.02	2.95	1.68	0.18	0.32
0.10	-0.5	-1.03	2.69	1.61	0.22	0.34
0.15	-0.8	-1.03	2.55	1.61	0.29	0.39
0.20	-1.4	-1.05	2.22	1.41	0.39	0.50
0.25	-1.8	-1.06	1.68	1.07	0.44	0.55
0.30	-2.4	-1.07	1.41	1.14	0.55	0.70
0.35	-3.0	-1.08	1.07	0.87	0.68	0.86
0.40	-3.6	-1.09	0.40	0.60	0.80	0.97
0.45	-4.4	-1.10	-0.07	0.27	0.93	1.14
0.50	-4.9	-1.11	-0.47	-0.13	1.06	1.34
0.55	-5.7	-1.12	-1.01	-0.54	1.19	1.58
0.60	-6.5	-1.13	-1.54	-0.94	1.34	1.80
0.65	-7.1	-1.14	-2.01	-1.48	1.50	2.00
0.70	-7.9	-1.15	-2.69	-1.88	1.66	2.28
0.75	-8.9	-1.16	-3.36	-2.55	1.83	2.57
0.80	-9.8	-1.17	-4.03	-3.16	2.02	2.87
0.85	-10.5	-1.18	-4.63	-3.63	2.18	3.17
0.90	-11.3	-1.19	-5.17	-4.03	2.38	3.49
0.95	-12.1	-1.20	-5.84	-4.83	2.55	3.81
1.00	-12.7	-1.21	-6.51	-5.37	2.72	4.08
1.05	-13.6	-1.22	-7.18	-6.04	2.94	4.46
1.10	-14.2	-1.23	-7.92	-6.51	3.11	4.73
1.15	-15.0	-1.25	-8.53	-7.18	3.32	5.07
1.20	-15.6	-1.26	-9.27	-7.79	3.51	5.39
1.25	-16.5	-1.27	-10.00	-8.46	3.73	5.76
1.30	-17.0	-1.28	-10.68	-9.06	3.91	6.09
1.35	-17.9	-1.29	-11.35	-9.60	4.14	6.48
1.40	-18.6	-1.30	-12.09	-10.27	4.36	6.85
1.45	-19.5	-1.31	-12.96	-11.08	4.59	7.27
1.50	-20.1	-1.32	-13.70	-11.82	4.81	7.64
1.55	-20.6	-1.33	-14.50	-12.49	4.99	7.96
1.60	-21.3	-1.33	-15.17	-13.23	5.21	8.36
1.65	-22.2	-1.35	-15.98	-13.90	5.48	8.85
1.70	-22.6	-1.36	-16.85	-14.50	5.68	9.20
1.75	-23.4	-1.37	-17.66	-15.38	5.93	9.63
1.80	-24.0	-1.38	-18.40	-16.05	6.15	10.05
1.85	-24.6	-1.39	-19.14	-16.72	6.38	10.52
1.90	-25.1	-1.40	-19.87	-17.39	6.60	10.88
1.95	-25.6	-1.41	-20.68	-17.99	6.83	11.36
2.00	-26.3	-1.42	-21.49	-18.93	7.07	11.78
2.05	-26.9	-1.43	-22.22	-19.74	7.32	12.25
2.10	-27.5	-1.44	-23.10	-20.55	7.54	12.71
2.15	-28.2	-1.45	-24.10	-21.28	7.81	13.21
2.20	-28.6	-1.46	-24.71	-22.09	8.05	13.63
2.25	-29.5	-1.47	-25.71	-22.96	8.33	14.20

Table F.11 IDT Strength Data (NU 58-40 #11), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	μm	μm	μm	μm
2.30	-30.2	-1.48	-26.59	-23.90	8.60	14.74
2.35	-30.9	-1.50	-27.53	-24.77	8.88	15.26
2.40	-31.3	-1.50	-28.47	-25.71	9.15	15.79
2.45	-32.0	-1.52	-29.41	-26.65	9.42	16.38
2.50	-32.3	-1.52	-30.21	-27.33	9.67	16.85
2.55	-32.9	-1.53	-31.22	-28.20	9.95	17.37
2.60	-33.7	-1.54	-32.23	-29.34	10.24	17.98
2.65	-34.1	-1.56	-33.10	-30.08	10.51	18.56
2.70	-34.9	-1.57	-34.11	-31.15	10.83	19.17
2.75	-35.3	-1.58	-35.18	-32.03	11.12	19.84
2.80	-36.0	-1.59	-36.12	-33.03	11.41	20.46
2.85	-36.5	-1.60	-37.13	-33.97	11.71	21.07
2.90	-36.6	-1.61	-38.07	-34.85	11.97	21.67
2.95	-37.3	-1.62	-38.94	-35.92	12.25	22.34
3.00	-38.0	-1.63	-40.02	-36.86	12.60	23.01
3.05	-38.5	-1.64	-41.22	-37.93	12.89	23.63
3.10	-38.9	-1.65	-42.10	-38.74	13.20	24.32
3.15	-39.3	-1.66	-43.17	-39.88	13.49	24.96
3.20	-39.9	-1.67	-44.18	-40.89	13.81	25.66
3.25	-40.5	-1.69	-45.45	-42.03	14.15	26.39
3.30	-41.0	-1.69	-46.39	-42.97	14.48	27.12
3.35	-41.4	-1.70	-47.47	-43.98	14.79	27.83
3.40	-41.9	-1.71	-48.68	-45.05	15.12	28.64
3.45	-42.3	-1.72	-49.75	-46.06	15.46	29.34
3.50	-42.7	-1.73	-50.89	-47.13	15.79	30.05
3.55	-43.1	-1.74	-51.97	-48.14	16.10	30.77
3.60	-43.6	-1.75	-53.11	-49.28	16.46	31.54
3.65	-43.9	-1.77	-54.12	-50.29	16.78	32.29
3.70	-44.4	-1.78	-55.32	-51.36	17.15	33.08
3.75	-45.0	-1.79	-56.60	-52.50	17.49	33.91
3.80	-45.2	-1.79	-57.54	-53.58	17.83	34.66
3.85	-45.9	-1.81	-58.95	-54.72	18.20	35.53
3.90	-46.4	-1.81	-60.36	-56.13	18.56	36.36
3.95	-46.6	-1.83	-61.43	-57.00	18.97	37.23
4.00	-46.8	-1.84	-62.44	-57.94	19.29	38.00
4.05	-47.4	-1.85	-63.72	-59.22	19.69	38.91
4.10	-47.7	-1.86	-64.99	-60.43	20.05	39.75
4.15	-48.2	-1.87	-66.27	-61.57	20.44	40.65
4.20	-48.5	-1.88	-67.41	-62.58	20.83	41.54
4.25	-49.1	-1.89	-68.75	-63.85	21.24	42.45
4.30	-49.4	-1.90	-70.09	-65.06	21.64	43.39
4.35	-49.9	-1.91	-71.44	-66.34	22.05	44.36
4.40	-50.2	-1.92	-72.85	-67.54	22.44	45.29
4.45	-50.5	-1.93	-73.99	-68.68	22.84	46.19
4.50	-51.2	-1.94	-75.40	-69.96	23.29	47.25

Table F.11 IDT Strength Data (NU 58-40 #11), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
4.55	-51.6	-1.95	-76.94	-71.30	23.73	48.27
4.60	-51.6	-1.96	-78.15	-72.44	24.13	49.26
4.65	-51.9	-1.97	-79.56	-73.65	24.52	50.22
4.70	-52.4	-1.98	-80.90	-74.86	24.98	51.28
4.75	-52.8	-2.00	-82.25	-76.14	25.42	52.34
4.80	-53.3	-2.01	-83.86	-77.61	25.88	53.46
4.85	-53.6	-2.02	-85.27	-78.82	26.34	54.52
4.90	-53.9	-2.02	-86.75	-80.03	26.79	55.64
4.95	-54.3	-2.04	-88.29	-81.31	27.27	56.77
5.00	-54.3	-2.05	-89.57	-82.45	27.70	57.81
5.05	-54.8	-2.06	-91.11	-83.72	28.17	59.00
5.10	-55.4	-2.07	-92.72	-85.40	28.69	60.21
5.16	-55.7	-2.08	-94.33	-86.68	29.18	61.40
5.21	-55.8	-2.09	-95.88	-87.95	29.65	62.51
5.26	-56.2	-2.10	-97.35	-89.30	30.15	63.75
5.31	-56.3	-2.11	-98.90	-90.57	30.62	64.93
5.36	-56.2	-2.12	-100.24	-91.65	31.09	66.03
5.41	-57.1	-2.13	-101.99	-93.26	31.64	67.34
5.46	-57.4	-2.14	-103.73	-94.67	32.17	68.65
5.51	-57.6	-2.15	-105.28	-96.08	32.70	69.98
5.56	-57.9	-2.16	-106.96	-97.42	33.23	71.29
5.61	-58.1	-2.18	-108.57	-98.83	33.77	72.60
5.66	-58.6	-2.18	-110.25	-100.38	34.33	74.02
5.71	-58.7	-2.19	-111.72	-101.45	34.88	75.37
5.76	-59.1	-2.20	-113.67	-103.20	35.43	76.73
5.81	-59.2	-2.21	-115.28	-104.40	35.98	78.14
5.86	-59.5	-2.23	-117.03	-105.95	36.54	79.53
5.91	-59.6	-2.23	-118.70	-107.29	37.09	80.95
5.96	-59.9	-2.24	-120.45	-108.84	37.66	82.38
6.01	-60.4	-2.25	-122.26	-110.31	38.30	83.99
6.06	-60.5	-2.27	-124.01	-111.72	38.88	85.50
6.11	-61.0	-2.28	-125.89	-113.40	39.50	87.06
6.16	-61.0	-2.29	-127.57	-114.61	40.10	88.64
6.21	-61.3	-2.30	-129.38	-116.22	40.72	90.24
6.26	-61.6	-2.31	-131.33	-117.76	41.35	91.88
6.31	-62.0	-2.32	-133.14	-119.38	42.02	93.63
6.36	-62.2	-2.33	-135.29	-121.05	42.65	95.27
6.41	-62.4	-2.34	-136.97	-122.46	43.30	97.07
6.46	-62.7	-2.35	-138.98	-124.21	43.97	98.95
6.51	-62.9	-2.36	-140.93	-125.82	44.66	100.85
6.56	-63.0	-2.37	-142.81	-127.30	45.30	102.69
6.61	-63.1	-2.38	-144.76	-128.84	45.97	104.55
6.66	-63.4	-2.39	-146.77	-130.59	46.69	106.49
6.71	-63.5	-2.41	-148.72	-132.20	47.38	108.48
6.76	-63.6	-2.41	-150.73	-133.81	48.06	110.40

Table F.11 IDT Strength Data (NU 58-40 #11), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
6.81	-63.9	-2.42	-152.75	-135.56	48.77	112.46
6.86	-63.8	-2.43	-154.63	-137.17	49.46	114.49
6.91	-63.9	-2.44	-156.57	-138.85	50.15	116.52
6.96	-64.2	-2.45	-158.65	-140.53	50.88	118.69
7.01	-64.4	-2.46	-160.80	-142.34	51.63	120.84
7.06	-64.4	-2.48	-162.82	-144.02	52.34	123.04
7.11	-64.6	-2.49	-164.76	-145.49	53.10	125.23
7.16	-65.0	-2.49	-166.91	-147.51	53.89	127.58
7.21	-65.1	-2.50	-169.06	-149.25	54.68	129.92
7.26	-65.4	-2.51	-171.34	-151.13	55.49	132.42
7.31	-65.7	-2.53	-173.63	-153.01	56.30	134.90
7.36	-65.6	-2.54	-175.71	-154.83	57.10	137.39
7.41	-65.9	-2.55	-177.99	-156.64	57.96	140.02
7.46	-66.1	-2.56	-180.27	-158.59	58.80	142.74
7.51	-66.3	-2.57	-182.56	-160.53	59.66	145.46
7.56	-66.3	-2.58	-184.84	-162.48	60.51	148.16
7.61	-66.5	-2.59	-187.12	-164.43	61.41	151.05
7.66	-66.4	-2.60	-189.27	-166.17	62.26	153.84
7.71	-66.4	-2.61	-191.69	-168.32	63.13	156.67
7.76	-66.7	-2.62	-194.04	-170.20	64.05	159.79
7.81	-66.8	-2.63	-196.32	-172.28	65.01	162.87
7.86	-66.9	-2.64	-198.74	-174.43	65.92	166.02
7.91	-66.9	-2.65	-201.15	-176.38	66.85	169.19
7.96	-67.2	-2.66	-203.64	-178.66	67.82	172.53
8.01	-67.3	-2.67	-206.05	-180.74	68.82	176.03
8.06	-67.3	-2.68	-208.54	-182.96	69.79	179.48
8.11	-67.4	-2.69	-210.89	-185.11	70.80	183.08
8.16	-67.5	-2.70	-213.51	-187.32	71.81	186.75
8.21	-67.5	-2.71	-216.06	-189.67	72.83	190.53
8.26	-67.6	-2.72	-218.68	-192.09	73.86	194.41
8.31	-67.8	-2.74	-221.23	-194.37	74.95	198.45
8.36	-67.8	-2.74	-223.78	-196.79	76.00	202.51
8.41	-68.0	-2.76	-226.60	-199.81	77.11	206.86
8.46	-68.0	-2.77	-229.29	-202.76	78.23	211.28
8.51	-68.0	-2.78	-231.90	-205.58	79.34	215.76
8.56	-68.1	-2.79	-234.66	-208.67	80.47	220.41
8.61	-67.8	-2.80	-237.34	-211.29	81.58	225.07
8.66	-68.0	-2.81	-240.30	-214.51	82.74	230.01
8.71	-68.2	-2.82	-242.98	-217.13	83.96	235.23
8.76	-68.1	-2.83	-245.80	-219.95	85.16	240.46
8.81	-68.1	-2.84	-248.62	-222.97	86.34	245.89
8.86	-68.0	-2.85	-251.58	-225.66	87.57	251.49
8.91	-68.1	-2.86	-254.60	-228.61	88.81	257.38
8.96	-68.3	-2.87	-257.62	-231.50	90.13	263.68
9.01	-68.2	-2.88	-260.64	-234.25	91.41	270.11

Table F.11 IDT Strength Data (NU 58-40 #11), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	μm	μm	μm	μm
9.06	-67.9	-2.89	-263.66	-237.21	92.65	276.59
9.11	-68.1	-2.90	-266.68	-239.69	94.01	283.59
9.16	-67.9	-2.91	-269.70	-242.24	95.31	290.77
9.21	-68.0	-2.93	-272.99	-245.20	96.67	298.37
9.26	-67.9	-2.94	-276.15	-247.88	98.04	306.36
9.31	-67.9	-2.94	-279.51	-250.70	99.42	314.79
9.36	-67.7	-2.96	-282.86	-253.39	100.84	323.74
9.41	-67.8	-2.97	-286.36	-256.07	102.26	333.39
9.46	-67.5	-2.98	-289.85	-258.69	103.65	343.73
9.51	-67.4	-2.99	-293.34	-261.04	105.02	355.02
9.56	-67.2	-3.00	-296.96	-262.92	106.36	367.53
9.61	-66.9	-3.01	-300.59	-264.53	107.64	381.17
9.66	-66.6	-3.02	-304.42	-266.15	108.89	396.21
9.71	-66.2	-3.03	-308.24	-267.56	110.08	412.60
9.76	-66.0	-3.05	-312.81	-269.64	111.28	430.29
9.81	-65.4	-3.06	-316.77	-271.58	112.40	448.82
9.86	-65.0	-3.06	-320.73	-273.80	113.52	468.51
9.91	-64.6	-3.07	-325.03	-276.35	114.66	489.59
9.96	-64.2	-3.09	-329.46	-278.97	115.80	511.85
10.01	-63.8	-3.09	-333.89	-282.06	116.99	535.33
10.06	-63.1	-3.11	-338.39	-285.42	118.18	559.69
10.11	-62.6	-3.11	-342.95	-288.71	119.44	584.83
10.16	-62.0	-3.12	-347.79	-291.53	120.79	611.13

Table F.12 IDT Strength Data (NU 58-40 #12)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
0.00	-0.1	-0.92	0.94	0.34	0.09	0.03
0.05	-0.1	-0.93	0.94	0.34	0.09	0.07
0.10	-0.2	-0.94	0.94	0.54	0.12	0.12
0.15	-0.4	-0.95	0.81	0.07	0.13	0.15
0.20	-0.7	-0.96	0.67	-0.13	0.16	0.25
0.25	-1.1	-0.98	0.60	-0.34	0.18	0.35
0.30	-1.7	-0.98	0.34	-0.60	0.27	0.57
0.35	-2.2	-0.99	0.07	-1.01	0.34	0.77
0.40	-2.5	-1.00	-0.27	-1.34	0.39	0.89
0.45	-3.2	-1.02	-0.40	-1.75	0.48	1.12
0.50	-3.7	-1.03	-0.67	-2.08	0.55	1.38
0.55	-4.3	-1.04	-1.07	-2.69	0.67	1.59
0.60	-4.9	-1.05	-1.34	-2.95	0.75	1.85
0.65	-5.8	-1.06	-1.68	-3.76	0.88	2.15
0.70	-6.5	-1.07	-2.22	-4.23	0.98	2.47
0.75	-7.2	-1.08	-2.55	-4.83	1.12	2.80
0.80	-7.9	-1.09	-3.09	-5.37	1.23	3.11
0.85	-8.4	-1.10	-3.42	-5.98	1.33	3.36
0.90	-9.1	-1.11	-3.83	-6.58	1.48	3.71
0.95	-9.9	-1.12	-4.36	-7.32	1.61	4.06
1.00	-10.7	-1.13	-4.83	-7.99	1.76	4.46
1.05	-11.4	-1.14	-5.44	-8.73	1.89	4.85
1.10	-12.0	-1.15	-5.91	-9.20	2.04	5.19
1.15	-12.7	-1.16	-6.38	-10.07	2.18	5.59
1.20	-13.3	-1.17	-6.85	-10.74	2.31	5.94
1.25	-14.0	-1.18	-7.39	-11.41	2.48	6.33
1.30	-14.6	-1.19	-7.86	-12.09	2.62	6.71
1.35	-15.1	-1.20	-8.33	-12.62	2.76	7.07
1.40	-15.9	-1.22	-9.06	-13.43	2.94	7.50
1.45	-16.5	-1.22	-9.47	-14.23	3.09	7.91
1.50	-17.1	-1.23	-10.00	-14.97	3.24	8.33
1.55	-17.8	-1.24	-10.54	-15.85	3.42	8.73
1.60	-18.6	-1.26	-11.35	-16.58	3.59	9.23
1.65	-19.3	-1.26	-11.75	-17.39	3.78	9.70
1.70	-19.7	-1.28	-12.42	-18.13	3.94	10.10
1.75	-20.4	-1.29	-13.03	-19.07	4.10	10.54
1.80	-21.1	-1.29	-13.70	-19.74	4.27	10.99
1.85	-21.7	-1.31	-14.23	-20.75	4.47	11.51
1.90	-22.3	-1.32	-14.84	-21.49	4.66	11.98
1.95	-22.9	-1.33	-15.44	-22.36	4.84	12.47
2.00	-23.4	-1.34	-16.05	-23.10	5.03	12.94
2.05	-24.1	-1.35	-16.72	-23.97	5.22	13.46
2.10	-24.5	-1.36	-17.32	-24.84	5.38	13.88
2.15	-25.1	-1.37	-18.13	-25.92	5.57	14.38
2.20	-25.9	-1.38	-18.73	-26.59	5.80	14.96
2.25	-26.4	-1.39	-19.54	-27.59	5.99	15.49

Table F.12 IDT Strength Data (NU 58-40 #12), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
2.30	-27.1	-1.40	-20.01	-28.53	6.21	16.03
2.35	-27.6	-1.41	-20.88	-29.41	6.42	16.53
2.40	-28.2	-1.42	-21.62	-30.41	6.61	17.07
2.45	-28.8	-1.43	-22.29	-31.35	6.84	17.62
2.50	-29.4	-1.44	-23.16	-32.43	7.06	18.20
2.55	-29.8	-1.45	-23.83	-33.17	7.25	18.68
2.60	-30.6	-1.46	-24.64	-34.44	7.50	19.35
2.65	-31.2	-1.48	-25.45	-35.38	7.73	19.94
2.70	-31.8	-1.49	-26.25	-36.39	7.96	20.56
2.75	-32.5	-1.50	-27.06	-37.46	8.20	21.18
2.80	-32.8	-1.51	-27.93	-38.54	8.42	21.75
2.85	-33.4	-1.51	-28.74	-39.48	8.66	22.39
2.90	-34.1	-1.53	-29.47	-40.49	8.90	23.05
2.95	-34.5	-1.54	-30.35	-41.69	9.15	23.63
3.00	-35.0	-1.55	-31.15	-42.70	9.39	24.27
3.05	-35.4	-1.56	-31.89	-43.71	9.63	24.86
3.10	-36.2	-1.57	-32.76	-44.98	9.91	25.56
3.15	-36.7	-1.58	-33.77	-46.06	10.15	26.22
3.20	-37.0	-1.59	-34.51	-47.00	10.38	26.79
3.25	-37.5	-1.60	-35.45	-48.27	10.63	27.46
3.30	-38.2	-1.61	-36.32	-49.42	10.90	28.15
3.35	-38.6	-1.62	-37.26	-50.49	11.17	28.85
3.40	-39.1	-1.63	-38.14	-51.63	11.46	29.51
3.45	-39.2	-1.64	-38.94	-52.64	11.68	30.10
3.50	-40.2	-1.65	-40.15	-53.98	11.98	30.90
3.55	-40.4	-1.66	-40.89	-55.06	12.24	31.57
3.60	-40.9	-1.67	-41.90	-56.20	12.53	32.28
3.65	-41.6	-1.68	-42.77	-57.54	12.81	33.03
3.70	-41.9	-1.69	-43.78	-58.68	13.07	33.70
3.75	-42.3	-1.70	-44.78	-59.89	13.37	34.48
3.80	-42.9	-1.71	-45.72	-61.10	13.65	35.22
3.85	-43.4	-1.72	-46.73	-62.44	13.95	35.95
3.90	-43.6	-1.73	-47.67	-63.52	14.23	36.64
3.95	-44.0	-1.75	-48.68	-64.66	14.52	37.40
4.00	-44.5	-1.76	-49.82	-66.07	14.82	38.19
4.05	-45.1	-1.77	-51.03	-67.48	15.12	38.96
4.10	-45.0	-1.78	-51.77	-68.35	15.38	39.60
4.15	-45.5	-1.79	-52.77	-69.49	15.69	40.33
4.20	-46.0	-1.80	-53.65	-70.83	16.00	41.16
4.25	-46.4	-1.81	-54.92	-72.11	16.31	41.96
4.30	-46.8	-1.81	-55.86	-73.38	16.62	42.75
4.35	-47.3	-1.83	-56.94	-74.73	16.95	43.57
4.40	-47.8	-1.84	-58.21	-76.34	17.25	44.40
4.45	-48.5	-1.85	-59.22	-77.55	17.62	45.35
4.50	-48.6	-1.85	-60.29	-78.82	17.93	46.14

Table F.12 IDT Strength Data (NU 58-40 #12), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
4.55	-49.3	-1.87	-61.57	-80.30	18.29	47.07
4.60	-49.5	-1.88	-62.58	-81.64	18.63	47.92
4.65	-50.0	-1.89	-63.78	-83.19	18.98	48.81
4.70	-50.5	-1.90	-65.06	-84.66	19.34	49.77
4.75	-50.7	-1.91	-66.20	-85.81	19.68	50.59
4.80	-51.0	-1.92	-67.28	-87.15	20.03	51.48
4.85	-51.1	-1.93	-68.35	-88.36	20.36	52.27
4.90	-51.8	-1.94	-69.56	-90.10	20.74	53.23
4.95	-52.2	-1.95	-70.90	-91.51	21.11	54.20
5.00	-52.5	-1.96	-71.97	-92.79	21.47	55.07
5.05	-52.9	-1.97	-73.18	-94.33	21.85	56.10
5.10	-53.4	-1.98	-74.39	-95.81	22.23	57.02
5.16	-53.5	-1.99	-75.73	-97.22	22.58	57.93
5.21	-53.9	-2.00	-76.88	-98.70	22.98	58.88
5.26	-54.2	-2.01	-78.08	-100.11	23.36	59.86
5.31	-54.7	-2.03	-79.29	-101.65	23.77	60.90
5.36	-54.9	-2.03	-80.50	-102.99	24.15	61.82
5.41	-55.0	-2.04	-81.71	-104.40	24.51	62.74
5.46	-55.3	-2.06	-82.85	-105.81	24.92	63.70
5.51	-55.8	-2.07	-84.33	-107.56	25.33	64.76
5.56	-56.0	-2.08	-85.47	-108.90	25.74	65.76
5.61	-56.3	-2.09	-86.68	-110.31	26.14	66.75
5.66	-56.7	-2.09	-87.95	-111.92	26.57	67.80
5.71	-57.1	-2.11	-89.36	-113.53	27.00	68.87
5.76	-57.6	-2.12	-90.71	-115.28	27.45	70.01
5.81	-57.7	-2.13	-91.98	-116.69	27.86	71.02
5.86	-58.1	-2.14	-93.39	-118.44	28.30	72.09
5.91	-58.1	-2.15	-94.53	-119.78	28.73	73.15
5.96	-58.4	-2.16	-95.81	-121.39	29.18	74.22
6.01	-58.9	-2.17	-97.15	-123.00	29.63	75.35
6.06	-59.0	-2.18	-98.43	-124.55	30.08	76.46
6.11	-59.2	-2.19	-99.84	-126.16	30.52	77.56
6.16	-59.2	-2.20	-101.18	-127.50	30.97	78.55
6.21	-59.4	-2.21	-102.52	-129.04	31.42	79.61
6.26	-60.0	-2.22	-104.07	-130.79	31.90	80.79
6.31	-60.1	-2.23	-105.28	-132.33	32.37	82.00
6.36	-60.4	-2.24	-106.82	-133.95	32.84	83.10
6.41	-60.7	-2.26	-108.16	-135.62	33.34	84.31
6.46	-61.1	-2.27	-109.84	-137.30	33.85	85.55
6.51	-61.3	-2.27	-111.25	-138.98	34.35	86.76
6.56	-61.8	-2.28	-112.73	-140.79	34.85	88.02
6.61	-62.0	-2.30	-114.27	-142.47	35.39	89.31
6.66	-61.9	-2.31	-115.75	-144.08	35.87	90.46
6.71	-62.1	-2.32	-117.23	-145.76	36.39	91.65
6.76	-62.5	-2.33	-118.77	-147.37	36.92	92.94

Table F.12 IDT Strength Data (NU 58-40 #12), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
6.81	-63.0	-2.34	-120.52	-149.25	37.47	94.37
6.86	-63.2	-2.35	-121.99	-150.93	38.03	95.68
6.91	-63.4	-2.36	-123.67	-152.81	38.58	97.00
6.96	-63.6	-2.37	-125.28	-154.56	39.13	98.33
7.01	-63.9	-2.38	-126.96	-156.30	39.71	99.74
7.06	-63.9	-2.39	-128.44	-157.98	40.26	101.03
7.11	-64.1	-2.40	-129.98	-159.79	40.85	102.42
7.16	-64.0	-2.41	-131.60	-161.54	41.39	103.68
7.21	-64.3	-2.42	-133.21	-163.35	41.99	105.09
7.26	-64.7	-2.43	-134.95	-165.17	42.59	106.57
7.31	-65.0	-2.44	-136.63	-166.98	43.22	108.06
7.36	-65.2	-2.45	-138.44	-168.93	43.83	109.49
7.41	-65.3	-2.46	-140.19	-170.87	44.45	110.98
7.46	-65.3	-2.47	-141.80	-172.55	45.06	112.44
7.51	-65.5	-2.48	-143.48	-174.36	45.69	113.95
7.56	-65.8	-2.50	-145.29	-176.24	46.34	115.50
7.61	-65.9	-2.50	-147.04	-178.19	47.01	117.04
7.66	-66.0	-2.51	-148.85	-180.47	47.67	118.62
7.71	-66.3	-2.53	-150.60	-182.22	48.36	120.22
7.76	-66.4	-2.54	-152.41	-184.23	49.02	121.83
7.81	-66.5	-2.55	-154.16	-186.11	49.70	123.46
7.86	-66.7	-2.56	-155.90	-188.13	50.41	125.10
7.91	-67.0	-2.57	-157.71	-190.28	51.13	126.83
7.96	-67.2	-2.58	-159.66	-192.49	51.87	128.54
8.01	-67.3	-2.59	-161.54	-194.57	52.64	130.30
8.06	-67.4	-2.60	-163.35	-196.79	53.39	132.07
8.11	-67.3	-2.61	-165.23	-198.80	54.14	133.78
8.16	-67.4	-2.62	-167.05	-200.89	54.91	135.46
8.21	-67.5	-2.63	-168.99	-202.97	55.70	137.27
8.26	-67.9	-2.64	-170.94	-205.32	56.53	139.15
8.31	-68.0	-2.65	-172.95	-207.80	57.38	141.05
8.36	-68.2	-2.66	-175.10	-210.15	58.19	142.93
8.41	-68.4	-2.67	-177.12	-212.30	59.09	144.96
8.46	-68.6	-2.68	-179.20	-214.65	60.00	146.95
8.51	-68.8	-2.69	-181.35	-217.07	60.92	149.05
8.56	-68.8	-2.70	-183.36	-219.35	61.85	151.05
8.61	-69.0	-2.71	-185.44	-221.63	62.78	153.13
8.66	-69.0	-2.73	-187.66	-223.98	63.76	155.28
8.71	-69.0	-2.74	-189.74	-226.33	64.74	157.33
8.76	-69.0	-2.75	-191.89	-228.75	65.75	159.49
8.81	-69.1	-2.76	-194.04	-231.03	66.77	161.66
8.86	-69.3	-2.77	-196.39	-233.65	67.84	163.92
8.91	-69.3	-2.77	-198.54	-236.13	68.89	166.11
8.96	-69.4	-2.79	-200.55	-238.55	70.04	168.46
9.01	-69.5	-2.80	-202.70	-240.90	71.16	170.79

Table F.12 IDT Strength Data (NU 58-40 #12), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
9.06	-69.6	-2.81	-204.91	-243.52	72.34	173.27
9.11	-69.6	-2.82	-207.06	-245.87	73.53	175.64
9.16	-69.6	-2.83	-209.21	-248.42	74.74	178.07
9.21	-69.8	-2.84	-211.29	-251.04	75.99	180.59
9.26	-69.8	-2.85	-213.37	-253.59	77.28	183.16
9.31	-70.0	-2.86	-215.32	-256.41	78.63	185.86
9.36	-69.9	-2.87	-217.54	-258.83	79.96	188.46
9.41	-70.1	-2.88	-219.82	-261.85	81.36	191.28
9.46	-70.1	-2.89	-222.37	-264.74	82.80	194.10
9.51	-70.2	-2.90	-224.85	-267.29	84.30	197.04
9.56	-70.1	-2.91	-227.20	-269.91	85.83	199.93
9.61	-70.1	-2.92	-229.89	-272.73	87.40	202.90
9.66	-70.0	-2.93	-232.44	-275.41	89.03	205.92
9.71	-70.1	-2.94	-235.13	-278.37	90.70	209.03
9.76	-70.3	-2.96	-237.68	-281.12	92.47	212.23
9.81	-70.2	-2.96	-240.43	-284.01	94.32	215.56
9.86	-70.3	-2.97	-243.12	-287.03	96.20	218.85
9.91	-70.2	-2.99	-245.87	-289.78	98.16	222.27
9.96	-70.2	-3.00	-248.62	-292.40	100.22	225.79
10.01	-70.0	-3.01	-251.51	-295.28	102.31	229.25
10.06	-70.0	-3.02	-254.13	-298.24	104.53	232.84
10.11	-70.0	-3.02	-257.08	-301.33	106.86	236.54
10.16	-70.2	-3.04	-259.90	-304.68	109.37	240.50
10.21	-69.9	-3.05	-262.79	-307.71	111.93	244.31
10.26	-70.0	-3.07	-265.61	-310.93	114.71	248.42
10.31	-69.9	-3.07	-268.50	-314.15	117.62	252.52
10.36	-69.9	-3.08	-271.45	-317.51	120.74	256.75
10.41	-69.7	-3.09	-274.14	-320.60	124.04	260.99
10.46	-69.7	-3.10	-276.89	-323.89	127.68	265.49
10.51	-69.6	-3.11	-279.64	-327.38	131.64	270.04
10.56	-69.3	-3.12	-282.13	-330.74	135.87	274.49
10.61	-69.3	-3.13	-284.54	-334.36	140.61	279.34
10.66	-69.1	-3.14	-286.09	-337.92	145.75	284.11
10.71	-68.7	-3.16	-287.83	-341.95	151.28	288.92
10.76	-68.7	-3.17	-288.91	-345.51	157.28	293.96
10.81	-68.4	-3.18	-280.04	-349.47	163.70	299.06
10.86	-68.1	-3.19	-281.66	-353.63	170.52	304.25
10.91	-67.9	-3.20	-283.54	-357.66	177.76	309.60
10.96	-67.4	-3.21	-285.28	-361.82	185.36	314.92
11.01	-67.0	-3.22	-287.43	-366.05	193.43	320.43
11.06	-66.8	-3.23	-289.51	-370.55	202.04	326.25
11.11	-66.4	-3.24	-291.93	-375.12	211.12	332.13
11.16	-66.1	-3.25	-294.75	-379.82	219.64	338.47
11.21	-65.6	-3.26	-297.97	-384.92	219.64	344.82
11.26	-64.9	-3.27	-301.86	-389.89	219.64	351.30
11.31	-64.6	-3.28	-305.29	-395.26	219.64	358.28
11.36	-63.9	-3.29	-310.12	-400.43	219.64	365.36
11.41	-63.5	-3.30	-319.46	-405.93	219.64	373.03

Table F.13 IDT Strength Data (NU 58-40 #9)

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
0.00	-0.1	-0.56	1.07	0.81	0.08	-0.02
0.05	-0.3	-0.58	0.94	0.60	0.13	0.02
0.10	-0.7	-0.59	0.74	0.60	0.19	0.10
0.15	-1.1	-0.60	0.47	0.40	0.25	0.22
0.20	-1.6	-0.61	0.20	0.13	0.34	0.34
0.25	-2.0	-0.62	-0.07	-0.20	0.43	0.49
0.30	-2.6	-0.63	-0.34	-0.47	0.51	0.74
0.35	-3.2	-0.64	-0.81	-1.01	0.62	0.97
0.40	-4.0	-0.65	-1.14	-1.48	0.77	1.28
0.45	-4.8	-0.66	-1.61	-2.15	0.91	1.61
0.50	-5.5	-0.67	-1.88	-2.69	1.05	1.95
0.55	-6.2	-0.68	-2.42	-3.29	1.20	2.25
0.60	-6.8	-0.69	-2.95	-4.23	1.32	2.55
0.65	-7.7	-0.70	-3.36	-4.70	1.53	3.00
0.70	-8.5	-0.71	-3.63	-5.24	1.72	3.44
0.75	-9.0	-0.72	-4.30	-6.31	1.82	3.71
0.80	-9.9	-0.73	-4.83	-7.05	2.03	4.25
0.85	-10.6	-0.74	-5.17	-7.59	2.24	4.70
0.90	-11.2	-0.75	-5.71	-8.39	2.39	5.04
0.95	-12.1	-0.76	-6.38	-9.33	2.61	5.51
1.00	-12.7	-0.77	-6.78	-10.07	2.80	5.98
1.05	-13.4	-0.78	-7.25	-10.81	3.00	6.46
1.10	-14.0	-0.79	-7.92	-11.68	3.20	6.93
1.15	-14.8	-0.80	-8.39	-12.56	3.42	7.39
1.20	-15.4	-0.82	-8.93	-13.43	3.62	7.89
1.25	-16.0	-0.83	-9.47	-14.23	3.83	8.31
1.30	-16.7	-0.83	-10.07	-15.11	4.06	8.85
1.35	-17.3	-0.85	-10.47	-15.98	4.28	9.40
1.40	-18.0	-0.86	-11.28	-16.92	4.51	9.87
1.45	-18.8	-0.87	-11.82	-17.86	4.74	10.46
1.50	-19.4	-0.88	-12.56	-18.73	4.97	11.01
1.55	-20.3	-0.89	-13.03	-19.81	5.26	11.63
1.60	-20.8	-0.90	-13.76	-20.75	5.51	12.22
1.65	-21.5	-0.91	-14.23	-21.69	5.77	12.79
1.70	-22.2	-0.92	-15.04	-22.69	6.03	13.38
1.75	-22.7	-0.93	-15.64	-23.83	6.28	14.00
1.80	-23.3	-0.94	-16.32	-24.71	6.54	14.55
1.85	-24.0	-0.95	-16.99	-25.78	6.81	15.22
1.90	-24.7	-0.96	-17.59	-26.86	7.10	15.88
1.95	-25.1	-0.97	-18.26	-27.93	7.36	16.45
2.00	-25.9	-0.98	-19.00	-29.14	7.65	17.14
2.05	-26.9	-0.99	-19.87	-30.41	7.98	17.93
2.10	-27.2	-1.00	-20.55	-31.49	8.28	18.58
2.15	-27.5	-1.01	-21.02	-32.36	8.52	19.12
2.20	-28.4	-1.02	-21.89	-33.64	8.85	19.94
2.25	-28.8	-1.04	-22.49	-34.71	9.16	20.60

Table F.13 IDT Strength Data (NU 58-40 #9), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
2.30	-29.5	-1.04	-23.36	-35.85	9.48	21.33
2.35	-30.0	-1.05	-24.04	-37.06	9.77	22.07
2.40	-30.8	-1.06	-24.71	-38.34	10.12	22.84
2.45	-31.4	-1.08	-25.65	-39.61	10.47	23.63
2.50	-31.8	-1.09	-26.25	-40.82	10.78	24.41
2.55	-32.5	-1.10	-27.06	-42.03	11.12	25.18
2.60	-33.0	-1.11	-27.80	-43.17	11.46	25.93
2.65	-33.6	-1.12	-28.74	-44.58	11.82	26.74
2.70	-34.4	-1.12	-29.61	-45.86	12.21	27.66
2.75	-34.9	-1.14	-30.41	-47.27	12.57	28.43
2.80	-35.4	-1.15	-31.22	-48.54	12.96	29.29
2.85	-36.0	-1.16	-32.03	-49.89	13.33	30.20
2.90	-36.6	-1.17	-32.97	-51.30	13.72	31.10
2.95	-37.1	-1.18	-33.70	-52.50	14.12	31.99
3.00	-37.6	-1.19	-34.58	-54.05	14.51	32.87
3.05	-38.1	-1.20	-35.45	-55.32	14.92	33.81
3.10	-38.8	-1.21	-36.39	-56.73	15.33	34.76
3.15	-39.5	-1.22	-37.33	-58.35	15.79	35.80
3.20	-39.7	-1.23	-38.14	-59.55	16.18	36.68
3.25	-40.3	-1.24	-39.08	-61.10	16.61	37.63
3.30	-40.8	-1.25	-39.95	-62.51	17.05	38.66
3.35	-41.3	-1.26	-40.82	-63.92	17.50	39.65
3.40	-41.9	-1.27	-41.69	-65.46	17.94	40.72
3.45	-42.6	-1.28	-42.77	-66.94	18.45	41.85
3.50	-42.8	-1.29	-43.64	-68.42	18.90	42.84
3.55	-43.5	-1.30	-44.65	-69.96	19.38	43.93
3.60	-43.8	-1.31	-45.52	-71.44	19.83	44.97
3.65	-44.4	-1.32	-46.66	-72.98	20.33	46.11
3.70	-45.0	-1.34	-47.67	-74.59	20.86	47.28
3.75	-45.2	-1.35	-48.54	-76.07	21.33	48.36
3.80	-45.6	-1.35	-49.55	-77.55	21.81	49.45
3.85	-46.1	-1.36	-50.49	-79.09	22.32	50.64
3.90	-46.5	-1.38	-51.50	-80.77	22.85	51.78
3.95	-46.9	-1.38	-52.57	-82.31	23.36	52.96
4.00	-47.5	-1.40	-53.58	-83.86	23.89	54.18
4.05	-48.0	-1.41	-54.59	-85.47	24.45	55.42
4.10	-48.2	-1.42	-55.53	-86.88	24.96	56.57
4.15	-48.7	-1.43	-56.67	-88.42	25.51	57.84
4.20	-49.1	-1.44	-57.67	-90.17	26.09	59.10
4.25	-49.2	-1.45	-58.61	-91.58	26.61	60.29
4.30	-49.7	-1.46	-59.69	-93.19	27.18	61.57
4.35	-50.2	-1.47	-60.76	-94.80	27.76	62.93
4.40	-50.6	-1.48	-61.84	-96.55	28.35	64.22
4.45	-51.2	-1.49	-63.05	-98.23	28.99	65.66
4.50	-51.5	-1.50	-64.12	-99.91	29.58	67.02

Table F.13 IDT Strength Data (NU 58-40 #9), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
4.55	-51.8	-1.52	-65.26	-101.45	30.17	68.37
4.60	-52.2	-1.53	-66.34	-103.20	30.81	69.78
4.65	-52.4	-1.53	-67.41	-104.74	31.41	71.15
4.70	-52.7	-1.55	-68.55	-106.28	32.02	72.53
4.75	-53.2	-1.55	-69.49	-107.90	32.65	74.01
4.80	-53.7	-1.57	-70.90	-109.78	33.33	75.57
4.85	-54.1	-1.58	-72.11	-111.52	34.02	77.09
4.90	-54.6	-1.58	-73.25	-113.33	34.68	78.66
4.95	-54.9	-1.60	-74.46	-115.01	35.36	80.20
5.00	-55.1	-1.61	-75.67	-116.76	36.06	81.79
5.05	-55.5	-1.62	-76.88	-118.57	36.76	83.42
5.10	-55.8	-1.62	-78.02	-120.25	37.46	85.05
5.16	-56.0	-1.64	-79.23	-121.99	38.17	86.65
5.21	-56.1	-1.65	-80.37	-123.61	38.86	88.21
5.26	-56.4	-1.66	-81.58	-125.28	39.54	89.80
5.31	-56.8	-1.67	-82.78	-127.10	40.29	91.53
5.36	-57.2	-1.68	-84.13	-128.84	41.06	93.29
5.41	-57.5	-1.69	-85.27	-130.72	41.80	95.02
5.46	-57.7	-1.70	-86.48	-132.40	42.57	96.78
5.51	-58.3	-1.71	-87.89	-134.42	43.36	98.70
5.56	-58.4	-1.72	-89.10	-136.23	44.13	100.48
5.61	-58.6	-1.73	-90.37	-138.04	44.93	102.32
5.66	-58.7	-1.74	-91.58	-139.65	45.71	104.12
5.71	-58.8	-1.75	-92.86	-141.40	46.49	105.91
5.76	-59.2	-1.76	-94.13	-143.35	47.31	107.83
5.81	-59.7	-1.77	-95.54	-145.36	48.16	109.83
5.86	-60.0	-1.79	-96.88	-147.17	49.02	111.82
5.91	-60.1	-1.79	-98.16	-148.92	49.85	113.80
5.96	-60.0	-1.80	-99.30	-150.53	50.66	115.65
6.01	-60.2	-1.82	-100.58	-152.28	51.50	117.65
6.06	-60.5	-1.82	-101.99	-154.29	52.39	119.71
6.11	-60.9	-1.83	-103.13	-155.97	53.30	121.88
6.16	-61.3	-1.85	-104.81	-158.38	54.22	124.06
6.21	-61.4	-1.86	-106.22	-160.13	55.10	126.16
6.26	-61.5	-1.87	-107.43	-161.94	56.05	128.37
6.31	-61.6	-1.88	-108.70	-163.62	57.00	130.54
6.36	-61.8	-1.89	-110.11	-165.70	57.93	132.72
6.41	-61.9	-1.90	-111.52	-167.52	58.86	134.90
6.46	-62.5	-1.91	-113.00	-169.73	59.90	137.40
6.51	-62.5	-1.92	-114.21	-171.41	60.89	139.69
6.56	-62.9	-1.93	-115.68	-173.49	61.92	142.15
6.61	-63.1	-1.94	-117.29	-175.77	62.97	144.67
6.66	-63.3	-1.95	-118.64	-177.52	64.01	147.17
6.71	-63.4	-1.96	-120.05	-179.53	65.08	149.72
6.76	-63.4	-1.97	-121.26	-181.21	66.14	152.29

Table F.13 IDT Strength Data (NU 58-40 #9), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	µm	µm	µm	µm
6.81	-63.6	-1.98	-122.80	-183.29	67.19	154.84
6.86	-63.7	-2.00	-124.21	-185.24	68.27	157.41
6.91	-64.1	-2.00	-125.75	-187.32	69.42	160.21
6.96	-64.4	-2.02	-127.30	-189.47	70.58	163.07
7.01	-64.4	-2.03	-128.78	-191.49	71.76	165.90
7.06	-64.4	-2.04	-130.12	-193.43	72.89	168.67
7.11	-64.7	-2.04	-131.73	-195.58	74.09	171.66
7.16	-64.8	-2.06	-133.34	-197.66	75.31	174.65
7.21	-64.9	-2.06	-134.68	-199.54	76.51	177.62
7.26	-65.2	-2.08	-136.36	-201.69	77.77	180.74
7.31	-65.1	-2.09	-137.77	-203.77	79.00	183.80
7.36	-65.1	-2.10	-139.25	-205.72	80.27	186.97
7.41	-65.4	-2.10	-140.86	-207.80	81.57	190.24
7.46	-65.4	-2.12	-142.34	-209.88	82.87	193.55
7.51	-65.6	-2.13	-143.95	-212.10	84.23	196.99
7.56	-65.6	-2.14	-145.49	-214.18	85.57	200.38
7.61	-66.0	-2.15	-147.11	-216.33	87.01	204.07
7.66	-65.9	-2.16	-148.65	-218.41	88.39	207.65
7.71	-66.2	-2.17	-150.33	-220.76	89.89	211.53
7.76	-66.1	-2.18	-151.87	-222.77	91.36	215.29
7.81	-66.2	-2.19	-153.48	-224.99	92.86	219.18
7.86	-66.2	-2.20	-155.16	-227.20	94.38	223.14
7.91	-66.2	-2.21	-156.64	-229.15	95.89	227.12
7.96	-66.4	-2.22	-158.32	-231.37	97.48	231.32
8.01	-66.4	-2.23	-159.86	-233.52	99.07	235.58
8.06	-66.4	-2.24	-161.47	-235.80	100.73	239.98
8.11	-66.4	-2.25	-163.15	-238.15	102.38	244.43
8.16	-66.4	-2.26	-164.83	-240.23	104.08	249.04
8.21	-66.6	-2.28	-166.58	-242.51	105.84	253.84
8.26	-66.7	-2.29	-168.25	-244.80	107.63	258.81
8.31	-66.8	-2.30	-170.00	-247.08	109.48	263.95
8.36	-66.7	-2.31	-171.75	-249.29	111.32	269.08
8.41	-66.6	-2.32	-173.36	-251.51	113.20	274.34
8.46	-66.8	-2.33	-175.17	-253.79	115.17	279.93
8.51	-66.6	-2.34	-176.92	-256.01	117.14	285.55
8.56	-66.6	-2.35	-178.66	-258.36	119.19	291.36
8.61	-66.6	-2.36	-180.41	-260.57	121.29	297.42
8.66	-66.6	-2.37	-182.29	-263.06	123.45	303.64
8.71	-66.3	-2.38	-183.90	-264.74	125.62	309.97
8.76	-66.2	-2.39	-185.71	-267.22	127.84	316.42
8.81	-66.4	-2.40	-187.59	-269.64	130.22	323.35
8.86	-66.4	-2.41	-189.40	-271.85	132.71	330.60
8.91	-66.2	-2.42	-191.49	-274.14	135.19	337.97
8.96	-66.1	-2.43	-193.16	-276.35	137.77	345.66
9.01	-66.1	-2.44	-195.18	-278.50	140.48	353.73

Table F.13 IDT Strength Data (NU 58-40 #9), continued

Time	Axial Force	Axial Displ.	Vert front	Vert back	Horz front	Horz back
Sec	kN	mm	μm	μm	μm	μm
9.06	-66.0	-2.46	-196.92	-280.78	143.30	362.12
9.11	-65.7	-2.47	-198.80	-282.86	146.17	370.80
9.16	-65.6	-2.47	-200.82	-285.01	149.17	379.78
9.21	-65.7	-2.49	-202.90	-287.16	152.43	389.68
9.26	-65.5	-2.49	-204.85	-289.18	155.75	399.87
9.31	-65.3	-2.51	-206.93	-291.32	159.20	410.62
9.36	-65.0	-2.52	-208.87	-293.14	162.82	421.90
9.41	-64.8	-2.53	-210.96	-294.88	166.61	433.83
9.46	-64.5	-2.54	-213.17	-296.49	170.59	446.49
9.51	-64.2	-2.55	-215.25	-297.90	174.79	459.90
9.56	-63.9	-2.56	-217.47	-299.25	179.20	474.20
9.61	-63.5	-2.57	-219.68	-300.39	183.86	489.49
9.66	-63.0	-2.58	-221.77	-301.39	188.75	505.84
9.71	-62.7	-2.59	-224.18	-302.47	194.03	523.71
9.76	-62.1	-2.60	-226.40	-303.21	199.62	542.90
9.81	-61.5	-2.61	-228.61	-304.21	205.52	563.08
9.86	-61.0	-2.62	-230.96	-305.02	211.99	585.01
9.91	-60.3	-2.64	-233.18	-306.16	218.75	608.43
9.96	-59.6	-2.64	-235.26	-306.97	226.04	632.90